SECTION 1 – REQUIREMENTS

1 *GENERAL*

1.1 JAR–25 is based on Part 25 of the Federal Aviation Regulations and is termed 'Joint Aviation Requirements for Large Aeroplanes' or 'JAR–25'. JAR–25 does not contain requirements for reciprocating engined aeroplanes, seaplanes, skiplanes or credit for standby power (e.g. rockets).

1.2 There are, however, a number of areas in which variations and additions to FAR Part 25 have been considered necessary in order to reach agreement to a code acceptable to the participating countries, and these differences (Complementary Technical Conditions) are indicated in this Section 1 by underlining. Where an FAR Part 25 regulation is not required for JAR–25, this is so stated. (See paragraph 2.3.)

2 *PRESENTATION*

2.1 The requirements of JAR–25 are presented in two columns on loose pages, each page being identified by the date of issue or the Change number under which it is amended or reissued.

2.2 In general, the JAR paragraphs carry the same number as the corresponding FAR Section. In cases where new JAR material is introduced on a subject already dealt with in FAR, this is included within the numbering system of the relevant FAR Section. In cases where new JAR material is introduced, and there is no corresponding section in FAR, a number is chosen for it which attempts to place the new material in the right context within the FAR numbering system; in such cases, the number is prefaced by the letter 'X' (e.g. JAR 25X799) to indicate that it is a European number rather than one corresponding to an FAR number.

2.3 Explanatory notes not forming part of the JAR text appear in an italic typeface. These are used, for example, to show where FAR text has not been accepted for JAR. Also, sub-headings are in italic typeface.

2.4 New, amended and corrected text is enclosed within heavy brackets.

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SUBPART A – GENERAL

JAR 25.1 Applicability

(a) This Code prescribes airworthiness standards for the issue of type certificates, and changes to those certificates, for Large Turbine-powered Aeroplanes.

(b) Each person who applies for such a certificate or change must show compliance with the applicable requirements in this Code.

JAR 25.2 Special retroactive requirements

(None applicable for JAR–25.)

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SUBPART B – FLIGHT

GENERAL

JAR 25X20 Applicability

(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 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.

[Ch.13, 05.10.89]

JAR 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

JAR 25.21(d) (continued)

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 JAR 25.671 and 25.672.

(f) In meeting the requirements of JAR 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.

[Ch.14, 27.05.94; Amdt. 16, 01.05.03]

JAR 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.

JAR 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.

JAR 25.25(a) (continued)

[(3) The highest weight at which compliance is shown with the certification requirements of JAR-36. **]**

(b) Minimum weight. The minimum weight (the lowest weight at which compliance with each applicable requirement of this JAR–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 JAR–25 is shown); or

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

[Amdt. 16, 01.05.03]

JAR 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.

JAR 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 JAR 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.

JAR 25.29 (continued)

(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.

[Ch.14, 27.05.94]

JAR 25.31 Removable ballast

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

JAR 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 JAR 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.

[Ch.12, 10.05.88; Ch.13, 05.10.89; Ch.14, 27.05.94]

PERFORMANCE

JAR 25.101 General
(See ACJ 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:

JAR 25.101(b) (continued)

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

(2) 34%, at and above standard temperatures plus 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 **[** ACJ No. 1 and No. 2 to JAR 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 JAR 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 ACJ 25.101(h)(3).)

(i) The accelerate-stop and landing distances prescribed in JAR 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 ACJ 25.101(i).)

[Ch.8, 30.11.81; Ch.10, 19.12.83; Ch.12, 10.05.88; Ch.15, 01.10.00; Amdt. 16, 01.05.03]

JAR 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 and landing gear) 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}.

JAR 25.103(b) (continued)

(c) Starting from the stabilised trim condition, apply the longitudinal control to decelerate the aeroplane so that the speed reduction does not exceed one knot per second. (See ACJ 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 2 knots or 2%, whichever is greater, above the speed at which the device operates.

[Ch.11, 17.03.86; Ch.15, 01.10.00]

JAR 25.105 Take-off

(a) The take-off speeds described in JAR 25.107, the accelerate-stop distance described in JAR 25.109, the take-off path described in JAR 25.111, and the take-off distance and take-off run described in JAR 25.113, must be determined –

(1) At each weight, altitude, and ambient temperature within the operational limits selected by the applicant; and

(2) In the selected configuration for take-off.

(b) No take-off made to determine the data required by this section 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.

[Ch.13, 05.10.89; Ch.15, 01.10.00]

JAR 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 JAR 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 JAR 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 JAR 25.121(b) but may not be less than –

(1) V_{2MIN};

(2) V_R plus the speed increment attained (in accordance with JAR 25.111(c)(2)) before reaching a height of 35 ft above the take-off surface; and

(3) A speed that provides the manoeuvring capability specified in JAR 15.143(g).

JAR 25.107 (continued)

(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 ACJ 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 JAR 25.111(c)(2)) that allows reaching V_2 before reaching a height of 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 ACJ 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 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 JAR 25.113(a)(1). (See ACJ 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-

JAR 25.107(e) (continued)

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 JAR 25.113(a). (See ACJ No. 1 to JAR 25.107(e) (4) and ACJ No. 2 to JAR 25.107(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 JAR 25.121(c), but may not less less than –

(1) 1·18 V_{SR}; and

(2) A speed that provides the manoeuvring capability specified in JAR 25.143(g).

[Ch.10, 19.12.83; Ch.15, 01.10.00; Amdt. 16, 01.05.03]

JAR 25.109 Accelerate-stop distance

(a) (See ACJ 25.109(a).) 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 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

JAR 25.109(a) (continued)

(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 ACJ 25.109(a).) 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:

JAR 25.109(b) (continued)

(i) The wheel brakes stopping force determined in meeting the requirements of JAR 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):

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

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.

(2) (See ACJ 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,

(2) (See ACJ 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):

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

JAR 25.109(d) (continued)

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.

(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) Shall 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 ACJ 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

JAR 25.109(h) (continued)

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.

[Ch.10, 19.12.83; Ch.13, 05.10.89; Ch.15, 01.10.00]

JAR 25.111 Take-off path
(See ACJ 25.111)

(a) The take-off path extends from a standing start to a point in the take-off at which the aeroplane is 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 JAR 25.101(f);

(2) The aeroplane must be accelerated on the ground to V_{EF}, 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 ACJ 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;

JAR 25.111(c) (continued)

(2) The aeroplane must reach V_2 before it is 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 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 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, and

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

(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 JAR–25.

[Ch.9, 30.11.82; Ch.10, 19.12.83; Ch.11, 17.03.86; Ch.14, 27.05.94; Ch.15, 01.10.00]

JAR 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 35 ft above the take-off surface, determined under JAR 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 35 ft above the take-off surface, as determined by a procedure consistent with JAR 25.111. (See ACJ 25.113(a)(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 15 ft above the take-off surface, achieved in a manner consistent with the achievement of V_2 before reaching 35 ft above the take-off surface, determined under JAR 25.111 for a wet runway. (See ACJ 113(a)(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 35 ft above the take-off surface, as determined under JAR 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 35 ft above the take-off surface, determined by a procedure consistent with JAR 25.111. (See ACJ 25.113(a)(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-

JAR 25.113(c) (continued)

off to the point at which the aeroplane is 15 ft above the take-off surface, achieved in a manner consistent with the achievement of V_2 before reaching 35 ft above the take-off surface, determined under JAR 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 35 ft above the take-off surface, determined by a procedure consistent with JAR 25.111. (See ACJ 25.113(a)(2).)

[Ch.11, 17.03.86; Ch.13, 05.10.89; Ch.15, 01.10.00]

JAR 25.115 Take-off flight path

(a) The take-off flight path shall be considered to begin 35 ft above the take-off surface at the end of the take-off distance determined in accordance with JAR 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 JAR 25.111 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.

[Ch.15, 01.10.00]

JAR 25.117 Climb: general

Compliance with the requirements of JAR 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.

JAR 25.119 Landing climb: all-engines-operating

In the landing configuration, the steady gradient of climb may not be less than 3·2%, with –

(a) 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 ACJ 25.119(a)); and

(b) A climb speed which is –

(1) Not less than –

(i) 1·08 V_{SR} for aeroplanes with four engines on which the application of power results in a significant reduction in stall speed; or

(ii) 1·13 V_{SR} for all other aeroplanes;

(2) Not less than V_{MCL}; and

(3) Not greater than V_{REF}.

[Ch.9, 30.11.82; Ch.10, 19.12.83; Ch.15, 01.10.00]

JAR 25.121 Climb: one-engine-inoperative (See ACJ 25.121)

(a) *Take-off; landing gear extended.* (See ACJ 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 JAR 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 JAR 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 ACJ 25.121(a)(1)); and

(2) The weight equal to the weight existing when retraction of the landing gear is begun determined under JAR 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 JAR 25.111 but without ground effect, the steady gradient of climb may not be less than 2·4% for two-engined

JAR 25.121(b) (continued)

aeroplanes, 2·7% for three-engined aeroplanes and 3·0% for four-engined aeroplanes, at V_2 and with –

(1) 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 JAR 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 400 ft above the take-off surface (see ACJ 25.121(b)(1)) ; and

(2) The weight equal to the weight existing when the aeroplane's landing gear is fully retracted, determined under JAR 25.111.

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

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

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

(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, 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 –

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

(2) The maximum landing weight;

(3) A climb speed established in connection with normal landing procedures, but not more than 1·4 V_{SR}; and

(4) Landing gear retracted**.**

[Ch.10, 19.12.83; Ch.13, 05.10.89; Ch.15, 01.10.00]

JAR 25.123 En-route flight paths
(See ACJ 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

JAR 25.123(a) (continued)

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 any selected speed, 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.

(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.

[Ch.10, 19.12.83]

JAR 25.125 Landing

(a) The horizontal distance necessary to land and to come to a complete stop from a point 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) as follows:

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

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

(i) 1·23 V_{SR0};

(ii) V_{MCL} established under JAR 25.149(f); and

(iii) A speed that provides the manoeuvring capability specified in JAR 25.143(g).

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

JAR 25.125(a) (continued)

(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.

(b) The landing distance must be determined on a level, smooth, dry, hard-surfaced runway. (See ACJ 25.125(b).) 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 ACJ 25.125(b)(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.

(c) Not required for JAR–25.

(d) Not required for JAR–25.

(e) 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 long the landing path in the direction of landing.

(f) 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.

[Ch.9, 30.11.82; Ch.10, 19.12.83; Ch.13, 05.10.89; Ch.14, 27.05.94; Ch.15, 01.10.00]

CONTROLLABILITY AND MANOEUVRABILITY

JAR 25.143 General

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

(1) Take-off;

(2) Climb;

(3) Level flight;

JAR 25.143(a) (continued)

(4) Descent; and

(5) Landing.

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

Force, in 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	75	50	–
For short term application for pitch and roll control – one hand available for control	50	25	–
For short term application for yaw control	–	–	150
For long term application	10	5	20

(d) 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 (c) 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.

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

(f) When manoeuvring at a constant airspeed or Mach number (up to V_{FC}/M_{FC}), the stick forces and

JAR 25.143(f) (continued)

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 ACJ No. 1 to JAR 25.143(f)), 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 ACJ No. 2 to JAR 25.143(f)).

(g) (See ACJ 25.143(g)). 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

JAR 25.143(g) (continued)

[(1)] A combination of weight, altitude and temperature (WAT) such that the thrust or power setting produces the minimum climb gradient specified in JAR 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.

[Ch.11, 17.03.86; Ch.12, 10.05.88; Ch.13, 05.10.89; Ch.14, 27.05.94; Ch.15, 01.10.00]

JAR 25.145 Longitudinal control

(a) (See ACJ 25.145(a).) It must be possible at any point between the trim speed prescribed in JAR 25.103(b)(6) and stall identification (as defined in JAR 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 JAR 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.

JAR 25.145 (continued)

(b) With the landing gear extended, no change in trim control, or exertion of more than 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 ACJ 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 ACJ 25.145(b)(2) and ACJ 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 ACJ 25.145(b)(1), (b)(2) and (b)(3).)

(4) With power off, wing-flaps retracted and the aeroplane trimmed at 1·3 V_{SR_1}, 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_{SR_1} obtain and maintain airspeeds between V_{SW} and either 1·6 V_{SR_1}, or V_{FE}, whichever is the lower.

(c) It must be possible, without exceptional piloting skill, to prevent loss of altitude when

JAR 25.145(c) (continued)

complete retraction of the high lift devices from any position is begun during steady, straight, level flight at 1·08 V_{SR_1}, for propeller powered aeroplanes or 1·13 V_{SR_1}, 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 ACJ 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.

[Ch.8, 30.11.81; Ch.13, 05.10.89; Ch.14, 27.05.94; Ch.15, 01.10.00]

JAR 25.147 Directional and lateral control

(a) *Directional control; general.* (See ACJ 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_{SR_1}, for heading changes up to 15º (except that the heading change at which the rudder pedal force is 150 pounds 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_{SR_1}, but not more than maximum continuous power;

JAR 25.147(a) (continued)

(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_{SR_1}, 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 ACJ 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_{SR_1}, 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

JAR 25.147(f) (continued)

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 ACJ 25.147(e).)

[Ch.14, 27.05.94; Ch.15, 01.10.00; Amdt. 16, 01.05.03]

JAR 25.149 Minimum control speed (See ACJ 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 $1{\cdot}13\ V_{SR}$ 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 JAR 25.121.

(d) The rudder forces required to maintain control at V_{MC} may not exceed 150 pounds nor may it

JAR 25.149(d) (continued)

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 pounds), 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 30 ft (9 144 m) 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 ACJ 25.149(e).)

(f) (See ACJ 25.149(f)) VMCL, 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. VMCL 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;

JAR 25.149(f) (continued)

(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 ACJ 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 150 pounds;

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

JAR 25.149(h) (continued)

(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 ACJ 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 ACJ 25.149 (h)(4)).

[Ch.9, 30.11.82; Ch.10, 19.12.83; Ch.14, 27.05.94; Ch.15, 01.10.00; Amdt. 16, 01.05.03]

TRIM

JAR 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_{SR_1}, 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_{SR_1}, 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_{SR_1} 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_{SR_1}, to V_{MO}/M_{MO}, with the landing gear and wing-flaps retracted, and from 1·3 V_{SR_1} 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

JAR 25.161(d) (continued)

angle of bank may not exceed 5º) at 1·3 VSR1, 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 JAR 25.123(a) for the purpose of establishing the en-route flight paths with two engines inoperative.]

[Ch.8, 30.11.81; Ch.12, 10.05.88; Ch.15, 01.10.00; Amdt. 16, 01.05.03]

STABILITY

JAR 25.171 General

The aeroplane must be longitudinally, directionally and laterally stable in accordance with the provisions of JAR 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.

JAR 25.173 Static longitudinal stability

Under the conditions specified in JAR 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 JAR 25.175(a), (c) and (d), and must return to within 7·5% of the original trim speed for the cruising condition specified in JAR 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 1 pound for each 6 knots. (See ACJ 25.173(c).)

JAR 25.173 (continued)

(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.

JAR 25.175 Demonstration of static longitudinal stability

Static longitudinal stability must be shown as follows:

(a) *Climb.* The stick 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_{SR_1}.

(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 50 knots 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 50 pounds), with –

(i) The wing-flaps retracted;

(ii) The centre of gravity in the most adverse position (see JAR 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 JAR 25.1521), except that the power need not exceed that required at V_{MO}/M_{MO}; and

JAR 25.175(b) (continued)

(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 50 knots 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 50 pounds), 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 $\frac{V_{MO} + 1 \cdot 3 V_{SR1}}{2}$; 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 50 knots 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 50 pounds), 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_{SR_1} with –

(1) Wing-flaps in the approach position;

(2) Landing gear retracted;

JAR 25.175(c) (continued)

(3) Maximum landing weight; and

(4) The aeroplane trimmed at 1·3 V_{SR_1}, 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 80 pounds at speeds between $V_{SW,}$ and 1·7 V_{SR_0} with –

(1) Wing-flaps in the landing position;

(2) Landing gear extended;

(3) Maximum landing weight;

(4) The aeroplane trimmed at 1·3 V_{SR_0} with –

(i) Power or thrust off, and

(ii) Power or thrust for level flight.

[Ch.14, 27.05.94; Ch.15, 01.10.00]

JAR 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-flap extended configurations nor speeds higher than V_{LE} for landing gear extended configurations) in the following airspeed ranges:

[(1) From 1·13 V_{SR1} 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 180 pounds (81·72kg), 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]

JAR 25.177(c) (continued)

[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 ACJ 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 180 pounds (81·72kg) 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 180 pounds (81·72kg); 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 ACJ 25.177(d).).]

[Ch.9, 30.11.82; Ch.14, 27.05.94; Ch.15, 01.10.00; Amdt. 16, 01.05.03]

JAR 25.181 Dynamic stability
(See ACJ 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 VSR 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.

[Ch.8, 30.11.81; Ch.14, 27.05.94; Ch.15, 01.10.00]

STALLS

JAR 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

JAR 25.201(a) (continued)

reference stall speed at maximum landing weight with flaps in the approach position and the landing gear retracted. (See ACJ 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 JAR 25.203 with –

(1) Flaps, landing gear and deceleration devices in any likely combination of positions approved for operation; (See ACJ 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 JAR 25.103 (b)(6).

(c) The following procedures must be used to show compliance with JAR 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 one knot per second until the aeroplane is stalled. (See ACJ 25.103(c).)

(2) In addition, for turning flight stalls, apply the longitudinal control to achieve airspeed deceleration rates up to 3 knots per second. (See ACJ 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 ACJ 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 ACJ 25.201(d)(3).)

[Ch.11, 17.03.86; Ch.15, 01.10.00]

JAR 25.203 Stall characteristics
(See ACJ 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 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 1 knot per second.

[Ch.15, 01.10.00]

JAR 25.205 Reserved

[Ch.14, 27.05.94]

JAR 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 may 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. (See ACJ 25.207(b).)

(c) When the speed is reduced at rates not exceeding one knot per second, stall warning must

JAR 25.207(c) (continued)

begin, in each normal configuration, at a speed, $V_{SW,}$ exceeding the speed at which the stall is identified in accordance with JAR 25.201 (d) by not less than 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 ACJ 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 one knot per second, in straight flight with engines idling and at the centre-of-gravity position specified in JAR 25.103(b)(5), V_{SW}, in each normal configuration, must exceed V_{SR} by not less than three knots or three percent CAS, whichever is greater. (See ACJ 25.207(c) and (d)).

(e) The stall warning margin must be sufficient to allow the pilot to prevent stalling (as defined in JAR 25.201(d)) when recovery is initiated 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 2 knots per second, with the flaps and landing gear in any normal position, with the aeroplane trimmed for straight flight at a speed of 1·3 V_{SR}, and with the power or thrust necessary to maintain level flight at 1·3 V_{SR}.

(f) 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 Flight Manual procedures).

[Ch.11, 17.03.86; Ch.15, 01.10.00]

GROUND HANDLING CHARACTERISTICS

JAR 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_{SR1}.

(b) *Not required for JAR–25*

[Ch.15, 01.10.00]

JAR 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 20 knots or 0·2 V_{SR0}, whichever is greater, except that the wind velocity need not exceed 25 knots 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 JAR 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.

[Ch.15, 01.10.00]

JAR 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.

JAR 25.237 Wind velocities

(a) 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 20 knots or 0·2 V_{SR0}, whichever is greater, except that it need not exceed 25 knots.

(b) *Not required for JAR–25.*

[Ch.15, 01.10.00]

MISCELLANEOUS FLIGHT REQUIREMENTS

JAR 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 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

JAR 25.251(b) (continued)

limitations of the aeroplane in accordance with JAR 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 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 ACJ 25.251(e).)

[Ch.14, 27.05.94; Amdt. 16, 01.05.03]

JAR 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

JAR 25.253(a) (continued)

(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 great 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 ACJ 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 pilot's 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 ACJ 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 JAR 25.143(f), 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. It 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.

[Ch.10, 19.12.83; Ch.13, 05.10.89; Ch.14, 27.05.94; Ch.15, 01.10.00; Amdt. 16, 01.05.03]

JAR 25.255 Out-of-trim characteristics (See ACJ 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 JAR 25.655 (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 JAR 25.333 (b) and 25.337, and the manoeuvring load factors associated with probable inadvertent excursions beyond the boundaries of the buffet onset envelopes determined

JAR 25.255(e) (continued)

under JAR 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 125 pounds 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 JAR 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.

[Ch.8, 30.11.81]

JAR 25X261 Flight in rough air

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[Amdt. 16, 01.05.03]

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SUBPART C – STRUCTURE

GENERAL

JAR 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. 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 ACJ 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.

JAR 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.

JAR 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) Not required for JAR–25.

(f) Not required for JAR–25.

[Ch.14, 27.05.94; Ch.15, 01.10.00]

JAR 25.307 Proof of structure

(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 those for which experience has shown this method to be reliable. In other cases, substantiating load tests must be made. Where substantiating load tests are made these must cover loads up to the ultimate load, unless it is agreed with the Authority that in the circumstances of the case, equivalent substantiation can be obtained from tests to agreed lower levels. (See ACJ 25.307.)

(b) Reserved

(c) Reserved

(d) When static or dynamic tests are used to show compliance with the requirements of JAR 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.

[Ch.14, 27.05.94]

FLIGHT LOADS

JAR 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

JAR 25.321(a) (continued)

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.

[Ch.14, 27.05.94; Ch.15, 01.10.00]

FLIGHT MANOEUVRE AND GUST CONDITIONS

JAR 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 JAR 25.255 must be considered.

JAR 25.331 (continued)

(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 JAR 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, JAR 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 JAR 25.333(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 JAR 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 $0 \leq t \leq t_{max}$

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 JAR 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 **]**

JAR 25.331(c) (continued)

[control system stops, control surface stops, or by pilot effort in accordance with JAR 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:

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

where:

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

V_A = the design manoeuvring speed prescribed in JAR 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 JAR 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 $t_2 \le t \le tmax$

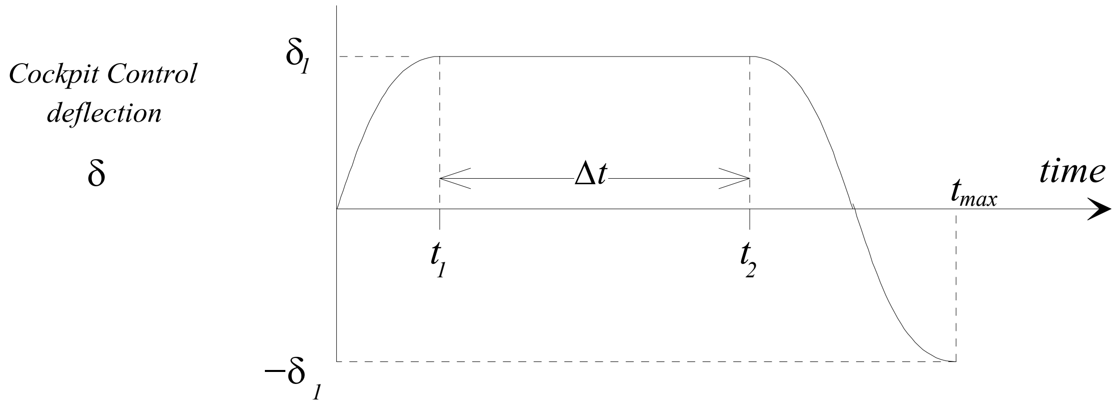
where:

t_1 = $\pi/2\omega$

t_2 = $t_1 + \Delta t$

tmax = $t_2 + \pi/\omega$;

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).



JAR 25.331(c) (continued)

(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 shall 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 JAR 25.337;

(C) t_{max}.]

[Ch.14, 27.05.94; Ch.15, 01.10.00; Amdt. 16, 01.05.03]

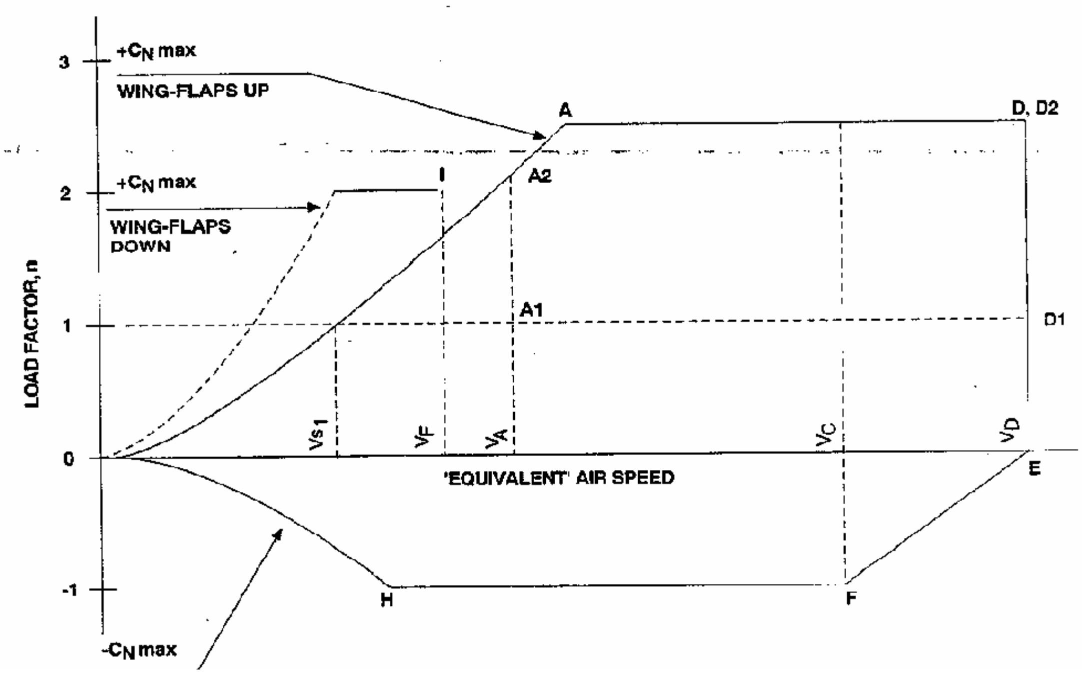
JAR 25.333 Flight manoeuvring envelope

(a) *General.* The strength requirements must be met at each combination of airspeed and load factor on and within the boundaries of the representative

JAR 25.333(a) (continued)

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 JAR 25.1501.

(b) *Manoeuvring envelope*



JAR 25.333 (continued)

(c) Reserved

[Ch.14, 27.05.94; Ch.15, 01.10.00]

JAR 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 JAR 25.1505.)

JAR 25.335 (continued)

(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 7·5° 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 JAR 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

JAR 25.335(b) (continued)

automatic systems. In any case, the margin may [not be reduced to less than 0·05M. See ACJ 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 JAR 25.341(a)(5)(i);

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

$$K_g = \frac{\cdot 88\mu}{5\cdot 3+\mu}$$

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

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;

JAR 25.335(d) (continued)

(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 JAR 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.

[Ch.13, 05.10.89; Ch.14, 27.05.94; Ch.15, 01.10.00; Amdt. 16, 01.05.03]

JAR 25.337 Limit manoeuvring load factors [(See ACJ 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

JAR 25.337(a) (continued)

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. **[ ]**

[Amdt. 16, 01.05.03]

JAR 25.341 Gust and turbulence loads

(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:

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

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

where –

s = distance penetrated into the gust (feet);

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 (feet) 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 30 feet to 350 feet must be investigated to find the critical response for each load quantity.

JAR 25.341(a) (continued)

(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 the aeroplane design speed V_C:

Positive and negative gusts with reference gust velocities of 17·07 m/sec (56·0 ft/sec) EAS must be considered at sea level. The reference gust velocity may be reduced linearly from 17·07 m/sec (56·0 ft/sec) EAS at sea level to 13·41 m/sec (44·0 ft/sec) EAS at 15 000 feet. The reference gust velocity may be further reduced linearly from 13·41 m/sec (44·0 ft/sec) EAS at 15 000 feet to 7·92 m/sec (26·0 ft/sec) EAS at 50 000 feet.

(ii) At the aeroplane design speed V_D:

The reference gust velocity must be 0·5 times the value obtained under JAR 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 JAR 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 –

$$F_{gz} = 1 - \frac{Z_{mo}}{250\,000};$$

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

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

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

Z_{mo} = maximum operating altitude defined in JAR 25.1527.

(7) When a stability augmentation system is included in the analysis, the effect of any significant system non-linearities should be

JAR 25.341(a) (continued)

accounted for when deriving limit loads from limit gust conditions.

(b) *Continuous Gust Design Criteria.* The dynamic response of the aeroplane to vertical and lateral continuous turbulence must be taken into account. (See ACJ 25.341(b).)

(c) Reserved

[Ch.8, 30.11.81; Ch.13, 05.10.89; Ch.14, 27.05.94; Ch.15, 01.10.00]

JAR 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 JAR 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 conditions of JAR 25.341 (a), but assuming 85% of the design velocities prescribed in JAR 25.341(a)(4).

(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.

[Ch.12, 10.05.88; Ch.14, 27.05.94; Ch.15, 01.10.00]

JAR 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 JAR 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

JAR 25.345(a) (continued)

(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 ACJ 25.345(a).) The shape of the gust must be as described in JAR 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 (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 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 JAR 25.337(b); and

(2) The discrete vertical gust criteria in JAR 25.341(a). (See ACJ 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.

[Ch.11, 17.03.86; Ch.13, 05.10.89; Ch.14, 27.05.94; Ch.15, 01.10.00]

JAR 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.

JAR 25.349 (continued)

(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 JAR 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 JAR 25.341(a), or the wing maximum airload derived indirectly from the vertical load factor calculated from JAR 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.

[Ch.14, 27.05.94; Ch.15, 01.10.00]

JAR 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

JAR 25.351(a) (continued)

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 1 335 N (300 pounds) from V_{MC} to V_A and 890 N (200 pounds) 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.

[Ch.8, 30.11.81; Ch.10, 19.12.83; Ch.13, 05.10.89; Ch.14, 27.05.94; Ch.15, 01.10.00]

SUPPLEMENTARY CONDITIONS

JAR 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 JAR 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 JAR 25.333(b); and

(3) For turbo-propeller installations, in addition to the conditions specified in sub-paragraphs (a)(1) and (2) of this paragraph, a limit engine torque corresponding to take-off power and propeller speed, multiplied by a factor accounting for propeller control system malfunction, including quick feathering, acting simultaneously with 1 g level flight loads. In the absence of a rational analysis, a factor of 1·6 must be used.

(b) For turbine engines and auxiliary power unit installations, the limit torque load imposed by sudden stoppage due to malfunction or structural failure

JAR 25.361(b) (continued)

(such as a compressor jamming) must be considered in the design of engine and auxiliary power unit mounts and supporting structure. In the absence of better information a sudden stoppage must be assumed to occur in 3 seconds.

(c) The limit engine torque to be considered under sub-paragraph (a)(2) of this paragraph is obtained by multiplying the mean torque by a factor of 1·25 for turbo-propeller installations.

(d) When applying JAR 25.361(a) to turbo-jet engines, the limit engine torque must be equal to the maximum accelerating torque for the case considered. (See ACJ 25.301(b).)

[Ch.8, 30.11.81; Ch.14, 27.05.94]

JAR 25.363 Side load on engine and auxiliary power unit mounts

(a) Each engine and auxiliary power unit mount and its supporting structure must be designed for a limit load factor in a lateral direction, for the side load on the engine and auxiliary power unit mount, at least equal to the maximum load factor obtained in the yawing conditions but not less than –

(1) 1·33; or

(2) One-third of the limit load factor for flight condition A as prescribed in JAR 25.333(b).

(b) The side load prescribed in sub-paragraph (a) of this paragraph may be assumed to be independent of other flight conditions.

[Ch.8, 30.11.81]

JAR 25.365 Pressurised compartment loads

For aeroplanes with one or more pressurised compartments the following apply:

(a) The aeroplane structure must be strong enough to withstand the flight loads combined with pressure differential loads from zero up to the maximum relief valve setting.

(b) The external pressure distribution in flight, and stress concentrations and fatigue effects must be accounted for.

(c) If landings may be made with the compartment pressurised, landing loads must be combined with pressure differential loads from zero up to the maximum allowed during landing.

(d) The aeroplane structure must be strong enough to withstand the pressure differential loads

JAR 25.365(d) (continued)

corresponding to the maximum relief valve setting multiplied by a factor of 1·33, omitting other loads.

(e) Any structure, component or part, inside or outside a pressurised compartment, the failure of which could interfere with continued safe flight and landing, must be designed to withstand the effects of a sudden release of pressure through an opening in any compartment at any operating altitude resulting from each of the following conditions:

(1) The penetration of the compartment by a portion of an engine following an engine disintegration.

(2) Any opening in any pressurised compartment up to the size H_o in square feet; however, small compartments may be combined with an adjacent pressurised compartment and both considered as a single compartment for openings that cannot reasonably be expected to be confined to the small compartment. The size H_o must be computed by the following formula:

$$H_o = PA_s$$

where,

H_o = maximum opening in square feet, need not exceed 20 square feet.

$$P = \frac{A_s}{6240} + \cdot 024$$

A_s = maximum cross sectional area of the pressurised shell normal to the longitudinal axis, in square feet; and

(3) The maximum opening caused by aeroplane or equipment failures not shown to be extremely improbable. (See ACJ 25.365(e).)

(f) In complying with sub-paragraph (e) of this paragraph, the fail-safe features of the design may be considered in determining the probability of failure or penetration and probable size of openings, provided that possible improper operation of closure devices and inadvertent door openings are also considered. Furthermore, the resulting differential pressure loads must be combined in a rational and conservative manner with 1 g level flight loads and any loads arising from emergency depressurisation conditions. These loads may be considered as ultimate conditions; however, any deformation associated with these conditions must not interfere with continued safe flight and landing. The pressure relief provided by the intercompartment venting may also be considered.

(g) Bulkheads, floors, and partitions in pressurised compartments for occupants must be designed to withstand conditions specified in sub-paragraph (e) of this paragraph. In addition, reasonable design precautions must be taken to

JAR 25.365(g) (continued)

minimise the probability of parts becoming detached and injuring occupants while in their seats.

[Ch.10, 19.12.83; Ch.12, 10.05.88; Ch.14, 27.05.94]

JAR 25.367 Unsymmetrical loads due to engine failure

(a) The aeroplane must be designed for the unsymmetrical loads resulting from the failure of the critical engine. Turbo-propeller aeroplanes must be designed for the following conditions in combination with a single malfunction of the propeller drag limiting system, considering the probable pilot corrective action on the flight controls:

(1) At speeds between V_{MC} and V_D, the loads resulting from power failure because of fuel flow interruption are considered to be limit loads.

(2) At speeds between V_{MC} and V_C, the loads resulting from the disconnection of the engine compressor from the turbine or from loss of the turbine blades are considered to be ultimate loads.

(3) The time history of the thrust decay and drag build-up occurring as a result of the prescribed engine failures must be substantiated by test or other data applicable to the particular engine-propeller combination.

(4) The timing and magnitude of the probable pilot corrective action must be conservatively estimated, considering the characteristics of the particular engine-propeller-aeroplane combination.

(b) Pilot corrective action may be assumed to be initiated at the time maximum yawing velocity is reached, but not earlier than two seconds after the engine failure. The magnitude of the corrective action may be based on the control forces specified in JAR 25.397(b) except that lower forces may be assumed where it is shown by analysis or test that these forces can control the yaw and roll resulting from the prescribed engine failure conditions.

JAR 25.371 Gyroscopic loads

The structure supporting any engine or auxiliary power unit must be designed for the loads, including the gyroscopic loads, arising from the conditions specified in JAR 25.331, 25.341(a), 25.349, 25.351, 25.473, 25.479 and 25.481, with the engine or auxiliary power unit at the maximum rpm appropriate to the condition. For the purposes of compliance with this paragraph, the pitch manoeuvre in JAR 25.331(c)(1) must be carried out until the positive

JAR 25.371 (continued)

limit manoeuvring load factor (point A_2 in JAR 25.333(b)) is reached.

[Ch.8, 30.11.81; Ch.14, 27.05.94; Ch.15, 01.10.00]

JAR 25.373 Speed control devices

If speed control devices (such as spoilers and drag flaps) are installed for use in en-route conditions –

(a) The aeroplane must be designed for the symmetrical manoeuvres prescribed in JAR 25.333 and 25.337, the yawing manoeuvres prescribed in JAR 25.351 and the vertical and lateral gust conditions prescribed in JAR 25.341(a), at each setting and the maximum speed associated with that setting; and

(b) If the device has automatic operating or load limiting features, the aeroplane must be designed for the manoeuvre and gust conditions prescribed in sub-paragraph (a) of this paragraph, at the speeds and corresponding device positions that the mechanism allows.

[Ch.13, 05.10.89; Ch.14, 27.05.94]

CONTROL SURFACE AND SYSTEM LOADS

JAR 25.391 Control surface loads: general

The control surfaces must be designed for the limit loads resulting from the flight conditions in JAR [25.331, 25.341 (a) and (b), 25.349 and 25.351, considering] the requirements for –

(a) Loads parallel to hinge line, in JAR 25.393;

(b) Pilot effort effects, in JAR 25.397;

(c) Trim tab effects, in JAR 25.407;

(d) Unsymmetrical loads, in JAR 25.427; and

(e) Auxiliary aerodynamic surfaces, in JAR 25.445.

[Ch.14, 27.05.94; Ch.15, 01.10.00; Amdt. 16, 01.05.03]

JAR 25.393 Loads parallel to hinge line

(a) Control surfaces and supporting hinge brackets must be designed for inertia loads acting parallel to the hinge line. (See ACJ 25.393(a).)

(b) In the absence of more rational data, the inertia loads may be assumed to be equal to KW, where –

(1) K = 24 for vertical surfaces;

(2) K = 12 for horizontal surfaces; and

(3) W = weight of the movable surfaces.

JAR 25.395 Control system

(a) Longitudinal, lateral, directional and drag control systems and their supporting structures must be designed for loads corresponding to 125% of the computed hinge moments of the movable control surface in the conditions prescribed in JAR 25.391.

[(b) The system limit loads of paragraph (a)], need not exceed the loads that can be produced by the pilot (or pilots) and by automatic or power devices operating the controls.

(c) The loads must not be less than those resulting from application of the minimum forces prescribed in JAR 25.397(c).

[Ch.14, 27.05.94; Amdt. 16, 01.05.03]

JAR 25.397 Control system loads

(a) *General.* The maximum and minimum pilot forces, specified in sub-paragraph (c) of this paragraph, are assumed to act at the appropriate control grips or pads (in a manner simulating flight conditions) and to be reacted at the attachment of the control system to the control surface horn.

(b) *Pilot effort effects.* In the control surface flight loading condition, the air loads on movable surfaces and the corresponding deflections need not exceed those that would result in flight from the application of any pilot force within the ranges specified in sub-paragraph (c) of this paragraph. Two-thirds of the maximum values specified for the aileron and elevator may be used if control surface hinge moments are based on reliable data. In applying this criterion, the effects of servo mechanisms, tabs, and automatic pilot systems, must be considered.

(c) *Limit pilot forces and torques.* The limit pilot forces and torques are as follows:

Control	Maximum forces or torques	Minimum forces or torques
Aileron: Stick Wheel*	 100 lb 80 D in.lb**	 40 lb 40 D in.lb
Elevator: Stick Wheel (symmetrical) Wheel (unsymmetrical)†	 250 lb 300 lb	 100 lb 100 lb 100 lb
Rudder	300 lb	130 lb

JAR 25.397(c) (continued)

*The critical parts of the aileron control system must be designed for a single tangential force with a limit value equal to 1·25 times the couple force determined from these criteria.

**D = wheel diameter (inches)

†The unsymmetrical forces must be applied at one of the normal handgrip points on the periphery of the control wheel.

[Ch.14, 27.05.94]

JAR 25.399 Dual control system

(a) Each dual control system must be designed for the pilots operating in opposition, using individual pilot forces not less than –

(1) 0·75 times those obtained under JAR 25.395; or

(2) The minimum forces specified in JAR 25.397(c).

(b) The control system must be designed for pilot forces applied in the same direction, using individual pilot forces not less than 0·75 times those obtained under JAR 25.395.

JAR 25.405 Secondary control system

Secondary controls, such as wheel brake, spoiler, and tab controls, must be designed for the maximum forces that a pilot is likely to apply to those controls. The following values may be used:

PILOT CONTROL FORCE LIMITS (SECONDARY CONTROLS).

Control	Limit pilot forces
Miscellaneous: *Crank, wheel, or lever.	$\left(\frac{1+R}{3}\right)$ x 50 lb, but not less than 50 lb nor more than 150 lb (R = radius). (Applicable to any angle within 20º of plane of control).
Twist	133 in.lb
Push-pull	To be chosen by applicant.

*Limited to flap, tab, stabiliser, spoiler, and landing gear operation controls.

JAR 25.407 Trim tab effects

The effects of trim tabs on the control surface design conditions must be accounted for only where the surface loads are limited by maximum pilot effort. In these cases, the tabs are considered to be deflected in the direction that would assist the pilot, and the deflections are –

(a) For elevator trim tabs, those required to trim the aeroplane at any point within the positive portion of the pertinent flight envelope in JAR 25.333(b), except as limited by the stops; and

(b) For aileron and rudder trim tabs, those required to trim the aeroplane in the critical unsymmetrical power and loading conditions, with appropriate allowance for rigging tolerances.

JAR 25.409 Tabs

(a) *Trim tabs.* Trim tabs must be designed to withstand loads arising from all likely combinations of tab setting, primary control position, and aeroplane speed (obtainable without exceeding the flight load conditions prescribed for the aeroplane as a whole), when the effect of the tab is opposed by pilot effort forces up to those specified in JAR 25.397(b).

(b) *Balancing tabs.* Balancing tabs must be designed for deflections consistent with the primary control surface loading conditions.

(c) *Servo tabs.* Servo tabs must be designed for deflections consistent with the primary control surface loading conditions obtainable within the pilot manoeuvring effort, considering possible opposition from the trim tabs.

JAR 25.415 Ground gust conditions

[(a) The flight control systems and surfaces must be designed for the limit loads generated when the aircraft is subjected to a horizontal 65 knots ground gust from any direction, while taxying with the controls locked and unlocked and while parked with the controls locked.

(b) The control system and surface loads due to ground gust may be assumed to be static loads and the hinge moments H, in Newton metres (foot pounds), must be computed from the formula:

$$H = K\ 1/2 \rho_o V^2 c S$$

where:

K = hinge moment factor for ground gusts derived in subparagraph (c) of this paragraph

JAR 25.415(b) (continued)

ρ_o = density of air at sea level = 1·225 (kg/m^3) (0·0023769 (slugs/ft^3) = 0·0023769 (lb-sec^2/ ft^4))

V = 33·44 m/sec (65 knots = 109·71 fps) relative to the aircraft

S = area of the control surface aft of the hinge line (m^2) (ft^2)

C = mean aerodynamic chord of the control surface aft of the hinge line (m) (ft)

(c) The hinge moment factor K for ground gusts must be taken from the following table:

Surface	*K*	Position of controls
(a) Aileron ----	0·75	Control column locked or lashed in mid-position.
(b) Aileron ----	*±0·50	Ailerons at full throw.
(c) Elevator----	*±0·75	(c) Elevator full down.
(d) Elevator----	*±0·75	(d) Elevator full up.
(e) Rudder-----	0·75	(e) Rudder in neutral.
(f) Rudder------	0·75	(f) Rudder at full throw.

* A positive value of K indicates a moment tending to depress the surface, while a negative value of K indicates a moment tending to raise the surface.

(d) The computed hinge moment of subparagraph (b) must be used to determine the limit loads due to ground gust conditions for the control surface. A 1·25 factor on the computed hinge moments must be used in calculating limit control system loads.

(e) Where control system flexibility is such that the rate of load application in the ground gust conditions might produce transient stresses appreciably higher than those corresponding to static loads, in the absence of a rational analysis an additional factor of 1·60 must be applied to the control system loads of subparagraph (d) to obtain limit loads. If a rational analysis is used, the additional factor must not be less than 1·20.

(f) For the condition of the control locks engaged, the control surfaces, the control system locks and the parts of the control systems (if any) between the surfaces and the locks must be designed to the respective resultant limit loads. Where control locks are not provided then the control surfaces, the control system stops nearest the surfaces and the parts of the control systems (if any) between the surfaces and the stops must be designed to the]

JAR 25. 415(f) (continued)

[resultant limit loads. If the control system design is such as to allow any part of the control system to impact with the stops due to flexibility, then the resultant impact loads must be taken into account in deriving the limit loads due to ground gust.

(g) For the condition of taxying with the control locks disengaged, the following apply:

(1) The control surfaces, the control system stops nearest the surfaces and the parts of the control systems (if any) between the surfaces and the stops must be designed to the resultant limit loads.

(2) The parts of the control systems between the stops nearest the surfaces and the cockpit controls must be designed to the resultant limit loads, except that the parts of the control system where loads are eventually reacted by the pilot need not exceed:

(i) The loads corresponding to the maximum pilot loads in JAR 25.397(c) for each pilot alone; or

(ii) 0·75 times these maximum loads for each pilot when the pilot forces are applied in the same direction.]

[Ch.14, 27.05.94; Ch.15, 01.10.00; Amdt. 16, 01.05.03]

JAR 25.427 Unsymmetrical loads

(a) In designing the aeroplane for lateral gust, yaw manoeuvre and roll manoeuvre conditions, account must be taken of unsymmetrical loads on the empennage arising from effects such as slipstream and aerodynamic interference with the wing, vertical fin and other aerodynamic surfaces.

(b) The horizontal tail must be assumed to be subjected to unsymmetrical loading conditions determined as follows:

(1) 100% of the maximum loading from the symmetrical manoeuvre conditions of JAR 25.331 and the vertical gust conditions of JAR 25.341(a) acting separately on the surface on one side of the plane of symmetry; and

(2) 80% of these loadings acting on the other side.

(c) For empennage arrangements where the horizontal tail surfaces have dihedral angles greater than plus or minus 10 degrees, or are supported by the vertical tail surfaces, the surfaces and the supporting structure must be designed for gust velocities specified in JAR 25.341(a) acting in any orientation at right angles to the flight path.

[Ch.14, 27.05.94; Ch.15, 01.10.00]

JAR 25.445 Outboard fins

(a) When significant, the aerodynamic influence between auxiliary aerodynamic surfaces, such as outboard fins and winglets, and their supporting aerodynamic surfaces must be taken into account for all loading conditions including pitch, roll and yaw manoeuvres, and gusts as specified in JAR 25.341(a) acting at any orientation at right angles to the flight path.

(b) To provide for unsymmetrical loading when outboard fins extend above and below the horizontal surface, the critical vertical surface loading (load per unit area) determined under JAR 25.391 must also be applied as follows:

(1) 100% to the area of the vertical surfaces above (or below) the horizontal surface.

(2) 80% to the area below (or above) the horizontal surface.

[Ch.15, 01.10.00]

JAR 25.457 Wing-flaps

Wing flaps, their operating mechanisms, and their supporting structures must be designed for critical loads occurring in the conditions prescribed in JAR 25.345, accounting for the loads occurring during transition from one wing-flap position and airspeed to another.

JAR 25.459 Special devices

The loading for special devices using aero-dynamic surfaces (such as slots, slats and spoilers) must be determined from test data.

[Ch.14, 27.05.94]

GROUND LOADS

JAR 25.471 General

(a) *Loads and equilibrium.* For limit ground loads –

(1) Limit ground loads obtained under this Subpart are considered to be external forces applied to the aeroplane structure; and

(2) In each specified ground load condition, the external loads must be placed in equilibrium with the linear and angular inertia loads in a rational or conservative manner.

(b) *Critical centres of gravity.* The critical centres of gravity within the range for which certification is requested must be selected so that the maximum design loads are obtained in each landing

JAR 25.471(b) (continued)

gear element. Fore and aft, vertical, and lateral aeroplane centres of gravity must be considered. Lateral displacements of the centre of gravity from the aeroplane centreline which would result in main gear loads not greater than 103% of the critical design load for symmetrical loading conditions may be selected without considering the effects of these lateral centre of gravity displacements on the loading of the main gear elements, or on the aeroplane structure provided –

(1) The lateral displacement of the centre of gravity results from random passenger or cargo disposition within the fuselage or from random unsymmetrical fuel loading or fuel usage; and

(2) Appropriate loading instructions for random disposable loads are included under the provisions of JAR 25.1583(c)(1) to ensure that the lateral displacement of the centre of gravity is maintained within these limits.

(c) *Landing gear dimension data.* Figure 1 of Appendix A contains the basic landing gear dimension data.

JAR 25.473 Landing load conditions and assumptions

(a) For the landing conditions specified in JAR 25.479 to 25.485, the aeroplane is assumed to contact the ground:

(1) In the attitudes defined in JAR 25.479 and JAR 25.481.

(2) With a limit descent velocity of 3·05 m/sec (10 fps) at the design landing weight (the maximum weight for landing conditions at maximum descent velocity); and

(3) With a limit descent velocity of 1·83 m/sec (6 fps) at the design take-off weight (the maximum weight for landing conditions at a reduced descent velocity).

(4) The prescribed descent velocities may be modified if it is shown that the aeroplane has design features that make it impossible to develop these velocities.

(b) Aeroplane lift, not exceeding aeroplane weight, may be assumed, unless the presence of systems or procedures significantly affects the lift.

(c) The method of analysis of aeroplane and landing gear loads must take into account at least the following elements:

(1) Landing gear dynamic characteristics.

(2) Spin-up and spring back.

(3) Rigid body response.

JAR 25.473(c) (continued)

(4) Structural dynamic response of the airframe, if significant.

(d) The landing gear dynamic characteristics must be validated by tests as defined in JAR 25.723(a).

(e) The coefficient of friction between the tyres and the ground may be established by considering the effects of skidding velocity and tyre pressure. However, this coefficient of friction need not be more than 0·8.

[Ch.15, 01.10.00]

JAR 25.477 Landing gear arrangement

JAR 25.479 to 25.485 apply to aeroplanes with conventional arrangements of main and nose gears, or main and tail gears, when normal operating techniques are used.

JAR 25.479 Level landing conditions

(a) In the level attitude, the aeroplane is assumed to contact the ground at forward velocity components, ranging from V_{L_1} to 1·25 V_{L_2} parallel to the ground under the conditions prescribed in JAR 25.473 with:

(1) V_{L_1} equal to V_{S_0}(TAS) at the appropriate landing weight and in standard sea-level conditions; and

(2) V_{L_2}, equal to V_{S_0}(TAS) at the appropriate landing weight and altitudes in a hot day temperature of 22·8ºC (41ºF) above standard.

(3) The effects of increased contact speed must be investigated if approval of downwind landings exceeding 10 knots is requested.

(b) For the level landing attitude for aeroplanes with tail wheels, the conditions specified in this paragraph must be investigated with the aeroplane horizontal reference line horizontal in accordance with Figure 2 of Appendix A of JAR–25.

(c) For the level landing attitude for aeroplanes with nose wheels, shown in Figure 2 of Appendix A of JAR–25, the conditions specified in this paragraph must be investigated assuming the following attitudes:

(1) An attitude in which the main wheels are assumed to contact the ground with the nose wheel just clear of the ground; and

(2) If reasonably attainable at the specified descent and forward velocities an attitude in which the nose and main wheels are assumed to contact the ground simultaneously.

JAR 25.479 (continued)

(d) In addition to the loading conditions prescribed in sub-paragraph (a) of this paragraph, but with maximum vertical ground reactions calculated from paragraph (a), the following apply:

(1) The landing gear and directly affected structure must be designed for the maximum vertical ground reaction combined with an aft acting drag component of not less than 25% of this maximum vertical ground reaction.

(2) The most severe combination of loads that are likely to arise during a lateral drift landing must be taken into account. In absence of a more rational analysis of this condition, the following must be investigated:

(i) A vertical load equal to 75% of the maximum ground reaction of JAR 25.473(a)(2) must be considered in combination with a drag and side load of 40% and 25%, respectively, of that vertical load.

(ii) The shock absorber and tyre deflections must be assumed to be 75% of the deflection corresponding to the maximum ground reaction of JAR 25.473(a)(2). This load case need not be considered in combination with flat tyres.

(3) The combination of vertical and drag components is considered to be acting at the wheel axle centreline.

[Ch.15, 01.10.00]

JAR 25.481 Tail-down landing conditions

(a) In the tail-down attitude, the aeroplane is assumed to contact the ground at forward velocity components, ranging from V_{L_1} to V_{L_2}, parallel to the ground under the conditions prescribed in JAR 25.473 with:

(1) V_{L_1} equal to V_{S_0} (TAS) at the appropriate landing weight and in standard sea-level conditions; and

(2) V_{L_2} equal to V_{S_0} (TAS) at the appropriate landing weight and altitudes in a hot-day temperature of 41ºF above standard.

The combination of vertical and drag components is considered to be acting at the main wheel axle centreline.

(b) For the tail-down landing condition for aeroplanes with tail wheels, the main and tail wheels are assumed to contact the ground simultaneously, in accordance with Figure 3 of Appendix A. Ground reaction conditions on the tail wheel are assumed to act –

JAR 25.481(b) (continued)

(1) Vertically; and

(2) Up and aft through the axle at 45º to the ground line.

(c) For the tail-down landing condition for aeroplanes with nose wheels, the aeroplane is assumed to be at an attitude corresponding to either the stalling angle or the maximum angle allowing clearance with the ground by each part of the aeroplane other than the main wheels, in accordance with Figure 3 of Appendix A, whichever is less.

JAR 25.483 One-gear landing conditions

For the one-gear landing conditions, the aeroplane is assumed to be in the level attitude and to contact the ground on one main landing gear, in accordance with Figure 4 of Appendix A of JAR–25. In this attitude –

(a) The ground reactions must be the same as those obtained on that side under JAR 25.479(d)(1), and

(b) Each unbalanced external load must be reacted by aeroplane inertia in a rational or conservative manner.

JAR 25.485 Side load conditions

In addition to JAR 25.479(d)(2) the following conditions must be considered:

(a) For the side load condition, the aeroplane is assumed to be in the level attitude with only the main wheels contacting the ground, in accordance with Figure 5 of Appendix A.

(b) Side loads of 0·8 of the vertical reaction (on one side) acting inward and 0·6 of the vertical reaction (on the other side) acting outward must be combined with one-half of the maximum vertical ground reactions obtained in the level landing conditions. These loads are assumed to be applied at the ground contact point and to be resisted by the inertia of the aeroplane. The drag loads may be assumed to be zero.

[Ch.15, 01.10.00]

JAR 25.487 Rebound landing condition

(a) The landing gear and its supporting structure must be investigated for the loads occurring during rebound of the aeroplane from the landing surface.

JAR 25.487 (continued)

(b) With the landing gear fully extended and not in contact with the ground, a load factor of 20·0 must act on the unsprung weights of the landing gear. This load factor must act in the direction of motion of the unsprung weights as they reach their limiting positions in extending with relation to the sprung parts of the landing gear.

JAR 25.489 Ground handling conditions

Unless otherwise prescribed, the landing gear and aeroplane structure must be investigated for the conditions in JAR 25.491 to 25.509 with the aeroplane at the design ramp weight (the maximum weight for ground handling conditions). No wing lift may be considered. The shock absorbers and tyres may be assumed to be in their static position.

JAR 25.491 Taxi, takeoff and landing roll

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

[Ch.15, 01.10.00; Amdt. 16, 01.05.03]

JAR 25.493 Braked roll conditions

(a) An aeroplane with a tail wheel is assumed to be in the level attitude with the load on the main wheels, in accordance with Figure 6 of Appendix A. The limit vertical load factor is 1·2 at the design landing weight, and 1·0 at the design ramp weight. A drag reaction equal to the vertical reaction multiplied by a coefficient of friction of 0·8, must be combined with the vertical ground reaction and applied at the ground contact point.

(b) For an aeroplane with a nose wheel, the limit vertical load factor is 1·2 at the design landing weight, and 1·0 at the design ramp weight. A drag reaction equal to the vertical reaction, multiplied by a coefficient of friction of 0·8, must be combined with the vertical reaction and applied at the ground contact point of each wheel with brakes. The following two attitudes, in accordance with Figure 6 of Appendix A, must be considered:

(1) The level attitude with the wheels contacting the ground and the loads distributed between the main and nose gear. Zero pitching acceleration is assumed.

JAR 25.493(b) (continued)

(2) The level attitude with only the main gear contacting the ground and with the pitching moment resisted by angular acceleration.

(c) A drag reaction lower than that prescribed in this paragraph may be used if it is substantiated that an effective drag force of 0·8 times the vertical reaction cannot be attained under any likely loading condition. **[ ]**

(d) An aeroplane equipped with a nose gear must be designed to withstand the loads arising from the dynamic pitching motion of the aeroplane due to sudden application of maximum braking force. The aeroplane is considered to be at design takeoff weight with the nose and main gears in contact with the ground, and with a steady state vertical load factor of 1·0. The steady state nose gear reaction must be combined with the maximum incremental nose gear vertical reaction caused by sudden application of maximum braking force as described in sub-paragraphs (b) and (c) of this paragraph.

(e) In the absence of a more rational analysis, the nose gear vertical reaction prescribed in sub-paragraph (d) of this paragraph must be calculated in accordance with the following formula:

$$V_N = \frac{W_T}{A+B}\left\{B + \frac{f\mu AE}{A+B+\mu E}\right\}$$

Where:

V_N = Nose gear vertical reaction

W_T = Design take-off weight

A = Horizontal distance between the c.g. of the aeroplane and the nose wheel.

B = Horizontal distance between the c.g. of the aeroplane and the line joining the centres of the main wheels.

E = Vertical height of the c.g. of the aeroplane above the ground in the 1·0 g static condition.

μ = Coefficient of friction of 0·8.

f = Dynamic response factor; 2·0 is to be used unless a lower factor is substantiated.

In the absence of other information, the dynamic response factor f may be defined by the equation.

$$f = 1 + \exp\left[\frac{-\pi\xi}{\sqrt{1-\xi^2}}\right]$$

Where: ξ is the critical damping ratio of the rigid body pitching mode about the main landing gear effective ground contact point.

[Ch.13, 05.10.89; Ch.15, 01.10.00; Amdt. 16, 01.05.03]

JAR 25.495 Turning

In the static position, in accordance with Figure 7 of Appendix A, the aeroplane is assumed to execute a steady turn by nose gear steering, or by application of sufficient differential power, so that the limit load factors applied at the centre of gravity are 1·0 vertically and 0·5 laterally. The side ground reaction of each wheel must be 0·5 of the vertical reaction.

JAR 25.497 Tail-wheel yawing

(a) A vertical ground reaction equal to the static load on the tail wheel, in combination with a side component of equal magnitude, is assumed.

(b) If there is a swivel, the tail wheel is assumed to be swivelled 90º to the aeroplane longitudinal axis with the resultant load passing through the axle.

(c) If there is a lock, steering device, or shimmy damper the tail wheel is also assumed to be in the trailing position with the side load acting at the ground contact point.

JAR 25.499 Nose-wheel yaw and steering

(a) A vertical load factor of 1·0 at the aeroplane centre of gravity, and a side component at the nose wheel ground contact equal to 0·8 of the vertical ground reaction at that point are assumed.

(b) With the aeroplane assumed to be in static equilibrium with the loads resulting from the use of brakes on one side of the main landing gear, the nose gear, its attaching structure, and the fuselage structure forward of the centre of gravity must be designed for the following loads:

(1) A vertical load factor at the centre of gravity of 1·0.

(2) A forward acting load at the aeroplane centre of gravity of 0·8 times the vertical load on one main gear.

(3) Side and vertical loads at the ground contact point on the nose gear that are required for static equilibrium.

(4) A side load factor at the aeroplane centre of gravity of zero.

(c) If the loads prescribed in sub-paragraph (b) of this paragraph result in a nose gear side load higher than 0·8 times the vertical nose gear load, the design nose gear side load may be limited to 0·8 times the vertical load, with unbalanced yawing moments assumed to be resisted by aeroplane inertia forces.

JAR 25.499 (continued)

(d) For other than the nose gear, its attaching structure, and the forward fuselage structure the loading conditions are those prescribed in sub-paragraph (b) of this paragraph, except that –

(1) A lower drag reaction may be used if an effective drag force of 0·8 times the vertical reaction cannot be reached under any likely loading condition; and

(2) The forward acting load at the centre of gravity need not exceed the maximum drag reaction on one main gear, determined in accordance with JAR 25.493(b).

(e) With the aeroplane at design ramp weight, and the nose gear in any steerable position, the combined application of full normal steering torque and vertical force equal to 1·33 times the maximum static reaction on the nose gear must be considered in designing the nose gear, its attaching structure and the forward fuselage structure.

[Ch.15, 01.10.00]

JAR 25.503 Pivoting

(a) The aeroplane is assumed to pivot about one side of the main gear with the brakes on that side locked. The limit vertical load factor must be 1·0 and the coefficient of friction 0·8.

(b) The aeroplane is assumed to be in static equilibrium, with the loads being applied at the ground contact points, in accordance with Figure 8 of Appendix A.

JAR 25.507 Reversed braking

(a) The aeroplane must be in a three point static ground attitude. Horizontal reactions parallel to the ground and directed forward must be applied at the ground contact point of each wheel with brakes. The limit loads must be equal to 0·55 times the vertical load at each wheel or to the load developed by 1·2 times the nominal maximum static brake torque, whichever is less.

(b) For aeroplanes with nose wheels, the pitching moment must be balanced by rotational inertia.

(c) For aeroplanes with tail wheels, the resultant of the ground reactions must pass through the centre of gravity of the aeroplane.

JAR 25.509 Towing Loads

(a) The towing loads specified in sub-paragraph (d) of this paragraph must be considered separately.

JAR 25.509(a) (continued)

These loads must be applied at the towing fittings and must act parallel to the ground. In addition –

(1) A vertical load factor equal to 1·0 must be considered acting at the centre of gravity;

(2) The shock struts and tyres must be in their static positions; and

(3) With W_T as the design ramp weight, the towing load, F_{TOW} is –

(i) 0·3 W_T for W_T less than 30 000 pounds;

(ii) $\frac{6WT + 450\,000}{70}$ for W_T between 30 000 and 100 000 pounds; and

(iii) 0·15 W_T for W_T over 100 000 pounds.

(b) For towing points not on the landing gear but near the plane of symmetry of the aeroplane, the drag and side tow load components specified for the auxiliary gear apply. For towing points located outboard of the main gear, the drag and side tow load components specified for the main gear apply. Where the specified angle of swivel cannot be reached, the maximum obtainable angle must be used.

JAR 25.509(b) (continued)

(c) The towing loads specified in sub-paragraph (d) of this paragraph must be reacted as follows:

(1) The side component of the towing load at the main gear must be reacted by a side force at the static ground line of the wheel to which the load is applied.

(2) The towing loads at the auxiliary gear and the drag components of the towing loads at the main gear must be reacted as follows:

(i) A reaction with a maximum value equal to the vertical reaction must be applied at the axle of the wheel to which the load is applied. Enough aeroplane inertia to achieve equilibrium must be applied.

(ii) The loads must be reacted by aeroplane inertia.

(d) The prescribed towing loads are as specified in the following Table:

Tow Point	Position	Load		
		Magnitude	No.	Direction
Main gear		0·75 F_{TOW} per main gear unit	1 2 3 4	Forward, parallel to drag axis Forward, at 30º to drag axis Aft, parallel to drag axis Aft, at 30º to drag axis
Auxiliary gear	Swivelled forward	1·0 F_{TOW}	5 6	Forward Aft
	Swivelled aft		7 8	Forward Aft
	Swivelled 45º from forward	0·5 F_{TOW}	9 10	Forward, in plane of wheel Aft, in plane of wheel
	Swivelled 45ºfrom aft		11 12	Forward, in plane of wheel Aft, in plane of wheel

JAR 25.511 Ground load: unsymmetrical loads on multiple-wheel units

(a) *General*. Multiple-wheel landing gear units are assumed to be subjected to the limit ground loads prescribed in this Subpart under sub-paragraphs (b) through (f) of this paragraph. In addition –

JAR 25.511(a) (continued)

(1) A tandem strut gear arrangement is a multiple-wheel unit; and

(2) In determining the total load on a gear unit with respect to the provisions of sub-paragraphs (b) through (f) of this paragraph, the transverse shift in the load centroid, due to unsymmetrical load distribution on the wheels, may be neglected.

JAR 25.511 (continued)

(b) *Distribution of limit loads to wheels; tyres inflated*. The distribution of the limit loads among the wheels of the landing gear must be established for each landing, taxying, and ground handling condition, taking into account the effects of the following factors:

(1) The number of wheels and their physical arrangements. For truck type landing gear units, the effects of any see-saw motion of the truck during the landing impact must be considered in determining the maximum design loads for the fore and aft wheel pairs.

(2) Any differentials in tyre diameters resulting from a combination of manufacturing tolerances, tyre growth, and tyre wear. A maximum tyre-diameter differential equal to two-thirds of the most unfavourable combination of diameter variations that is obtained when taking into account manufacturing tolerances, tyre growth and tyre wear, may be assumed.

(3) Any unequal tyre inflation pressure, assuming the maximum variation to be ±5% of the nominal tyre inflation pressure.

(4) A runway crown of zero and a runway crown having a convex upward shape that may be approximated by a slope of 1·5% with the horizontal. Runway crown effects must be considered with the nose gear unit on either slope of the crown.

(5) The aeroplane attitude.

(6) Any structural deflections.

(c) *Deflated tyres.* The effect of deflated tyres on the structure must be considered with respect to the loading conditions specified in sub-paragraphs (d) through (f) of this paragraph, taking into account the physical arrangement of the gear components. In addition –

(1) The deflation of any one tyre for each multiple wheel landing gear unit, and the deflation of any two critical tyres for each landing gear unit using four or more wheels per unit, must be considered; and

(2) The ground reactions must be applied to the wheels with inflated tyres except that, for multiple-wheel gear units with more than one shock strut, a rational distribution of the ground reactions between the deflated and inflated tyres, accounting for the differences in shock strut extensions resulting from a deflated tyre, may be used.

(d) *Landing conditions*. For one and for two deflated tyres, the applied load to each gear unit is assumed to be 60% and 50%, respectively, of the limit load applied to each gear for each of the prescribed landing conditions. However, for the drift landing condition of JAR 25.485, 100% of the vertical load must be applied.

(e) *Taxying and ground handling conditions.* For one and for two deflated tyres –

(1) The applied side or drag load factor, or both factors, at the centre of gravity must be the most critical value up to 50% and 40%, respectively, of the limit side or drag load factors, or both factors, corresponding to the most severe condition resulting from consideration of the prescribed taxying and ground handling conditions.

(2) For the braked roll conditions of JAR 25.493(a) and (b)(2), the drag loads on each inflated tyre may not be less than those at each tyre for the symmetrical load distribution with no deflated tyres;

(3) The vertical load factor at the centre of gravity must be 60% and 50% respectively, of the factor with no deflated tyres, except that it may not be less than 1 g; and

(4) Pivoting need not be considered.

(f) *Towing conditions*. For one and for two deflated tyres, the towing load, F_{TOW}, must be 60% and 50% respectively, of the load prescribed.

[Ch.15, 01.10.00]

JAR 25.519 Jacking and tie-down provisions

(a) *General*. The aeroplane must be designed to withstand the limit load conditions resulting from the static ground load conditions of sub-paragraph (b) of this paragraph and, if applicable, sub-paragraph (c) of this paragraph at the most critical combinations of aeroplane weight and centre of gravity. The maximum allowable load at each jack pad must be specified.

(b) *Jacking*. The aeroplane must have provisions for jacking and must withstand the following limit loads when the aeroplane is supported on jacks:

(1) For jacking by the landing gear at the maximum ramp weight of the aeroplane, the aeroplane structure must be designed for a vertical load of 1·33 times the vertical static reaction at each jacking point acting singly and in combination with a horizontal load of 0·33 times the vertical static reaction applied in any direction.

JAR 25.519(b) (continued)

(2) For jacking by other aeroplane structure at maximum approved jacking weight:

(i) The aeroplane structure must be designed for a vertical load of 1·33 times the vertical reaction at each jacking point acting singly and in combination with a horizontal load of 0·33 times the vertical static reaction applied in any direction.

(ii) The jacking pads and local structure must be designed for a vertical load of 2·0 times the vertical static reaction at each jacking point, acting singly and in combination with a horizontal load of 0·33 times the vertical static reaction applied in any direction.

(c) *Tie-down.* If tie-down points are provided, the main tie-down points and local structure must withstand the limit loads resulting from a 65-knot horizontal wind from any direction.

[Ch.15, 01.10.00]

EMERGENCY LANDING CONDITIONS

JAR 25.561 General
(See ACJ 25.561.)

(a) The aeroplane, although it may be damaged in emergency landing conditions on land or water, must be designed as prescribed in this paragraph to protect each occupant under those conditions.

(b) The structure must be designed to give each occupant every reasonable chance of escaping serious injury in a minor crash landing when –

(1) Proper use is made of seats, belts, and all other safety design provisions;

(2) The wheels are retracted (where applicable); and

(3) The occupant experiences the following ultimate inertia forces acting separately relative to the surrounding structure:

(i) Upward, 3·0g

(ii) Forward, 9·0g

(iii) Sideward, 3·0g on the airframe and 4·0g on the seats and their attachments

(iv) Downward, 6·0g

(v) Rearward, 1·5g (See AMJ 25.561(b)(3).)

JAR 25.561 (continued)

(c) For equipment, cargo in the passenger compartments and any other large masses, the following apply:

(1) These items must be positioned so that if they break loose they will be unlikely to:

(i) Cause direct injury to occupants;

(ii) Penetrate fuel tanks or lines or cause fire or explosion hazard by damage to adjacent systems; or

(iii) Nullify any of the escape facilities provided for use after an emergency landing.

(2) When such positioning is not practical (e.g. fuselage mounted engines or auxiliary power units) each such item of mass shall be restrained under all loads up to those specified in paragraph (b)(3) of this section. The local attachments for these items should be designed to withstand 1·33 times the specified loads if these items are subject to severe wear and tear through frequent removal (e.g. quick change interior items).

(d) Seats and items of mass (and their supporting structure) must not deform under any loads up to those specified in sub-paragraph (b)(3) of this paragraph in any manner that would impede subsequent rapid evacuation of occupants. (See ACJ 25.561(d).)

[Ch.11, 17.03.86; Ch.13, 05.10.89; Ch.15, 01.10.00]

JAR 25.562 Emergency landing dynamic conditions

(a) The seat and restraint system in the aeroplane must be designed as prescribed in this paragraph to protect each occupant during an emergency landing condition when –

(1) Proper use is made of seats, safety belts, and shoulder harnesses provided for in the design; and

(2) The occupant is exposed to loads resulting from the conditions prescribed in this paragraph.

(b) [With the exception of flight deck crew seats, each seat type design approved for occupancy] must successfully complete dynamic tests or be demonstrated by rational analysis based on dynamic tests of a similar type seat, in accordance with each of the following emergency landing conditions. The tests must be conducted with an occupant simulated by a 170-pound (77·11 kg) anthropomorphic, test dummy sitting in the normal upright position:

JAR 25.562(b) (continued)

(1) A change in downward vertical velocity, (Δv) of not less than 35 feet per second (10·67 m/s), with the aeroplane's longitudinal axis canted downward 30 degrees with respect to the horizontal plane and with the wings level. Peak floor deceleration must occur in not more than 0·08 seconds after impact and must reach a minimum of 14 g.

(2) A change in forward longitudinal velocity (Δv) of not less than 44 feet per second (13·41 m/s), with the aeroplane's longitudinal axis horizontal and yawed 10 degrees either right or left, whichever would cause the greatest likelihood of the upper torso restraint system (where installed) moving off the occupant's shoulder, and with the wings level. Peak floor deceleration must occur in not more than 0·09 seconds after impact and must reach a minimum of 16 g. Where floor rails or floor fittings are used to attach the seating devices to the test fixture, the rails or fittings must be misaligned with respect to the adjacent set of rails or fittings by at least 10 degrees vertically (i.e. out of parallel) with one rolled 10 degrees.

(c) The following performance measures must not be exceeded during the dynamic tests conducted in accordance with sub-paragraph (b) of this paragraph:

(1) Where upper torso straps are used tension loads in individual straps must not exceed 1 750 pounds (793·78 kg). If dual straps are used for restraining the upper torso, the total strap tension loads must not exceed 2 000 pounds (907·18 kg).

(2) The maximum compressive load measured between the pelvis and the lumbar column of the anthropomorphic dummy must not exceed 1 500 pounds (680·38 kg).

(3) The upper torso restraint straps (where installed) must remain on the occupant's shoulder during the impact.

(4) The lap safety belt must remain on the occupant's pelvis during the impact.

(5) Each occupant must be protected from serious head injury under the conditions prescribed in sub-paragraph (b) of this paragraph. Where head contact with seats or other structure can occur, protection must be provided so that the head impact does not exceed a Head Injury Criterion (HIC) of 1 000 units. The level of HIC is defined by the equation –

$$HIC = \left\{ (t_2 - t_1) \left[\frac{1}{(t_2 - t_1)} \int_{t_1}^{t_2} a(t)dt \right]^{2 \cdot 5} \right\}_{max}$$

JAR 25.562(c) (continued)

Where –

t_1 is the initial integration time,

t_2 is the final integration time, and

a(t) is the total acceleration vs. time curve for the head strike, and where

(t) is in seconds, and (a) is in units of gravity (g).

(6) Where leg injuries may result from contact with seats or other structure, protection must be provided to prevent axially compressive loads exceeding 2 250 pounds (1 020·58 kg) in each femur.

(7) The seat must remain attached at all points of attachment, although the structure may have yielded.

(8) Seats must not yield under the tests specified in sub-paragraphs (b)(1) and (b)(2) of this paragraph to the extent they would impede rapid evacuation of the aeroplane occupants.

[Ch.13, 05.10.89; Amdt. 16, 01.05.03]

JAR 25.563 Structural ditching provisions

Structural strength considerations of ditching provisions must be in accordance with JAR 25.801 (e).

FATIGUE EVALUATION

JAR 25.571 Damage-tolerance and fatigue evaluation of structure

(a) *General.* An evaluation of the strength, detail design, and fabrication must show that catastrophic failure due to fatigue, corrosion, or accidental damage, will be avoided throughout the operational life of the aeroplane. This evaluation must be conducted in accordance with the provisions of sub-paragraphs (b) and (e) of this paragraph, except as specified in sub-paragraph (c) of this paragraph, for each part of the structure which could contribute to a catastrophic failure (such as wing, empennage, control surfaces and their systems, the fuselage, engine mounting, landing gear, and their related primary attachments). (See ACJ 25.571(a).) For turbine engine powered aeroplanes, those parts which could contribute to a catastrophic failure must also be evaluated under sub-paragraph (d) of this paragraph. In addition, the following apply:

JAR 25.571(a) (continued)

(1) Each evaluation required by this paragraph must include –

(i) The typical loading spectra, temperatures, and humidities expected in service;

(ii) The identification of principal structural elements and detail design points, the failure of which could cause catastrophic failure of the aeroplane; and

(iii) An analysis, supported by test evidence, of the principal structural elements and detail design points identified in sub-paragraph (a)(1)(ii) of this paragraph.

(2) The service history of aeroplanes of similar structural design, taking due account of differences in operating conditions and procedures, may be used in the evaluations required by this paragraph.

(3) Based on the evaluations required by this paragraph, inspections or other procedures must be established as necessary to prevent catastrophic failure, and must be included in the Airworthiness Limitations Section of the Instructions for Continued Airworthiness required by JAR 25.1529.

(b) *Damage-tolerance (fail-safe) evaluation*. The evaluation must include a determination of the probable locations and modes of damage due to fatigue, corrosion, or accidental damage. The determination must be by analysis supported by test evidence and (if available) service experience. Damage at multiple sites due to prior fatigue exposure must be included where the design is such that this type of damage can be expected to occur. The evaluation must incorporate repeated load and static analyses supported by test evidence. The extent of damage for residual strength evaluation at any time within the operational life must be consistent with the initial detectability and subsequent growth under repeated loads. The residual strength evaluation must show that the remaining structure is able to withstand loads (considered as static ultimate loads) corresponding to the following conditions:

(1) The limit symmetrical manoeuvring conditions specified in JAR 25.337 up to V_C and in JAR 25.345.

(2) The limit gust conditions specified in JAR 25.341 at the specified speeds up to V_C and in JAR 25.345.

(3) The limit rolling conditions specified in JAR 25.349 and the limit unsymmetrical conditions specified in JAR 25.367 and JAR 25.427(a) through (c), at speeds up to V_C.

JAR 25.571(b) (continued)

(4) The limit yaw manoeuvring conditions specified in JAR 25.351 at the specified speeds up to V_C.

(5) For pressurised cabins, the following conditions:

(i) The normal operating differential pressure combined with the expected external aerodynamic pressures applied simultaneously with the flight loading conditions specified in sub-paragraphs (b)(1) to (b)(4) of this paragraph if they have a significant effect.

(ii) The maximum value of normal operating differential pressure (including the expected external aerodynamic pressures during 1 g level flight) multiplied by a factor of 1·15 omitting other loads.

(6) For landing gear and directly-affected airframe structure, the limit ground loading conditions specified in JAR 25.473, JAR 25.491 and JAR 25.493.

If significant changes in structural stiffness or geometry, or both, follow from a structural failure, or partial failure, the effect on damage tolerance must be further investigated. (See ACJ 25.571 (b).) The residual strength requirements of this sub-paragraph (b) apply, where the critical damage is not readily detectable. On the other hand, in the case of damage which is readily detectable within a short period, smaller loads than those of sub-paragraphs (b)(1) to (b)(6) inclusive may be used by agreement with the Authority. A probability approach may be used in these latter assessments, substantiating that catastrophic failure is extremely improbable. (See ACJ 25.571(a), paragraph 2.1.2.)

(c) *Fatigue (safe-life) evaluation*. Compliance with the damage-tolerance requirements of sub-paragraph (b) of this paragraph is not required if the applicant establishes that their application for particular structure is impractical. This structure must be shown by analysis, supported by test evidence, to be able to withstand the repeated loads of variable magnitude expected during its service life without detectable cracks. Appropriate safe-life scatter factors must be applied.

(d) *Sonic fatigue strength.* It must be shown by analysis, supported by test evidence, or by the service history of aeroplanes of similar structural design and sonic excitation environment, that –

(1) Sonic fatigue cracks are not probable in any part of the flight structure subject to sonic excitation; or

JAR 25.571(d) (continued)

(2) Catastrophic failure caused by sonic cracks is not probable assuming that the loads prescribed in sub-paragraph (b) of this paragraph are applied to all areas affected by those cracks.

(e) *Damage-tolerance (discrete source) evaluation.* The aeroplane must be capable of successfully completing a flight during which likely structural damage occurs as a result of –

(1) Bird impact as specified in JAR 25.631;

(2) Reserved

(3) Reserved

(4) Sudden decompression of compartments as specified in JAR 25.365(e) and (f).

The damaged structure must be able to withstand the static loads (considered as ultimate loads) which are reasonably expected to occur at the time of the occurrence and during the completion of the flight. Dynamic effects on these static loads need not be considered. Corrective action to be taken by the pilot following the incident, such as limiting manoeuvres, avoiding turbulence, and reducing speed, may be considered. If significant changes in structural stiffness or geometry, or both, follow from a structural failure or partial failure, the effect on damage tolerance must be further investigated. (See ACJ 25.571(a), paragraph 2.7.2 and ACJ 25.571(b).)

[Ch.10, 19.12.83; Ch.11, 17.03.86; Ch.12, 10.05.88; Ch.14, 27.05.94; Ch.15, 01.10.00]

LIGHTNING PROTECTION

JAR 25.581 Lightning protection

(a) The aeroplane must be protected against **[** catastrophic effects from lightning. (See JAR 25.899 and ACJ 25.581.) **]**

(b) For metallic components, compliance with sub-paragraph (a) of this paragraph may be shown by –

(1) Bonding the components properly to the airframe; or

(2) Designing the components so that a strike will not endanger the aeroplane.

(c) For non-metallic components, compliance with sub-paragraph (a) of this paragraph may be shown by –

JAR 25.581(c) (continued)

(1) Designing the components to minimise the effect of a strike; or

(2) Incorporating acceptable means of diverting the resulting electrical current so as not to endanger the aeroplane.

[Amdt. 16, 01.05.03]

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SUBPART D – DESIGN AND CONSTRUCTION

GENERAL

JAR 25.601 General

The aeroplane may not have design features or details that experience has shown to be hazardous or unreliable. The suitability of each questionable design detail and part must be established by tests.

JAR 25.603 Materials (For Composite Materials
(See ACJ 25.603.)

The suitability and durability of materials used for parts, the failure of which could adversely affect safety, must –

(a) Be established on the basis of experience or tests;

(b) Conform to approved specifications (such as industry or military specifications, or Technical Standard Orders) that ensure their having the strength and other properties assumed in the design data; and

(c) Take into account the effects of environmental conditions, such as temperature and humidity, expected in service.

[Ch.12, 10.05.88]

JAR 25.605 Fabrication methods

[(a) The methods of fabrication used must produce a consistently sound structure. If a fabrication process (such as gluing, spot welding, or heat treating) requires close control to reach this objective, the process must be performed under an approved process specification.**]**

(b) Each new aircraft fabrication method must be substantiated by a test programme.

[Amdt. 16, 01.05.03]

JAR 25.607 Fasteners
[(See ACJ 25.607) **]**

(a) Each removable bolt, screw, nut, pin or **[** other removable fastener must incorporate two **]** separate locking devices if –

(1) Its loss could preclude continued flight and landing within the design limitations of the aeroplane using normal pilot skill and strength; or

JAR 25.607(a) (continued)

(2) Its loss could result in reduction in pitch, roll or yaw control capability or response below that required by Subpart B of this JAR–25.

(b) The fasteners specified in sub-paragraph (a) of this paragraph and their locking devices may not be adversely affected by the environmental conditions associated with the particular installation.

(c) No self-locking nut may be used on any bolt subject to rotation in operation unless a non-friction locking device is used in addition to the self-locking device.

[Amdt. 16, 01.05.03]

JAR 25.609 Protection of structure

Each part of the structure must (see ACJ 25.609)-

(a) Be suitably protected against deterioration or loss of strength in service due to any cause, including –

(1) Weathering;

(2) Corrosion; and

(3) Abrasion; and

(b) Have provisions for ventilation and drainage where necessary for protection.

JAR 25.611 Accessibility provisions

Means must be provided to allow inspection (including inspection of principal structural elements and control systems), replacement of parts normally requiring replacement, adjustment, and lubrication as necessary for continued airworthiness. The inspection means for each item must be practicable for the inspection interval for the item. Non-destructive inspection aids may be used to inspect structural elements where it is impracticable to provide means for direct visual inspection if it is shown that the inspection is effective and the inspection procedures are specified in the maintenance manual required by JAR 25.1529.

JAR 25.613 Material strength properties and design values

(a) Material strength properties must be based on enough tests of material meeting approved

JAR 25.613(a) (continued)

specifications to establish design values on a statistical basis.

(b) Design values must be chosen to minimise the probability of structural failures due to material variability. Except as provided in sub-paragraph (e) of this paragraph, compliance with this sub-paragraph must be shown by selecting design values which assure material strength with the following probability:

(1) Where applied loads are eventually distributed through a single member within an assembly, the failure of which would result in loss of structural integrity of the component, 99% probability with 95% confidence.

(2) For redundant structure, in which the failure of individual elements would result in applied loads being safely distributed to other load carrying members, 90% probability with 95% confidence.

(c) The effects of temperature on allowable stresses used for design in an essential component or structure must be considered where thermal effects are significant under normal operating conditions.

(d) The strength, detail design, and fabrication of the structure must minimise the probability of disastrous fatigue failure, particularly at points of stress concentration.

(e) Greater design values may be used if a 'premium selection' of the material is made in which a specimen of each individual item is tested before use to determine that the actual strength properties of that particular item will equal or exceed those used in design.

[Ch.11, 17.03.86; Ch.14, 27.05.94]

JAR 25.615 Reserved

[Ch.14, 27.05.94]

JAR 25.619 Special factors

The factor of safety prescribed in JAR 25.303 must be multiplied by the highest pertinent special factor of safety prescribed in JAR 25.621 through JAR 25.625 for each part of the structure whose strength is –

(a) Uncertain.

(b) Likely to deteriorate in service before normal replacement; or

(c) Subject to appreciable variability because of uncertainties in manufacturing processes or inspection methods.

JAR 25.619(c) (continued)

Where the Authority is not satisfied in a specific case that a special factor is the correct approach to ensuring the necessary integrity of the parts of the structure under service conditions, other appropriate measures must be taken.

JAR 25.621 Casting factors

The approved national standards of the participants are accepted by the Authorities as alternatives to FAR 25.621.

JAR 25.623 Bearing factors

(a) Except as provided in sub-paragraph (b) of this paragraph, each part that has clearance (free fit), and that is subject to pounding or vibration, must have a bearing factor large enough to provide for the effects of normal relative motion.

(b) No bearing factor need be used for a part for which any larger special factor is prescribed.

JAR 25.625 Fitting factors

For each fitting (a part or terminal used to join one structural member to another), the following apply:

(a) For each fitting whose strength is not proven by limit and ultimate load tests in which actual stress conditions are simulated in the fitting and surrounding structures, a fitting factor of at least 1·15 must be applied to each part of –

(1) The fitting;

(2) The means of attachment; and

(3) The bearing on the joined members.

(b) No fitting factor need be used –

(1) For joints made under approved practices and based on comprehensive test data (such as continuous joints in metal plating, welded joints, and scarf joints in wood); or

(2) With respect to any bearing surface for which a larger special factor is used.

(c) For each integral fitting, the part must be treated as a fitting up to the point at which the section properties become typical of the member.

(d) For each seat, berth, safety belt, and harness, the fitting factor specified in JAR 25.785(f)(3) applies.

[Ch.14, 27.05.94]

JAR 25.629 Flutter, deformation, and failsafe criteria

(a) G*eneral.* Compliance with this paragraph must be shown by calculations, resonance tests, or other tests found necessary by the Authority. Full scale flight flutter tests at speeds up to V_{DF}/M_{DF} for the critical aeroplane flutter modes must be conducted when –

(1) M_D is equal to or greater than 0·8 M;

(2) The adequacy of flutter analysis and wind tunnel tests have not been established by previous experience with aircraft having similar design features; or

(3) The conditions specified in sub-paragraph (a)(1) or (2) of this paragraph exist, and modifications to the type design have a significant effect on the critical flutter modes.

(b) Flutter and divergence prevention. The dynamic evaluation of the aeroplane must include an investigation of the significant elastic, inertia, and aerodynamic forces associated with the rotations and displacements of the plane of the propeller. In addition, the following apply:

(1) The aeroplane must be designed to be free from flutter and divergence (unstable structural distortion due to aerodynamic loading) for all combinations of altitude and speed encompassed by the V_D/M_D versus altitude envelope enlarged at all points by an increase of 20% in equivalent air-speed at both constant Mach number and constant altitude, except that the envelope may be limited to a maximum Mach number of 1·0 when M_D is less than 1·0 at all design altitudes and the following is established:

(i) A proper margin of damping exists at all speeds up to M_D; and

(ii) There is no large and rapid reduction in damping as M_D is approached.

(2) If concentrated balance weights are used on control surfaces, their effectiveness and strength, including supporting structure, must be substantiated.

(c) *Loss of control due to structural* deformation. The aeroplane must be designed to be free from control reversal and from undue loss of longitudinal, lateral, and directional stability and control, as a result of structural deformation (including that of the control surface covering) at speeds up to the speed prescribed in sub-paragraph (b) of this paragraph for flutter prevention.

(d) *Fail-safe criteria.* The following fail-safe criteria must be met:

(1) It must be shown, by analysis or tests, that the aeroplane is free from such flutter or divergence that would preclude safe flight, at any speed up to V_D, after each of the following:

(i) Each of the failures, malfunctions, or adverse conditions listed in sub-paragraph (d)(4) of this paragraph.

(ii) Any other combination of failures, malfunctions, or adverse conditions not shown to be extremely improbable.

(2) If a failure, malfunction, or adverse condition described in sub-paragraph (d)(4) of this paragraph is simulated during a flight test in showing compliance with this paragraph, the maximum speed investigated need not exceed V_{FC} if it is shown, by correlation of the flight test data with other test data or analyses, that hazardous flutter or divergence will not occur at any speed up to V_D.

(3) The structural failures described in sub-paragraphs (d)(4)(i) and (ii) of this paragraph need not be considered in showing compliance with this paragraph if engineering data substantiate that the probability of their occurrence is negligible by showing that the structural element is designed with –

(i) Conservative static strength margins for each ground and flight loading conditions specified in this JAR–25; or

(ii) Sufficient fatigue strength for the loading spectrum expected in operation.

(4) The failures, malfunctions, or adverse conditions used to show compliance with this paragraph are as follows:

(i) Failure of any single element of the structure supporting any engine, independently mounted propeller shaft, large auxiliary power unit, or large externally mounted aerodynamic body (such as an external fuel tank).

(ii) Any single failure of the engine structure, on turbo-propeller aeroplanes, that would reduce the yaw or pitch rigidity of the propeller rotational axis.

(iii) Absence of propeller aerodynamic forces resulting from the feathering of any single propeller, and, for aeroplanes with four or more engines, the feathering of the critical combination of two propellers. In addition, any single

JAR 25.629(d)(4) (continued)

feathered propeller must be paired with the failures, specified in (d)(4)(i) of this sub-paragraph, involving failure of any single element of the structure supporting any engine or independently mounted propeller shaft, and the failures specified in (d)(4)(ii) of this sub-paragraph.

(iv) Any single propeller rotating at the highest likely overspeed.

(v) Failure of each principal structural element selected for compliance with JAR 25.571 (b). Safety following a failure may be substantiated by showing that losses in rigidity or changes in frequency, mode shape, or damping are within the parameter variations shown to be satisfactory in the flutter and divergence investigations.

(vi) Any single failure or malfunction, or combinations thereof, in the flight control system considered under JAR 25.671, 25.672 and 25.1309, and any single failure in any flutter damper system. Investigation of forced structural vibration other than flutter, resulting from failures, malfunctions, or adverse conditions in the automatic flight control system may be limited to airspeed up to V_C.

[Ch.14, 27.05.94]

JAR 25.631 Bird strike damage

The aeroplane must be designed to assure capability of continued safe flight and landing of the aeroplane after impact with a 4 lb bird when the velocity of the aeroplane (relative to the bird along the aeroplane's flight path) is equal to V_C at sea-level or 0·85 V_C at 8 000 ft, whichever is the more critical. Compliance may be shown by analysis only when based on tests carried out on sufficiently representative structures of similar design. (See ACJ 25.631.)

CONTROL SURFACES

JAR 25.651 Proof of strength

(a) Limit load tests of control surfaces are required. These tests must include the horn or fitting to which the control system is attached.

(b) Compliance with the special factors requirements of JAR 25.619 to 25.625 and 25.657 for control surface hinges must be shown by analysis or individual load tests.

JAR 25.655 Installation

(a) Movable tail surfaces must be installed so that there is no interference between any surfaces when one is held in its extreme position and the others are operated through their full angular movement.

(b) If an adjustable stabiliser is used, it must have stops that will limit its range of travel to the maximum for which the aeroplane is shown to meet the trim requirements of JAR 25.161.

JAR 25.657 Hinges

(a) For control surface hinges, including ball, roller, and self-lubricated bearing hinges, the approved rating of the bearing may not be exceeded. For non-standard bearing hinge configurations, the rating must be established on the basis of experience or tests and, in the absence of a rational investigation, a factor of safety of not less than 6·67 must be used with respect to the ultimate bearing strength of the softest material used as a bearing.

(b) Hinges must have enough strength and rigidity for loads parallel to the hinge line.

CONTROL SYSTEMS

JAR 25.671 General

(a) Each control and control system must operate with the ease, smoothness, and positiveness appropriate to its function. (See ACJ 25.671(a).)

(b) Each element of each flight control system must be designed, or distinctively and permanently marked, to minimise the probability of incorrect assembly that could result in the malfunctioning of the system. (See ACJ 25.671(b).)

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

(1) Any single failure not shown to be extremely improbable, excluding jamming, (for example, disconnection or failure of mechanical elements, or structural failure of hydraulic components, such as actuators, control spool housing, and valves). (See ACJ 25.671(c)(1).)

JAR 25.671(c) (continued)

(2) Any combination of failures not shown to be extremely improbable, excluding jamming (for example, dual electrical or hydraulic system failures, or any single failure in combination with any probable hydraulic or electrical failure).

(3) Any jam in a control position normally encountered during take-off, climb, cruise, normal turns, descent and landing unless the jam is shown to be extremely improbable, or can be alleviated. A runaway of a flight control to an adverse position and jam must be accounted for if such runaway and subsequent jamming is not extremely improbable.

(d) The aeroplane must be designed so that it is controllable if all engines fail. Compliance with this requirement may be shown by analysis where that method has been shown to be reliable.

JAR 25.672 Stability augmentation and automatic and power-operated systems

If the functioning of stability augmentation or other automatic or power-operated systems is necessary to show compliance with the flight characteristics requirements of this JAR-25, such systems must comply with JAR 25.671 and the following:

(a) A warning which is clearly distinguishable to the pilot under expected flight conditions without requiring his attention must be provided for any failure in the stability augmentation system or in any other automatic or power-operated system which could result in an unsafe condition if the pilot were not aware of the failure. Warning systems must not activate the control systems.

(b) The design of the stability augmentation system or of any other automatic or power-operated system must permit initial counteraction of failures of the type specified in JAR 25.671(c) without requiring exceptional pilot skill or strength, by either the deactivation of the system, or a failed portion thereof, or by overriding the failure by movement of the flight controls in the normal sense.

(c) It must be shown that after any single failure of the stability augmentation system or any other automatic or power-operated system –

(1) The aeroplane is safely controllable when the failure or malfunction occurs at any speed or altitude within the approved operating limitations that is critical for the type of failure being considered. (See ACJ 25.672(c)(1).)

JAR 25.672(c) (continued)

(2) The controllability and manoeuvrability requirements of this JAR-25 are met within a practical operational flight envelope (for example, speed, altitude, normal acceleration, and aeroplane configurations) which is described in the Aeroplane Flight Manual; and

(3) The trim, stability, and stall characteristics are not impaired below a level needed to permit continued safe flight and landing.

JAR 25.673 Reserved

[Ch.14, 27.05.94]

JAR 25.675 Stops

(a) Each control system must have stops that positively limit the range of motion of each movable aerodynamic surface controlled by the system.

(b) Each stop must be located so that wear, slackness, or take-up adjustments will not adversely affect the control characteristics of the aeroplane because of a change in the range of surface travel.

(c) Each stop must be able to withstand any loads corresponding to the design conditions for the control system.

JAR 25.677 Trim systems

(a) Trim controls must be designed to prevent inadvertent or abrupt operation and to operate in the plane, and the sense of motion, of the aeroplane.

(b) There must be means adjacent to the trim control to indicate the direction of the control movement relative to the aeroplane motion. In addition, there must be clearly visible means to indicate the position of the trim device with respect to the range of adjustment. The indicator must be clearly marked with the range within which it has been demonstrated that take-off is safe for all centre of gravity positions approved for take-off.

(c) Trim control systems must be designed to prevent creeping in flight. Trim tab controls must be irreversible unless the tab is appropriately balanced and shown to be free from flutter.

(d) If an irreversible tab control system is used, the part from the tab to the attachment of the irreversible unit to the aeroplane structure must consist of a rigid connection.

[Ch.11, 17.03.86]

JAR 25.679 Control system gust locks

(a) There must be a device to prevent damage to the control surfaces (including tabs), and to the control system, from gusts striking the aeroplane while it is on the ground. If the device, when engaged, prevents normal operation of the control surfaces by the pilot, it must –

(1) Automatically disengage when the pilot operates the primary flight controls in a normal manner; or

(2) Limit the operation of the aeroplane so that the pilot receives unmistakable warning at the start of take-off. (See ACJ 25.679(a)(2).)

(b) The device must have means to preclude the possibility of it becoming inadvertently engaged in flight. (See ACJ 25.679(b).)

[Ch.14, 27.05.94]

JAR 25.681 Limit load static tests

(a) Compliance with the limit load requirements of this JAR–25 must be shown by tests in which –

(1) The direction of the test loads produces the most severe loading in the control system; and

(2) Each fitting, pulley, and bracket used in attaching the system to the main structure is included.

(b) Compliance must be shown (by analyses or individual load tests) with the special factor requirements for control system joints subject to angular motion.

JAR 25.683 Operation tests

(a) It must be shown by operation tests that when portions of the control system subject to pilot effort loads are loaded to 80% of the limit load specified for the system and the powered portions of the control system are loaded to the maximum load expected in normal operation, the system is free from –

(1) Jamming;

(2) Excessive friction; and

(3) Excessive deflection.

(b) It must be shown by analysis and, where necessary, by tests that in the presence of deflections of the aeroplane structure due to the separate application of pitch, roll and yaw limit manoeuvre loads, the control system, when loaded

JAR 25.683(b) (continued)

to obtain these limit loads and operated within its operational range of deflections can be exercised about all control axes and remain free from-

(1) Jamming;

(2) Excessive friction;

(3) Disconnection, and

(4) Any form of permanent damage.

(c) It must be shown that under vibration loads in the normal flight and ground operating conditions, no hazard can result from interference or contact with adjacent elements.

JAR 25.685 Control system details

(a) Each detail of each control system must be designed and installed to prevent jamming, chafing, and interference from cargo, passengers, loose objects or the freezing of moisture. (See ACJ 25.685 (a).)

(b) There must be means in the cockpit to prevent the entry of foreign objects into places where they would jam the system.

(c) There must be means to prevent the slapping of cables or tubes against other parts.

(d) JAR 25.689 and JAR 25.693 apply to cable systems and joints.

JAR 25.689 Cable systems

(a) Each cable, cable fitting, turnbuckle, splice, and pulley must be approved. In addition –

(1) No cable smaller than 0·125 inch diameter may be used in the aileron, elevator, or rudder systems; and

(2) Each cable system must be designed so that there will be no hazardous change in cable tension throughout the range of travel under operating conditions and temperature variations.

(b) Each kind and size of pulley must correspond to the cable with which it is used. Pulleys and sprockets must have closely fitted guards to prevent the cables and chains from being displaced or fouled. Each pulley must lie in the plane passing through the cable so that the cable does not rub against the pulley flange.

(c) Fairleads must be installed so that they do not cause a change in cable direction of more than three degrees.

JAR 25.689 (continued)

(d) Clevis pins subject to load or motion and retained only by cotter pins may not be used in the control system.

(e) Turnbuckles must be attached to parts having angular motion in a manner that will positively prevent binding throughout the range of travel.

(f) There must be provisions for visual inspection of fairleads, pulleys, terminals, and turnbuckles.

JAR 25.693 Joints

Control system joints (in push-pull systems) that are subject to angular motion, except those in ball and roller bearing systems must have a special factor of safety of not less than 3·33 with respect to the ultimate bearing strength of the softest material used as a bearing. This factor may be reduced to 2·0 for joints in cable control systems. For ball or roller bearings, the approved ratings, may not be exceeded.

JAR 25.697 Lift and drag devices, controls

(a) Each lift device control must be designed so that the pilots can place the device in any take-off, en-route, approach, or landing position established under JAR 25.101(d). Lift and drag devices must maintain the selected positions, except for movement produced by an automatic positioning or load limiting device, without further attention by the pilots.

(b) Each lift and drag device control must be designed and located to make inadvertent operation improbable. Lift and drag devices intended for ground operation only must have means to prevent the inadvertent operation of their controls in flight if that operation could be hazardous.

(c) The rate of motion of the surfaces in response to the operation of the control and the characteristics of the automatic positioning or load limiting device must give satisfactory flight and performance characteristics under steady or changing conditions of airspeed, engine power, and aeroplane attitude.

(d) The lift device control must be designed to retract the surfaces from the fully extended position, during steady flight at maximum continuous engine power at any speed below V_F + 9·0 (knots).

[Ch.15, 01.10.00]

JAR 25.699 Lift and drag device indicator

(a) There must be means to indicate to the pilots the position of each lift or drag device having a separate control in the cockpit to adjust its position. In addition, an indication of unsymmetrical operation or other malfunction in the lift or drag device systems must be provided when such indication is necessary to enable the pilots to prevent or counteract an unsafe flight or ground condition, considering the effects on flight characteristics and performance.

(b) There must be means to indicate to the pilots the take-off, en-route, approach, and landing lift device positions.

(c) If any extension of the lift and drag device beyond the landing position is possible, the control must be clearly marked to identify this range of extension.

JAR 25.701 Flap and slat interconnection

(a) Unless the aeroplane has safe flight characteristics with the flaps or slats retracted on one side and extended on the other, the motion of flaps or slats on opposite sides of the plane of symmetry must be synchronised by a mechanical interconnection or approved equivalent means.

(b) If a wing-flap or slat interconnection or equivalent means is used, it must be designed to account for the applicable unsymmetrical loads, including those resulting from flight with the engines on one side of the plane of symmetry inoperative and the remaining engines at take-off power.

(c) For aeroplanes with flaps or slats that are not subjected to slipstream conditions, the structure must be designed for the loads imposed when the wing-flaps or slats on one side are carrying the most severe load occurring in the prescribed symmetrical conditions and those on the other side are carrying not more than 80% of that load.

(d) The interconnection must be designed for the loads resulting when interconnected flap or slat surfaces on one side of the plane of symmetry are jammed and immovable while the surfaces on the other side are free to move and the full power of the [surface actuating system is applied. (See ACJ 25.701(d).)]

[Ch.14, 27.05.94; Amdt. 16, 01.05.03]

JAR 25.703 Take-off warning system [(See ACJ 25.703)]

A take-off warning system must be installed and must meet the following requirements:

(a) The system must provide to the pilots an aural warning that is automatically activated during the initial portion of the take-off roll if the aeroplane is in a configuration, including any of the following, that would not allow a safe take-off:

(1) The wing-flaps or leading edge devices are not within the approved range of take-off positions.

(2) Wing spoilers (except lateral control spoilers meeting the requirements of JAR 25.671), speed brakes, or longitudinal trim devices are in a position that would not allow a safe take-off.

(3) The parking brake is unreleased.

[(b) The aural warning required by sub-paragraph (a) of this paragraph must continue until –

(1) The take-off configuration is changed to allow a safe take-off;

(2) Action is taken by the pilot to terminate the take-off roll;

(3) The aeroplane is rotated for take-off; or

(4) The warning is manually silenced by the pilot. The means to silence the warning must not be readily available to the flight crew such that it could be operated instinctively, inadvertently, or by habitual reflexive action. Before each take-off, the warning must be rearmed automatically, or manually if the absence of automatic rearming is clear and unmistakable.]

(c) The means used to activate the system must function properly for all authorised take-off power settings and procedures, and throughout the ranges of take-off weights, altitudes, and temperatures for which certification is requested.

[Ch.8, 30.11.81; Amdt. 16, 01.05.03]

LANDING GEAR

JAR 25.721 General

(a) The main landing gear system must be designed so that if it fails due to overloads during take-off and landing (assuming the overloads to act

JAR 25.721(a) (continued)

in the upward and aft directions), the failure mode is not likely to cause –

(1) For aeroplanes that have a passenger seating configuration, excluding pilots seats, of nine seats or less, the spillage of enough fuel from any fuel system in the fuselage to constitute a fire hazard; and

(2) For aeroplanes that have a passenger seating configuration, excluding pilots seats, of 10 seats or more, the spillage of enough fuel from any part of the fuel system to constitute a fire hazard.

(b) Each aeroplane that has a passenger seating configuration, excluding pilots seats, of 10 or more must be designed so that with the aeroplane under control it can be landed on a paved runway with any one or more landing gear legs not extended without sustaining a structural component failure that is likely to cause the spillage of enough fuel to constitute a fire hazard.

(c) Compliance with the provisions of this paragraph may be shown by analysis or tests, or both.

JAR 25.723 Shock absorption tests [(See ACJ 25.723)]

(a) The analytical representation of the landing gear dynamic characteristics that is used in determining the landing loads must be validated by energy absorption tests. A range of tests must be conducted to ensure that the analytical representation is valid for the design conditions specified in JAR 25.473.

(1) The configurations subjected to energy absorption tests at limit design conditions must include at least the design landing weight or the design takeoff weight, whichever produces the greater value of landing impact energy.]

(2) The test attitude of the landing gear unit and the application of appropriate drag loads during the test must simulate the aeroplane landing conditions in a manner consistent with the development of rational or conservative limit loads.

(3) [Revoked.]

(b) The landing gear may not fail in a test, demonstrating its reserve energy absorption capacity, simulating a descent velocity of 12 fps at design landing weight, assuming aeroplane lift not greater than the aeroplane weight acting during the landing impact.

JAR 25.723 (continued)

[(c) In lieu of the tests prescribed in this paragraph, changes in previously approved design weights and minor changes in design may be substantiated by analyses based on previous tests conducted on the same basic landing gear system that has similar energy absorption characteristics. **]**

[Ch.8, 30.11.81; Ch.14, 27.05.94; Ch.15, 01.10.00 ; Amdt. 16, 01.05.03]

JAR 25.725 Limit drop tests

Reserved

[Ch.15, 01.10.00]

JAR 25.727 Reserve energy absorption drop tests

Reserved

[Ch.15, 01.10.00]

JAR 25.729 Retracting mechanism

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

(1) The landing gear retracting mechanism, wheel well doors, and supporting structure, must be designed for –

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

(ii) The combination of friction loads, inertia loads, brake torque loads, air loads, and gyroscopic loads resulting from **[** the wheels rotating at a peripheral speed equal to $1{\cdot}23\ V_{SR}$ (with the flaps in take- **]** off position at design take-off weight), **[** occurring during retraction and extension at any airspeed up to $1{\cdot}5\ V_{SR1}$ with the **]** wing-flaps in the approach position at design landing weight, and

(iii) Any load factor up to those specified in JAR 25.345(a) for the wing-flaps extended condition.

(2) Unless there are other means to decelerate the aeroplane in flight at this speed, the landing gear, the retracting mechanism, and the aeroplane structure (including wheel well doors) must be designed to withstand the flight loads occurring with the landing gear in the extended position at any speed up to $0{\cdot}67\ V_C$.

(3) Landing gear doors, their operating mechanism, and their supporting structures must be designed for the yawing manoeuvres

JAR 25.729(a)(3) (continued)

prescribed for the aeroplane in addition to the conditions of airspeed and load factor prescribed in sub-paragraphs (a)(1) and (2) of this paragraph.

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

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

(1) Any reasonably probable failure in the normal retraction system; or

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

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

(e) *Position indicator and warning device.* (See ACJ 25.729(e).) If a retractable landing gear is used, there must be a landing gear position indicator easily visible to the pilot or to the appropriate crew members (as well as necessary devices to actuate the indicator) to indicate without ambiguity that the retractable units and their associated doors are secured in the extended (or retracted) position. The means must be designed as follows:

(1) If switches are used, they must be located and coupled to the landing gear mechanical systems in a manner that prevents an erroneous indication of 'down and locked' if the landing gear is not in a fully extended position, or of 'up and locked' if the landing gear is not in the fully retracted position. The switches may be located where they are operated by the actual landing gear locking latch or device.

(2) The flight crew must be given an aural warning that functions continuously, or is periodically repeated, if a landing is attempted when the landing gear is not locked down.

(3) The warning must be given in sufficient time to allow the landing gear to be locked down or a go-around to be made.

(4) There must not be a manual shut-off means readily available to the flight crew for the warning required by sub-paragraph (e)(2) of this paragraph such that it could be operated instinctively, inadvertently or by habitual reflexive action.

JAR 25.729(e) (continued)

(5) The system used to generate the aural warning must be designed to minimise false or inappropriate alerts.

(6) Failures of systems used to inhibit the landing gear aural warning, that would prevent the warning system from operating, must be improbable.

(7) A clear indication or warning must be provided whenever the landing gear position is not consistent with the landing gear selector lever position.

(f) *Protection of equipment on landing gear and in wheel wells*. Equipment that is essential to the safe operation of the aeroplane and that is located on the landing gear and in wheel wells must be protected from the damaging effects of –

(1) A bursting tyre, (see ACJ 25.729(f));

(2) A loose tyre tread unless it is shown that a loose tyre tread cannot cause damage; and

(3) Possible wheel brake temperatures, (see ACJ 25.729(f)).

[Ch.10, 19.12.83; Ch.14, 27.05.94 ; Amdt. 16, 01.05.03]

JAR 25.731 Wheels

(a) Each main and nose wheel must be approved.

(b) The maximum static load rating of each wheel may not be less than the corresponding static ground reaction with –

(1) Design maximum weight; and

(2) Critical centre of gravity.

(c) The maximum limit load rating of each wheel must equal or exceed the maximum radial limit load determined under the applicable ground load requirements of this JAR–25.

[(d) Overpressure burst prevention. Means must be provided in each wheel to prevent wheel failure and tyre burst that may result from excessive pressurisation of the wheel and tyre assembly.

(e) Braked wheels. Each braked wheel must meet the applicable requirements of JAR 25.735.]

[Ch.14, 27.05.94; Amdt. 16, 01.05.03]

JAR 25.733 Tyres

(a) When a landing gear axle is fitted with a single wheel and tyre assembly, the wheel must be [fitted with a suitable tyre of proper fit with a] speed rating approved by the Authorities that is not exceeded under critical conditions, and with a load rating approved by the Authorities that is not exceeded under –

(1) The loads on the main wheel tyre, corresponding to the most critical combination of aeroplane weight (up to the maximum weight) [and centre of gravity position ; and]

(2) The loads corresponding to the ground reactions in sub-paragraph (b) of this paragraph, on the nose-wheel tyre, except as provided in sub-paragraphs (b)(2) and (b)(3) of this paragraph.

(b) The applicable ground reactions for nose-wheel tyres are as follows:

(1) The static ground reaction for the tyre corresponding to the most critical combination of aeroplane weight (up to maximum ramp weight) and centre of gravity position with a force of 1·0 g acting downward at the centre of gravity. This load may not exceed the load rating of the tyre.

(2) The ground reaction of the tyre corresponding to the most critical combination of aeroplane weight (up to maximum landing weight) and centre of gravity position combined with forces of 1·0 g downward and 0·31 g forward acting at the centre of gravity. The reactions in this case must be distributed to the nose and main wheels by the principles of statics with a drag reaction equal to 0·31 times the vertical load at each wheel with brakes capable of producing this ground reaction. This nose tyre load may not exceed 1·5 times the load rating of the tyre.

(3) The ground reaction of the tyre corresponding to the most critical combination of aeroplane weight (up to maximum ramp weight) and centre of gravity position combined with forces of 1·0 g downward and 0·20 g forward acting at the centre of gravity. The reactions in this case must be distributed to the nose and main wheels by the principles of statics with a drag reaction equal to 0·20 times the vertical load at each wheel with brakes capable of producing this ground reaction. This nose tyre load may not exceed 1·5 times the load rating of the tyre.

(c) When a landing gear axle is fitted with more than one wheel and tyre assembly, such as dual or dual-tandem, each wheel must be fitted with a suitable tyre of proper fit with a speed rating approved by the Authority that is not exceeded under critical conditions, and with a load rating approved by the Authority that is not exceeded by –

JAR 25.733(c) (continued)

(1) The loads on each main wheel tyre, corresponding to the most critical combination of aeroplane weight (up to maximum weight) and centre of gravity position, when multiplied by a factor of 1·07; and

(2) Loads specified in sub-paragraphs (a)(2), (b)(1), (b)(2) and (b)(3) of this paragraph on each nose-wheel tyre.

(d) Each tyre installed on a retractable landing gear system must, at the maximum size of the tyre type expected in service, have a clearance to surrounding structure and systems that is adequate to prevent unintended contact between the tyre and any part of the structure or systems.

[(e) For an aeroplane with a maximum certificated take-off weight of more than 75 000 pounds (34 090·91 kg), tyres mounted on braked wheels must be inflated with dry nitrogen or other gases shown to be inert so that the gas mixture in the tyre does not contain oxygen in excess of 5% by volume, unless it can be shown that the tyre liner material will not produce a volatile gas when heated, or that means are provided to prevent tyre temperatures from reaching unsafe levels.]

[Ch.8, 30.11.81; Ch.14, 27.05.94 ; Amdt. 16, 01.05.03]

JAR 25.735 Brakes [(See ACJ 25.735)

(a) *Approval.* Each assembly consisting of a wheel(s) and brake(s) must be approved.

(b) *Brake system capability*. The brake system, associated systems and components must be designed and constructed so that:

(1) If any electrical, pneumatic, hydraulic, or mechanical connecting or transmitting element fails, or if any single source of hydraulic or other brake operating energy supply is lost, it is possible to bring the aeroplane to rest with a braked roll stopping distance of not more than two times that obtained in determining the landing distance as prescribed in JAR 25.125.

(2) Fluid lost from a brake hydraulic system following a failure in, or in the vicinity of, the brakes is insufficient to cause or support a hazardous fire on the ground or in flight.

(c) *Brake controls*. The brake controls must be designed and constructed so that:

(1) Excessive control force is not required for their operation.

(2) If an automatic braking system is installed, means are provided to:

JAR 25.735(c)(2) (continued)

(i) Arm and disarm the system, and

(ii) Allow the pilot(s) to override the system by use of manual braking.

(d) *Parking brake.* The aeroplane must have a parking brake control that, when selected on, will, without further attention, prevent the aeroplane from rolling on a dry and level paved runway when the most adverse combination of maximum thrust on one engine and up to maximum ground idle thrust on any, or all, other engine(s) is applied. The control must be suitably located or be adequately protected to prevent inadvertent operation. There must be indication in the cockpit when the parking brake is not fully released.

(e) *Anti-skid system*. If an anti-skid system is installed:

(1) It must operate satisfactorily over the range of expected runway conditions, without external adjustment.

(2) It must, at all times, have priority over the automatic braking system, if installed.

(f) *Kinetic energy capacity*—

(1) *Design landing stop.* The design landing stop is an operational landing stop at maximum landing weight. The design landing stop brake kinetic energy absorption requirement of each wheel, brake, and tyre assembly must be determined. It must be substantiated by dynamometer testing that the wheel, brake and tyre assembly is capable of absorbing not less than this level of kinetic energy throughout the defined wear range of the brake. The energy absorption rate derived from the aeroplane manufacturer's braking requirements must be achieved. The mean deceleration must not be less than 10 fps^2 (3·05 m/s^2).

(2) *Maximum kinetic energy accelerate-stop.* The maximum kinetic energy accelerate-stop is a rejected take-off for the most critical combination of aeroplane take-off weight and speed. The accelerate-stop brake kinetic energy absorption requirement of each wheel, brake, and tyre assembly must be determined. It must be substantiated by dynamometer testing that the wheel, brake, and tyre assembly is capable of absorbing not less than this level of kinetic energy throughout the defined wear range of the brake. The energy absorption rate derived from the aeroplane manufacturer's braking requirements must be achieved. The mean deceleration must not be less than 6 fps^2 (1·83 m/s^2).]

JAR 25.735(f) (continued)

(3) *Most severe landing stop.* The most severe landing stop is a stop at the most critical combination of aeroplane landing weight and speed. The most severe landing stop brake kinetic energy absorption requirement of each wheel, brake, and tyre assembly must be determined. It must be substantiated by dynamometer testing that, at the declared fully worn limit(s) of the brake heat sink, the wheel, brake and tyre assembly is capable of absorbing not less than this level of kinetic energy. The most severe landing stop need not be considered for extremely improbable failure conditions or if the maximum kinetic energy accelerate-stop energy is more severe.

(g) *Brake condition after high kinetic energy dynamometer stop(s).* Following the high kinetic energy stop demonstration(s) required by sub-paragraph (f) of this paragraph, with the parking brake promptly and fully applied for at least 3 minutes, it must be demonstrated that for at least 5 minutes from application of the parking brake, no condition occurs (or has occurred during the stop), including fire associated with the tyre or wheel and brake assembly, that could prejudice the safe and complete evacuation of the aeroplane.

(h) *Stored energy systems*. An indication to the flight crew of the usable stored energy must be provided if a stored energy system is used to show compliance with sub-paragraph (b)(1) of this paragraph. The available stored energy must be sufficient for:

(1) At least 6 full applications of the brakes when an anti-skid system is not operating; and

(2) Bringing the aeroplane to a complete stop when an anti-skid system is operating, under all runway surface conditions for which the aeroplane is certificated.

(i) *Brake wear indicators*. Means must be provided for each brake assembly to indicate when the heat sink is worn to the permissible limit. The means must be reliable and readily visible.

(j) *Over-temperature burst prevention*. Means must be provided in each braked wheel to prevent a wheel failure, a tyre burst, or both, that may result from elevated brake temperatures. Additionally, all wheels must meet the requirements of JAR 25.731(d).

(k) *Compatibility*. Compatibility of the wheel and brake assemblies with the aeroplane and its systems must be substantiated. **]**

[Ch.10, 19.12.83; Ch.12, 10.05.88; Ch.14, 27.05.94; Ch.15, 01.10.00; Amdt. 16, 01.05.03]

JAR 25X745 Nose-wheel steering

(a) The nose-wheel steering system, unless it is restricted in use to low-speed manoeuvring, must be so designed that exceptional skill is not required for its use during take-off and landing, including the case of cross-wind, and in the event of sudden power-unit failure at any stage during the take-off run. This must be shown by tests. (See ACJ 25X745(a).)

(b) It must be shown that, in any practical circumstances, movement of the pilot's steering control (including movement during retraction or extension or after retraction of the landing gear) cannot interfere with the correct retraction or extension of the landing gear.

(c) Under failure conditions the system must comply with JAR 25.1309(b), (c) and (d). The arrangement of the system must be such that no single failure will result in a nose-wheel position which will lead to a Hazardous Effect. Where reliance is placed on nose-wheel steering in showing compliance with JAR 25.233, the nose-wheel steering system must be shown to comply with JAR 25.1309. (See ACJ 25X745(c).)

(d) The design of the attachment for towing the aeroplane on the ground must be such as to preclude damage to the steering system.

(e) Unless the nose-wheel, when lowered, is automatically in the fore-and-aft attitude successful landings must be demonstrated with the nose-wheel initially in all possible off-centre positions.

[Ch.8, 30.11.81]

PERSONNEL AND CARGO ACCOMMODATIONS

JAR 25.771 Pilot compartment

(a) Each pilot compartment and its equipment must allow the minimum flight crew (established under JAR 25.1523) to perform their duties without unreasonable concentration or fatigue.

(b) The primary controls listed in JAR 25.779 (a), excluding cables and control rods, must be located with respect to the propellers so that no member of the minimum flight crew (established under JAR 25.1523), or part of the controls, lies in the region between the plane of rotation of any inboard propeller and the surface generated by a line passing through the centre of the propeller hub making an angle of 5º forward or aft of the plane of rotation of the propeller.

JAR 25.771 (continued)

(c) If provision is made for a second pilot, the aeroplane must be controllable with equal safety from either pilot seat.

(d) The pilot compartment must be constructed so that, when flying in rain or snow, it will not leak in a manner that will distract the crew or harm the structure.

(e) Vibration and noise characteristics of cockpit equipment may not interfere with safe operation of the aeroplane.

JAR 25.772 Pilot compartment doors

[For an aeroplane that has a lockable door installed between the pilot compartment and the passenger compartment –

(a) For airplanes with a passenger seating configuration of 20 seats or more, the emergency exit configuration must be designed so that neither crew members nor passengers require use of the flightdeck door in order to reach the emergency exits provided for them; and]

(b) Means must be provided to enable flight-crew members to directly enter the passenger compartment from the pilot compartment if the [cockpit door becomes jammed; and

(c) There must be an emergency means to enable a crew member to enter the pilot compartment in the event that the flight crew becomes incapacitated.]

[Ch.14, 27.05.94; Amdt. 16, 01.05.03]

JAR 25.773 Pilot compartment view

(a) *Non-precipitation conditions*. For non-precipitation conditions, the following apply:

(1) Each pilot compartment must be arranged to give the pilots a sufficiently extensive, clear, and undistorted view, to enable them to safely perform any manoeuvres within the operating limitations of the aeroplane, including taxying, take-off, approach and landing.

(2) Each pilot compartment must be free of glare and reflection that could interfere with the normal duties of the minimum flight crew (established under JAR 25.1523). This must be shown in day and night flight tests under non-precipitation conditions.

(b) *Precipitation conditions*. For precipitation conditions, the following apply:

JAR 25.773(b) (continued)

(1) The aeroplane must have a means to maintain a clear portion of the windshield during precipitation conditions, sufficient for both pilots to have a sufficiently extensive view along the flight path in normal flight attitudes of the aeroplane. This means must be designed to function, without continuous attention on the part of the crew, in –

[(i) Heavy rain at speeds up to 1·5 V_{SR1}, with lift and drag devices retracted;] and

(ii) The icing conditions specified in JAR 25.1419 if certification with ice protection provisions is requested. (See ACJ 25.773(b)(1)(ii).)

(2) No single failure of the systems used to provide the view required by sub-paragraph (b)(1) of this paragraph must cause the loss of that view by both pilots in the specified precipitation conditions.

(3) The first pilot must have –

(i) A window that is openable under the conditions prescribed in sub-paragraph (b)(1) of this paragraph when the cabin is not pressurised, provides the view specified in that paragraph, and gives sufficient protection from the elements against impairment of the pilot's vision; or

(ii) An alternate means to maintain a clear view under the conditions specified in sub-paragraph (b)(1) of this paragraph, considering the probable damage due to a severe hail encounter.

(4) The openable window specified in sub-paragraph (b)(3) of this paragraph need not be provided if it is shown that an area of the transparent surface will remain clear sufficient for at least one pilot to land the aeroplane safely in the event of -

(i) Any system failure or combination of failures which is not Extremely Improbable under the precipitation conditions specified in sub-paragraph (b)(1) of this paragraph.

(ii) An encounter with hail, birds, or insects.

(c) *Internal windshield and window fogging*. The aeroplane must have a means to prevent fogging to the internal portions of the windshield and window panels over an area which would provide the visibility specified in sub-paragraph (a) of this paragraph under all internal and external ambient conditions, including precipitation

JAR 25.773(c) (continued)

conditions, in which the aeroplane is intended to be operated.

(d) Fixed markers or other guides must be installed at each pilot station to enable the pilots to position themselves in their seats for an optimum combination of outside visibility and instrument scan. If lighted markers or guides are used they must comply with the requirements specified in JAR 25.1381.

[Ch.13, 05.10.89; Ch.14, 27.05.94; Ch.15, 01.10.00; Amdt. 16, 01.05.03]

JAR 25.775 Windshields and windows

(a) Internal panes must be made of non-splintering material.

(b) Windshield panes directly in front of the pilots in the normal conduct of their duties, and the supporting structures for these panes, must withstand, without penetration, the bird impact conditions specified in JAR 25.631.

(c) Unless it can be shown by analysis or tests that the probability of occurrence of a critical windshield fragmentation condition is of a low order, the aeroplane must have a means to minimise the danger to the pilots from flying windshield fragments due to bird impact. This must be shown for each transparent pane in the cockpit that –

(1) Appears in the front view of the aeroplane;

(2) Is inclined 15º or more to the longitudinal axis of the aeroplane; and

(3) Has any part of the pane located where its fragmentation will constitute a hazard to the pilots.

(d) The design of windshields and windows in pressurised aeroplanes must be based on factors peculiar to high altitude operation, including the effects of continuous and cyclic pressurisation loadings, the inherent characteristics of the material used, and the effects of temperatures and temperature differentials. The windshield and window panels must be capable of withstanding the maximum cabin pressure differential loads combined with critical aerodynamic pressure and temperature effects after any single failure in the installation or associated systems. It may be assumed that, after a single failure that is obvious to the flight crew (established under JAR 25.1523), the cabin pressure differential is reduced from the maximum, in accordance with appropriate operating limitations, to allow continued safe flight of the aeroplane with a cabin pressure altitude of not more than 15 000 ft (see ACJ 25.775(d)).

JAR 25.775 (continued)

(e) The windshield panels in front of the pilots must be arranged so that, assuming the loss of vision through any one panel, one or more panels remain available for use by a pilot seated at a pilot station to permit continued safe flight and landing.

JAR 25.777 Cockpit controls

[(a) Each cockpit control must be located to provide convenient operation and to prevent confusion and inadvertent operation.]

(b) The direction of movement of cockpit controls must meet the requirements of JAR 25.779. Wherever practicable, the sense of motion involved in the operation of other controls must correspond to the sense of the effect of the operation upon the aeroplane or upon the part operated. Controls of a variable nature using a rotary motion must move clockwise from the off position, through an increasing range, to the full on position.

[(c) The controls must be located and arranged, with respect to the pilots' seats, so that there is full and unrestricted movement of each control without interference from the cockpit structure or the clothing of the minimum flight crew (established under JAR 25.1523) when any member of this flight crew from 5ft 2 inches (1 575 m) to 6ft 3 inches (1 905 m) in height, is seated with the seat belt and shoulder harness (if provided) fastened.]

(d) Identical powerplant controls for each engine must be located to prevent confusion as to the engines they control.

[(e) Wing-flap controls and other auxiliary lift device controls must be located on top of the pedestal, aft of the throttles, centrally or to the right of the pedestal centre line, and not less than 10 inches (254 mm) aft of the landing gear control.

(f) The landing gear control must be located forward of the throttles and must be operable by each pilot when seated with seat belt and shoulder harness (if provided) fastened.

(g) Control knobs must be shaped in accordance with JAR 25.781. In addition, the knobs must be of the same colour and this colour must contrast with the colour of control knobs for other purposes and the surrounding cockpit.

(h) If a flight engineer is required as part of the minimum flight crew (established under JAR 25.1523), the aeroplane must have a flight engineer station located and arranged so that the flight-crew members can perform their functions efficiently and without interfering with each other.]

[Amdt. 16. 01.05.03]

JAR 25.779 Motion and effect of cockpit controls

Cockpit controls must be designed so that they operate in accordance with the following movement and actuation:

(a) Aerodynamic controls –

(1) *Primary.*

Controls	*Motion and effect*
Aileron	Right (clockwise) for right wing down
Elevator	Rearward for nose up.
Rudder	Right pedal forward for nose right.

(2) *Secondary.*

Controls	*Motion and effect*
Flaps (or auxiliary lift devices)	Forward for wing-flaps up; rearward for flaps down.
Trim tabs (or equivalent).	Rotate to produce similar rotation of the aeroplane about an axis parallel to the axis of the control.

(b) Powerplant and auxiliary controls –

(1) *Powerplant.*

Controls	*Motion and effect*
Power or thrust	Forward to increase forward thrust and rearward to increase rearward thrust.
Propellers	Forward to increase rpm.

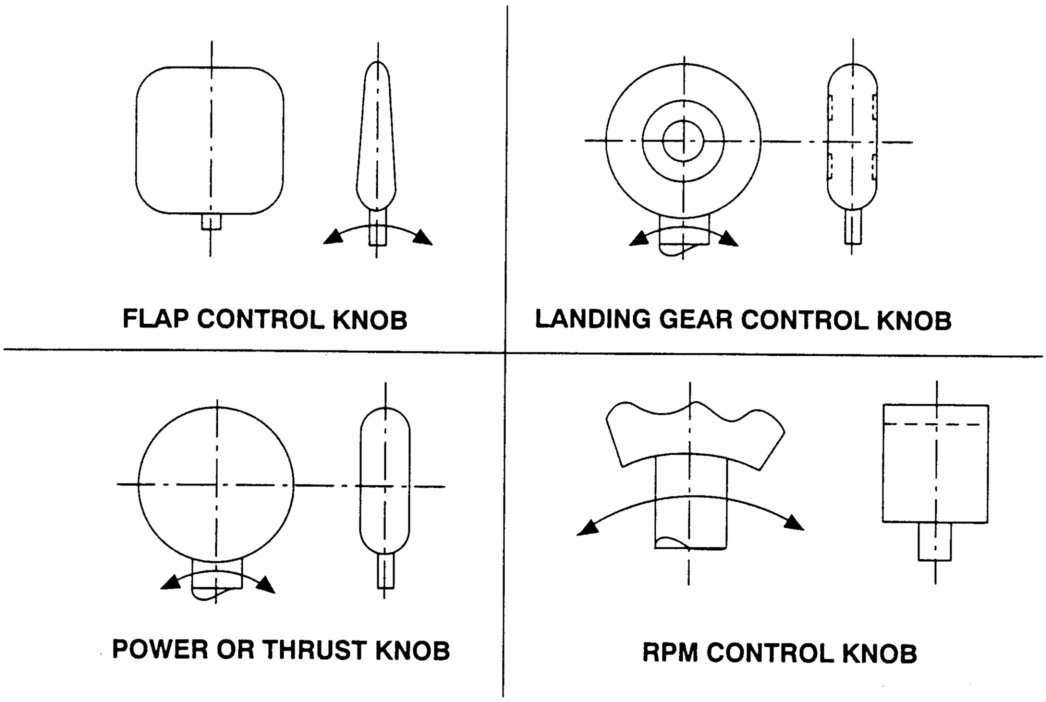
(2) *Auxiliary.*

Controls	*Motion and effect*
Landing gear	Down to extend.

[Ch.14, 27.05.94]

JAR 25.781 Cockpit control knob shape [ ]

Cockpit control knobs must conform to the general shapes (but not necessarily the exact sizes or specific proportions) in the following figure:



[Amdt. 16, 01.05.03]

JAR 25.783 Doors

(a) Each cabin must have at least one easily accessible external door.

(b) There must be a means to lock and safeguard each external door against opening in flight (either inadvertently by persons or as a result of mechanical failure or failure of a single structural element either during or after closure). Each external door must be openable from both the inside and the outside, even though persons may be crowded against the door on the inside of the aeroplane. Inward opening doors may be used if there are means to prevent occupants from crowding against the door to an extent that would interfere with the opening of the door. The means of opening must be simple and obvious and must be arranged and marked so that it can be readily located and operated, even in darkness. Auxiliary locking devices may be used.

(c) Each external door must be reasonably free from jamming as a result of fuselage deformation in a minor crash.

(d) Each external door must be located where persons using them will not be endangered by the propeller when appropriate operating procedures are used.

(e) There must be provision for direct visual inspection of the locking mechanism to determine if external doors, for which the initial opening movement is not inward (including passenger, crew, service, and cargo doors), are fully closed and locked. The provision must be discernible under operational lighting conditions by appropriate crew members using a flashlight or equivalent lighting source. In addition there must be a visual warning means to signal the appropriate flight-crew members if any external door is not fully closed and locked. The means must be designed such that any failure or combination of failures that would result in an erroneous closed and locked indication is improbable for doors for which the initial opening movement is not inward.

(f) External doors must have provisions to prevent the initiation of pressurisation of the aeroplane to an unsafe level if the door is not fully closed and locked. In addition, it must be shown by safety analysis that inadvertent opening is extremely improbable.

(g) Cargo and service doors not suitable for use as emergency exits need only meet sub-paragraphs (e) and (f) of this paragraph and be safeguarded against opening in flight as a result of mechanical failure or failure of a single structural element.

JAR 25.783 (continued)

(h) Each passenger entry door in the side of the fuselage must qualify as a Type A, Type I, or Type II passenger emergency exit and must meet the requirements of JAR 25.807 to 25.813 that apply to that type of passenger emergency exit.

(i) If an integral stair is installed in a passenger entry door that is qualified as a passenger emergency exit, the stair must be designed so that under the following conditions the effectiveness of passenger emergency egress will not be impaired:

(1) The door, integral stair, and operating mechanism have been subjected to the inertia forces specified in JAR 25.561(b)(3), acting separately relative to the surrounding structure.

(2) The aeroplane is in the normal ground attitude and in each of the attitudes corresponding to collapse of one or more legs of the landing gear.

(j) All lavatory doors must be designed to preclude anyone from becoming trapped inside the lavatory, and if a locking mechanism is installed, it must be capable of being unlocked from the outside without the aid of special tools.

[Ch.10, 19.12.83; Ch.14, 27.05.94]

JAR 25.785 Seats, berths, safety belts and harnesses

(a) A seat (or berth for a non ambulant person) must be provided for each occupant who has reached his or her second birthday.

(b) Each seat, berth, safety belt, harness, and adjacent part of the aeroplane at each station designated as occupiable during take-off and landing must be designed so that a person making proper use of these facilities will not suffer serious injury in an emergency landing as a result of the inertia forces specified in JAR 25.561 and JAR 25.562.

(c) Each seat or berth must be approved.

(d) Each occupant of a seat (see ACJ 25.785(d)) that makes more than an 18-degree angle with the vertical plane containing the aeroplane centreline must be protected from head injury by a safety belt and an energy absorbing rest that will support the arms, shoulders, head and spine, or by a safety belt and shoulder harness that will prevent the head from contacting any injurious object. Each occupant of any other seat must be protected from head injury by a safety belt and, as appropriate to the type, location, and angle of facing of each seat, by one or more of the following:

JAR 25.785(d) (continued)

(1) A shoulder harness that will prevent the head from contacting any injurious object.

(2) The elimination of any injurious object within striking radius of the head.

(3) An energy absorbing rest that will support the arms, shoulders, head and spine.

(e) Each berth must be designed so that the forward part has a padded end board, canvas diaphragm, or equivalent means, that can withstand the static load reaction of the occupant when subjected to the forward inertia force specified in JAR 25.561. Berths must be free from corners and protuberances likely to cause injury to a person occupying the berth during emergency conditions.

(f) Each seat or berth, and its supporting structure, and each safety belt or harness and its anchorage must be designed for an occupant weight of 170 pounds, considering the maximum load factors, inertia forces, and reactions among the occupant, seat, safety belt, and harness for each relevant flight and ground load condition (including the emergency landing conditions prescribed in JAR 25.561). In addition –

(1) The structural analysis and testing of the seats, berths, and their supporting structures may be determined by assuming that the critical load in the forward, sideward, downward, upward, and rearward directions (as determined from the prescribed flight, ground, and emergency landing conditions) acts separately or using selected combinations of loads if the required strength in each specified direction is substantiated. The forward load factor need not be applied to safety belts for berths.

(2) Each pilot seat must be designed for the reactions resulting from the application of the pilot forces prescribed in JAR 25.395.

(3) For the determination of the strength of the local attachments (see ACJ 25.561(c)) of –

(i) Each seat to the structure; and

(ii) Each belt or harness to the seat or structure; a multiplication factor of 1·33 instead of the fitting factor as defined in JAR 25.625 should be used for the inertia forces specified in JAR 25.561. (For the lateral forces according to JAR 25.561(b)(3) 1·33 times 3·0 g should be used.)

(g) Each crew member seat at a flight-deck station must have a shoulder harness. These seats must meet the strength requirements of sub-paragraph (f) of this paragraph, except that where a seat forms part of the load path, the safety belt or shoulder harness attachments need only be proved

JAR 25.785(g) (continued)

to be not less strong than the actual strength of the seat. (See ACJ 25.785(g).)

(h) Each seat located in the passenger compartment and designated for use during take- [off and landing by a cabin crew member] required by the National Operating Rules must be –

(1) Near a required floor level emergency exit, except that another location is acceptable if the emergency egress of passengers [would be enhanced with that location. A cabin crew member seat must be located adjacent to each Type A emergency exit. Other cabin crew member seats must be evenly distributed] among the required floor level emergency exits to the extent feasible.

(2) To the extent possible, without compromising proximity to a required floor level emergency exit, located to provide a direct view [of the cabin area for which the cabin crew member is responsible.]

(3) Positioned so that the seat will not interfere with the use of a passageway or exit when the seat is not in use.

(4) Located to minimise the probability that occupants would suffer injury by being struck by items dislodged from service areas, stowage compartments, or service equipment.

(5) Either forward or rearward facing with an energy absorbing rest that is designed to support the arms, shoulders, head and spine.

(6) Equipped with a restraint system consisting of a combined safety belt and shoulder harness unit with a single point release. There must be means to secure each restraint system when not in use to prevent interference with rapid egress in an emergency.

(i) Each safety belt must be equipped with a metal to metal latching device.

(j) If the seat backs do not provide a firm handhold, there must be a handgrip or rail along each aisle to enable persons to steady themselves while using the aisles in moderately rough air.

(k) Each projecting object that would injure persons seated or moving about the aeroplane in normal flight must be padded.

(l) Each forward observer's seat required by the operating rules must be shown to be suitable for use in conducting the necessary en-route inspections.

[Ch.8, 30.11.81; Ch.13, 05.10.89; Ch.14, 27.05.94; Ch.15, 01.10.00; Amdt. 16, 01.05.03]

JAR 25.787 Stowage compartments

(a) Each compartment for the stowage of cargo, baggage, carry-on articles and equipment (such as life rafts) and any other stowage compartment must be designed for its placarded maximum weight of contents and for the critical load distribution at the appropriate maximum load factors corresponding to the specified flight and ground load conditions and, where the breaking loose of the contents of such compartments could–

(1) Cause direct injury to occupants;

(2) Penetrate fuel tanks or lines or cause fire or explosion hazard by damage to adjacent systems; or

(3) Nullify any of the escape facilities provided for use after an emergency landing, to the emergency landing conditions of JAR 25.561(b)(3).

If the aeroplane has a passenger seating configuration, excluding pilot seats, of 10 seats or more, each stowage compartment in the passenger cabin, except for underseat and overhead compartments for passenger convenience, must be completely enclosed.

(b) There must be a means to prevent the contents in the compartments from becoming a hazard by shifting, under the loads specified in sub-paragraph (a) of this paragraph. (See ACJ 25.787(b).)

(c) If cargo compartment lamps are installed, each lamp must be installed so as to prevent contact between lamp bulb and cargo.

[Ch.8, 30.11.81; Ch.11, 17.03.86; Ch.13, 05.10.89]

JAR 25.789 Retention of items of mass in passenger and crew compartments and galleys

(a) Means must be provided to prevent each item of mass (that is part of the aeroplane type design) in a passenger or crew compartment or galley from becoming a hazard by shifting under the appropriate maximum load factors corresponding to the specified flight and ground load conditions, and to the emergency landing conditions of JAR 25.561(b).

(b) Each interphone restraint system must be designed so that when subjected to the load factors specified in JAR 25.561 (b)(3), the interphone will remain in its stowed position.

JAR 25.791 Passenger information signs and placards [(See ACJ 25.791)]

(a) If smoking is to be prohibited, there must be at least one placard so stating that is legible to each person seated in the cabin. If smoking is to be allowed, and if the crew compartment is separated from the passenger compartment, there must be at least one sign notifying when smoking is prohibited. Signs which notify when smoking is prohibited must be installed so as to be operable from either pilot's seat and, when illuminated, must be legible under all probable conditions of cabin illumination to each person seated in the cabin.

(b) Signs that notify when seat belts should be fastened and that are installed to comply with the National Operating Rules must be installed so as to be operable from either pilot's seat and, when illuminated, must be legible under all probable conditions of cabin illumination to each person seated in the cabin.

(c) A placard must be located on or adjacent to the door of each receptacle used for the disposal of flammable waste materials to indicate that use of the receptacle for disposal of cigarettes, etc., is prohibited.

(d) Lavatories must have 'No Smoking' or 'No Smoking in Lavatory' placards positioned adjacent to each ashtray. The placards must have red letters at least 0·5 inches (12·7mm) high on a white background of at least 1·0 inches (25·4 mm) high. (A No Smoking symbol may be included on the placard.)

[(e) Symbols that clearly express the intent of the sign or placard may be used in lieu of letters.]

[Ch.14, 27.05.94; Amdt. 16, 01.05.03]

JAR 25.793 Floor surfaces

The floor surface of all areas which are likely to become wet in service must have slip resistant properties.

[JAR 25.795 Security considerations (See ACJ 25.795

(a) *Protection of flightdeck.* If a secure flightdeck door is required by operating rules, the door installation must be designed to:

(1) Resist forcible intrusion by unauthorized persons and be capable of withstanding impacts of 300 Joules (221·3 foot-pounds) at the critical locations on the door, as well as a 1 113 Newton (250 pound) constant]

JAR 25.795(a) (continued)

[tensile load on the knob or handle (see ACJ 25.795(a)(1)), and

(2) Resist penetration by small arms fire and fragmentation devices by meeting the following projectile definitions and projectile speeds (See ACJ 25.795(a)(2)):

(i) *Demonstration Projectile #1*. A 9 mm full metal jacket, round nose (FMJ RN) bullet with nominal mass of 8·0 g (124 grain) and reference velocity 436 m/s (1 430 ft/s).

(ii) *Demonstration Projectile #2*. A ·44 Magnum, jacketed hollow point (JHP) bullet with nominal mass of 15·6 g (240 grain) and reference velocity 436 m/s (1 430 ft/s).

(b) Reserved]

[Amdt. 16, 01.05.03]

JAR 25X799 Water systems

[Deleted]

[Amdt. 16, 01.05.03]

EMERGENCY PROVISIONS

JAR 25.801 Ditching

(a) If certification with ditching provisions is requested, the aeroplane must meet the requirements of this paragraph and JAR 25.807(e), 25.1411 and 25.1415(a).

(b) Each practicable design measure, compatible with the general characteristics of the aeroplane, must be taken to minimise the probability that in an emergency landing on water, the behaviour of the aeroplane would cause immediate injury to the occupants or would make it impossible for them to escape.

(c) The probable behaviour of the aeroplane in a water landing must be investigated by model tests or by comparison with aeroplanes of similar configuration for which the ditching characteristics are known. Scoops, wing-flaps, projections, and any other factor likely to affect the hydrodynamic characteristics of the aeroplane, must be considered.

(d) It must be shown that, under reasonably probable water conditions, the flotation time and trim of the aeroplane will allow the occupants to leave the aeroplane and enter the liferafts required by JAR 25.1415. If compliance with this provision is shown by buoyancy and trim computations,

JAR 25.801(d) (continued)

appropriate allowances must be made for probable structural damage and leakage. If the aeroplane has fuel tanks (with fuel jettisoning provisions) that can reasonably be expected to withstand a ditching without leakage, the jettisonable volume of fuel may be considered as buoyancy volume.

(e) Unless the effects of the collapse of external doors and windows are accounted for in the investigation of the probable behaviour of the aeroplane in a water landing (as prescribed in sub-paragraphs (c) and (d) of this paragraph), the external doors and windows must be designed to withstand the probable maximum local pressures.

[Ch.14, 27.05.94]

JAR 25.803 Emergency evacuation [(See ACJ 25.803)]

(a) Each crew and passenger area must have emergency means to allow rapid evacuation in crash landings, with the landing gear extended as well as with the landing gear retracted, considering the possibility of the aeroplane being on fire.

(b) Reserved.

(c) For aeroplanes having a seating capacity of more than 44 passengers, it must be shown that the maximum seating capacity, including the number of crew members required by the operating rules for which certification is requested, can be evacuated from the aeroplane to the ground under simulated emergency conditions within 90 seconds. Compliance with this requirement must be shown by actual demonstration using the test criteria outlined in Appendix J of this JAR–25 unless the Authorities find that a combination of analysis and testing will provide data equivalent to that which would be obtained by actual demonstration.

(d) Reserved.

(e) Reserved.

[Ch.14, 27.05.94; Amdt. 16, 01.05.03]

JAR 25.805 Reserved

[Ch.14, 27.05.94]

JAR 25.807 Emergency exits [(See ACJ Nr 1 to 25.807 and ACJ Nr 2 to 25.807)]

(a) *Type*. For the purpose of this JAR–25, the types of exits are defined as follows:

(1) *Type I*. This type is a floor level exit with a rectangular opening of not less than 24

JAR 25.807(a) (continued)

inches (609·6 mm) wide by 48 inches (1 219 m) high, with corner radii not greater than one-third the width of the exit.

(2) *Type II*. This type is a rectangular opening of not less than 20 inches (508 mm) wide by 44 inches (1·12 m) high, with corner radii not greater than one-third the width of the exit. Type II exits must be floor level exits unless located over the wing, in which case they may not have a step-up inside the aeroplane of more than 10 inches (254 mm) nor a step-down outside the aeroplane of more than 17 inches (431·8 mm).

(3) *Type III*. This type is a rectangular opening of not less than 20 inches (508 mm) wide by 36 inches (914·4 mm) high, with corner radii not greater than one-third the width of the exit, and with a step-up inside the aeroplane of not more than 20 inches (508 mm). If the exit is located over the wing, the step-down outside the aeroplane may not exceed 27 inches (685·8 mm).

(4) *Type IV*. This type is a rectangular opening of not less than 19 inches (482·6 mm) wide by 26 inches (660·4 mm) high, with corner radii not greater than one-third the width of the exit, located over the wing, with a step-up inside the aeroplane of not more than 29 inches (736·6 mm) and a step-down outside the aeroplane of not more than 36 inches (914·4 mm).

(5) *Ventral*. This type is an exit from the passenger compartment through the pressure shell and the bottom fuselage skin. The dimensions and physical configuration of this type of exit must allow at least the same rate of egress as a Type I exit with the aeroplane in the normal ground attitude, with landing gear extended.

(6) *Tail cone*. This type is an aft exit from the passenger compartment through the pressure shell and through an openable cone of the fuselage aft of the pressure shell. The means of opening the tail cone must be simple and obvious and must employ a single operation.

(7) *Type A*. This type is a floor level exit with a rectangular opening of not less than 42 inches (1 067 m) wide by 72 inches (1 829 m) high with corner radii not greater than one-sixth of the width of the exit.

(b) *Step down distance*. Step down distance, as used in this paragraph, means the actual distance between the bottom of the required opening and a usable foot hold, extending out from the fuselage, that is large enough to be effective without searching by sight or feel.

JAR 25.807 (continued)

(c) *Over-sized exits*. Openings larger than those specified in this paragraph, whether or not of rectangular shape, may be used if the specified rectangular opening can be inscribed within the opening and the base of the inscribed rectangular opening meets the specified step-up and step-down heights.

(d) *Passenger emergency exits*. (See ACJ 25.807 (d). Except as provided in sub-paragraphs (d)(3) to (7) of this paragraph, the minimum number and type of passenger emergency exits is as follows:

(1) For passenger seating configurations of 1 to 299 seats –

Passenger seating configuration (crew member seats not included)	Emergency exits for each side of the fuselage			
	Type I	Type II	Type III	Type IV
1 to 9				1
10 to 19			1	
20 to 39		1	1	
40 to 79	1		1	
80 to 109	1		2	
110 to 139	2		1	
140 to 179	2		2	

Additional exits are required for passenger seating configurations greater than 179 seats in accordance with the following table:

Additional emergency exits (each side of fuselage)	Increase in passenger seating configuration allowed
Type A	110
Type I	45
Type II	40
Type III	35

(2) For passenger seating configurations greater than 299 seats, each emergency exit in the side of the fuselage must be either a Type A or a Type I. A passenger seating configuration of 110 seats is allowed for each pair of Type A exits and a passenger seating configuration of 45 seats is allowed for each pair of Type I exits.

(3) If a passenger ventral or tail cone exit is installed and that exit provides at least the same rate of egress as a Type III exit with the aeroplane in the most adverse exit opening condition that would result from the collapse of one or more legs of the landing gear, an increase in the passenger seating configuration beyond

JAR 25.807(d) (continued)

the limits specified in sub-paragraph (d)(1) or (2) of this paragraph may be allowed as follows:

(i) For a ventral exit, 12 additional passenger seats.

(ii) For a tail cone exit incorporating a floor level opening of not less than 20 inches (508 mm) wide by 60 inches (1 524 m) high, with corner radii not greater than one-third the width of the exit, in the pressure shell and incorporating an approved assist means in accordance with JAR 25.809(h), 25 additional passenger seats.

(iii) For a tail cone exit incorporating an opening in the pressure shell which is at least equivalent to a Type III emergency exit with respect to dimensions, step-up and step-down distance, and with the top of the opening not less than 56 inches (1 422 m) from the passenger compartment floor, 15 additional passenger seats.

(4) For aeroplanes on which the vertical location of the wing does not allow the installation of over-wing exits, an exit of at least the dimensions of a Type III exit must be installed instead of each Type IV exit required by sub-paragraph (1) of this paragraph.

(5) An alternate emergency exit configuration may be approved in lieu of that specified in sub-paragraph (d)(1) or (2) of this paragraph provided the overall evacuation capability is shown to be equal to or greater than that of the specified emergency exit configuration.

(6) The following must also meet the applicable emergency exit requirements of JAR 25.809 to 25.813:

(i) Each emergency exit in the passenger compartment in excess of the minimum number of required emergency exits.

(ii) Any other floor level door or exit that is accessible from the passenger compartment and is as large or larger than a Type II exit, but less than 46 inches (1 168 m) wide.

(iii) Any other passenger ventral or tail cone exit.

(7) For an aeroplane that is required to have more than one passenger emergency exit for each side of the fuselage, no passenger emergency exit shall be more than 60 feet

(18 288 m) from any adjacent passenger emergency exit on the same side of the same deck of the fuselage, as measured parallel to the aeroplane's longitudinal axis between the nearest exit edges.

(e) *Ditching emergency exits for passengers.* Ditching emergency exits must be provided in accordance with the following requirements whether or not certification with ditching provisions is requested:

(1) For aeroplanes that have a passenger seating configuration of nine seats or less, excluding pilots seats, one exit above the waterline in each side of the aeroplane, meeting at least the dimensions of a Type IV exit.

(2) For aeroplanes that have a passenger seating configuration of 10 seats or more, excluding pilots seats, one exit above the waterline in a side of the aeroplane, meeting at least the dimensions of a Type III exit for each unit (or part of a unit) of 35 passenger seats, but no less than two such exits in the passenger cabin, with one on each side of the aeroplane. The passenger seat/exit ratio may be increased through the use of larger exits, or other means, provided it is shown that the evacuation capability during ditching has been improved accordingly.

(3) If it is impractical to locate side exits above the waterline, the side exits must be replaced by an equal number of readily accessible overhead hatches of not less than the dimensions of a Type III exit, except that for aeroplanes with a passenger configuration of 35 seats or less, excluding pilots seats, the two required Type III side exits need be replaced by only one overhead hatch.

(f) *Flight crew emergency exits.* For aeroplanes in which the proximity of passenger emergency exits to the flight crew area does not offer a convenient and readily accessible means of evacuation of the flight crew, and for all aeroplanes having a passenger seating capacity greater than 20, flight crew exits shall be located in the flight crew area. Such exits shall be of sufficient size and so located as to permit rapid evacuation by the crew. One exit shall be provided on each side of the aeroplane; or, alternatively, a top hatch shall be provided. Each exit must encompass an unobstructed rectangular opening of at least 19 by 20 inches (482·6 by 508 mm) unless satisfactory exit utility can be demonstrated by a typical crew member.

[Ch.10, 19.12.83; Ch.13, 05.10.89; Ch.14, 27.05.94; Amdt. 16, 01.05.03]

JAR 25.809 Emergency exit arrangement

(a) Each emergency exit, including a flight crew emergency exit, must be a movable door or hatch in the external walls of the fuselage, allowing unobstructed opening to the outside.

(b) Each emergency exit must be openable from the inside and the outside except that sliding window emergency exits in the flight crew area need not be openable from the outside if other approved exits are convenient and readily accessible to the flight crew area. Each emergency exit must be capable of being opened, when there is no fuselage deformation –

(1) With the aeroplane in the normal ground attitude and in each of the attitudes corresponding to collapse of one or more legs of the landing gear; and

(2) Within 10 seconds measured from the time when the opening means is actuated to the time when the exit is fully opened.

(c) The means of opening emergency exits must be simple and obvious and may not require exceptional effort. Internal exit-opening means involving sequence operations (such as operation of two handles or latches or the release of safety catches) may be used for flight crew emergency exits if it can be reasonably established that these means are simple and obvious to crew members trained in their use.

(d) If a single power-boost or single power-operated system is the primary system for operating more than one exit in an emergency, each exit must be capable of meeting the requirements of sub-paragraph (b) of this paragraph in the event of failure of the primary system. Manual operation of the exit (after failure of the primary system) is acceptable.

(e) Each emergency exit must be shown by tests, or by a combination of analysis and tests, to meet the requirements of sub-paragraphs (b) and (c) of this paragraph.

(f) There must be a means to lock each emergency exit and to safeguard against its opening in flight, either inadvertently by persons or as a result of mechanical failure. In addition, there must be a means for direct visual inspection of the locking mechanism by crew members to determine that each emergency exit, for which the initial opening movement is outward, is fully locked.

(g) There must be provisions to minimise the probability of jamming of the emergency exits resulting from fuselage deformation in a minor crash landing.

JAR 25.809 (continued)

(h) *Not required for JAR–25.*

[Ch.8, 30.11.81; Ch.14, 27.05.94]

JAR 25.810 Emergency egress assist means and escape routes

(a) Each non-over-wing landplane emergency exit more than 6 feet from the ground with the aeroplane on the ground and the landing gear extended and each non-over-wing Type A exit must have an approved means to assist the occupants in descending to the ground.

(1) The assisting means for each passenger emergency exit must be a self-supporting slide or equivalent; and, in the case of a Type A exit, it must be capable of carrying simultaneously two parallel lines of evacuees. In addition, the assisting means must be designed to meet the following requirements.

(i) It must be automatically deployed and deployment must begin during the interval between the time the exit opening means is actuated from inside the aeroplane and the time the exit is fully opened. However, each passenger emergency exit which is also a passenger entrance door or a service door must be provided with means to prevent deployment of the assisting means when it is opened from either the inside or the outside under non-emergency conditions for normal use.

(ii) It must be automatically erected within 10 seconds after deployment is begun.

(iii) It must be of such length after full deployment that the lower end is self-supporting on the ground and provides safe evacuation of occupants to the ground after collapse of one or more legs of the landing gear.

(iv) It must have the capability, in 25-knot winds directed from the most critical angle, to deploy and, with the assistance of only one person, to remain usable after full deployment to evacuate occupants safely to the ground.

(v) For each system installation (mock-up or aeroplane installed), five consecutive deployment and inflation tests must be conducted (per exit) without failure, and at least three tests of each such five-test series must be conducted using a single representative sample of the device.

JAR 25.810(a)(1) (continued)

The sample devices must be deployed and inflated by the system's primary means after being subjected to the inertia forces specified in JAR 25.561(b). If any part of the system fails or does not function properly during the required tests, the cause of the failure or malfunction must be corrected by positive means and after that, the full series of five consecutive deployment and inflation tests must be conducted without failure.

(2) The assisting means for flight crew emergency exits may be a rope or any other means demonstrated to be suitable for the purpose. If the assisting means is a rope, or an approved device equivalent to a rope, it must be–

(i) Attached to the fuselage structure at or above the top of the emergency exit opening, or, for a device at a pilot's emergency exit window, at another approved location if the stowed device, or its attachment, would reduce the pilot's view in flight.

(ii) Able (with its attachment) to withstand a 400-lb (181·6 kg) static load.

(b) Assist means from the cabin to the wing are required for each Type A exit located above the wing and having a step-down unless the exit without an assist means can be shown to have a rate of passenger egress at least equal to that of the same type of non-over-wing exit. If an assist means is required, it must be automatically deployed and automatically erected, concurrent with the opening of the exit and self-supporting within 10 seconds.

(c) An escape route must be established from each over-wing emergency exit, and (except for flap surfaces suitable as slides) covered with a slip resistant surface. Except where a means for channelling the flow of evacuees is provided –

(1) The escape route must be at least 42 inches (1 067 m) wide at Type A passenger emergency exits and must be at least 2 feet (609·6 mm) wide at all other passenger emergency exits, and

(2) The escape route surface must have a reflectance of at least 80%, and must be defined by markings with a surface-to-marking contrast ratio of at least 5:1. (See ACJ 25.810(c)(2).)

(d) If the place on the aeroplane structure at which the escape route required in sub-paragraph (c) of this paragraph terminates, is more than 6 feet (1 829 m) from the ground with the aeroplane on

JAR 25.810(d) (continued)

the ground and the landing gear extended, means to reach the ground must be provided to assist evacuees who have used the escape route. If the escape route is over a flap, the height of the terminal edge must be measured with the flap in the take-off or landing position, whichever is higher from the ground. The assisting means must be usable and self-supporting with one or more landing gear legs collapsed and under a 25-knot wind directed from the most critical angle. The assisting means provided for each escape route leading from a Type A emergency exit must be capable of carrying simultaneously two parallel lines of evacuees. For other than Type A exits, the assist means must be capable of carrying simultaneously as many parallel lines of evacuees as there are required escape routes.

[Ch.14, 27.05.94]

JAR 25.811 Emergency exit marking

(a) Each passenger emergency exit, its means of access, and its means of opening must be conspicuously marked.

(b) The identity and location of each passenger emergency exit must be recognisable from a distance equal to the width of the cabin.

(c) Means must be provided to assist the occupants in locating the exits in conditions of dense smoke.

(d) The location of each passenger emergency exit must be indicated by a sign visible to occupants approaching along the main passenger aisle (or aisles). There must be –

(1) A passenger emergency exit locator sign above the aisle (or aisles) near each passenger emergency exit, or at another overhead location if it is more practical because of low headroom, except that one sign may serve more than one exit if each exit can be seen readily from the sign;

(2) A passenger emergency exit marking sign next to each passenger emergency exit, except that one sign may serve two such exits if they both can be seen readily from the sign; and

(3) A sign on each bulkhead or divider that prevents fore and aft vision along the passenger cabin to indicate emergency exits beyond and obscured by the bulkhead or divider, except that if this is not possible the sign may be placed at another appropriate location.

(e) The location of the operating handle and instructions for opening exits from the inside of the aeroplane must be shown in the following manner:

JAR 25.811(e) (continued)

(1) Each passenger emergency exit must have, on or near the exit, a marking that is readable from a distance of 30 inches.

(2) Each passenger emergency exit operating handle and the cover removal instructions, if the operating handle is covered, must –

(i) Be self-illuminated with an initial brightness of at least 160 micro-lamberts; or

(ii) Be conspicuously located and well illuminated by the emergency lighting even in conditions of occupant crowding at the exit.

(3) Reserved

(4) All Type II and larger passenger emergency exits with a locking mechanism released by motion of a handle, must be marked by a red arrow with a shaft at least three quarters of an inch (19 mm) wide, adjacent to the handle, that indicates the full extent and direction of the unlocking motion required. The word OPEN must be horizontally situated adjacent to the arrow head and must be in red capital letters at least 1 inch (25 mm) high. The arrow and word OPEN must be located on a background which provides adequate contrast. (See ACJ 25.811(e)(4).)

(f) Each emergency exit that is required to be openable from the outside, and its means of opening, must be marked on the outside of the aeroplane. In addition, the following apply:

(1) The outside marking for each passenger emergency exit in the side of the fuselage must include a 2-inch coloured band outlining the exit.

(2) Each outside marking including the band, must have colour contrast to be readily distinguishable from the surrounding fuselage surface. The contrast must be such that if the reflectance of the darker colour is 15% or less, the reflectance of the lighter colour must be at least 45%. 'Reflectance' is the ratio of the luminous flux reflected by a body to the luminous flux it receives. When the reflectance of the darker colour is greater than 15%, at least a 30% difference between its reflectance and the reflectance of the lighter colour must be provided.

(3) In the case of exits other than those in the side of the fuselage, such as ventral or tail cone exits, the external means of opening, including instructions if applicable, must be conspicuously marked in red, or bright chrome yellow if the background colour is such that red is inconspicuous. When the opening means is located on only one side of the fuselage, a conspicuous marking to that effect must be provided on the other side.

JAR 25.811(f)(3) (continued)

(g) Each sign required by sub-paragraph (d) of this paragraph may use the word 'exit' in its legend in place of the term 'emergency exit'.

[Ch.14, 27.05.94]

JAR 25.812 Emergency lighting [(See ACJ 25.812)]

(a) An emergency lighting system, independent of the main lighting system, must be installed. However, the sources of general cabin illumination may be common to both the emergency and the main lighting systems if the power supply to the emergency lighting system is independent of the power supply to the main lighting system. The emergency lighting system must include-

(1) Illuminated emergency exit marking and locating signs, sources of general cabin illumination, interior lighting in emergency exit areas, and floor proximity escape path marking.

(2) Exterior emergency lighting.

(b) *Emergency exit signs –*

(1) For aeroplanes that have a passenger seating configuration, excluding pilot seats, of 10 seats or more must meet the following requirements:

(i) Each passenger emergency exit locator sign required by JAR 25.811(d)(1) and each passenger emergency exit marking sign required by JAR 25.811(d)(2) must have red letters at least 1·5 inches high on an illuminated white background, and must have an area of at least 21 square inches excluding the letters. The lighted background-to-letter contrast must be at least 10:1. The letter height to stroke-width ratio may not be more than 7:1 nor less than 6:1. These signs must be internally electrically illuminated with a background brightness of at least 25 foot-lamberts and a high-to-low background contrast no greater than 3:1.

(ii) Each passenger emergency exit sign required by JAR 25.811(d)(3) must have red letters at least 1·5 inches high on a white background having an area of at least 21 square inches excluding the letters. These signs must be internally electrically illuminated or self-illuminated by other than electrical means and must have an initial brightness of at least 400 microlamberts. The colours may be reversed in the case of a sign that is self-illuminated by other than electrical means.

(2) For aeroplanes that have a passenger seating configuration, excluding pilot seats, of 9 seats or less, that are required by JAR 25.811(d)(1), (2), and (3) must have red letters at least 1 inch high on a white background at least 2 inches high. These signs may be internally electrically illuminated, or self-illuminated by other than electrical means, with an initial brightness of at least 160 microlamberts. The colours may be reversed in the case of a sign that is self-illuminated by other than electrical means.

(c) General illumination in the passenger cabin must be provided so that when measured along the centreline of main passenger aisle(s), and cross aisle(s) between main aisles, at seat armrest height and at 40-inch intervals, the average illumination is not less than 0·05 foot-candle and the illumination at each 40-inch interval is not less than 0·01 foot-candle. A main passenger aisle(s) is considered to extend along the fuselage from the most forward passenger emergency exit or cabin occupant seat, whichever is farther forward, to the most rearward passenger emergency exit or cabin occupant seat, whichever is farther aft.

(d) The floor of the passageway leading to each floor-level passenger emergency exit, between the main aisles and the exit openings, must be provided with illumination that is not less than 0·02 foot-candle measured along a line that is within 6 inches of and parallel to the floor and is centred on the passenger evacuation path.

(e) Floor proximity emergency escape path marking must provide emergency evacuation guidance for passengers when all sources of illumination more than 4 ft above the cabin aisle floor are totally obscured. In the dark of the night, the floor proximity emergency escape path marking must enable each passenger to –

(1) After leaving the passenger seat, visually identify the emergency escape path along the cabin aisle floor to the first exits or pair of exits forward and aft of the seat; and

(2) Readily identify each exit from the emergency escape path by reference only to markings and visual features not more than 4 ft above the cabin floor.

(f) Except for sub-systems provided in accordance with sub-paragraph (h) of this paragraph that serve no more than one assist means, are independent of the aeroplane's main emergency lighting system, and are automatically activated when the assist means is erected, the emergency lighting system must be designed as follows:

(1) The lights must be operable manually from the flight crew station and from a point in the passenger compartment that is readily accessible to a normal cabin crew member seat.

(2) There must be a flight crew warning light which illuminates when power is on in the aeroplane and the emergency lighting control device is not armed.

(3) The cockpit control device must have an 'on', 'off' and 'armed' position so that when armed in the cockpit or turned on at either the cockpit or cabin crew member station the lights will either light or remain lighted upon interruption (except an interruption caused by a transverse vertical separation of the fuselage during crash landing) of the aeroplane's normal electric power. There must be a means to safeguard against inadvertent operation of the control device from the 'armed' or 'on' positions.

(g) Exterior emergency lighting must be provided as follows:

(1) At each overwing emergency exit the illumination must be –

(i) Not less than 0·03 foot-candle (measured normal to the direction of the incident light) on a two-square-foot area where an evacuee is likely to make his first step outside the cabin;

(ii) Not less than 0·05 foot-candle (measured normal to the direction of the [incident light) along the 30% of the slip-resistant portion of the escape route required in JAR 25.810(c) that is farthest from the exit for the minimum required width of the escape route; and]

(iii) Not less than 0·03 foot-candle on the ground surface with the landing gear extended (measured normal to the direction of the incident light) where an evacuee using the established escape route would normally make first contact with the ground.

(2) At each non-overwing emergency exit not required by JAR 25.809(f) to have descent assist means the illumination must be not

JAR 25.812(g) (continued)

less than 0·03 foot-candle (measured normal to the direction of the incident light) on the ground surface with the landing gear extended where an evacuee is likely to make his first contact with the ground outside the cabin.

(h) The means required in JAR 25.810(a)(1) and (d) to assist the occupants in descending to the ground must be illuminated so that the erected assist means is visible from the aeroplane. In addition –

(1) If the assist means is illuminated by exterior emergency lighting, it must provide illumination of not less than 0·03 foot-candle (measured normal to the direction of the incident light) at the ground end of the erected assist means where an evacuee using the established escape route would normally make first contact with the ground, with the aeroplane in each of the attitudes corresponding to the collapse of one or more legs of the landing gear.

(2) If the emergency lighting sub-system illuminating the assist means serves no other assist means, is independent of the aeroplane's main emergency lighting system, and is automatically activated when the assist means is erected, the lighting provisions –

(i) May not be adversely affected by stowage; and

(ii) Must provide illumination of not less than 0·03 foot-candle (measured normal to the direction of the incident light) at the ground end of the erected assist means where an evacuee would normally make first contact with the ground, with the aeroplane in each of the attitudes corresponding to the collapse of one or more legs of the landing gear.

(i) The energy supply to each emergency lighting unit must provide the required level of illumination for at least 10 minutes at the critical ambient conditions after emergency landing.

(j) If storage batteries are used as the energy supply for the emergency lighting system, they may be recharged from the aeroplane's main electric power system: *Provided*, that the charging circuit is designed to preclude inadvertent battery discharge into charging circuit faults.

(k) Components of the emergency lighting system, including batteries, wiring relays, lamps, and switches must be capable of normal operation after having been subjected to the inertia forces listed in JAR 25.561(b).

JAR 25.812 (continued)

(l) The emergency lighting system must be designed so that after any single transverse vertical separation of the fuselage during crash landing –

(1) Not more than 25% of all electrically illuminated emergency lights required by this paragraph are rendered inoperative, in addition to the lights that are directly damaged by the separation;

(2) Each electrically illuminated exit sign required under JAR 25.811(d) (2) remains operative exclusive of those that are directly damaged by the separation; and

(3) At least one required exterior emergency light for each side of the aeroplane remains operative exclusive of those that are directly damaged by the separation.

[Ch.12, 10.05.88; Ch.15, 01.10.00; Amdt. 16, 01.05.03]

JAR 25.813 Emergency exit access (See ACJ 25.807)

Each required emergency exit must be accessible to the passengers and located where it will afford an effective means of evacuation. Emergency exit distribution must be as uniform as practical, taking passenger distribution into account; however, the size and location of exits on both sides of the cabin need not be symmetrical. If only one floor level exit per side is prescribed, and the aeroplane does not have a tail cone or ventral emergency exit, the floor level exit must be in the rearward part of the passenger compartment, unless another location affords a more effective means of passenger evacuation. Where more than one floor level exit per side is prescribed, at least one floor level exit per side must be located near each end of the cabin, except that this provision does not apply to combination cargo/passenger configuration. In addition –

(a) There must be a passageway leading from each main aisle to each Type I, Type II, or Type A emergency exit and between individual passenger areas. If two or more main aisles are provided, there must be a cross aisle leading directly to each passageway between the exit and the nearest main aisle. Each passageway leading to a Type A exit must be unobstructed and at least 36 inches (914·4 mm) wide. Other passageways and cross aisles must be unobstructed and at least 20 inches (508 mm) wide. Unless there are two or more main aisles, each Type A exit must be located so that there is passenger flow along the main aisle to that exit from both the forward and aft directions.

JAR 25.813 (continued)

(b) Adequate space to allow crew-member(s) to assist in the evacuation of passengers must be provided as follows:

(1) The assist space must not reduce the unobstructed width of the passageway below that required for the exit.

(2) For each Type A exit, assist space must be provided at each side of the exit regardless of whether the exit is covered by JAR 25.810(a).

(3) For any other type exit that is covered by JAR 25.810(a), space must at least be provided at one side of the passageway.

(c) There must be access from each aisle to each Type III or Type IV exit, and –

(1) For aeroplanes that have a passenger seating configuration, excluding pilot's seats, of 20 or more, the projected opening of the exit provided may not be obstructed and there must be no interference in opening the exit by seats, berths, or other protrusions (including seatbacks in any position) for a distance from that exit not less than the width of the narrowest passenger seat installed on the aeroplane.

(2) For aeroplanes that have a passenger seating configuration, excluding pilots seats, of 19 or less, there may be minor obstructions in this region, if there are compensating factors to maintain the effectiveness of the exit.

(d) If it is necessary to pass through a passageway between passenger compartments to reach any required emergency exit from any seat in the passenger cabin, the passageway must be unobstructed. However, curtains may be used if they allow free entry through the passageway.

(e) No door may be installed in any partition between passenger compartments.

(f) If it is necessary to pass through a doorway separating the passenger cabin from other areas to reach any required emergency exit from any passenger seat, the door must have a means to latch it in open position. The latching means must be able to withstand the loads imposed upon it when the door is subjected to the ultimate inertia forces, relative to the surrounding structure, listed in JAR 25.561(b).

[Ch.14, 27.05.94]

JAR 25.815 Width of aisle [(See ACJ 25.815)]

The passenger aisle width at any point between seats must equal or exceed the values in the following table:

Passenger seating capacity	Minimum passenger aisle width (inches)	
	Less than 25 inches from floor	25 inches and more from floor
10 or less	12*	15
11 to 19	12	20
20 or more	15	20

* A narrower width not less than 9 inches may be approved when substantiated by tests found necessary by the Authority.

[Amdt. 16, 01.05.03]

JAR 25.817 Maximum number of seats abreast

On aeroplanes having only one passenger aisle, no more than 3 seats abreast may be placed on each side of the aisle in any one row.

JAR 25.819 Lower deck service compartments (including galleys)

For aeroplanes with a service compartment located below the main deck, which may be occupied during the taxi or flight but not during take-off or landing, the following apply:

(a) There must be at least two emergency evacuation routes, one at each end of each lower deck service compartment or two having sufficient separation within each compartment, which could be used by each occupant of the lower deck service compartment to rapidly evacuate to the main deck under normal and emergency lighting conditions. The routes must provide for the evacuation of incapacitated persons, with assistance. The use of the evacuation routes may not be dependent on any powered device. The routes must be designed to minimise the possibility of blockage which might result from fire, mechanical or structural failure, or persons standing on top of or against the escape routes. In the event the aeroplane's main power system or compartment main lighting system should fail, emergency illumination for each lower deck service compartment must be automatically provided.

(b) There must be a means for two-way voice communication between the flight deck and each

JAR 25.819(b) (continued)

lower deck service compartment, which remains available following loss of normal electrical power generating system.

(c) There must be an aural emergency alarm system, audible during normal and emergency conditions, to enable crew members on the flight deck and at each required floor level emergency exit to alert occupants of each lower deck service compartment of an emergency situation.

(d) There must be a means, readily detectable by occupants of each lower deck service compartment, that indicates when seat belts should be fastened.

(e) If a public address system is installed in the aeroplane, speakers must be provided in each lower deck service compartment.

(f) For each occupant permitted in a lower deck service compartment, there must be a forward or aft facing seat which meets the requirements of JAR 25.785(d) and must be able to withstand maximum flight loads when occupied.

(g) For each powered lift system installed between a lower deck service compartment and the main deck for the carriage of persons or equipment, or both, the system must meet the following requirements:

(1) Each lift control switch outside the lift, except emergency stop buttons, must be designed to prevent the activation of the lift if the lift door, or the hatch required by sub-paragraph (g)(3) of this paragraph, or both are open.

(2) An emergency stop button, that when activated will immediately stop the lift, must be installed within the lift and at each entrance to the lift.

(3) There must be a hatch capable of being used for evacuating persons from the lift that is openable from inside and outside the lift without tools, with the lift in any position.

[Ch.14, 27.05.94]

VENTILATION AND HEATING

JAR 25.831 Ventilation

(a) Each passenger and crew compartment must be ventilated and each crew compartment must have enough fresh air (but not less than 10 cubic ft per minute per crew member) to enable crew members to perform their duties without undue discomfort or fatigue. (See ACJ 25.831(a).)

JAR 25.831 (continued)

(b) Crew and passenger compartment air must be free from harmful or hazardous concentrations of gases or vapours. In meeting this requirement, the following apply:

(1) Carbon monoxide concentrations in excess of one part in 20 000 parts of air are considered hazardous. For test purposes, any acceptable carbon monoxide detection method may be used.

[(2) Carbon dioxide concentration during flight must be shown not to exceed 0·5% by volume (seal level equivalent) in compartments normally occupied by passengers or crew members. For the purpose of this sub-paragraph, "sea level equivalent" refers to conditions of 25°C (77° F) and 760 millimetres of mercury pressure (1 013·2 hPa).]

(c) There must be provisions made to ensure that the conditions prescribed in sub-paragraph (b) of this paragraph are met after reasonably probable failures or malfunctioning of the ventilating, heating, pressurisation or other systems and equipment. (See ACJ 25.831(c).)

(d) If accumulation of hazardous quantities of smoke in the cockpit area is reasonably probable, smoke evacuation must be readily accomplished, starting with full pressurisation and without de-pressurising beyond safe limits.

(e) Except as provided in sub-paragraph (f) of this paragraph, means must be provided to enable the occupants of the following compartments and areas to control the temperature and quantity of ventilating air supplied to their compartment or area independently of the temperature and quantity of air supplied to other compartments and areas:

(1) The flight-crew compartment.

(2) Crew-member compartments and areas other than the flight-crew compartment unless the crew-member compartment or area is ventilated by air interchange with other compartments or areas under all operating conditions.

(f) Means to enable the flight crew to control the temperature and quantity of ventilating air supplied to the flight-crew compartment independently of the temperature and quantity of ventilating air supplied to other compartments are not required if all of the following conditions are met:

(1) The total volume of the flight-crew and passenger compartments is 800 cubic ft or less.

JAR 25.831(f) (continued)

(2) The air inlets and passages for air to flow between flight-crew and passenger compartments are arrange to provide compartment temperatures within 5ºF of each other and adequate ventilation to occupants in both compartments.

(3) The temperature and ventilation controls are accessible to the flight crew.

(g) Reserved

[Amdt. 16, 01.05.03]

JAR 25.832 Cabin ozone concentration

[(a) The aeroplane cabin ozone concentration during flight must be shown not to exceed –]

[(1) 0·25 parts per million by volume, sea level equivalent, at any time above flight level 320; and

(2) 0·1 parts per million by volume, sea level equivalent, time-weighted average during any 3-hour interval above flight level 270.

(b) For the purpose of this paragraph, "sea level equivalent" refers to conditions of 25° C (77°F) and 760 millimetres of mercury pressure (1 013·2 hPa).

(c) Compliance with this paragraph must be shown by analysis or tests based on aeroplane operational procedures and performance limitations, that demonstrated that either –

(1) The aeroplane cannot be operated at an altitude which would result in cabin ozone concentrations exceeding the limits prescribed by sub-paragraph (a) of this paragraph; or

(2) The aeroplane ventilation system, including any ozone control equipment, will maintain cabin ozone concentrations at or below the limits prescribed by sub-paragraph (a) of this paragraph.]

[Amdt. 16, 01.05.03]

JAR 25.833 Combustion heating systems

Combustion heaters must be approved.

[Ch.14, 27.05.94]

PRESSURISATION

JAR 25.841 Pressurised cabins

(a) Pressurised cabins and compartments to be occupied must be equipped to provide a cabin

JAR 25.841(a) (continued)

pressure altitude of not more than 8 000 ft at the maximum operating altitude of the aeroplane under normal operating conditions. If certification for operation over 25 000 ft is requested, the aeroplane must be able to maintain a cabin pressure altitude of not more than 15 000 ft in the event of any reasonably probable failure or malfunction in the pressurisation system.

(b) Pressurised cabins must have at least the following valves, controls, and indicators for controlling cabin pressure:

(1) Two pressure relief values to automatically limit the positive pressure differential to a predetermined valve at the maximum rate of flow delivered by the pressure source. The combined capacity of the relief valves must be large enough so that the failure of any one valve would not cause an appreciable rise in the pressure differential. The pressure differential is positive when the internal pressure is greater than the external.

(2) Two reverse pressure differential relief valves (or their equivalents) to automatically prevent a negative pressure differential that would damage the structure. One valve is enough, however, if it is of a design that reasonably precludes its malfunctioning.

(3) A means by which the pressure differential can be rapidly equalised.

(4) An automatic or manual regulator for controlling the intake or exhaust airflow, or both, for maintaining the required internal pressures and airflow rates.

(5) Instruments at the pilot or flight engineer station to show the pressure differential, the cabin pressure altitude, and the rate of change of the cabin pressure altitude.

(6) Warning indication at the pilot or flight engineer station to indicate when the safe or pre-set pressure differential and cabin pressure altitude limits are exceeded. Appropriate warning markings on the cabin pressure differential indicator meet the warning requirement for pressure differential limits and an aural or visual signal (in addition to cabin altitude indicating means) meets the warning requirement for cabin pressure altitude limits if it warns the flight crew when the cabin pressure altitude exceeds 10 000 ft.

(7) A warning placard at the pilot or flight engineer station if the structure is not designed for pressure differentials up to the maximum relief valve setting in combination with landing loads.

JAR 25.841(b) (continued)

(8) The pressure sensors necessary to meet the requirements of sub-paragraphs (b)(5) and (b)(6) of this paragraph and JAR 25.1447(c), must be located and the sensing system designed so that, in the event of loss of cabin pressure in any passenger or crew compartment (including upper and lower lobe galleys), the warning and automatic presentation devices, required by those provisions, will be actuated without any delay that would significantly increase the hazards resulting from decompression.

JAR 25.843 Tests for pressurised cabins

(a) *Strength test.* The complete pressurised cabin, including doors, windows, and valves, must be tested as a pressure vessel for the pressure differential specified in JAR 25.365(d).

(b) *Functional tests*. The following functional tests must be performed:

(1) Tests of the functioning and capacity of the positive and negative pressure differential valves, and of the emergency release valve, to simulate the effects of closed regulator valves.

(2) Tests of the pressurisation system to show proper functioning under each possible condition of pressure, temperature, and moisture, up to the maximum altitude for which certification is requested.

(3) Flight tests, to show the performance of the pressure supply, pressure and flow regulators, indicators, and warning signals, in steady and stepped climbs and descents at rates corresponding to the maximum attainable within the operating limitations of the aeroplane, up to the maximum altitude for which certification is requested.

(4) Tests of each door and emergency exit, to show that they operate properly after being subjected to the flight tests prescribed in sub-paragraph (b)(3) of this paragraph.

[Ch.12, 10.05.88]

FIRE PROTECTION

JAR 25.851 Fire extinguishers

(a) *Hand fire extinguishers*. (See ACJ 25.851(a).)

(1) The following minimum number of hand fire extinguishers must be conveniently located and evenly distributed in passenger compartments. (See ACJ 25.851(a)(1).):

JAR 25.851(a) (continued)

Passenger capacity	*Number of extinguishers*
7 to 30........................	1
31 to 60........................	2
61 to 200......................	3
201 to 300......................	4
301 to 400......................	5
401 to 500......................	6
501 to 600......................	7
601 to 700......................	8

(2) At least one hand fire extinguisher must be conveniently located in the pilot compartment (see ACJ 25.851(a)(2)).

(3) At least one readily accessible hand fire extinguisher must be available for use in each Class A or Class B cargo or baggage compartment and in each Class E cargo or baggage compartment that is accessible to crew members in flight.

(4) At least one hand fire extinguisher must be located in, or readily accessible for use in, each galley located above or below the passenger compartment.

(5) Each hand fire extinguisher must be approved.

(6) At least one of the required fire extinguishers located in the passenger compartment of an aeroplane with a passenger capacity of at least 31 and not more than 60, and at least two of the fire extinguishers located in the passenger compartment of an aeroplane with a passenger capacity of 61 or more must contain Halon 1211 (bromochlorodifluoromethane, $CBrC_1F_2$), or equivalent, as the extinguishing agent. The type of extinguishing agent used in any other extinguisher required by this paragraph must be appropriate for the kinds of fires likely to occur where used.

(7) The quantity of extinguishing agent used in each extinguisher required by this paragraph must be appropriate for the kinds of fires likely to occur where used.

(8) Each extinguisher intended for use in a personnel compartment must be designed to minimise the hazard of toxic gas concentration.

(b) *Built-in fire extinguishers*. If a built-in fire extinguisher is provided –

(1) Each built-in fire extinguishing system must be installed so that –

JAR 25.851(b)(1) (continued)

(i) No extinguishing agent likely to enter personnel compartments will be hazardous to the occupants; and

(ii) No discharge of the extinguisher can cause structural damage.

(2) The capacity of each required built-in fire extinguishing system must be adequate for any fire likely to occur in the compartment where used, considering the volume of the compartment and the ventilation rate.

[Ch.8, 30.11.81; Ch.9, 30.11.82; Ch.14, 27.05.94]

JAR 25.853 Compartment interiors [(See ACJ 25.853)]

For each compartment occupied by the crew or passengers, the following apply:

(a) Materials (including finishes or decorative surfaces applied to the materials) must meet the applicable test criteria prescribed in Part I of Appendix F or other approved equivalent methods, [regardless of the passenger capacity of the aeroplane].

(b) [*Reserved*]

(c) [In addition to meeting the requirements of sub-paragraph (a) of this paragraph, seat cushions, except those on flight crewmember seats, must meet the test requirements of part II of appendix F, or other equivalent methods, regardless of the passenger capacity of the aeroplane.]

(d) [Except as provided in sub-paragraph (e) of this paragraph, the following interior components of aeroplanes with passenger capacities of 20 or more must also meet the test requirements of parts IV and V of appendix F, or other approved equivalent method, in addition to the flammability requirements prescribed in sub-paragraph (a) of this paragraph:

(1) Interior ceiling and wall panels, other than lighting lenses and windows;

(2) Partitions, other than transparent panels needed to enhance cabin safety;

(3) Galley structure, including exposed surfaces of stowed carts and standard containers and the cavity walls that are exposed when a full complement of such carts or containers is not carried; and

(4) Large cabinets and cabin stowage compartments, other than underseat stowage compartments for stowing small items such as magazines and maps.]

JAR 25.853 (continued)

(e) [The interiors of compartments, such as pilot compartments, galleys, lavatories, crew rest quarters, cabinets and stowage compartments, need not meet the standards of sub-paragraph (d) of this paragraph, provided the interiors of such compartments are isolated from the main passenger cabin by doors or equivalent means that would normally be closed during an emergency landing condition.]

(f) [Smoking is not to be allowed in lavatories. If smoking is to be allowed in any other compartment occupied by the crew or passengers, an adequate number of self-contained, removable ashtrays must be provided for all seated occupants.]

[(g)] Regardless of whether smoking is allowed in any other part of the aeroplane, lavatories must have self-contained removable ashtrays located conspicuously both inside and outside each lavatory. One ashtray located outside a lavatory door may serve more than one lavatory door if the ashtray can be seen readily from the cabin side of each lavatory door served.

[(h)] Each receptacle used for the disposal of flammable waste material must be fully enclosed, constructed of at least fire resistant materials, and must contain fires likely to occur in it under normal use. The ability of the receptacle to contain those fires under all probable conditions of wear, misalignment, and ventilation expected in service must be demonstrated by test.

[Ch.12, 10.05.88; Ch.13, 05.10.89; Ch.14, 27.05.94; Amdt. 16, 01.05.03]

JAR 25.854 Lavatory fire protection

For aeroplanes with a passenger capacity of 20 or more –

(a) Each lavatory must be equipped with a smoke detector system or equivalent that provides a warning light in the cockpit, or provides a warning light or audible warning in the passenger cabin that would be readily detected by a cabin crew member; and

(b) Each lavatory must be equipped with a built-in fire extinguisher for each disposal receptacle for towels, paper, or waste, located within the lavatory. The extinguisher must be designed to discharge automatically into each disposal receptacle upon occurrence of a fire in that receptacle.

[Ch.14, 27.05.94; Ch.15, 01.10.00]

JAR 25.855 Cargo or baggage compartments

For each cargo or baggage compartment not occupied by crew or passengers, the following apply:

(a) The compartment must meet one of the class requirements of JAR 25.857.

(b) Class B through Class E cargo or baggage compartments, as defined in JAR 25.857, must have a liner, and the liner must be separate from (but may be attached to) the aeroplane structure.

(c) Ceiling and sidewall liner panels of Class C and D compartments must meet the test requirements of Part III of Appendix F or other approved equivalent methods.

(d) All other materials used in the construction of the cargo or baggage compartment must meet the applicable test criteria prescribed in Part I of Appendix F, or other approved equivalent methods.

(e) No compartment may contain any controls, wiring, lines, equipment, or accessories whose damage or failure would affect safe operation, unless those items are protected so that–

(1) They cannot be damaged by the movement of cargo in the compartment; and

(2) Their breakage or failure will not create a fire hazard.

(f) There must be means to prevent cargo or baggage from interfering with the functioning of the fire protective features of the compartment.

(g) Sources of heat within the compartment must be shielded and insulated to prevent igniting the cargo or baggage.

(h) Flight tests must be conducted to show compliance with the provisions of JAR 25.857 concerning –

(1) Compartment accessibility;

(2) The entry of hazardous quantities of smoke or extinguishing agent into compartments occupied by the crew or passengers; and

(3) The dissipation of the extinguishing agent in Class C compartments.

(i) During the above tests, it must be shown that no inadvertent operation of smoke or fire detectors in any compartment would occur as a result of fire contained in any other compartment, either during or after extinguishment, unless the extinguishing system floods each such compartment simultaneously.

[Ch.12, 10.05.88; Ch.14, 27.05.94]

JAR 25.857 Cargo compartment classification [(See ACJ 25.857)]

(a) *Class A*. A Class A cargo or baggage compartment is one in which –

(1) The presence of a fire would be easily discovered by a crew member while at his station; and

(2) Each part of the compartment is easily accessible in flight.

(b) Class *B*. (See ACJ 25.857(b).) A Class B cargo or baggage compartment is one in which –

(1) There is sufficient access in flight to enable a crew member to effectively reach any part of the compartment with the contents of a hand fire extinguisher;

(2) When the access provisions are being used no hazardous quantity of smoke, flames or extinguishing agent will enter any compartment occupied by the crew or passengers; and

(3) There is a separate approved smoke detector or fire detector system to give warning to the pilot or flight engineer station.

(c) *Class C*. A Class C cargo or baggage compartment is one not meeting the requirements for either a Class A or B compartment but in which–

(1) There is a separate approved smoke detector or fire detector system to give warning at the pilot or flight engineer station;

(2) There is an approved built-in fire-[extinguishing or suppression system controllable from the cockpit].

(3) There are means to exclude hazardous quantities of smoke, flames, or extinguishing agent, from any compartment occupied by the crew or passengers; and

(4) There are means to control ventilation and draughts within the compartment so that the extinguishing agent used can control any fire that may start within the compartment.

(d) *Class D*. (See ACJ 25.857(d).) A Class D cargo or baggage compartment is one in which –

(1) A fire occurring in it will be completely confined without endangering the safety of the aeroplane or the occupants;

(2) There are means to exclude hazardous quantities of smoke, flames, or other noxious gases, from any compartment occupied by the crew or passengers;

JAR 25.857(d) (continued)

(3) Ventilation and draughts are controlled within each compartment so that any fire likely to occur in the compartment will not progress beyond safe limits;

(4) Reserved.

(5) Consideration is given to the effect of heat within the compartment on adjacent critical parts of the aeroplane.

(6) The compartment volume does not exceed 1 000 cubic ft.

For compartments of 500 cubic ft or less, an airflow of 1 500 cubic ft per hour is acceptable.

(e) *Class E.* A Class E cargo compartment is one on aeroplanes used only for the carriage of cargo and in which –

(1) Reserved.

(2) There is a separate approved smoke or fire detector system to give warning at the pilot or flight engineer station;

(3) There are means to shut off the ventilating airflow to, or within, the compartment, and the controls for these means are accessible to the flight crew in the crew compartment;

(4) There are means to exclude hazardous quantities of smoke, flames, or noxious gases, from the flight-crew compartment; and

(5) The required crew emergency exits are accessible under any cargo loading condition.

[Ch.12, 10.05.88; Amdt. 16, 01.05.03]

JAR 25.858 Cargo compartment fire detection systems

If certification with cargo compartment fire detection provisions is requested, the following must be met for each cargo compartment with those provisions:

(a) The detection system must provide a visual indication to the flight crew within one minute after the start of a fire.

(b) The system must be capable of detecting a fire at a temperature significantly below that at which the structural integrity of the aeroplane is substantially decreased.

(c) There must be means to allow the crew to check in flight, the functioning of each fire detector circuit.

JAR 25.858 (continued)

(d) The effectiveness of the detection system must be shown for all approved operating configurations and conditions.

[Ch.10, 19.12.83]

JAR 25.859 Combustion heater fire protection

(a) *Combustion heater fire zones.* The following combustion heater fire zones must be protected from fire in accordance with the applicable provisions of JAR 25.1181 to 25.1191 and 25.1195 to 25.1203:

(1) The region surrounding the heater, if this region contains any flammable fluid system components (excluding the heater fuel system), that could –

(i) Be damaged by heater malfunctioning; or

(ii) Allow flammable fluids or vapours to reach the heater in case of leakage.

(2) The region surrounding the heater, if the heater fuel system has fittings that, if they leaked, would allow fuel or vapours to enter this region.

(3) The part of the ventilating air passage that surrounds the combustion chamber. However, no fire extinguishment is required in cabin ventilating air passages.

(b) *Ventilating air ducts.* Each ventilating air duct passing through any fire zone must be fireproof. In addition –

(1) Unless isolation is provided by fireproof valves or by equally effective means, the ventilating air duct downstream of each heater must be fireproof for a distance great enough to ensure that any fire originating in the heater can be contained in the duct; and

(2) Each part of any ventilating duct passing through any region having a flammable fluid system must be constructed or isolated from that system so that the malfunctioning of any component of that system cannot introduce flammable fluids or vapours into the ventilating airstream.

(c) *Combustion air ducts.* Each combustion air duct must be fireproof for a distance great enough to prevent damage from backfiring or reverse flame propagation. In addition –

(1) No combustion air duct may have a common opening with the ventilating airstream unless flames from backfires or reverse burning

JAR 25.859(c) (continued)

cannot enter the ventilating airstream under any operating condition, including reverse flow or malfunctioning of the heater or its associated components; and

(2) No combustion air duct may restrict the prompt relief of any backfire that, if so restricted, could cause heater failure.

(d) *Heater controls; general*. Provision must be made to prevent the hazardous accumulation of water or ice on or in any heater control component, control system tubing, or safety control.

(e) *Heater safety controls.* For each combustion heater there must be the following safety control means:

(1) Means independent of the components provided for the normal continuous control of air temperature, airflow, and fuel flow must be provided, for each heater, to automatically shut off the ignition and fuel supply to that heater at a point remote from that heater when any of the following occurs:

(i) The heat exchanger temperature exceeds safe limits.

(ii) The ventilating air temperature exceeds safe limits.

(iii) The combustion airflow becomes inadequate for safe operation.

(iv) The ventilating airflow becomes inadequate for safe operation.

(2) The means of complying with sub-paragraph (e) (1) of this paragraph for any individual heater must –

(i) Be independent of components serving any other heater whose heat output is essential for safe operation; and

(ii) Keep the heater off until restarted by the crew.

(3) There must be means to warn the crew when any heater whose heat output is essential for safe operation has been shut off by the automatic means prescribed in sub-paragraph (e)(1) of this paragraph.

(f) *Air intakes*. Each combustion and ventilating air intake must be located so that no flammable fluids or vapours can enter the heater system under any operating condition –

(1) During normal operation; or

(2) As a result of the malfunctioning of any other component.

JAR 25.859 (continued)

(g) *Heater exhaust*. Heater exhaust systems must meet the provisions of JAR 25.1121 and 25.1123. In addition, there must be provisions in the design of the heater exhaust system to safely expel the products of combustion to prevent the occurrence of –

(1) Fuel leakage from the exhaust to surrounding compartments;

(2) Exhaust gas impingement on surrounding equipment or structure;

(3) Ignition of flammable fluids by the exhaust, if the exhaust is in a compartment containing flammable fluid lines; and

(4) Restriction by the exhaust of the prompt relief of backfires that, if so restricted, could cause heater failure.

(h) *Heater fuel systems*. Each heater fuel system must meet each powerplant fuel system requirement affecting safe heater operation. Each heater fuel system component within the ventilating airstream must be protected by shrouds so that no leakage from those components can enter the ventilating airstream.

(i) *Drains*. There must be means to safely drain fuel that might accumulate within the combustion chamber or the heater exchanger. In addition –

(1) Each part of any drain that operates at high temperatures must be protected in the same manner as heater exhausts; and

(2) Each drain must be protected from hazardous ice accumulation under any operating conditions.

JAR 25.863 Flammable fluid fire protection

(a) In each area where flammable fluids or vapours might escape by leakage of a fluid system, there must be means to minimise the probability of ignition of the fluids and vapours, and the resultant hazards if ignition does occur. (See ACJ 25.863(a).)

(b) Compliance with sub-paragraph (a) of this paragraph must be shown by analysis or tests, and the following factors must be considered.

(1) Possible sources and paths of fluid leakage, and means of detecting leakage.

(2) Flammability characteristics of fluids, including effects of any combustible or absorbing materials.

JAR 25.863(b) (continued)

(3) Possible ignition sources, including electrical faults, overheating of equipment, and malfunctioning of protective devices.

(4) Means available for controlling or extinguishing a fire, such as stopping flow of [fluids, shutting down equipment, fireproof] containment, or use of extinguishing agents.

(5) Ability of aeroplane components that are critical to safety of flight to withstand fire and heat.

(c) If action by the flight crew is required to prevent or counteract a fluid fire (e.g. equipment shutdown or actuation of a fire extinguisher) quick acting means must be provided to alert the crew.

(d) Each area where flammable fluids or vapours might escape by leakage of a fluid system must be identified and defined.

[Ch.14, 27.05.94; Amdt. 16, 01.05.03]

JAR 25.865 Fire protection of flight controls, engine mounts, and other flight structure

Essential flight controls, engine mounts, and other flight structures located in designated fire zones or in adjacent areas which would be subjected to the effects of fire in the fire zone must be constructed of fireproof material or shielded so that they are capable of withstanding the effects of fire.

JAR 25.867 Fire protection: other components

(a) Surfaces to the rear of the nacelles, within one nacelle diameter of the nacelle centreline, must be constructed of materials at least equivalent in resistance to fire as aluminium alloy in dimensions appropriate for the purpose for which they are used.

(b) Sub-paragraph (a) of this paragraph does not apply to tail surfaces to the rear of the nacelles that could not be readily affected by heat, flames, or sparks coming from a designated fire zone or engine compartment of any nacelle.

[Ch.14, 27.05.94]

JAR 25.869 Fire protection: systems

(a) Electrical system components:

(1) Components of the electrical system must meet the applicable fire and smoke protection requirements of JAR 25.831(c) and JAR 25.863. (See ACJ 25.869(a)(1).)

JAR 25.869(a) (continued)

(2) Electrical cables, terminals, and equipment in designated fire zones, that are used during emergency procedures, must be at least fire resistant.

(3) Main power cables (including generator cables) in the fuselage must be designed to allow a reasonable degree of deformation and stretching without failure and must be –

(i) Isolated from flammable fluid lines; or

(ii) Shrouded by means of electrically insulated, flexible conduit, or equivalent, which is in addition to the normal cable insulation.

(4) Insulation on electrical wire and electrical cable installed in any area of the aeroplane must be self-extinguishing when tested in accordance with the applicable portions of Part I, Appendix F.

(b) Each vacuum air system line and fitting on the discharge side of the pump that might contain flammable vapours or fluids must meet the requirements of JAR 25.1183 if the line or fitting is in a designated fire zone. Other vacuum air systems components in designated fire zones must be at least fire resistant.

(c) (See ACJ 25.869(c).) Oxygen equipment and lines must –

(1) Not be located in any designated fire zone.

(2) Be protected from heat that may be generated in, or escape from, any designated fire zone, and

(3) Be installed so that escaping oxygen cannot cause ignition of grease, fluid, or vapour accumulations that are present in normal operation or as a result of failure or malfunction of any system.

[Ch.14, 27.05.94]

MISCELLANEOUS

JAR 25.871 Levelling means

There must be means for determining when the aeroplane is in a level position on the ground.

JAR 25.875 Reinforcement near propellers

(a) Each part of the aeroplane near the propeller tips must be strong and stiff enough to withstand the effects of the induced vibration and of ice thrown from the propeller.

(b) No window may be near the propeller tips unless it can withstand the most severe ice impact likely to occur.

[JAR 25.899 Electrical bonding and protection against static electricity
(See ACJ 25.899.)

(a) Electrical bonding and protection against static electricity must be designed to minimise accumulation of electrostatic charge, which would cause:

(1) Human injury from electrical shock,

(2) Ignition of flammable vapours, or

(3) Interference with installed electrical/electronic equipment.

(b) Compliance with sub-paragraph (a) of this paragraph may be shown by

(1) Bonding the components properly to the airframe or

(2) Incorporating other acceptable means to dissipate the static charge so as not to endanger the aeroplane, personnel or operation of the installed electrical/electronic systems.]

[Amdt. 16, 01.05.03]

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SUBPART E – POWERPLANT

GENERAL

JAR 25.901 Installation

(a) For the purpose of this JAR–25 the aeroplane powerplant installation includes each component that –

(1) Is necessary for propulsion;

(2) Affects the control of the major propulsive units; or

(3) Affects the safety of the major propulsive units between normal inspections or overhauls.

(b) For each powerplant –

(1) The installation must comply with –

(i) The installation instructions provided under JAR–E20 (d) and (e); and

(ii) The applicable provisions of this Subpart (see also AMJ 20X-1).

(2) The components of the installation must be constructed, arranged, and installed so as to ensure their continued safe operation between normal inspections or overhauls. (See ACJ 25.901(b)(2).)

(3) The installation must be accessible for necessary inspections and maintenance; and

(4) The major components of the installation must be electrically bonded to the other parts of the aeroplane. (See ACJ 25.901(b)(4).)

(c) The powerplant installation must comply with JAR 25.1309.

(d) *Not required for JAR–25.*

(e) Revoked

[Ch.14, 27.05.94; Ch.15, 01.10.00]

JAR 25.903 Engines

(a) *Engine type certification.*

(1) Each engine must have a type certificate. (See ACJ 25.903(a).)

(2) Any engine not certificated to JAR–E must be shown to comply with JAR–E 790 and JAR–E 800 or be shown to have a foreign object ingestion service history in similar installation locations which has not resulted in any unsafe condition.

JAR 25.903 (continued)

(b) *Engine isolation.* The powerplants must be arranged and isolated from each other to allow operation, in at least one configuration, so that the failure or malfunction of any engine, or of any system that can affect the engine, will not –

(1) Prevent the continued safe operation of the remaining engines; or

(2) Require immediate action by any crew member for continued safe operation.

(c) *Control of engine rotation.* There must be means for stopping the rotation of any engine individually in flight, except that, for turbine engine installations, the means for stopping the rotation of any engine need be provided only where continued rotation could jeopardise the safety of the aeroplane. Each component of the stopping system on the engine side of the firewall that might be exposed to fire must be at least fire resistant. If hydraulic propeller feathering systems are used for this purpose, the feathering lines must be at least fire-resistant under the operating conditions that may be expected to exist during feathering.

(d) *Turbine engine installations.* For turbine engine installations –

(1) Design precautions must be taken to minimise the hazards to the aeroplane in the event of an engine rotor failure or of a fire originating within the engine which burns through the engine case. (See ACJ 25.903(d)(1) and AMJ 20-128A.)

(2) The powerplant systems associated with engine control devices, systems, and instrumentation, must be designed to give reasonable assurance that those engine operating limitations that adversely affect turbine rotor structural integrity will not be exceeded in service.

(e) *Restart capability.*

(1) Means to restart any engine in flight must be provided.

(2) An altitude and airspeed envelope must be established for in-flight engine restarting, and each engine must have a restart capability within that envelope. (See ACJ 25.903(e)(2).)

(3) For turbine engine powered aeroplanes, if the minimum windmilling speed of the engines, following the in-flight shut-down of all engines, is insufficient to provide the necessary electrical power for engine

JAR 25.903(e)(3) (continued)

ignition, a power source independent of the engine-driven electrical power generating system must be provided to permit in-flight engine ignition for restarting.

(f) *Not required for JAR–25*. See Subpart J.

[Ch.8, 30.11.81; Ch.11, 17.03.86; Ch.12, 10.05.88; Ch.13, 05.10.89; Ch.14, 27.05.94; Ch.15, 01.10.00]

[JAR 25.904 Automatic Takeoff Thrust Control System (ATTCS)

Each applicant seeking approval for installation of an engine power control system that automatically resets the power or thrust on the operating engine(s) when any engine fails during the takeoff must comply with the requirements of Appendix I.]

[Amdt 16, 01.05.03]

JAR 25.905 Propellers

(a) Each propeller must have a type certificate or equivalent approval. (See ACJ 25.905(a).)

(b) Engine power and propeller shaft rotational speed may not exceed the limits for which the propeller is certificated. (See JAR–P 80.)

(c) Each component of the propeller blade pitch control system must meet the requirements of JAR–P 200.

(d) Design precautions must be taken to minimise the hazards to the aeroplane in the event a propeller blade fails or is released by a hub failure. The hazards which must be considered include damage to structure and critical systems due to impact of a failed or released blade and the unbalance created by such failure or release. (See ACJ 25.905 (d).)

[Ch.10, 19.12.83; Ch.12, 10.05.88; Ch.14, 27.05.94]

JAR 25.907 Propeller vibration (See JAR–P 190.)

[(a) The magnitude of the propeller blade vibration stresses under any normal condition of operation must be determined by actual measurement or by comparison with similar installations for which these measurements have been made.

JAR 25.907 (continued)

(b) The determined vibration stresses may not exceed values that have been shown to be safe for continuous operation.]

[Ch.12, 10.05.88; Amdt. 16, 01.05.03]

JAR 25.925 Propeller clearance

Unless smaller clearances are substantiated, propeller clearances with the aeroplane at maximum weight, with the most adverse centre of gravity, and with the propeller in the most adverse pitch position, may not be less than the following:

(a) *Ground clearance*. There must be a clearance of at least 7 inches (177·8 mm) (for each aeroplane with nose wheel landing gear) or 9 inches (228·6 mm) (for each aeroplane with tail-wheel landing gear) between each propeller and the ground with the landing gear statically deflected and in the level take-off, or taxying attitude, whichever is most critical. In addition, there must be positive clearance between the propeller and the ground when in the level take-off attitude with the critical tyre(s) completely deflated and the corresponding landing gear strut bottomed.

(b) Not required for JAR–25.

(c) *Structural clearance*. There must be –

(1) At least 1·0 inches radial clearance between the blade tips and the aeroplane structure, plus any additional radial clearance necessary to prevent harmful vibration;

(2) At least 0·5 inches longitudinal clearance between propeller blades or cuffs and stationary parts of the aeroplane; and

(3) Positive clearance between other rotating parts of the propeller or spinner and stationary parts of the aeroplane.

[Ch.14, 27.05.94]

JAR 25.929 Propeller de-icing

(a) For aeroplanes intended for use where icing may be expected, there must be a means to prevent or remove hazardous ice accumulation on propellers or on accessories where ice accumulation would jeopardise engine performance. [ ]

(b) If combustible fluid is used for propeller de-icing, JAR 25.1181 to JAR 25.1185 and JAR 25.1189 apply.

[Amdt.16, 01.05.03]

JAR 25.933 Reversing systems

[(a) *For turbojet reversing systems* -

(1) Each system intended for ground operation only must be designed so that during any reversal in flight the engine will produce no more than flight idle thrust. In addition, it must be shown by analysis or test, or both, that -

(i) Each operable reverser can be restored to the forward thrust position; and

(ii) The airplane is capable of continued safe flight and landing under any possible position of the thrust reverser.

(2) Each system intended for inflight use must be designed so that no unsafe condition will result during normal operation of the system, or from any failure (or reasonably likely combination of failures) of the reversing system, under any anticipated condition of operation of the airplane including ground operation. Failure of structural elements need not be considered if the probability of this kind of failure is extremely remote.

(3) Each system must have means to prevent the engine from producing more than idle thrust when the reversing system malfunctions, except that it may produce any greater forward thrust that is shown to allow directional control to be maintained, with aerodynamic means alone, under the most critical reversing condition expected in operation.

(b) *For propeller reversing systems* -

(1) Each system intended for ground operation only must be designed so that no single failure (or reasonably likely combination of failures) or malfunction of the system will result in unwanted reverse thrust under any expected operating condition. Failure of structural elements need not be considered if this kind of failure is extremely remote.

(2) Compliance with this paragraph may be shown by failure analysis or testing, or both, for propeller systems that allow propeller blades to move from the flight low-pitch position to a position that is substantially less than that at the normal flight low-pitch position. The analysis may include or be supported by the analysis made to show compliance with the requirements of JAR-P 70 for the propeller and associated installation components.]

[Ch.10, 19.12.83; Ch.14, 27.05.94; Amdt. 16, 01.05.03]

JAR 25.934 Turbo-jet engine thrust reverser system tests

Thrust reversers installed on turbo-jet engines must meet the requirements of JAR–E 890.

[Ch.14, 27.05.94]

JAR 25.937 Turbo-propeller-drag limiting systems

Turbo-propeller powered aeroplane propeller-drag limiting systems must be designed so that no single failure or malfunction of any of the systems during normal or emergency operation results in propeller drag in excess of that for which the aeroplane was designed under JAR 25.367. Failure of structural elements of the drag limiting systems need not be considered if the probability of this kind of failure is extremely remote.

JAR 25.939 Turbine engine operating characteristics
[(See ACJ 25.939)]

(a) Turbine engine operating characteristics must be investigated in flight to determine that no adverse characteristics (such as stall, surge, or flame-out) are present, to a hazardous degree, during normal and emergency operation within the range of operation limitations of the aeroplane and of the engine. (See ACJ 25.939(a).)

(b) Reserved.

(c) The turbine engine air inlet system may not, as a result of air flow distortion during normal operation, cause vibration harmful to the engine. (See ACJ 25.939(c).)

(d) [Deleted]

[Ch.8, 30.11.81; Ch.14, 27.05.94; Amdt. 16, 01.05.03]

JAR 25.941 Inlet, engine, and exhaust compatibility

For aeroplanes using variable inlet or exhaust system geometry, or both –

(a) The system comprised of the inlet, engine (including thrust augmentation systems, if incorporated), and exhaust must be shown to function properly under all operating conditions for which approval is sought, including all engine rotating speeds and power settings, and engine inlet and exhaust configurations;

(b) The dynamic effects of the operation of these (including consideration of probable

JAR 25.941(b) (continued)

malfunctions) upon the aerodynamic control of the aeroplane may not result in any condition that would require exceptional skill, alertness, or strength on the part of the pilot to avoid exceeding an operational or structural limitation of the aeroplane; and

(c) In showing compliance with sub-paragraph (b) of this paragraph, the pilot strength required may not exceed the limits set forth in JAR 25.143(c) subject to the conditions set forth in sub-paragraphs (d) and (e) of JAR 25.143.

[Ch.13, 05.10.89]

JAR 25.943 Negative acceleration

No hazardous malfunction of an engine or any component or system associated with the powerplant may occur when the aeroplane is operated at the negative accelerations within the flight envelopes prescribed in JAR 25.333. This must be shown for the greatest duration expected for the acceleration. (See also JAR 25X 1315.)

JAR 25.945 Thrust or power augmentation system

(a) *General.* Each fluid injection system must provide a flow of fluid at the rate and pressure established for proper engine functioning under each intended operating condition. If the fluid can freeze, fluid freezing may not damage the aeroplane or adversely affect aeroplane performance.

(b) *Fluid tanks.* Each augmentation system fluid tank must meet the following requirements:

(1) Each tank must be able to withstand without failure the vibration, inertia, fluid, and structural loads that it may be subjected to in operation.

(2) The tanks as mounted in the aeroplane must be able to withstand without failure or leakage an internal pressure 1·5 times the maximum operating pressure.

(3) If a vent is provided, the venting must be effective under all normal flight conditions.

(4) Reserved.

(5) Each tank must have an expansion space of not less than 2% of the tank capacity. It must be impossible to fill the expansion space inadvertently with the aeroplane in the normal ground attitude.

JAR 25.945 (continued)

(c) Augmentation system drains must be designed and located in accordance with JAR 25.1455 if –

(1) The augmentation system fluid is subject to freezing; and

(2) The fluid may be drained in flight or during ground operation.

(d) The augmentation liquid tank capacity available for the use of each engine must be large enough to allow operation of the aeroplane under the approved procedures for the use of liquid-augmented power. The computation of liquid consumption must be based on the maximum approved rate appropriate for the desired engine output and must include the effect of temperature on engine performance as well as any other factors that might vary the amount of liquid required.

(e) *Not required for JAR–25.*

[Ch.14, 27.05.94; Ch.15, 01.10.00]

FUEL SYSTEM

JAR 25.951 General

(a) Each fuel system must be constructed and arranged to ensure a flow of fuel at a rate and pressure established for proper engine functioning under each likely operating condition, including any manoeuvre for which certification is requested and during which the engine is permitted to be in operation.

(b) Each fuel system must be arranged so that any air which is introduced into the system will not result in –

(1) *Not required for JAR–25.*

(2) Flameout.

(c) Each fuel system must be capable of sustained operation throughout its flow and pressure range with fuel initially saturated with water at 80ºF (26·7ºC) and having 0·75 cc of free water per US gallon added and cooled to the most critical condition for icing likely to be encountered in operation.

(d) **[**Each fuel system must meet the applicable fuel venting requirements of ICAO Annex 16, Volume II, Part II.**]**

[Ch.15, 01.10.00; Amdt. 16, 01.05.03]

JAR 25.952 Fuel system analysis and test

(a) Proper fuel system functioning under all probable operating conditions must be shown by analysis and those tests found necessary by the Authority. Tests, if required, must be made using the aeroplane fuel system or a test article that reproduces the operating characteristics of the portion of the fuel system to be tested.

(b) The likely failure of any heat exchanger using fuel as one of its fluids may not result in a hazardous condition.

(c) **[** Deleted **]**

[Ch.9, 30.11.82; Amdt. 16, 01.05.03]

JAR 25.953 Fuel system independence

Each fuel system must meet the requirements of JAR 25.903(b) by –

(a) Allowing the supply of fuel to each engine through a system independent of each part of the system supplying fuel to any other engine; or

(b) Any other acceptable method.

JAR 25.954 Fuel system lightning protection

The fuel system must be designed and arranged to prevent the ignition of fuel vapour within the **[** system (see ACJ 25. 581, ACJ 25.899 and ACJ 25.954) by – **]**

(a) Direct lightning strikes to areas having a high probability of stroke attachment;

(b) Swept lightning strokes to areas where swept strokes are highly probable; and

(c) Corona and streamering at fuel vent outlets.

[Ch.15, 01.10.00, Amdt. 16, 01.05.03]

JAR 25.955 Fuel flow

(a) Each fuel system must provide at least 100% of the fuel flow required under each intended operating condition and manoeuvre. Compliance must be shown as follows:

(1) Fuel must be delivered to each engine at a pressure within the limits specified in the engine type certificate.

(2) The quantity of fuel in the tank may not exceed the amount established as the unusable fuel supply for that tank under the requirements of JAR 25.959 plus that necessary to show compliance with this paragraph.

JAR 25.955(a) (continued)

(3) Each main pump must be used that is necessary for each operating condition and attitude for which compliance with this paragraph is shown, and the appropriate emergency pump must be substituted for each main pump so used.

(4) If there is a fuel flowmeter, it must be blocked and the fuel must flow through the meter or its bypass. (See ACJ 25.955(a)(4).)

(b) If an engine can be supplied with fuel from more than one tank, the fuel system must –

(1) *Not required for JAR–25.*

(2) For each engine, in addition to having appropriate manual switching capability, be designed to prevent interruption of fuel flow to that engine, without attention by the flight crew, when any tank supplying fuel to that engine is depleted of usable fuel during normal operation, and any other tank, that normally supplies fuel to that engine alone, contains usable fuel.

[Ch.13, 05.10.89]

JAR 25.957 Flow between interconnected tanks

If fuel can be pumped from one tank to another in flight, the fuel tank vents and the fuel transfer system must be designed so that no structural damage to the tanks can occur because of over-filling.

JAR 25.959 Unusable fuel supply

The unusable fuel quantity for each fuel tank and its fuel system components must be established at not less than the quantity at which the first evidence of engine malfunction occurs under the most adverse fuel feed condition for all intended operations and flight manoeuvres involving fuel feeding from that tank. Fuel system component failures need not be considered.

JAR 25.961 Fuel system hot weather operation

(a) The fuel system must perform satisfactorily in hot weather operation. This must be shown by showing that the fuel system from the tank outlets to each engine is pressurised, under all intended operations, so as to prevent vapour formation, or must be shown by climbing from the altitude of the airport elected by the applicant to the maximum altitude established as an operating limitation under JAR 25.1527. If a climb test is

JAR 25.961(a) (continued)

[elected, there may be no evidence of vapour] lock or other malfunctioning during the climb test conducted under the following conditions:

(1) *Not required for JAR–25.*

(2) For turbine engine powered aeroplanes, the engines must operate at take-off power for the time interval selected for showing the take-off flight path, and at maximum continuous power for the rest of the climb.

(3) The weight of the aeroplane must be the weight with full fuel tanks, minimum crew, and the ballast necessary to maintain the centre of gravity within allowable limits.

(4) The climb airspeed may not exceed –

(i) *Not required for JAR–25.*

(ii) The maximum airspeed established for climbing from take-off to the maximum operating altitude.

(5) The fuel temperature must be at least 110ºF. [ ]

(b) The test prescribed in sub-paragraph (a) of this paragraph may be performed in flight or on the ground under closely simulated flight conditions. If a flight test is performed in weather cold enough to interfere with the proper conduct of the test, the fuel tank surfaces, fuel lines, and other fuel system parts subject to cold air must be insulated to simulate, insofar as practicable, flight in hot weather.

[Amdt. 16, 01.05.03]

JAR 25.963 Fuel tanks: general

(a) Each fuel tank must be able to withstand, without failure, the vibration, inertia, fluid and structural loads that it may be subjected to in operation. (See ACJ 25.963(a).)

(b) Flexible fuel tank liners must be approved or must be shown to be suitable for the particular application.

(c) Integral fuel tanks must have facilities for interior inspection and repair.

(d) Fuel tanks must, so far as it is practicable, be designed, located and installed so that no fuel is released in or near the fuselage or near the engines in quantities sufficient to start a serious fire in otherwise survivable crash conditions. (See also ACJ 25.963(d).)

(e) Fuel tanks within the fuselage contour must be able to resist rupture, and to retain fuel, under the inertia forces prescribed for the emergency landing conditions in JAR 25.561. In

JAR 25.963(e) (continued)

addition, these tanks must be in a protected position so that exposure of the tanks to scraping action with the ground is unlikely.

(f) For pressurised fuel tanks, a means with failsafe features must be provided to prevent the build-up of an excessive pressure difference between the inside and the outside of the tank.

(g) Fuel tank access covers must comply with the following criteria in order to avoid loss of hazardous quantities of fuel:

(1) All covers located in an area where experience or analysis indicates a strike is likely, must be shown by analysis or tests to minimise penetration and deformation by tyre fragments, low energy engine debris, or other likely debris.

(2) Reserved

(See ACJ 25.963(g).)

[Ch.11, 17.03.86; Ch.13, 05.10.89; Ch.14, 27.05.94]

JAR 25.965 Fuel tank tests

(a) It must be shown by tests that the fuel tanks, as mounted in the aeroplane can withstand, without failure or leakage, the more critical of the pressures resulting from the conditions specified in sub-paragraphs (a)(1) and (2) of this paragraph. In addition it must be shown by either analysis or tests, (see ACJ 25.965(a)) that tank surfaces subjected to more critical pressures resulting from the conditions of sub-paragraphs (a)(3) and (4) of this paragraph, are able to withstand the following pressures:

(1) An internal pressure of 3·5 psi.

(2) 125% of the maximum air pressure developed in the tank from ram effect.

(3) Fluid pressures developed during maximum limit accelerations, and deflections, of the aeroplane with a full tank.

(4) Fluid pressures developed during the most adverse combination of aeroplane roll and fuel load.

(b) Each metallic tank with large unsupported or unstiffened flat surfaces, whose failure or deformation could cause fuel leakage, must be able to withstand the following test, or its equivalent, without leakage or excessive deformation of the tank walls:

(1) Each complete tank assembly and its supports must be vibration tested while mounted to simulate the actual installation.

JAR 25.965(b) (continued)

(2) Except as specified in sub-paragraph (b)(4) of this paragraph, the tank assembly must be vibrated for 25 hours at an amplitude of not less than 0·03125 of an inch (unless another amplitude is substantiated) while two-thirds filled with water or other suitable test fluid.

(3) The test frequency of vibration must be as follows:

(i) If no frequency of vibration resulting from any rpm within the normal operating range of engine speeds is critical, the test frequency of vibration must be 2 000 cycles per minute.

(ii) If only one frequency of vibration resulting from any rpm within the normal operating range of engine speeds is critical, that frequency of vibration must be the test frequency.

(iii) If more than one frequency of vibration resulting from any rpm within the normal operating range of engine speeds is critical, the most critical of these frequencies must be the test frequency.

(4) Under sub-paragraph (b)(3) (ii) and (iii) of this paragraph, the time of test must be adjusted to accomplish the same number of vibration cycles that would be accomplished in 25 hours at the frequency specified in sub-paragraph (b)(3)(i) of this paragraph.

(5) During the test, the tank assembly must be rocked at the rate of 16 to 20 complete cycles per minute, through an angle of 15º on both sides of the horizontal (30º total), about the most critical axis, for 25 hours. If motion about more than one axis is likely to be critical, the tank must be rocked about each critical axis for 12·5 hours.

(c) Except where satisfactory operating experience with a similar tank in a similar installation is shown, non-metallic tanks must withstand the test specified in sub-paragraph (b)(5) of this paragraph, with fuel at a temperature of 110ºF. During this test, a representative specimen of the tank must be installed in a supporting structure simulating the installation in the aeroplane.

(d) For pressurised fuel tanks, it must be shown by analysis or tests that the fuel tanks can withstand the maximum pressure likely to occur on the ground or in flight.

JAR 25.967 [Fuel tank installations]

(a) Each fuel tank must be supported so that tank loads (resulting from the weight of the fuel in the tanks) are not concentrated on unsupported tank surfaces. In addition –

(1) There must be pads, if necessary, to prevent chafing between the tank and its supports;

(2) Padding must be non-absorbent or treated to prevent the absorption of fluids;

(3) If a flexible tank liner is used, it must be supported so that it is not required to withstand fluid loads (see ACJ 25.967(a)(3)); and

(4) Each interior surface of the tank compartment must be smooth and free of projections that could cause wear of the liner unless –

(i) Provisions are made for protection of the liner at these points; or

(ii) That construction of the liner itself provides that protection.

(b) Spaces adjacent to tank surfaces must be ventilated to avoid fume accumulation due to minor leakage. If the tank is in a sealed compartment, ventilation may be limited to drain holes large enough to prevent excessive pressure resulting from altitude changes.

(c) The location of each tank must meet the requirements of JAR 25.1185(a).

(d) No engine nacelle skin immediately behind a major air outlet from the engine compartment may act as the wall of an integral tank.

(e) Each fuel tank must be isolated from personnel compartments by a fumeproof and fuelproof enclosure.

[Amdt. 16, 01.05.03]

JAR 25.969 Fuel tank expansion space

Each fuel tank must have an expansion space of not less than 2% of the tank capacity. It must be impossible to fill the expansion space inadvertently with the aeroplane in the normal ground attitude. For pressure fuelling systems, compliance with this paragraph may be shown with the means provided to comply with JAR 25.979(b).

JAR 25.971 Fuel tank sump

(a) Each fuel tank must have a sump with an effective capacity, in the normal ground attitude, of not less than the greater of 0·10% of the tank capacity or one-quarter of a litre unless operating limitations are established to ensure that the accumulation of water in service will not exceed the sump capacity.

(b) Each fuel tank must allow drainage of any hazardous quantity of water from any part of the tank to its sump with the aeroplane in the ground attitude.

(c) Each fuel tank sump must have an accessible drain that –

(1) Allows complete drainage of the sump on the ground;

(2) Discharges clear of each part of the aeroplane; and

(3) Has manual or automatic means for positive locking in the closed position.

JAR 25.973 Fuel tank filler connection

Each fuel tank filler connection must prevent the entrance of fuel into any part of the aeroplane other than the tank itself. In addition –

(a) Reserved

(b) Each recessed filler connection that can retain any appreciable quantity of fuel must have a drain that discharges clear of each part of the aeroplane;

(c) Each filler cap must provide a fuel-tight seal; and

(d) Each fuel filling point must have a provision for electrically bonding the aeroplane to ground fuelling equipment.

[Ch.14, 27.05.94]

JAR 25.975 Fuel tank vents

(a) *Fuel tank vents*. Each fuel tank must be vented from the top part of the expansion space so that venting is effective under any normal flight condition. In addition –

(1) Each vent must be arranged to avoid stoppage by dirt or ice formation;

(2) The vent arrangement must prevent siphoning of fuel during normal operation;

(3) The venting capacity and vent pressure levels must maintain acceptable

JAR 25.975(a) (continued)

differences of pressure between the interior and exterior of the tank, during –

(i) Normal flight operation;

(ii) Maximum rate of ascent and descent; and

(iii) Refuelling and defuelling (where applicable);

(4) Airspaces of tanks with interconnected outlets must be interconnected;

(5) [There may be no point in any] vent line where moisture can accumulate with the aeroplane in the ground attitude or the level flight attitude, unless drainage is provided; and

(6) No vent or drainage provision may end at any point –

(i) Where the discharge of fuel from the vent outlet would constitute a fire hazard; or

(ii) From which fumes could enter personnel compartments.

(b) *Not required for JAR–25.*

[Amdt. 16, 01.05.03]

JAR 25.977 Fuel tank outlet

(a) There must be a fuel strainer for the fuel tank outlet or for the booster pump. This strainer must –

(1) *Not required for JAR–25.*

(2) Prevent the passage of any object that could restrict fuel flow or damage any fuel system component.

(b) Reserved.

(c) The clear area of each fuel tank outlet strainer must be at least five times the area of the outlet line.

(d) The diameter of each strainer must be at least that of the fuel tank outlet.

(e) Each finger strainer must be accessible for inspection and cleaning.

JAR 25.979 Pressure fuelling system

For pressure fuelling systems, the following apply:

(a) Each pressure fuelling system fuel manifold connection must have means to prevent the escape of hazardous quantities of fuel from the system if the fuel entry valve fails.

JAR 25.979 (continued)

(b) An automatic shut-off means must be provided to prevent the quantity of fuel in each tank from exceeding the maximum quantity approved for that tank. This means must –

(1) Allow checking for proper shut-off operation before each fuelling of the tank; and

(2) Provide indication, at each fuelling station, of failure of the shut-off means to stop the fuel flow at the maximum quantity approved for that tank.

(c) A means must be provided to prevent damage to the fuel system in the event of failure of the automatic shut-off means prescribed in sub-paragraph (b) of this paragraph.

(d) The aeroplane pressure fuelling system (not including fuel tanks and fuel tank vents) must withstand an ultimate load that is 2·0 times the load arising from the maximum pressures, including surge, that is likely to occur during fuelling. The maximum surge pressure must be established with any combination of tank valves being either intentionally or inadvertently closed. (See ACJ 25.979(d).)

(e) The aeroplane defuelling system (not including fuel tanks and fuel tank vents) must withstand an ultimate load that is 2·0 times the load arising from the maximum permissible defuelling pressure (positive or negative) at the aeroplane fuelling connection.

[Ch.14, 27.05.94]

JAR 25.981 Fuel tank temperature [(See ACJ 25.981)]

(a) The highest temperature allowing a safe margin below the lowest expected auto-ignition temperature of the fuel in the fuel tanks must be determined.

(b) No temperature at any place inside any fuel tank where fuel ignition is possible may exceed the temperature determined under sub-paragraph (a) of this paragraph. This must be shown under all probable operating, failure, and malfunction conditions of any component whose operation, failure, or malfunction could increase the temperature inside the tank.

[Amdt. 16, 01.05.03]

FUEL SYSTEM COMPONENTS

JAR 25.991 Fuel pumps

(a) *Main pumps*. Each fuel pump required for proper engine operation, or required to meet the fuel system requirements of this Subpart (other than those in sub-paragraph (b) of this paragraph), is a main pump. For each main pump, provision must be made to allow the bypass of each positive displacement fuel pump approved as part of the engine.

(b) *Emergency pumps*. There must be emergency pumps or another main pump to feed each engine immediately after failure of any main pump.

JAR 25.993 Fuel system lines and fittings

(a) Each fuel line must be installed and supported to prevent excessive vibration and to withstand loads due to fuel pressure and accelerated flight conditions.

(b) Each fuel line connected to components of the aeroplane between which relative motion could exist must have provisions for flexibility.

(c) Each flexible connection in fuel lines that may be under pressure and subject to axial loading must use flexible hose assemblies [ ].

(d) Flexible hose must be approved or must be shown to be suitable for the particular application.

(e) No flexible hose that might be adversely affected by exposure to high temperatures may be used where excessive temperatures will exist during operation or after engine shut-down.

(f) Each fuel line within the fuselage must be designed and installed to allow a reasonable degree of deformation and stretching without leakage.

[Amdt. 16, 01.05.03]

JAR 25.994 Fuel system components [(See ACJ 25.994)]

Fuel system components in an engine nacelle or in the fuselage must be protected from damage which could result in spillage of enough fuel to constitute a fire hazard as a result of a wheels-up landing on a paved runway.

[Ch.12, 10.05.88; Amdt. 16, 01.05.03]

JAR 25.995 Fuel valves

In addition to the requirements of JAR 25.1189 for shut-off means, each fuel valve must –

(a) Reserved.

(b) Be supported so that no loads resulting from their operation or from accelerated flight conditions are transmitted to the lines attached to the valve.

JAR 25.997 Fuel strainer or filter

[ ]

There must be a fuel strainer or filter between the fuel tank outlet and the inlet of either the fuel metering device or an engine driven positive displacement pump, whichever is nearer the fuel tank outlet. This fuel strainer or filter must –

(a) Be accessible for draining and cleaning and must incorporate a screen or element which is easily removable;

(b) Have a sediment trap and drain except that it need not have a drain if the strainer or filter is easily removable for drain purposes;

(c) Be mounted so that its weight is not supported by the connecting lines or by the inlet or outlet connections of the strainer or filter itself, unless adequate strength margins under all loading conditions are provided in the lines and connections; and

(d) Have the capacity (with respect to operating limitations established for the engine) to ensure that engine fuel system functioning is not impaired, with the fuel contaminated to a degree (with respect to particle size and density) that is greater than that established for the engine in JAR–E.

[Ch.12, 10.05.88; Amdt. 16, 01.05.03]

JAR 25.999 Fuel systems drains

(a) Drainage of the fuel system must be accomplished by the use of fuel strainer and fuel tank sump drains.

(b) Each drain required by sub-paragraph (a) of this paragraph must –

(1) Discharge clear of all parts of the aeroplane;

(2) Have manual or automatic means for positive locking in the closed position; and

(3) Have a drain valve –

JAR 25.999(b)(3) (continued)

(i) That is readily accessible and which can be easily opened and closed; and

(ii) That is either located or protected to prevent fuel spillage in the event of a landing with landing gear retracted.

JAR 25.1001 Fuel jettisoning system

(a) A fuel jettisoning system must be installed on each aeroplane unless it is shown that the aeroplane meets the climb requirements of JAR 25.119 and 25.121(d) at maximum take-off weight, less the actual or computed weight of fuel necessary for a 15-minute flight comprised of a take-off, go-around, and landing at the airport of departure with the aeroplane configuration, speed, power, and thrust the same as that used in meeting the applicable take-off, approach, and landing climb performance requirements of this JAR–25.

(b) If a fuel jettisoning system is required it must be capable of jettisoning enough fuel within 15 minutes, starting with the weight given in sub-paragraph (a) of this paragraph, to enable the aeroplane to meet the climb requirements of JAR 25.119 and 25.121(d), assuming that the fuel is jettisoned under the conditions, except weight, found least favourable during the flight tests prescribed in sub-paragraph (c) of this paragraph.

(c) Fuel jettisoning must be demonstrated beginning at maximum take-off weight with wing-flaps and landing gear up and in –

(1) A power-off glide at 1·3 V_{SR1};

(2) A climb at the one-engine inoperative best rate-of-climb speed, with the critical engine inoperative and the remaining engines at maximum continuous power; and

(3) Level flight at 1·3 V_{SR1}, if the results of the tests in the condition specified in sub-paragraphs (c)(1) and (2) of this paragraph show that this condition could be critical.

(d) During the flight tests prescribed in sub-paragraph (c) of this paragraph, it must be shown that –

(1) The fuel jettisoning system and its operation are free from fire hazard;

(2) The fuel discharges clear of any part of the aeroplane;

(3) Fuel or fumes do not enter any parts of the aeroplane;

JAR 25.1001(d) (continued)

(4) The jettisoning operation does not adversely affect the controllability of the aeroplane.

(e) *Not required for JAR–25.*

(f) Means must be provided to prevent jettisoning the fuel in the tanks used for take-off and landing below the level allowing climb from sea level to 10 000 ft and thereafter allowing 45 minutes cruise at a speed for maximum range. However, if there is an auxiliary control independent of the main jettisoning control, the system may be designed to jettison the remaining fuel by means of the auxiliary jettisoning control.

(g) The fuel jettisoning valve must be designed to allow flight personnel to close the valve during any part of the jettisoning operation.

(h) Unless it is shown that using any means (including flaps, slots and slats) for changing the airflow across or around the wings does not adversely affect fuel jettisoning, there must be a placard, adjacent to the jettisoning control, to warn flight-crew members against jettisoning fuel while the means that change the airflow are being used.

(i) The fuel jettisoning system must be designed so that any reasonably probable single malfunction in the system will not result in a hazardous condition due to unsymmetrical jettisoning of, or inability to jettison, fuel.

[Ch.12, 10.05.88; Ch.15, 01.10.00]

OIL SYSTEM

JAR 25.1011 General

(a) Each engine must have an independent oil system that can supply it with an appropriate quantity of oil at a temperature not above that safe for continuous operation.

(b) The usable oil capacity may not be less than the product of the endurance of the aeroplane under critical operating conditions and the approved maximum allowable oil consumption of the engine under the same conditions, plus a suitable margin to ensure system circulation.

(c) *Not required for JAR–25.*

JAR 25.1013 Oil tanks

[ ]

(a) *Installation.* Each oil tank installation must meet the requirements of JAR 25.967.

JAR 25.1013 (continued)

(b) *Expansion space.* Oil tank expansion space must be provided as follows:

(1) Each oil tank must have an expansion space of not less than 10% of the tank capacity.

(2) Each reserve oil tank not directly connected to any engine may have an expansion space of not less than 2% of the tank capacity.

(3) It must be impossible to fill the expansion space inadvertently with the aeroplane in the normal ground attitude.

(c) *Filler connection.* Each recessed oil tank filler connection that can retain any appreciable quantity of oil must have a drain that discharges clear of each part of the aeroplane. In addition each oil tank filler cap must provide an oil-tight seal.

(d) *Vent.* Oil tanks must be vented as follows:

(1) Each oil tank must be vented from the top part of the expansion space so that venting is effective under any normal flight condition.

(2) Oil tank vents must be arranged so that condensed water vapour that might freeze and obstruct the line cannot accumulate at any point.

(e) *Outlet.* There must be means to prevent entrance into the tank itself, or into the tank outlet, of any object that might obstruct the flow of oil through the system. No oil tank outlet may be enclosed by any screen or guard that would reduce the flow of oil below a safe value at any operating temperature. There must be a shut-off valve at the outlet of each oil tank, unless the external portion of the oil system (including the oil tank supports) is fireproof.

(f) *Flexible oil tank liners.* Each flexible oil tank liner must be approved or must be shown to be suitable for the particular application.

[Ch.14, 27.05.94; Amdt. 16, 01.05.03]

JAR 25.1015 Oil tank tests

[ ]

Each oil tank must be designed and installed so that –

(a) It can withstand, without failure, each vibration, inertia, and fluid load that it may be subjected to in operation; and

(b) It meets the provisions of JAR 25.965, except –

JAR 25.1015(b) (continued)

(1) The test pressure –

(i) For pressurised tanks used with a turbine engine, may not be less than 5 psi plus the maximum operating pressure of the tank instead of the pressure specified in JAR 25.965(a); and

(ii) For all other tanks, may not be less than 5 psi instead of the pressure specified in JAR 25.965(a); and

(2) The test fluid must be oil at 250ºF instead of the fluid specified in JAR 25.965(c).

[Amdt. 16, 01.05.03]

JAR 25.1017 Oil lines and fittings

(a) Each oil line must meet the requirements of JAR 25.993 and each oil line and fitting in any designated fire zone must meet the requirements of JAR 25.1183.

(b) Breather lines must be arranged so that –

(1) Condensed water vapour that might freeze and obstruct the line cannot accumulate at any point;

(2) The breather discharge does not constitute a fire hazard if foaming occurs or causes emitted oil to strike the pilot's wind-shield; and

(3) The breather does not discharge into the engine air induction system.

JAR 25.1019 Oil strainer or filter

[ ]

(a) Each turbine engine installation must incorporate an oil strainer or filter through which all of the engine oil flows and which meets the following requirements:

(1) Each oil strainer or filter that has a bypass, must be constructed and installed so that oil will flow at the normal rate through the rest of the system with the strainer or filter completely blocked.

(2) The oil strainer or filter must have the capacity (with respect to operating limitations established for the engine) to ensure that engine oil system functioning is not impaired when the oil is contaminated to a degree (with respect to particle size and density) that is greater than that established for the engine under JAR–E.

(3) The oil strainer or filter, unless it is installed at an oil tank outlet, must incorporate

JAR 25.1019(a)(3) (continued)

an indicator that will indicate contamination before it reaches the capacity established in accordance with sub-paragraph (a)(2) of this paragraph.

(4) The bypass of a strainer or filter must be constructed and installed so that the release of collected contaminants is minimised by appropriate location of the bypass to ensure that collected contaminants are not in the bypass flow path.

(5) **[**An oil strainer or filter that has no bypass, except one that is installed at an oil tank outlet, must have a means to connect it to the warning system required in JAR 25.1305(c)(7).**]**

(b) *Not required for JAR–25.*

[Ch.12, 10.05.88; Amdt. 16, 01.05.03]

JAR 25.1021 Oil system drains

A drain (or drains) must be provided to allow safe drainage of the oil system. Each drain must –

(a) Be accessible; and

(b) Have manual or automatic means for positive locking in the closed position.

[Ch.12, 10.05.88]

JAR 25.1023 Oil radiators

(a) Each oil radiator must be able to withstand, without failure, any vibration, inertia, and oil pressure load to which it would be subjected in operation.

(b) Each oil radiator air duct must be located so that, in case of fire, flames coming from normal openings of the engine nacelle cannot impinge directly upon the radiator.

JAR 25.1025 Oil valves

(a) Each oil shut-off must meet the requirements of JAR 25.1189.

(b) The closing of oil shut-off means may not prevent propeller feathering.

(c) Each oil valve must have positive stops or suitable index provisions in the 'on' and 'off' positions and must be supported so that no loads resulting from its operation or from accelerated flight conditions are transmitted to the lines attached to the valve.

JAR 25.1027 Propeller feathering system
(See ACJ 25.1027.)

(a) If the propeller feathering system depends on engine oil, there must be means to trap an amount of oil in the tank if the supply becomes depleted due to failure of any part of the lubricating system other than the tank itself.

(b) The amount of trapped oil must be enough to accomplish the feathering operation and must be available only to the feathering pump. (See ACJ 25.1027(b).)

(c) The ability of the system to accomplish feathering with the trapped oil must be shown. This may be done on the ground using an auxiliary source of oil for lubricating the engine during operation.

(d) Provision must be made to prevent sludge or other foreign matter from affecting the safe operation of the propeller feathering system.

COOLING

JAR 25.1041 General

The powerplant cooling provisions must be able to maintain the temperatures of powerplant components, and engine fluids, within the temperature limits established for these components and fluids, under ground and flight operating conditions, and after normal engine shutdown.

JAR 25.1043 Cooling tests

(a) *General.* Compliance with JAR 25.1041 must be shown by tests, under critical ground and flight operating conditions. For these tests, the following apply:

(1) If the tests are conducted under conditions deviating from the maximum ambient atmospheric temperature, the recorded power-plant temperatures must be corrected under sub-paragraph (c) of this paragraph.

(2) No corrected temperatures determined under sub-paragraph (1) of this paragraph may exceed established limits.

(3) *Not required for JAR–25.*

(b) *Maximum ambient atmospheric temperature.* A maximum ambient atmospheric temperature corresponding to sea level conditions of at least 100ºF must be established. The assumed temperature lapse rate is 3·6ºF per thousand feet of altitude above sea level until a temperature of –69·7ºF is reached, above which altitude the temperature is considered at –69·7ºF. However, for winterization installations, the applicant may select a maximum ambient atmospheric temperature corresponding to sea-level conditions of less than 100ºF.

(c) *Correction factor.* Unless a more rational correction applies, temperatures of engine fluids and powerplant components for which temperature limits are established, must be corrected by adding to them the difference between the maximum ambient atmospheric temperature and the temperature of the ambient air at the time of the first occurrence of the maximum component or fluid temperature recorded during the cooling test.

(d) *Not required for JAR–25.*

JAR 25.1045 Cooling test procedures

(a) Compliance with JAR 25.1041 must be shown for the take-off, climb, en-route, and landing stages *of* flight that correspond to the applicable performance requirements. The cooling tests must be conducted with the aeroplane in the configuration, and operating under the conditions, that are critical relative to cooling during each stage of flight. For the cooling tests, a temperature is 'stabilised' when its rate of change is less than 2ºF per minute.

(b) Temperatures must be stabilised under the conditions from which entry is made into each stage of flight being investigated, unless the entry condition normally is not one during which component and engine fluid temperatures would stabilise (in which case, operation through the full entry condition must be conducted before entry into the stage of flight being investigated in order to allow temperatures to reach their natural levels at the time of entry). The take-off cooling test must be preceded by a period during which the powerplant component and engine fluid temperatures are stabilised with the engines at ground idle.

(c) Cooling tests for each stage of flight must be continued until –

(1) The component and engine fluid temperatures stabilise;

(2) The stage of flight is completed; or

(3) An operating limitation is reached.

(d) *Not required for JAR–25.*

(e) *Not required for JAR–25.*

AIR INTAKE SYSTEM

JAR 25.1091 Air intake

(a) The air intake system for each engine must supply –

(1) The air required by that engine under each operating condition for which certification is requested; and

(2) The air for proper fuel metering and mixture distribution with the air intake system valves in any position.

(b) *Not required for JAR–25.*

(c) Air intakes *may* not open within the cowling, unless that part of the cowling is isolated from the engine accessory section by means of a fireproof diaphragm.

(d) (1) There must be means to prevent hazardous quantities of fuel leakage or overflow from drains, vents, or other components of flammable fluid systems from entering the engine air intake system; and

(2) The aeroplane must be designed to prevent water or slush on the runway, taxiway, or other airport operating surfaces from being directed into the engine air intake ducts in hazardous quantities, and the air intake ducts must be located or protected so as to minimise the ingestion of foreign matter during take-off, landing and taxying. (See ACJ 25.1091(d)(2).)

(e) If the engine air intake system contains parts or components that could be damaged by foreign objects entering the air intake, it must be shown by tests or, if appropriate, by analysis that the air intake system design can withstand the foreign object ingestion test conditions of JAR–E 790 and JAR–E 800 without failure of parts or components that could create a hazard. (See ACJ 25.1091(e).)

[Ch.12, 10.05.88; Ch.14, 27.05.94]

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

(a) *Not required for JAR*–25.

(b) Turbine engines

(1) Each turbine engine must operate throughout the flight power range of the engine (including idling), without the accumulation of ice on the engine, inlet system components, or airframe components that would adversely affect engine operation or cause a serious loss of power or thrust (see ACJ 25.1093(b).) –

JAR 25.1093(b)(1) (continued)

(i) Under the icing conditions specified in Appendix C.

(ii) Reserved

(2) Each engine must idle for 30 minutes on the ground, with the air bleed available for engine icing protection at its critical condition, without adverse effect, in an atmosphere that is at a temperature between 15º and 30ºF (between –9º and –1ºC) and has a liquid water content not less than 0·3 grams per cubic metre in the form of drops having a mean effective diameter not less than 20 microns, followed by a momentary operation at take-off power or thrust. During the 30 minutes of idle operation, the engine may be run up periodically to a moderate power or thrust setting.

(c) *Not required for JAR–25.*

[Ch.12, 10.05.88; Ch.14, 27.05.94]

JAR 25.1103 Air intake system ducts and air duct systems

(a) *Not required for JAR–25.*

(b) Each air intake system must be –

(1) Strong enough to prevent structural failure resulting from engine surging; and

(2) Fire-resistant if it is in any fire zone for which a fire extinguishing system is required.

(c) Each duct connected to components between which relative motion could exist must have means for flexibility.

(d) For bleed air systems no hazard may result if a duct rupture or failure occurs at any point between the engine port and the aeroplane unit served by the bleed air. (See ACJ 25.1103(d).)

(e) *Not required for JAR–25.*

(f) *Not required for JAR–25.*

[Ch.12, 10.05.88]

JAR 25.1105 Air intake system screens

Not required for JAR–25.

[Ch.15, 01.10.00]

JAR 25.1107 Inter-coolers and after-coolers

Not required for JAR–25.

[Ch.15, 01.10.00]

EXHAUST SYSTEM

JAR 25.1121 General

For powerplant installations the following apply:

(a) Each exhaust system must ensure safe disposal of exhaust gases without fire hazard or carbon monoxide contamination in any personnel compartment. For test purposes, any acceptable carbon monoxide detection method may be used to show the absence of carbon monoxide. (See ACJ 25.1121(a).)

(b) Each exhaust system part with a surface hot enough to ignite flammable fluids or vapours must be located or shielded so that leakage from any system carrying flammable fluids or vapours will not result in a fire caused by impingement of the fluids or vapours on any part of the exhaust system including shields for the exhaust system. (See ACJ 25.1121(b).)

(c) Each component that hot exhaust gases could strike, or that could be subjected to high temperatures from exhaust system parts, must be fireproof. All exhaust system components must be separated by fireproof shields from adjacent parts of the aeroplane that are outside the engine compartment.

(d) No exhaust gases may discharge so as to cause a fire hazard with respect to any flammable fluid vent or drain.

(e) No exhaust gases may discharge where they will cause a glare seriously affecting pilot vision at night.

(f) Each exhaust system component must be ventilated to prevent points of excessively high temperature.

(g) Each exhaust shroud must be ventilated or insulated to avoid, during normal operation, a temperature high enough to ignite any flammable fluids or vapours external to the shroud.

JAR 25.1123 Exhaust piping

For powerplant installations, the following apply:

(a) Exhaust piping must be heat and corrosion resistant, and must have provisions to prevent failure due to expansion by operating temperatures.

JAR 25.1123 (continued)

(b) Piping must be supported to withstand any vibration and inertia loads to which it would be subjected in operation; and

(c) Piping connected to components between which relative motion could exist must have means for flexibility.

JAR 25.1125 Exhaust heat exchangers

Not required for JAR–25.

[Ch.15, 01.10.00]

JAR 25.1127 Exhaust driven turbo-superchargers

Not required for JAR–25.

[Ch.11, 17.03.86]]

POWERPLANT CONTROLS AND ACCESSORIES

JAR 25.1141 Powerplant controls: general

Each powerplant control must be located, arranged, and designed under JAR 25.777 to 25.781 and marked under JAR 25.1555. In addition, it must meet the following requirements:

(a) Each control must be located so that it cannot be inadvertently operated by persons entering, leaving, or moving normally in, the cockpit.

(b) Each flexible control must be approved or must be shown to be suitable for the particular application.

(c) Each control must have sufficient strength and rigidity to withstand operating loads without failure and without excessive deflection.

(d) Each control must be able to maintain any set position without constant attention by flight-crew members and without creep due to control loads or vibration.

(e) The portion of each powerplant control located in a designated fire zone that is required to be operated in the event of fire must be at least fire resistant. (See JAR 25.903(c).)

(f) Powerplant valve controls located in the cockpit must have –

(1) For manual valves, positive stops or in the case of fuel valves suitable index provisions, in the open and closed positions; and

JAR 25.1141(f) (continued)

(2) In the case of valves controlled from the cockpit other than by mechanical means, where the correct functioning of such a valve is essential for the safe operation of the aeroplane, a valve position indicator operated by a system which senses directly that the valve has attained the position selected, unless other indications in the cockpit give the flight crew a clear indication that the valve has moved to the selected position. (See ACJ 25.1141(f).)

[Ch.14, 27.05.94; Ch.15, 01.10.00]

JAR 25.1143 Engine controls

(a) There must be a separate power or thrust control for each engine.

(b) Power and thrust controls must be arranged to allow –

(1) Separate control of each engine; and

(2) Simultaneous control of all engines.

(c) Each power and thrust control must provide a positive and immediately responsive means of controlling its engine.

(d) For each fluid injection (other than fuel) system and its controls not provided and approved as part of the engine, the applicant must show that the flow of the injection fluid is adequately controlled.

(e) If a power or thrust control incorporates a fuel shut-off feature, the control must have a means to prevent the inadvertent movement of the control into the shut-off position. The means must –

(1) Have a positive lock or stop at the idle position; and

(2) Require a separate and distinct operation to place the control in the shut-off position.

[Ch.12, 10.05.88; Ch.13, 05.10.89]

JAR 25.1145 Ignition switches

(a) Ignition switches must control each engine ignition circuit on each engine.

(b) There must be means to quickly shut off all ignition by the grouping of switches or by a master ignition control.

JAR 25.1145 (continued)

(c) [Each group of ignition switches except ignition switches for turbine engines for which continuous ignition is not required, and each master ignition control must have a means to prevent its inadvertent operation.]

[Amdt. 16, 01.05.03]

JAR 25.1149 Propeller speed and pitch controls

(a) There must be a separate propeller speed and pitch control for each propeller.

(b) The controls must be grouped and arranged to allow –

(1) Separate control of each propeller; and

(2) Simultaneous control of all propellers.

(c) The controls must allow synchronisation of all propellers.

(d) The propeller speed and pitch controls must be to the right of, and at least one inch below, the pilot's throttle controls.

JAR 25.1153 Propeller feathering controls

(a) There must be a separate propeller feathering control for each propeller. The control must have means to prevent its inadvertent operation.

(b) If feathering is accomplished by movement of the propeller pitch or speed control lever, there must be means to prevent the inadvertent movement of this lever to the feathering position during normal operation.

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

[Each control for selecting propeller pitch settings below the flight regime (reverse thrust for turbo-jet powered airplanes) must have the following:

(a) A positive lock or stop which requires a separate and distinct operation by the flight crew to displace the control from the flight regime (forward thrust regime for turbo-jet powered airplanes), and it must only be possible to make this separate and distinct operation once the control has reached the flight idle position.

(b) A means to prevent both inadvertent and intentional selection or activation of propeller pitch settings below the flight regime (reverse [

JAR 25.1155(b) (continued)

[thrust for turbo-jet powered airplanes) when out of the approved in-flight operating envelope for that function, and override of that means is prohibited.

(c) A reliability, such that the loss of the means required by paragraph (b) above is remote.

(d) A caution provided to the flight crew when the means required by paragraph (b) above is lost.

(e) A caution provided to the flight crew when a cockpit control is displaced from the flight regime (forward thrust regime for turbo-jet powered airplanes) into a position to select propeller pitch settings below the flight regime (reverse thrust for turbo-jet powered airplanes) outside the approved in-flight operating envelope. This caution need not be provided if the means required by paragraph (b) is a mechanical baulk that prevents movement of the control.]

[Amdt. 16, 01.05.03]

JAR 25.1161 Fuel jettisoning system controls

Each fuel jettisoning system control must have guards to prevent inadvertent operation. No control may be near any fire extinguisher control or other control used to combat fire.

JAR 25.1163 Powerplant accessories

(a) Each engine-mounted accessory must –

(1) Be approved for mounting on the engine involved;

(2) Use the provisions on the engine for mounting; and

(3) Be sealed to prevent contamination of the engine oil system and the accessory system.

(b) Electrical equipment subject to arcing or sparking must be installed to minimise the probability of contact with any flammable fluids or vapours that might be present in a free state.

(c) If continued rotation of an engine-driven cabin supercharger or of any remote accessory driven by the engine is hazardous if malfunctioning occurs, there must be means to prevent rotation without interfering with the continued operation of the engine.

[Ch.12, 10.05.88]

JAR 25.1165 Engine ignition systems

(a) Each battery ignition system must be supplemented by a generator that is automatically available as an alternate source of electrical energy to allow continued engine operation if any battery becomes depleted.

(b) The capacity of batteries and generators must be large enough to meet the simultaneous demands of the engine ignition system and the greatest demands of any electrical system components that draw electrical energy from the same source.

(c) The design of the engine ignition system must account for –

(1) The condition of an inoperative generator;

(2) The condition of a completely depleted battery with the generator running at its normal operating speed; and

(3) The condition of a completely depleted battery with the generator operating at idling speed, if there is only one battery.

(d) *Not required for JAR–25.*

(e) No ground wire for any engine may be routed through a fire zone of another engine unless each part of that wire within that zone is fireproof.

(f) Each ignition system must be independent of any electrical circuit not used for assisting, controlling, or analysing the operation of that system.

(g) There must be means to warn appropriate flight-crew members if the malfunctioning of any part of the electrical system is causing the continuous discharge of any battery necessary for engine ignition.

(h) Each engine ignition system of a turbine powered aeroplane must be considered an essential electrical load.

[Ch.9, 30.11.82; Ch.14, 27.05.94]

JAR 25.1167 Accessory gearboxes

For aeroplanes equipped with an accessory gearbox that is not certificated as part of an engine –

(a) The engine with gearbox and connecting transmissions and shafts attached must be subjected to the test specified in JAR–E 160 and JAR–E 740, as applicable.

JAR 25.1167 (continued)

(b) The accessory gearbox must meet the requirements of JAR–E 80 and JAR–E 590, as applicable; and

(c) Possible misalignments and torsional loadings of the gearbox, transmission, and shaft system, expected to result under normal operating conditions must be evaluated.

[Ch.14, 27.05.94]

POWERPLANT FIRE PROTECTION

JAR 25.1181 Designated fire zones: regions included
(See ACJ 25.1181.)

(a) Designated fire zones are –

(1) The engine power section;

(2) The engine accessory section;

(3) Any complete powerplant compartment in which no isolation is provided between the engine power section and the engine accessory section;

(4) *Not required for JAR–25.*

(5) Any fuel-burning heater and other combustion equipment installation described in JAR 25.859;

(6) The compressor and accessory sections of turbine engines; and

(7) Combustor, turbine, and tailpipe sections of turbine engine installations that contain lines or components carrying flammable fluids or gases.

(b) Each designated fire zone must meet the [requirements of JAR 25.863, 25.867, 25.869,] and 25.1185 to 25.1203.

[Ch.12, 10.05.88; Ch.14, 27.05.94; Amdt. 16, 01.05.03]

JAR 25.1182 Nacelle areas behind firewalls, and engine pod attaching structures containing flammable fluid lines

(a) Each nacelle area immediately behind the firewall, and each portion of any engine pod attaching structure containing flammable fluid lines, must meet each requirement of JAR 25.1103(b), 25.1165(e), 25.1183, 25.1185(c), 21.1187, 25.1189 and 25.1195 to 25.1203, including those concerning designated fire zones. However, engine pod attaching structures need not contain fire detection or extinguishing means.

JAR 25.1182 (continued)

(b) For each area covered by sub-paragraph (a) of this paragraph that contains a retractable landing gear, compliance with that sub-paragraph need only be shown with the landing gear retracted.

JAR 25.1183 Flammable fluid-carrying components

(a) Except as provided in sub-paragraph (b) of this paragraph, each line, fitting, and other component carrying flammable fluid in any area subject to engine fire conditions, and each component which conveys or contains flammable fluid in a designated fire zone must be fire resistant, except that flammable fluid tanks and supports in a designated fire zone must be fireproof or be enclosed by a fireproof shield unless damage by fire to any non-fireproof part will not cause leakage or spillage of flammable fluid. Components must be shielded or located to safeguard against the ignition of leaking flammable fluid.

(b) Sub-paragraph (a) of this paragraph does not apply to –

(1) Lines, fittings and components which are already approved as part of a type certificated engine; and

(2) Vent and drain lines, and their fittings, whose failure will not result in, or add to, a fire hazard.

(c) All components, including ducts, within a designated fire zone must be fireproof if, when exposed to or damaged by fire, they could –

(1) Result in fire spreading to other regions of the aeroplane, or

(2) Cause unintentional operation of, or inability to operate, essential services or equipment.

[Ch.12, 10.05.88]

JAR 25.1185 Flammable fluids

(a) No tank or reservoir that is a part of a system containing flammable fluids or gases may be in a designated fire zone unless the fluid contained, the design of the system, the materials used in the tank, the shut-off means, and all connections, lines and controls provide a degree of safety equal to that which would exist if the tank or reservoir were outside such a zone.

(b) There must be at least 0·5 inches of clear airspace between each tank or reservoir and each firewall or shroud isolating a designated fire zone.

JAR 25.1185 (continued)

(c) Absorbent materials close to flammable fluid system components that might leak must be covered or treated to prevent the absorption of hazardous quantities of fluids.

[Ch.15, 01.10.00]

JAR 25.1187 Drainage and ventilation of fire zones

(a) There must be complete drainage of each part of each designated fire zone to minimise the hazards resulting from failure or malfunctioning of any component containing flammable fluids. The drainage means must be –

(1) Effective under conditions expected to prevail when drainage is needed; and

(2) Arranged so that no discharge fluid will cause an additional fire hazard.

(b) Each designated fire zone must be ventilated to prevent the accumulation of flammable vapours.

(c) No ventilation opening may be where it would allow the entry of flammable fluids, vapours, or flame from other zones.

(d) Each ventilation means must be arranged so that no discharged vapours will cause an additional fire hazard.

(e) Unless the extinguishing agent capacity and rate of discharge are based on maximum air flow through a zone, there must be a means to allow the crew to shut-off sources of forced ventilation to any fire zone except the engine power section of the nacelle and the combustion heater ventilating air ducts.

JAR 25.1189 Shut-off means

(a) Each engine installation and each fire zone specified in JAR 25.1181(a)(5) must have a means to shut off or otherwise prevent hazardous quantities of fuel, oil, de-icer, and other flammable fluids, from flowing into, within, or through any designated fire zone, except that shut-off means are not required for –

(1) Lines, fittings, and components forming an integral part of an engine; and

(2) Oil systems in which all components of the system in a designated fire zone, including the oil tanks, are fireproof or located in areas not subject to engine fire conditions.

(b) The closing of any fuel shut-off valve for any engine may not make fuel unavailable to the remaining engines.

JAR 25.1189 (continued)

(c) Operation of any shut-off means may not interfere with the later emergency operation of other equipment, such as the means for feathering the propeller.

(d) Each flammable fluid shut-off means and control must be fireproof or must be located and protected so that any fire in a fire zone will not affect its operation.

(e) No hazardous quantity of flammable fluid may drain into any designated fire zone after shut-off.

(f) There must be means to guard against inadvertent operation of the shut-off means and to make it possible for the crew to reopen the shut-off means in flight after it has been closed.

(g) Each tank-to-engine shut-off valve must be located so that the operation of the valve will not be affected by powerplant or engine mount structural failure.

(h) Each shut-off valve must have a means to relieve excessive pressure accumulation unless a means for pressure relief is otherwise provided in the system.

[Ch.12, 10.05.88]

JAR 25.1191 Firewalls

(a) Each engine, fuel-burning heater, other combustion equipment intended for operation in flight, and the combustion, turbine, and tailpipe sections of turbine engines, must be isolated from the rest of the aeroplane by firewalls, shrouds, or equivalent means.

(b) Each firewall and shroud must be –

(1) Fireproof;

(2) Constructed so that no hazardous quantity of air, fluid, or flame can pass from the compartment to other parts of the aeroplane;

(3) Constructed so that each opening is sealed with close fitting fireproof grommets, bushings, or firewall fittings; and

(4) Protected against corrosion.

JAR 25.1193 Cowling and nacelle skin

(a) Each cowling must be constructed and supported so that it can resist any vibration, inertia, and air load to which it may be subjected in operation.

(b) Cowling must meet the drainage and ventilation requirements of JAR 25.1187.

JAR 25.1193 (continued)

(c) On aeroplanes with a diaphragm isolating the engine power section from the engine accessory section, each part of the accessory section cowling subject to flame in case of fire in the engine power section of the powerplant must–

(1) Be fireproof; and

(2) Meet the requirements of JAR 25.1191.

(d) Each part of the cowling subject to high temperatures due to its nearness to exhaust system parts or exhaust gas impingement must be fireproof.

(e) Each aeroplane must –

(1) Be designed and constructed so that no fire originating in any fire zone can enter, either through openings or by burning through external skin, any other zone or region where it would create additional hazards;

(2) Meet sub-paragraph (e)(1) of this paragraph with the landing gear retracted (if applicable); and

(3) Have fireproof skin in areas subject to flame if a fire starts in the engine power or accessory sections.

JAR 25.1195 Fire-extinguisher systems

(a) Except for combustor, turbine, and tail pipe sections of turbine engine installations that contain lines or components carrying flammable fluids or gases for which it is shown that a fire originating in these sections can be controlled, there must be a fire extinguisher system serving each designated fire zone.

(b) The fire-extinguishing system, the quantity of the extinguishing agent, the rate of discharge, and the discharge distribution must be adequate to extinguish fires. It must be shown by either actual or simulated flight tests that under critical airflow conditions in flight the discharge of the extinguishing agent in each designated fire zone specified in sub-paragraph (a) of this paragraph will provide an agent concentration capable of extinguishing fires in that zone and of minimising the probability of re-ignition. An individual 'one-shot' system may be used for fuel burning heaters, and other combustion equipment. For each other designated fire zone, two discharges must be provided each of which produces adequate agent concentration. (See ACJ 25.1195(b).)

(c) The fire-extinguishing system for a nacelle must be able to simultaneously protect each zone of the nacelle for which protection is provided.

JAR 25.1195(c) (continued)

JAR 25.1197 Fire-extinguishing agents

(a) Fire-extinguishing agents must –

(1) Be capable of extinguishing flames emanating from any burning of fluids or other combustible materials in the area protected by the fire extinguishing system; and

(2) Have thermal stability over the temperature range likely to be experienced in the compartment in which they are stored.

(b) If any toxic extinguishing agent is used, provisions must be made to prevent harmful concentrations of fluid or fluid vapours (from leakage during normal operation of the aeroplane or as a result of discharging the fire extinguisher on the ground or in flight) from entering any personnel compartment, even though a defect may exist in the extinguishing system. This must be shown by test except for built-in carbon dioxide fuselage compartment fire extinguishing systems for which –

(1) Five pounds or less of carbon dioxide will be discharged, under established fire control procedures, into any fuselage compartment; or

(2) There is protective breathing equipment for each flight-crew member on flight deck duty.

JAR 25.1199 Extinguishing agent containers

(a) Each extinguishing agent container must have a pressure relief to prevent bursting of the container by excessive internal pressures.

(b) The discharge end of each discharge line from a pressure relief connection must be located so that discharge of the fire extinguishing agent would not damage the aeroplane. The line must also be located or protected to prevent clogging caused by ice or other foreign matter.

(c) There must be a means for each fire extinguishing agent container to indicate that the container has discharged or that the charging pressure is below the established minimum necessary for proper functioning.

(d) The temperature of each container must be maintained, under intended operating conditions, to prevent the pressure in the container from –

JAR 25.1199(d) (continued)

(1) Falling below that necessary to provide an adequate rate of discharge; or

(2) Rising high enough to cause premature discharge.

(e) If a pyrotechnic capsule is used to discharge the extinguishing agent, each container must be installed so that temperature conditions will not cause hazardous deterioration of the pyrotechnic capsule.

JAR 25.1201 Fire extinguishing system materials

(a) No material in any fire extinguishing system may react chemically with any extinguishing agent so as to create a hazard.

(b) Each system component in an engine compartment must be fireproof.

JAR 25.1203 Fire-detector system

(a) There must be approved, quick acting fire or overheat detectors in each designated fire zone, and in the combustion, turbine, and tailpipe sections of turbine engine installations, in numbers and locations ensuring prompt detection of fire in those zones.

(b) Each fire detector system must be constructed and installed so that –

(1) It will withstand the vibration, inertia, and other loads to which it may be subjected in operation;

(2) There is a means to warn the crew in the event that the sensor or associated wiring within a designated fire zone is severed at one point, unless the system continues to function as a satisfactory detection system after the severing; and

(3) There is a means to warn the crew in the event of a short circuit in the sensor or associated wiring within a designated fire zone, unless the system continues to function as a satisfactory detection system after the short circuit.

(c) No fire or overheat detector may be affected by any oil, water, other fluids, or fumes that might be present.

(d) There must be means to allow the crew to check, in flight, the functioning of each fire or overheat detector electric circuit.

(e) Wiring and other components of each fire or overheat detector system in a fire zone must be at least fire-resistant.

JAR 25.1203 (continued)

(f) No fire or overheat detector system component for any fire zone may pass through another fire zone, unless –

(1) It is protected against the possibility of false warnings resulting from fires in zones through which it passes; or

(2) Each zone involved is simultaneously protected by the same detector and extinguishing system.

(g) Each fire detector system must be constructed so that when it is in the configuration for installation it will not exceed the alarm activation time approved for the detectors using the response time criteria specified in the appropriate Technical Standard Order for the detector.

JAR 25.1207 Compliance

Unless otherwise specified, compliance with the requirements of JAR 25.1181 to 25.1203 must be shown by a full scale fire test or by one or more of the following methods:

(a) Tests of similar powerplant configurations;

(b) Tests of components;

(c) Service experience of aeroplanes with similar powerplant configurations;

(d) Analysis.

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SUBPART F – EQUIPMENT

GENERAL

JAR 25.1301 Function and installation

Each item of installed equipment must –

(a) Be of a kind and design appropriate to its intended function;

(b) Be labelled as to its identification, function, or operating limitations, or any applicable combination of these factors. (See ACJ 25.1301(b).)

(c) Be installed according to limitations specified for that equipment; and

(d) [Reserved]

[Amdt. 16, 01.05.03]

JAR 25.1303 Flight and navigation instruments

[ ]

(a) The following flight and navigation instruments must be installed so that the instrument is visible from each pilot station:

(1) A free-air temperature indicator or an air-temperature indicator which provides indications that are convertible to free-air temperature.

(2) A clock displaying hours, minutes, and seconds with a sweep-second pointer or digital presentation.

(3) A direction indicator (non-stabilised magnetic compass).

(b) The following flight and navigation instruments must be installed at each pilot station:

(1) An airspeed indicator. If airspeed limitations vary with altitude, the indicator must have a maximum allowable airspeed indicator showing the variation of V_{MO} with altitude.

(2) An altimeter (sensitive).

(3) A rate-of-climb indicator (vertical speed).

(4) A gyroscopic rate of turn indicator combined with an integral slip-skid indicator (turn-and-bank indicator) except that only a slip-[skid indicator is required on aeroplanes with a third attitude instrument system usable through flight attitudes of 360º of pitch and roll, which is powered from a source independent of the electrical generating system and continues reliable

JAR 25.1303(b)(4) (continued)

operation for a minimum of 30 minutes after total failure of the electrical generating system, and is installed in accordance with JAR 25.1321(a).]

(5) A bank and pitch indicator (gyroscopically stabilised). (See ACJ 25.1303(b)(5).)

(6) A direction indicator (gyroscopically stabilised, magnetic or non-magnetic).

(c) The following flight and navigation instruments are required as prescribed in this paragraph:

(1) A speed warning device which must give effective aural warning (differing distinctively from aural warnings used for other purposes) to the pilots whenever the speed exceeds V_{MO} plus 6 knots or M_{MO} + 0·01. The upper limit of the production tolerance for the warning device may not exceed the prescribed [warning speed. (See ACJ 25.1303 (c)(1).)]

(2) A machmeter is required at each pilot station for aeroplanes with compressibility limitations not otherwise indicated to the pilot by the airspeed indicating system required under sub-paragraph (b)(1) of this paragraph.

[Ch.8, 30.11.81; Ch.10, 19.12.83; Ch.11, 17.03.86; Ch.12, 10.05.88; Amdt. 16, 01.05.03]

JAR 25.1305 Powerplant instruments

The following are required powerplant instruments:

(a) *For all aeroplanes*

(1) A fuel pressure warning means for each engine, or a master warning means for all engines with provision for isolating the individual warning means from the master warning means.

(2) A fuel quantity indicator for each fuel tank.

(3) An oil quantity indicator for each oil [tank.]

(4) An oil pressure indicator for each independent pressure oil system of each engine.

(5) An oil pressure warning means for each engine, or a master warning means for all engines with provision for isolating the individual warning means from the master warning means.

(6) An oil temperature indicator for each engine.

(7) Fire-warning devices that provide visual and audible warning.

JAR 25.1305(a) (continued)

(8) An augmentation liquid quantity indicator (appropriate for the manner in which the liquid is to be used in operation) for each tank.

(9) [Deleted]

(b) *Not required for JAR–25*.

(c) For turbine engine-powered aeroplanes. In addition to the powerplant instruments required by sub-paragraph (a) of this paragraph, the following powerplant instruments are required:

(1) A gas temperature indicator for each engine.

(2) A fuel flowmeter indicator for each engine.

(3) A tachometer (to indicate the speed of the rotors with established limiting speeds) for each engine.

(4) A means to indicate, to the flight crew, the operation of each engine starter that can be operated continuously but that is neither designed for continuous operation nor designed to prevent hazard if it failed.

(5) An indicator to indicate the functioning of the powerplant ice protection [system for each engine].

(6) [An indicator for the fuel strainer or filter required by JAR 25.997 to indicate the occurrence of contamination of the strainer or filter before it reaches the capacity established in accordance with JAR 25.997(d).]

(7) [A warning means for the oil strainer or filter required by JAR 25.1019, if it has no bypass, to warn the pilot of the occurrence of contamination of the strainer or filter screen before it reaches the capacity established in accordance with JAR 25.1019(a)(2).]

(8) [An indicator to indicate the proper functioning of any heater used to prevent ice clogging of fuel system components.]

(d) *For turbo-jet engine-powered aeroplanes.* In addition to the powerplant instruments required by sub-paragraphs (a) and (c) of this paragraph, the following powerplant instruments are required:

(1) An indicator to indicate thrust, or a parameter that is directly related to thrust, to the pilot. The indication must be based on the direct measurement of thrust or of the parameters that are directly related to thrust. The indicator must indicate a change in thrust resulting from any engine malfunction, damage or deterioration. (See ACJ 25.1305(d)(1).)

JAR 25.1305(d) (continued)

(2) [A position indicating means to] indicate to the flight crew when the thrust reversing device –

(i) Is not in the selected position, and

(ii) Is in the reverse thrust position, for each engine using a thrust reversing device.

(3) An indicator to indicate rotor system unbalance.

(e) *For turbo-propeller-powered aeroplanes*. In addition to the powerplant instruments required by sub-paragraphs (a) and (c) of this paragraph, the following powerplant instruments are required:

(1) A torque indicator for each engine.

(2) Position indicating means to indicate to the flight crew when the propeller blade angle is below the flight low pitch position, for each propeller.

(3) Reserved

(f) For aeroplanes equipped with fluid systems (other than fuel) for thrust or power augmentation, an approved means must be provided to indicate the proper functioning of that system to the flight crew.

[Ch.9, 30.11.82; Ch.10, 19.12.83; Ch.11, 17.03.86; Ch.13, 05.10.89; Ch.14, 27.05.94; Amdt. 16, 01.05.03]

JAR 25.1307 Miscellaneous equipment

The following is required miscellaneous equipment:

(a) Reserved

(b) Two or more independent sources of electrical energy.

(c) Electrical protective devices, as prescribed in this JAR–25.

(d) Two systems for two-way radio communications, with controls for each accessible from each pilot station, designed and installed so that failure of one system will not preclude operation of the other system. The use of a common antenna system is acceptable if adequate reliability is shown.

(e) Two systems for radio navigation, with controls for each accessible from each pilot station, designed and installed so that failure of one system will not preclude operation of the other system. The use of a common antenna system is acceptable if adequate reliability is shown.

[Ch.14, 27.05.94]

JAR 25.1309 Equipment, systems and installations [(See ACJ 25.1309)]

[The requirements of this paragraph, except as identified below, are applicable, in addition to specific design requirements of JAR-25, to any equipment or system as installed in the aeroplane. Although this paragraph does not apply to the performance and flight characteristic requirements of Subpart B and the structural requirements of Subparts C and D, it does apply to any system on which compliance with any of those requirements is dependent. Certain single failures or jams covered by JAR 25.671(c)(1) and JAR 25.671(c)(3) are excepted from the requirements of JAR 25.1309(b)(1)(ii). Certain single failures covered by JAR 25.735(b)(1) are excepted from the requirements of JAR 25.1309(b). The failure effects covered by JAR 25.810(a)(1)(v) and JAR 25.812 are excepted from the requirements of JAR 25.1309(b). The requirements of JAR 25.1309(b) apply to powerplant installations as specified in JAR 25.901(c).

(a) The aeroplane equipment and systems must be designed and installed so that:

(1) Those required for type certification or by operating rules, or whose improper functioning would reduce safety, perform as intended under the aeroplane operating and environmental conditions.

(2) Other equipment and systems are not a source of danger in themselves and do not adversely affect the proper functioning of those covered by sub-paragraph (a)(1) of this paragraph.

(b) The aeroplane systems and associated components, considered separately and in relation to other systems, must be designed so that –

(1) Any catastrophic failure condition

(i) is extremely improbable; and

(ii) does not result from a single failure; and

(2) Any hazardous failure condition is extremely remote; and

(3) Any major failure condition is remote.

(c) Information concerning unsafe system operating conditions must be provided to the crew to enable them to take appropriate corrective action. A warning indication must be provided if immediate corrective action is required. Systems and controls, including indications and annunciations must be designed to minimise crew errors which could create additional hazards.]

[Ch.10, 19.12.83; Ch.14, 27.05.94; Amdt. 16, 01.05.03]

[JAR 25.1310 Power source capacity and distribution

(a) Each installation whose functioning is required for type certification or by operating rules and that requires a power supply is an "essential load" on the power supply. The power sources and the system must be able to supply the following power loads in probable operating combinations and for probable durations (see ACJ 25.1310(a)):

(1) Loads connected to the system with the system functioning normally.

(2) Essential loads, after failure of any one prime mover, power converter, or energy storage device.

(3) Essential loads after failure of -

(i) Any one engine on two-engined aeroplanes; and

(ii) Any two engines on three-or-more engined aeroplanes.

(4) Essential loads for which an alternate source of power is required, after any failure or malfunction in any one power supply system, distribution system, or other utilisation system.

(b) In determining compliance with sub-paragraphs (a)(2) and (3) of this paragraph, the power loads may be assumed to be reduced under a monitoring procedure consistent with safety in the kinds of operation authorised. Loads not required in controlled flight need not be considered for the two-engine-inoperative condition on aeroplanes with three or more engines.]

[Amdt. 16, 01.05.03]

JAR 25X1315 Negative acceleration

No hazardous malfunction may occur as a result of the aeroplane being operated at the negative accelerations within the flight envelopes prescribed in JAR 25.333. This must be shown for the greatest duration expected for the acceleration. (See also ACJ 25X1315.)

JAR 25.1316 System lightning protection

(a) For functions whose failure would contribute to or cause a condition that would prevent the continued safe flight and landing of the aeroplane, each electrical and electronic system that performs these functions must be designed and installed to ensure that the operation and operational capabilities of the systems to perform these functions

JAR 25.1316(a) (continued)

are not adversely affected when the aeroplane is exposed to lightning.

(b) For functions whose failure would contribute to or cause a condition that would reduce the capability of the aeroplane or the ability of the flightcrew to cope with adverse operating conditions, each electrical and electronic system that performs these functions must be designed and installed to ensure that these functions can be recovered in a timely manner after the aeroplane is exposed to lightning.

(c) Compliance with the lightning protection criteria prescribed in sub-paragraphs (a) and (b) of this paragraph must be shown for exposure to a severe lightning environment. The applicant must design for and verify that aircraft electrical/ electronic systems are protected against the effects of lightning by:

(1) Determining the lightning strike zones for the aeroplane;

(2) Establishing the external lightning environment for the zones;

(3) Establishing the internal environment;

(4) Identifying all the electrical and electronic systems that are subject to the requirements of this paragraph, and their locations on or within the aeroplane;

(5) Establishing the susceptibility of the systems to the internal and external lightning environment;

(6) Designing protection; and

(7) Verifying that the protection is adequate.

[Ch.15, 01.10.00]

INSTRUMENTS: INSTALLATION

JAR 25.1321 Arrangement and visibility

(a) Each flight, navigation, and powerplant instrument for use by any pilot must be plainly visible to him from his station with the minimum practicable deviation from his normal position and line of vision when he is looking forward along the flight path. **[ ]**

(b) The flight instruments required by JAR **[** 25.1303 must be grouped on the instrument panel **]** and centred as nearly as practicable about the vertical plane of the pilot's forward vision. In addition –

JAR 25.1321(b) (continued)

(1) The instrument that most effectively indicates attitude must be on the panel in the top centre position;

(2) The instrument that most effectively indicates airspeed must be adjacent to and directly to the left of the instrument in the top centre position;

(3) The instrument that most effectively indicates altitude must be adjacent to and directly to the right of the instrument in the top centre position; and

(4) The instrument that most effectively indicates direction of flight must be adjacent to and directly below the instrument in the top centre position.

(c) Required powerplant instruments must be closely grouped on the instrument panel. In addition –

(1) The location of identical powerplant instruments for the engines must prevent confusion as to which engine each instrument relates; and

(2) Powerplant instruments vital to the safe operation of the aeroplane must be plainly visible to the appropriate crew members.

(d) Instrument panel vibration may not damage or impair the accuracy of any instrument.

(e) If a visual indicator is provided to indicate malfunction of an instrument, it must be effective under all probable cockpit lighting conditions.

[Amdt. 16, 01.05.03]

JAR 25.1322 Warning, caution, and advisory lights

If warning, caution, or advisory lights are installed in the cockpit, they must, unless otherwise approved by the Authority, be –

(a) Red, for warning lights (lights indicating a hazard which may require immediate corrective action);

(b) Amber, for caution lights (lights indicating the possible need for future corrective action);

(c) Green, for safe operation lights; and

(d) Any other colour, including white, for lights not described in sub-paragraphs (a) to (c) of this paragraph, provided the colour differs sufficiently from the colours prescribed in sub-paragraphs (a) to (c) of this paragraph to avoid possible confusion.

JAR 25.1323 Airspeed indicating system

For each airspeed indicating system, the following apply:

(a) Each airspeed indicating instrument must be approved and must be calibrated to indicate true airspeed (at sea-level with a standard atmosphere) with a minimum practicable instrument calibration error when the corresponding pitot and static pressures are applied.

(b) Each system must be calibrated to determine the system error (that is, the relation between IAS and CAS) in flight and during the accelerated take-off ground run. The ground run calibration must be determined –

(1) From 0·8 of the minimum value of V_1, to the maximum value of V_2, considering the approved ranges of altitude and weight; and

(2) With the wing-flaps and power settings corresponding to the values determined in the establishment of the take-off path under JAR 25.111 assuming that the critical engine fails at the minimum value of V_1.

(c) The airspeed error of the installation, excluding the airspeed indicator instrument calibration error, may not exceed 3% or five knots, whichever is greater, throughout the speed range, from –

[(1)**]** V_{MO} to 1·23 V_{SR1} with wing-flaps retracted; and

[(2)**]** 1·23 V_{SR0} to V_{FE} with wing-flaps in the landing position.

[(d) From 1·23 V_{SR} to the speed at which stall warning begins the IAS must change perceptibly with CAS and in the same sense, and at speeds below stall warning speed the IAS must not change in an incorrect sense. (See ACJ 25.1323(d).) **]**

[(e) From V_{MO} to $V_{MO} + \frac{2}{3} (V_{DF} - V_{MO})$ the IAS must change perceptibly with CAS and in the same sense, and at higher speeds up to V_{DF} the IAS must not change in an incorrect sense. (See ACJ 25.1323(e).) **]**

[(f) There must be no indication of air-speed that would cause undue difficulty to the pilot during the take-off between the initiation of rotation and the achievement of a steady climbing condition. **]**

[(g) The effects of airspeed indicating system lag may not introduce significant takeoff indicated airspeed bias, or significant errors in takeoff or accelerate-stop distances. **]**

[(h)**]** Each system must be arranged, so far as practicable, to prevent malfunction or serious error due to the entry of moisture, dirt, or other substances. (See ACJ 25.1323(d).)

[(i)**]** Each system must have a heated pitot tube or an equivalent means of preventing malfunction due to icing. (See ACJ 25.1323(e).)

[(j)**]** Where duplicate airspeed indicators are required, their respective pitot tubes must be far enough apart to avoid damage to both tubes in a collision with a bird.

[Ch.12, 10.05.88; Ch.15, 01.10.00; Amdt. 16, 01.05.03]

JAR 25.1325 Static pressure systems [ ]

(a) Each instrument with static air case connections must be vented to the outside atmosphere through an appropriate piping system.

(b) Each static port must be designed and located in such manner that static pressure system performance is least affected by airflow variation, or by moisture or other foreign matter, and that the correlation between air pressure in the static pressure system and true ambient atmospheric static pressure is not changed when the aeroplane is exposed to the continuous and intermittent maximum icing **[** conditions defined in Appendix C. (See ACJ 25.1323 (e).) **]**

(c) The design and installation of the static pressure system must be such that –

(1) Positive drainage of moisture is provided; chafing of the tubing and excessive distortion or restriction at bends in the tubing is avoided; and the materials used are durable, suitable for the purpose intended, and protected against corrosion; and

(2) It is airtight except for the port into the atmosphere. A proof test must be conducted to demonstrate the integrity of the static pressure system in the following manner:

(i) *Unpressurised aeroplanes*. Evacuate the static pressure system to a pressure differential of approximately 1 inch of mercury or to a reading on the altimeter, 1 000 ft above the aeroplane elevation at the time of the test. Without additional pumping for a period of 1 minute, the loss of indicated altitude must not exceed 100 ft on the altimeter.

(ii) *Pressurised aeroplanes*. Evacuate the static pressure system until pressure differential equivalent to the maximum cabin pressure differential for which the aeroplane is type certificated is

JAR 25.1325(c)(2) (continued

achieved. Without additional pumping for a period of 1 minute, the loss of indicated altitude must not exceed 2% of the equivalent altitude of the maximum cabin differential pressure or 100 ft, whichever is greater.

(d) Each pressure altimeter must be approved and must be calibrated to indicate pressure altitude in a standard atmosphere, with a minimum practicable calibration error when the corresponding static pressures are applied.

(e) Each system must be designed and installed so that the error in indicated pressure altitude, at sea-level, with a standard atmosphere, excluding instrument calibration error, does not result in an error of more than ±30 ft per 100 knots speed for the appropriate configuration in the speed range between [1·23 V_{SR0} with wing-flaps extended and 1·7 V_{SR1}] with wing-flaps retracted. However, the error need not be less than ±30 ft.

(f) If an altimeter system is fitted with a device that provides corrections to the altimeter indication, the device must be designed and installed in such manner that it can be bypassed when it malfunctions, unless an alternate altimeter system is provided. Each correction device must be fitted with a means for indicating the occurrence of reasonably probable malfunctions, including power failure, to the flight crew. The indicating means must be effective for any cockpit lighting condition likely to occur.

(g) Except as provided in sub-paragraph (h) of this paragraph, if the static pressure system incorporates both a primary and an alternate static pressure source, the means for selecting one or the other source must be designed so that –

(1) When either source is selected, the other is blocked off; and

(2) Both sources cannot be blocked off simultaneously.

(h) For unpressurised aeroplanes, sub-paragraph (g)(1) of this paragraph does not apply if it can be demonstrated that the static pressure system calibration, when either static pressure source is selected, is not changed by the other static pressure source being open or blocked.

[Ch.15, 01.10.00; Amdt. 16, 01.05.03]

JAR 25.1326 Pitot heat indication systems

If a flight instrument pitot heating system is installed, an indication system must be provided to indicate to the flight crew when that pitot heating system is not operating. The indication system must comply with the following requirements:

JAR 25.1331 (continued)

(a) The indication provided must incorporate an amber light that is in clear view of a flight-crew member.

(b) The indication provided must be designed to alert the flight crew if either of the following conditions exist:

(1) The pitot heating system is switched 'off'.

(2) The pitot heating system is switched 'on' and any pitot tube heating element is inoperative.

[JAR 25.1327 Direction Indicator
(See ACJ 25.1327)

(a) Each magnetic direction indicator must be installed so that its accuracy is not excessively affected by the aeroplane's vibration or magnetic fields.

(b) The magnetic direction indicator required by JAR 25.1303(a)(3) may not have a deviation, after compensation, in normal level flight, greater than 10 degrees on any heading.

(c) Direction indicators required by JAR 25.1303(b)(6) must have an accuracy adequate for the safe operation of the aeroplane.]

[Ch.15, 01.10.00; Amdt. 16, 01.05.03]

JAR 25X1328 Direction indicator

[Deleted]

[Amdt. 16, 01.05.03]

JAR 25.1329 Automatic pilot system
(See ACJ 25.1329.)

(a) Each automatic pilot system must be approved and must be designed so that the automatic pilot can be quickly and positively disengaged by the pilots to prevent it from interfering with their control of the aeroplane.

(b) Unless there is automatic synchronisation, each system must have a means to readily indicate to the pilot the alignment of the actuating device in relation to the control system it operates.

(c) Each manually operated control for the system must be readily accessible to the pilots.

JAR 25.1329 (continued)

(d) Quick release (emergency) controls must be on both control wheels, on the side of each wheel opposite the throttles.

(e) Attitude controls must operate in the plane and sense of motion specified in JAR 25.777(b) and 25.779(a) for cockpit controls. The direction of motion must be plainly indicated on, or adjacent to, each control.

(f) The system must be designed and adjusted so that, within the range of adjustment available to the human pilot, it cannot produce hazardous loads on the aeroplane, or create hazardous deviations in the flight path, under any condition of flight appropriate to its use, either during normal operation, or in the event of a malfunction, assuming that corrective action begins within a reasonable period of time.

(g) If the automatic pilot integrates signals from auxiliary controls or furnishes signals for operation of other equipment, there must be positive interlocks and sequencing of engagement to prevent improper operation. Protection against adverse interaction of integrated components, resulting from a malfunction, is also required.

(h) Means must be provided to indicate to the flight crew the current mode of operation and any modes armed by the pilot. Selector switch position is not acceptable as a means of indication.

(i) A warning must be provided to each pilot in the event of automatic or manual disengagement of the automatic pilot. (See JAR 25.1322 and its AMJ.)

[Ch.12, 10.05.88; Ch.15, 01.10.00]

JAR 25.1331 Instruments using a power supply

(a) For each instrument required by JAR 25.1303(b) that uses a power supply, the following apply:

(1) Each instrument must have a visual means integral with the instrument, to indicate when power adequate to sustain proper instrument performance is not being supplied. The power must be measured at or near the point where it enters the instruments. For electric instruments, the power is considered to be adequate when the voltage is within approved limits.

(2) Each instrument must, in the event of the failure of one power source, be supplied by another power source. This may be accomplished automatically or by manual means. The failure of [one power source must not affect the same instrument of both pilot stations.]

JAR 25.1331(a) (continued)

(3) If an instrument presenting flight and/or navigation data receives information from sources external to that instrument and loss of that information would render the presented data unreliable, a clear and unambiguous visual warning must be given to the crew when such loss of information occurs that the presented data [should not be relied upon. The indication shall be incorporated in the instrument.]

(b) As used in this paragraph, 'instrument' includes devices that are physically contained in one unit, and devices that are composed of two or more physically separate units or components connected together (such as a remote indicating gyroscopic direction indicator that includes a magnetic sensing element, a gyroscopic unit, an amplifier, and an indicator connected together).

[Amdt. 16, 01.05.03]

JAR 25.1333 Instrument systems

[(a) For systems that operate the instruments required by JAR 25.1303(b) which are located at each pilot's station, means must be provided to connect the required instruments at the first pilot's station to operating systems which are independent of the operating systems at other flight crew stations, or other equipment.

(b) Equipment, systems, and installations must be designed so that sufficient information is available to assure control of the aeroplane in airspeed, altitude, direction and attitude by one of the pilots without additional flight crew action, after any single failure or combination of failures that is not assessed to be extremely improbable (see ACJ 25.1333(b)); and

(c) Additional instruments, systems, or equipment may not be connected to the operating systems for the instruments required by JAR 25.1303(b), unless provisions are made to ensure the continued normal functioning of the required instruments in the event of any malfunction of the additional instruments, systems, or equipment which is not shown to be extremely improbable.]

[Amdt. 16, 01.05.03]

JAR 25.1335 Flight director systems

Means must be provided to indicate to the flight crew the current mode of operation and any modes armed by the pilot. Selector switch position is not acceptable as a means of indication.

[Ch.12, 10.05.88]

JAR 25.1337 Powerplant instruments

(a) *Instruments and instrument lines*

(1) Each powerplant instrument line must meet the requirements of JAR 25.993 and JAR 25.1183.

(2) Each line carrying flammable fluids under pressure must –

(i) Have restricting orifices or other safety devices at the source of pressure to prevent the escape of excessive fluid if the line fails; and

(ii) Be installed and located so that the escape of fluids would not create a hazard.

(3) Each powerplant instrument that utilises flammable fluids must be installed and located so that the escape of fluid would not create a hazard.

(b) *Fuel quantity indicator*. There must be means to indicate to the flight-crew members, the quantity, in gallons or equivalent units, of usable fuel in each tank during flight. In addition –

(1) Each fuel quantity indicator must be calibrated to read 'zero' during level flight when the quantity of fuel remaining in the tank is equal to the unusable fuel supply determined under JAR 25.959;

(2) Tanks with interconnected outlets and airspaces may be treated as one tank and need not have separate indicators; and

(3) Each exposed sight gauge, used as a fuel quantity indicator, must be protected against damage.

(c) *Fuel flowmeter system*. If a fuel flowmeter system is installed, each metering component must have a means for bypassing the fuel supply if malfunction of that component severely restricts fuel flow.

(d) *Oil quantity indicator*. There must be a stick gauge or equivalent means to indicate the quantity of oil in each tank. If an oil transfer or reserve oil supply system is installed, there must be a means to indicate to the flight crew, in flight, the quantity of oil in each tank.

(e) *Turbo-propeller blade position indicator*. Required turbo-propeller blade position indicators must begin indicating before the blade moves more than 8º below the flight low pitch stop. The source of indication must directly sense the blade position.

(f) *Not required for JAR–25.*

ELECTRICAL SYSTEMS AND EQUIPMENT

JAR 25.1351 General

(a) *Electrical system capacity*. The required generating capacity, and number and kinds of power sources must –

(1) Be determined by an electrical load analysis; and

(2) Meet the requirements of JAR 25.1309.

(b) *Generating system*. The generating system includes electrical power sources, main power busses, transmission cables, and associated control, regulation, and protective devices. It must be designed so that –

(1) Power sources function properly when independent and when connected in combination;

(2) No failure or malfunction of any power source can create a hazard or impair the ability of remaining sources to supply essential loads;

(3) The system voltage and frequency (as applicable) at the terminals of all essential load equipment can be maintained within the limits for which the equipment is designed, during any probable operating condition;

(4) System transients due to switching, fault clearing, or other causes do not make essential loads inoperative, and do not cause a smoke or fire hazard;

(5) There are means accessible where necessary, in flight, to appropriate crew members for the individual and rapid disconnection of each electrical power source (see ACJ 25.1351(b)(5)); and

(6) There are means to indicate to appropriate crew members the generating system quantities essential for the safe operation of the system, such as the voltage and current supplied [by each generator. (See ACJ 25.1351(b)(6))]

(c) *External power*. If provisions are made for connecting external power to the aeroplane, and that external power can be electrically connected to equipment other than that used for engine starting, means must be provided to ensure that no external power supply having a reverse polarity, a reverse phase sequence (including crossed phase and neutral), open circuit line, incorrect frequency or [voltage, can supply power to the aeroplane's] electrical system.

JAR 25.1351 (continued)

(d) *Operation without normal electrical power.* (See ACJ 25.1351(d).) The following apply:

(1) Unless it can be shown that the loss of the normal electrical power generating system(s) is Extremely Improbable, alternate high integrity electrical power system(s), independent of the normal electrical power generating system(s), must be provided to power those services necessary to complete a flight and make a safe landing.

(2) The services to be powered must include –

(i) Those required for immediate safety and which must continue to operate following the loss of the normal electrical power generating system(s), without the need for flight crew action;

(ii) Those required for continued controlled flight; and

(iii) Those required for descent, approach and landing.

(3) Failures, including junction box, control panel or wire bundle fires, which would result in the loss of the normal and alternate systems must be shown to be Extremely Improbable.

[Ch.14, 27.05.94; Amdt. 16, 01.05.03]

JAR 25.1353 Electrical equipment and installations

(a) Electrical equipment, controls, and wiring must be installed so that operation of any one unit or system of units will not adversely affect the simultaneous operation of any other electrical unit or system essential to the safe operation. Any electrical interference likely to be present in the aeroplane must not result in hazardous effects upon the aeroplane or its systems except under extremely remote conditions. (See ACJ 25.1353(a).)

(b) Cables must be grouped, routed and spaced so that damage to essential circuits will be minimised if there are faults in cables, particularly heavy current-carrying cables.

(c) Storage batteries must be designed and installed as follows:

(1) Safe cell temperatures and pressures must be maintained during any probable charging or discharging condition. No uncontrolled increase in cell temperature may result when the battery is recharged (after previous complete discharge) –

JAR 25.1353(c)(1) (continued)

(i) At maximum regulated voltage or power;

(ii) During a flight of maximum duration; and

(iii) Under the most adverse cooling condition likely to occur in service.

(2) Compliance with sub-paragraph (1) of this paragraph must be shown by test unless experience with similar batteries and installations has shown that maintaining safe cell temperatures and pressures presents no problem.

(3) No explosive or toxic gases emitted by any battery in normal operation, or as the result of any probable malfunction in the charging system or battery installation, may accumulate in hazardous quantities within the aeroplane.

(4) No corrosive fluids or gases that may escape from the battery may damage surrounding aeroplane structures or adjacent essential equipment.

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

[(6) Nickel cadmium battery installations must have –]

(i) A system to control the charging rate of the battery automatically so [as to prevent battery overheating; or]

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

(iii) A battery failure sensing and warning system with a means for disconnecting the battery from its charging source in the event of battery failure. (See ACJ 25.1353(c)(6)(ii) and (iii).)

(d) Electrical cables and cable installations must be designed and installed as follows:

(1) The electrical cables used must be compatible with the circuit protection devices required by JAR 25.1357, such that a fire or smoke hazard cannot be created under temporary or continuous fault conditions.

(2) Means of permanent identification must be provided for electrical cables, connectors and terminals.

JAR 25.1353(d) (continued)

(3) Electrical cables must be installed such that the risk of mechanical damage and/or damage caused by fluids, vapours or sources of heat, is minimised.

[(e) Electrical bonding must provide an adequate electrical return path under both normal and fault conditions, on aeroplanes having earthed electrical systems (see JAR 25.899).]

[Ch.14, 27.05.94; Amdt. 16, 01.05.03]

JAR 25.1355 Distribution system

(a) The distribution system includes the distribution busses, their associated feeders, and each control protective device.

(b) Reserved.

(c) If two independent sources of electrical power for particular equipment or systems are [required for certification or by operating rules, in] the event of the failure of one power source for such equipment or system, another power source (including its separate feeder) must be automatically provided or be manually selectable to maintain equipment or system operation. (See ACJ 25.1355(c) [and ACJ JAR 25.1310(a).)]

[Ch.14, 27.05.94; Amdt. 16, 01.05.03]

JAR 25.1357 Circuit protective devices

(a) Automatic protective devices must be used to minimise distress to the electrical system and hazard to the aeroplane in the event of wiring faults or serious malfunction of the system or connected equipment. (See ACJ 25.1357(a).)

(b) The protective and control devices in the generating system must be designed to de-energise and disconnect faulty power sources and power transmission equipment from their associated busses with sufficient rapidity to provide protection from hazardous over-voltage and other malfunctioning.

(c) Each resettable circuit protective device must be designed so that, when an overload or circuit fault exists, it will open the circuit irrespective of the position of the operating control.

(d) If the ability to reset a circuit breaker or replace a fuse is essential to safety in flight, that circuit breaker or fuse must be located and identified so that it can be readily reset or replaced in flight. Where fuses are used, there must be spare fuses for use in-flight equal to at least 50% of the number of fuses of each rating required for complete circuit protection.

JAR 25.1357 (continued)

(e) Each circuit for essential loads must have individual circuit protection. However, individual protection for each circuit in an essential load system (such as each position light circuit in a system) is not required.

(f) Reserved

(g) Automatic reset circuit breakers may be used as integral protectors for electrical equipment (such as thermal cut-outs) if there is circuit protection to protect the cable to the equipment.

[Ch.14, 27.05.94]

JAR 25.1359 Reserved

[Ch.14, 27.05.94]

[JAR 25.1360 Precautions against injury]

(a) *Shock*. The electrical system must be designed so as to minimise the risk of electric shock to crew, passengers and servicing personnel and also to maintenance personnel using normal precautions. [(See ACJ 25.1360(a) and JAR 25.899).]

(b) *Burns*. The temperature rise of any part, which has to be handled during normal operation by the flight crew, must not be such as to cause dangerous inadvertent movement, or injury to the [crew member. (See ACJ 25.1360(b).)]

[Amdt. 16, 01.05.03]

[JAR 25.1362 Electrical supplies for emergency conditions (See ACJ 25.1362)]

[A suitable supply must be provided to those services which are required, in order that emergency procedures may be carried out, after an emergency landing or ditching. The circuits to these services must be so designed, protected and installed such that the risk of their causing a fire, under these conditions, is minimised.]

[Ch.14, 27.05.94, Amdt. 16, 01.05.03]

JAR 25.1363 Electrical system tests (See ACJ 25.1363)

(a) Tests must be made to determine that the performance of the electrical supply systems meets the requirements of this JAR–25 under all the appropriate normal and failure conditions. When laboratory tests of the electrical system are conducted –

JAR 25.1363(a) (continued)

(1) The tests must be performed on a mock-up using the same generating equipment used in the aeroplane;

(2) The equipment must simulate the electrical characteristics of the distribution wiring and connected loads to the extent necessary for valid test results; and

(3) Laboratory generator drives must simulate the actual prime movers on the aeroplane with respect to their reaction to generator loading, including loading due to faults.

(b) For each flight condition that cannot be simulated adequately in the laboratory or by ground tests on the aeroplane, flight tests must be made.

[Ch.14, 27.05.94; Ch.15, 01.10.00]

[JAR 25.1365 Electrical appliances, motors and transformers
(See ACJ 25.1365)

(a) Domestic appliances must be so designed and installed that in the event of failures of the electrical supply or control system, the requirements of JAR 25.1309(b), (c) and (d) will be satisfied.

(b) The installation of galleys and cooking appliances must be such as to minimise the risk of overheat or fire.

(c) Domestic appliances, particularly those in galley areas, must be so installed or protected as to prevent damage or contamination of other equipment or systems from fluids or vapours which may be present during normal operation or as a result of spillage, where such damage or contamination may hazard the aeroplane.

(d) Unless it can be shown that compliance with JAR 25.1309(b) is provided by the circuit protective device required by JAR 25.1357(a), electric motors and transformers etc. (including those installed in domestic systems, such as galleys and toilet flush systems) must be provided with a suitable thermal protection device if necessary to prevent them overheating such as to create a smoke or fire hazard under normal operation and failure conditions. **]**

[Amdt. 16, 01.05.03]

LIGHTS

JAR 25.1381 Instrument lights

(a) The instrument lights must –

JAR 25.1381(a) (continued)

(1) Provide sufficient illumination to make each instrument, switch and other device necessary for safe operation easily readable unless sufficient illumination is available from another source; and

(2) Be installed so that –

(i) Their direct rays are shielded from the pilot's eyes; and

(ii) No objectionable reflections are visible to the pilot.

(b) Unless undimmed instrument lights are satisfactory under each expected flight condition, there must be a means to control the intensity of illumination.

[Ch.14, 27.05.94]

JAR 25.1383 Landing lights

(a) Each landing light must be approved, and must be installed so that –

(1) No objectionable glare is visible to the pilot;

(2) The pilot is not adversely affected by halation; and

(3) It provides enough light for night landing.

(b) Except when one switch is used for the lights of a multiple light installation at one location, there must be a separate switch for each light.

(c) There must be a means to indicate to the pilots when the landing lights are extended.

JAR 25.1385 Position light system installation

(a) *General*. Each part of each position light system must meet the applicable requirements of this paragraph and each system as a whole must meet the requirements of JAR 25.1387 to 25.1397.

(b) *Forward position lights*. Forward position lights must consist of a red and a green light spaced laterally as far apart as practicable and installed forward on the aeroplane so that, with the aeroplane in the normal flying position, the red light is on the left side, and the green light is on the right side. Each light must be approved.

(c) *Rear position light.* The rear position light must be a white light mounted as far aft as practicable on the tail or on each wing tip, and must be approved.

JAR 25.1585 (continued)

(d) *Light covers and colour filters.* Each light cover or colour filter must be at least flame resistant and may not change colour or shape or lose any appreciable light transmission during normal use.

JAR 25.1387 Position light system dihedral angles

(a) Except as provided in sub-paragraph (e) of this paragraph, each forward and rear position light must, as installed, show unbroken light within the dihedral angles described in this section.

(b) Dihedral angle L (left) is formed by two intersecting vertical planes, the first parallel to the longitudinal axis of the aeroplane, and the other at 110º to the left of the first, as viewed when looking forward along the longitudinal axis.

(c) Dihedral angle R (right) is formed by two intersecting vertical planes, the first parallel to the longitudinal axis of the aeroplane, and the other at 110º to the right of the first, as viewed when looking forward along the longitudinal axis.

(d) Dihedral angle A (aft) is formed by two intersecting vertical planes making angles of 70º to the right and to the left, respectively, to a vertical plane passing through the longitudinal axis, as viewed when looking aft along the longitudinal axis.

(e) If the rear position light when mounted as far aft as practicable in accordance with JAR 25.1385(c), cannot show unbroken light within dihedral angle A (as defined in sub-paragraph (d) of this paragraph), a solid angle or angles of obstructed visibility totalling not more than 0·04 steradians is allowable within that dihedral angle, if such solid angle is within a cone whose apex is at the rear position light and whose elements make an angle of 30º with a vertical line passing through the rear position light.

JAR 25.1389 Position light distribution and intensities

(a) *General.* The intensities prescribed in this paragraph must be provided by new equipment with light covers and colour filters in place. Intensities must be determined with the light source operating at a steady value equal to the average luminous output of the source at the normal operating voltage of the aeroplane. The light distribution and intensity of each position light must meet the requirements of sub-paragraph (b) of this paragraph.

(b) *Forward and rear position lights.* The light distribution and intensities of forward and rear position lights must be expressed in terms of minimum intensities in the horizontal plane,

JAR 25.1389(b) (continued)

minimum intensities in any vertical plane, and maximum intensities in overlapping beams, within dihedral angles L, R and A, and must meet the following requirements:

(1) *Intensities in the horizontal plane.* Each intensity in the horizontal plane (the plane containing the longitudinal axis of the aeroplane and perpendicular to the plane of symmetry of the aeroplane) must equal or exceed the values in JAR 25.1391.

(2) *Intensities in any vertical plane.* Each intensity in any vertical plane (the plane perpendicular to the horizontal plane) must equal or exceed the appropriate value in JAR 25.1393, where I is the minimum intensity prescribed in JAR 25.1391 for the corresponding angles in the horizontal plane.

(3) *Intensities in overlaps between adjacent signals.* No intensity in any overlap between adjacent signals may exceed the values given in JAR 25.1395, except that higher intensities in overlaps may be used with main beam intensities substantially greater than the minima specified in JAR 25.1391 and 25.1393 if the overlap intensities in relation to the main beam intensities do not adversely affect signal clarity. When the peak intensity of the forward position lights is more than 100 candles, the maximum overlap intensities between them may exceed the values given in JAR 25.1395 if the overlap intensity in Area A is not more than 10% of peak position light intensity and the overlap intensity in Area B is not greater than 2·5% of peak position light intensity.

JAR 25.1391 Minimum intensities in the horizontal plane of forward and rear position lights

Each position light intensity must equal or exceed the applicable values in the following table:

Dihedral angle (light included)	Angle from right or left of longitudinal axis, measured from dead ahead	Intensity (candles)
L and R (forward red and green)	0º to 10º	40
	10º to 20º	30
	20º to 110º	5
A (rear white)	110º to 180º	20

[Ch.11, 17.03.86]

JAR 25.1393 Minimum intensities in any vertical plane of forward and rear position lights

Each position light intensity must equal or exceed the applicable values in the following table:

Angle above or below the horizontal plane:	Intensity
0º	1·00 I
0º to 5º	0·90 I
5º to 10º	0·80 I
10º to 15º	0·70 I
15º to 20º	0·50 I
20º to 30º	0·30 I
30º to 40º	0·10 I
40º to 90º	0·05 I

JAR 25.1395 Maximum intensities in over-lapping beams of forward and rear position lights

No position light intensity may exceed the applicable values in the following table, except as provided in JAR 25.1389 (b)(3):

Overlaps	Maximum intensity	
	Area A (candles)	Area B (candles)
Green in dihedral angle L	10	1
Red in dihedral angle R	10	1
Green in dihedral angle A	5	1
Red in dihedral angle A	5	1
Rear white in dihedral angle L	5	1
Rear white in dihedral angle R	5	1

Where –

(a) Area A includes all directions in the adjacent dihedral angle that pass through the light source and intersect the common boundary plane at more than 10º but less than 20º; and

(b) Area B includes all directions in the adjacent dihedral angle that pass through the light source and intersect the common boundary plane at more than 20º.

JAR 25.1397 Colour specifications

Each position light colour must have the applicable International Commission on Illumination chromaticity co-ordinates as follows:

(a) Aviation red –

JAR 25.1397(a) (continued)

‘y’ is not greater than 0·335; and
‘z’ is not greater than 0·002.

(b) Aviation green –

‘x’ is not greater than 0·440–0·320y;
‘x’ is not greater than y–0·170; and
‘y’ is not less than 0·390–0·170x.

(c) Aviation white –

‘x’ is not less than 0·300 and not greater than 0·540;

‘y’ is not less than ‘x–0·040’ or ‘y_o–0·010’, whichever is the smaller; and

‘y’ is not greater than ‘x+0·020’ nor ‘0·636–0·400x’; Where ‘y_o’ is the ‘y’ co-ordinate of the Planckian radiator for the value of ‘x’ considered.

JAR 25.1401 Anti-collision light system

(a) *General*. The aeroplane must have an anti-collision light system that –

(1) Consists of one or more approved anti-collision lights located so that their light will not impair the crew’s vision or detract from the conspicuity of the position lights; and

(2) Meets the requirements of sub-paragraphs (b) to (f) of this paragraph.

(b) *Field of coverage*. The system must consist of enough light to illuminate the vital areas around the aeroplane considering the physical configuration and flight characteristics of the aeroplane. The field of coverage must extend in each direction within at least 75º above and 75º below the horizontal plane of the aeroplane, except that a solid angle or angles of obstructed visibility totalling not more than 0·03 steradians is allowable within a solid angle equal to 0·15 steradians centred about the longitudinal axis in the rearward direction.

(c) *Flashing characteristics*. The arrangement of the system, that is, the number of light sources, beam width, speed of rotation, and other characteristics, must give an effective flash frequency of not less than 40, nor more than 100 cycles per minute. The effective flash frequency is the frequency at which the aeroplane’s complete anti-collision light system is observed from a distance, and applies to each section of light including any overlaps that exist when the system consists of more than one light source. In overlaps, flash frequencies may exceed 100, but not 180 cycles per minute.

(d) *Colour*. Each anti-collision light must be either aviation red or aviation white and must meet the applicable requirements of JAR 25.1397.

(e) *Light intensity*. The minimum light intensities in all vertical planes, measured with the

JAR 25.1397(e) (continued)

red filter (if used) and expressed in terms of 'effective' intensities, must meet the requirements of sub-paragraph (f) of this paragraph. The following relation must be assumed:

$$I_e = \frac{\int_{t_1}^{t_2} I(t)\,dt}{0{\cdot}2 + (t_2 - t_1)};$$

where:

I_e = effective intensity (candles)

$I(t)$ = instantaneous intensity as a function of time

t_2–t_1 = flash time interval (seconds)

Normally, the maximum value of effective intensity is obtained when t_2 and t_1 are chosen so that the effective intensity is equal to the instantaneous intensity at t_2 and t_1.

(f) *Minimum effective intensities for anti-collision lights.* Each anti-collision light effective intensity must equal or exceed the applicable values in the following table:

Angle above or below the horizontal plane:	Effective intensity (candles)
0º to 5º	400
5º to 10º	240
10º to 20º	80
20º to 30º	40
30º to 75º	20

JAR 25.1403 Wing icing detection lights

Unless operations at night in known or forecast icing conditions are prohibited by an operating limitation, a means must be provided for illuminating or otherwise determining the formation of ice on the parts of the wings that are critical from the standpoint of ice accumulation. Any illumination that is used must be of a type that will not cause glare or reflection that would handicap crew members in the performance of their duties.

SAFETY EQUIPMENT

JAR 25.1411 General

(a) *Accessibility*. Required safety equipment to be used by the crew in an emergency must be readily accessible.

(b) *Stowage provisions*. Stowage provisions for required emergency equipment must be furnished and must –

(1) Be arranged so that the equipment is directly accessible and its location is obvious; and

JAR 25.1411(b) (continued)

(2) Protect the safety equipment from inadvertent damage.

(c) Emergency *exit descent device*. The stowage provisions for the emergency exit descent device required by JAR 25.809(f) must be at the exits for which they are intended.

(d) *Liferafts*

(1) The stowage provisions for the liferafts described in JAR 25.1415 must accommodate enough rafts for the maximum number of occupants for which certification for ditching is requested.

(2) Liferafts must be stowed near exits through which the rafts can be launched during an unplanned ditching.

(3) Rafts automatically or remotely released outside the aeroplane must be attached to the aeroplane by means of the static line prescribed in JAR 25.1415.

(4) The stowage provisions for each portable liferaft must allow rapid detachment and removal of the raft for use at other than the intended exits.

(e) *Long-range signalling device*. The stowage provisions for the long-range signalling device required by JAR 25.1415 must be near an exit available during an unplanned ditching.

(f) *Life-preserver stowage provisions*. The stowage provisions for life preservers described in JAR 25.1415 must accommodate one life preserver for each occupant for which certification for ditching is requested. Each life preserver must be within easy reach of each seated occupant.

(g) *Life line stowage provisions.* If certification for ditching under JAR 25.801 is requested, there must be provisions to store the life lines. These provisions must –

(1) Allow one life line to be attached to each side of the fuselage; and

(2) Be arranged to allow the life lines to be used to enable the occupants to stay on the wing after ditching. This requirement is not applicable to aeroplanes having no over-wing ditching exits.

[Ch.14, 27.05.94]

JAR 25.1413 Reserved

[Ch.14, 27.05.94]

JAR 25.1415 Ditching equipment

(a) Ditching equipment used in aeroplanes to be certified for ditching under JAR 25.801, and required by the National Operating Rules, must meet the requirements of this paragraph.

(b) Each liferaft and each life preserver must be approved. In addition –

(1) Unless excess rafts of enough capacity are provided, the buoyancy and seating capacity beyond the rated capacity of the rafts must accommodate all occupants of the aeroplane in the event of a loss of one raft of the largest rated capacity; and

(2) Each raft must have a trailing line, and must have a static line designed to hold the raft near the aeroplane but to release it if the aeroplane becomes totally submerged.

(c) Approved survival equipment must be attached to, or stored adjacent to, each liferaft.

(d) [There must be an approved survival type emergency locator transmitter for use in one life raft.]

(e) [For aeroplanes, not certificated for ditching under JAR 25.801 and not having] approved life preservers, there must be an approved flotation means for each occupant. This means must be within easy reach of each seated occupant and must be readily removable from the aeroplane.

[Ch.8, 30.11.81; Ch.14, 27.05.94; Amdt. 16, 01.05.03]

JAR 25.1416 Reserved

[Ch.14, 27.05.94]

JAR 25.1419 Ice Protection
(See ACJ 25.1419)

If certification for flight in icing conditions is desired, the aeroplane must be able to safely operate in the continuous maximum and intermittent maximum icing conditions of Appendix C. To establish that the aeroplane can operate within the continuous maximum and intermittent maximum conditions of Appendix C –

(a) An analysis must be performed to establish that the ice protection for the various components of the aeroplane is adequate, taking into account the various aeroplane operational configurations; and

(b) To verify the ice protection analysis, to check for icing anomalies, and to demonstrate that the ice protection system and its components are effective, the aeroplane or its components must be

flight tested in the various operational configurations, in measured natural atmospheric icing conditions, and as found necessary, by one or more of the following means:

(1) Laboratory dry air or simulated icing tests, or a combination of both, of the components or models of the components.

(2) Flight dry air tests of the ice protection system as a whole, or of its individual components.

(3) Flight tests of the aeroplane or its components in measured simulated icing conditions.

(c) Caution information, such as an amber caution light or equivalent, must be provided to alert the flight crew when the anti-ice or de-ice system is not functioning normally.

(d) For turbine engine powered aeroplanes, the ice protection provisions of this paragraph are considered to be applicable primarily to the airframe. For the powerplant installation, certain additional provisions of Subpart E may be found applicable.

[Ch.14, 27.05.94]

JAR 25.1421 Megaphones

If a megaphone is installed, a restraining means must be provided that is capable of restraining the megaphone when it is subjected to the ultimate inertia forces specified in JAR 25.561(b)(3).

JAR 25.1423 Public address system

A public address system required by this JAR must –

(a) Be powerable when the aircraft is in flight or stopped on the ground, after the shutdown or failure of all engines and auxiliary power units, or the disconnection or failure of all power sources dependent on their continued operation, for –

(1) A time duration of at least 10 minutes, including an aggregate time duration of at least 5 minutes of announcements made by flight and cabin crew members, considering all other loads which may remain powered by the same source when all other power sources are inoperative; and

(2) An additional time duration in its standby state appropriate or required for any other loads that are powered by the same source and that are essential to safety of flight or required during emergency conditions.

(b) The system must be capable of operation within 3 seconds from the time a microphone is

JAR 25.1423(b) (continued)

removed from its stowage by a cabin crew member at those stations in the passenger compartment from which its use is accessible.

(c) Be intelligible at all passenger seats, lavatories, and cabin crew member seats and work stations.

(d) Be designed so that no unused, unstowed microphone will render the system inoperative.

(e) Be capable of functioning independently of any required crew member interphone system.

(f) Be accessible for immediate use from each of two flight-crew member stations in the pilot compartment.

(g) For each required floor-level passenger emergency exit which has an adjacent cabin crew member seat, have a microphone which is readily accessible to the seated cabin crew member, except that one microphone may serve more than one exit, provided the proximity of the exits allows unassisted verbal communications between seated cabin crew members.

[Ch.14, 27.05.94; Ch.15, 01.10.00]

MISCELLANEOUS EQUIPMENT

JAR 25.1431 Electronic equipment

(a) In showing compliance with JAR 25.1309(a) and (b) with respect to radio and electronic equipment and their installations, critical environmental conditions must be considered

(b) Radio and electronic equipment must be supplied with power under the requirements of JAR 25.1355 (c).

(c) Radio and electronic equipment, controls and wiring must be installed so that operation of any one unit or system of units will not adversely affect the simultaneous operation of any other radio or electronic unit, or system of units, required by this JAR–25.

(d) Electronic equipment must be designed and installed such that it does not cause essential loads to become inoperative, as a result of electrical power supply transients or transients from other causes.

[Ch.14, 27.05.94]

JAR 25.1433 Vacuum systems

There must be means, in addition to the normal pressure relief, to automatically relieve the pressure in the discharge lines from the vacuum air pump when the delivery temperature of the air becomes unsafe.

[Ch.14, 27.05.94]

JAR 25.1435 Hydraulic systems [(See ACJ 25.1435)]

[(a) *Element design*. Each element of the hydraulic system must be designed to:

(1) Withstand the proof pressure without permanent deformation that would prevent it from performing its intended function, and the ultimate pressure without rupture. The proof and ultimate pressures are defined in terms of the design operating pressure (DOP) as follows:

	Element	Proof (x DOP)	Ultimate (x DOP)
1.	Tubes and fittings	1·5	3·0
2.	Pressure vessels containing gas		
	High pressure (e.g. accumulators)	3·0	4·0
	Low pressure (e.g. reservoirs)	1·5	3·0
3.	Hoses	2·0	4·0
4.	All other elements	1·5	2·0

(2) Withstand, without deformation that would prevent it from performing its intended function, the design operating pressure in combination with limit structural loads that may be imposed;

(3) Withstand, without rupture, the design operating pressure multiplied by a factor of 1·5 in combination with ultimate structural loads that can reasonably occur simultaneously;

(4) Withstand the fatigue effects of all cyclic pressures, including transients, and associated externally induced loads, taking into account the consequences of element failure; and

(5) Perform as intended under all environmental conditions for which the aeroplane is certificated.

(b) *System design*. Each hydraulic system must:

(1) Have means located at a flight crew member station to indicate appropriate system parameters, if

(i) It performs a function necessary for continued safe flight and landing; or

(ii) In the event of hydraulic system malfunction, corrective action by the crew

JAR 25.1435(b)(1) (continued)

to ensure continued safe flight and landing is necessary;

(2) Have means to ensure that system pressures, including transient pressures and pressures from fluid volumetric changes in elements that are likely to remain closed long] [enough for such changes to occur, are within the design capabilities of each element, such that they meet the requirements defined in JAR 25.1435(a)(1) through JAR 25.1435(a)(5) inclusive;

(3) Have means to minimise the release of harmful or hazardous concentrations of hydraulic fluid or vapours into the crew and passenger compartments during flight;

(4) Meet the applicable requirements of JAR 25.863, 25.1183, 25.1185 and 25.1189 if a flammable hydraulic fluid is used; and

(5) Be designed to use any suitable hydraulic fluid specified by the aeroplane manufacturer, which must be identified by appropriate markings as required by JAR 25.1541.

(c) *Tests*. Tests must be conducted on the hydraulic system(s), and/or subsystem(s) and element(s), except that analysis may be used in place of or to supplement testing where the analysis is shown to be reliable and appropriate. All internal and external influences must be taken into account to an extent necessary to evaluate their effects, and to assure reliable system and element functioning and integration. Failure or unacceptable deficiency of an element or system must be corrected and be sufficiently retested, where necessary.

(1) The system(s), subsystem(s), or element(s) must be subjected to performance, fatigue, and endurance tests representative of aeroplane ground and flight operations.

(2) The complete system must be tested to determine proper functional performance and relation to other systems, including simulation of relevant failure conditions, and to support or validate element design.

(3) The complete hydraulic system(s) must be functionally tested on the aeroplane in normal operation over the range of motion of all associated user systems. The test must be conducted at the relief pressure or 1.25 times the DOP if a system pressure relief device is not part of the system design. Clearances between hydraulic system elements and other systems or structural elements must remain adequate and there must be no detrimental effects.]

[Ch.11, 17.03.86; Ch.14, 27.05.94; Ch.15, 01.10.00; Amdt. 16, 01.05.03]

JAR 25X1436 Pneumatic systems – high pressure

(a) *General*. Pneumatic systems which are powered by, and/or used for distributing or storing, air or nitrogen, must comply with the requirements of this paragraph.

(1) Compliance with JAR 25.1309 for pneumatic systems must be shown by functional tests, endurance tests and analysis. Any part of a pneumatic system which is an engine accessory must comply with the relevant requirements of JAR 25.1163.

(2) No element of the pneumatic system which would be liable to cause hazardous effects by exploding, if subject to a fire, may be mounted within an engine bay or other designated fire zone, or in the same compartment as a combustion heater.

(3) When the system is operating no hazardous blockage due to freezing must occur. If such blockage is liable to occur when the aeroplane is stationary on the ground, a pressure relieving device must be installed adjacent to each pressure source.

(b) *Design*. Each pneumatic system must be designed as follows:

(1) Each element of the pneumatic system must be designed to withstand the loads due to the working pressure, P_w, in the case of elements other than pressure vessels or to the limit pressure, P_L, in the case of pressure vessels, in combination with limit structural loads which may be imposed without deformation that would prevent it from performing its intended function, and to withstand without rupture, the working or limit pressure loads multiplied by a factor of 1·5 in combination with ultimate structural loads that can reasonably occur simultaneously.

(i) P_w. The working pressure is the maximum steady pressure in service acting on the element including the tolerances and possible pressure variations in normal operating modes but excluding transient pressures.

(ii) P_L. The limit pressure is the anticipated maximum pressure in service acting on a pressure vessel, including the tolerances and possible pressure variations in normal operating modes but excluding transient pressures.

(2) A means to indicate system pressure located at a flight-crew member station, must be provided for each pneumatic system that –

JAR 25X1436(b)(2) (continued)

(i) Performs a function that is essential for continued safe flight and landing; or

(ii) In the event of pneumatic system malfunction, requires corrective action by the crew to ensure continued safe flight and landing.

(3) There must be means to ensure that system pressures, including transient pressures and pressures from gas volumetric changes in components which are likely to remain closed long enough for such changes to occur –

(i) Will be within 90 to 110% of pump average discharge pressure at each pump outlet or at the outlet of the pump transient pressure dampening device, if provided; and

(ii) Except as provided in sub-paragraph (b)(6) of this paragraph, will not exceed 125% of the design operating pressure, excluding pressure at the outlets specified in sub-paragraph (b)(3)(i) of this paragraph. Design operating pressure is the maximum steady operating pressure.

The means used must be effective in preventing excessive pressures being generated during ground charging of the system. (See ACJ 25X1436(b)(3).)

(4) Each pneumatic element must be installed and supported to prevent excessive vibration, abrasion, corrosion, and mechanical damage, and to withstand inertia loads.

(5) Means for providing flexibility must be used to connect points in a pneumatic line between which relative motion or differential vibration exists.

(6) Transient pressure in a part of the system may exceed the limit specified in sub-paragraph (b)(3)(ii) of this paragraph if –

(i) A survey of those transient pressures is conducted to determine their magnitude and frequency; and

(ii) Based on the survey, the fatigue strength of that part of the system is substantiated by analysis or tests, or both.

(7) The elements of the system must be able to withstand the loads due to the pressure given in Appendix K, for the proof condition without leakage or permanent distortion and for the ultimate condition without rupture. Temperature must be those corresponding to normal operating conditions. Where elements are constructed from materials other than aluminium

JAR 25X1436(b)(7) (continued)

alloy, tungum, or medium-strength steel, the Authority may prescribe or agree other factors. The materials used should in all cases be resistant to deterioration arising from the environmental conditions of the installation, particularly the effects of vibration.

(8) Where any part of the system is subject to fluctuating or repeated external or internal loads, adequate allowance must be made for fatigue.

(c) *Tests*

(1) A complete pneumatic system must be static tested to show that it can withstand a pressure of 1·5 times the working pressure without a deformation of any part of the system that would prevent it from performing its intended function. Clearance between structural members and pneumatic system elements must be adequate and there must be no permanent detrimental deformation. For the purpose of this test, the pressure relief valve may be made inoperable to permit application of the required pressure.

(2) The entire system or appropriate sub-systems must be tested in an aeroplane or in a mock-up installation to determine proper performance and proper relation to other aeroplane systems. The functional tests must include simulation of pneumatic system failure conditions. The tests must account for flight loads, ground loads, and pneumatic system working, limit and transient pressures expected during normal operation, but need not account for vibration loads or for loads due to temperature effects. Endurance tests must simulate the repeated complete flights that could be expected to occur in service. Elements which fail during the tests must be modified in order to have the design deficiency corrected and, where necessary, must be sufficiently retested. Simulation of operating and environmental conditions must be completed on elements and appropriate portions of the pneumatic system to the extent necessary to evaluate the environmental effects. (See ACJ 25X1436 (c)(2).)

(3) Parts, the failure of which will significantly lower the airworthiness or safe handling of the aeroplane must be proved by suitable testing, taking into account the most critical combination of pressures and temperatures which are applicable.

[Ch.11, 17.03.86; Ch.15, 01.10.00]

JAR 25.1438 Pressurisation and low pressure pneumatic systems

Pneumatic systems (ducting and components) served by bleed air, such as engine bleed air, air conditioning, pressurisation, engine starting and hot-air ice-protection systems, which are essential for the safe operation of the aeroplane or whose failure may adversely affect any essential or critical part of the aeroplane or the safety of the occupants, must be so designed and installed as to comply the JAR 25.1309 In particular account must be taken of bursting or excessive leakage. (See ACJ 25.1438 paragraph 1 for strength and ACJ 25.1438 paragraph 2 for testing.)

JAR 25.1439 Protective breathing equipment

(a) Protective breathing equipment must be installed for use of appropriate crew members. Such equipment must be located so as to be available for use in compartments accessible in flight.

(b) For protective breathing equipment required by JAR 25.1439(a) or by the National Operating Regulations, the following apply:

(1) The equipment must be designed to protect the appropriate crew member from smoke, carbon dioxide, and other harmful gases while on flight deck duty or while combating fires.

(2) The equipment must include –

(i) Masks covering the eyes, nose and mouth, or

(ii) Masks covering the nose and mouth, plus accessory equipment to cover the eyes.

(3) Equipment, including portable equipment, while in use must allow communication with other crew members. Equipment available at flight crew assigned duty stations must enable the flight crew to use radio equipment.

(4) The part of the equipment protecting the eyes may not cause any appreciable adverse effect on vision and must allow corrective glasses to be worn.

(5) Each dispensing equipment must supply protective oxygen of 15 minutes duration at a pressure altitude of 8 000 ft with a respiratory minute volume of 30 litres per minute BTPD. The equipment and system must be designed to prevent any leakage to the inside of the mask and any significant increase in the oxygen content of

JAR 25.1439(b)(5) (continued)

the local ambient atmosphere. (See ACJ 25.1439(b)(5).)

(6) The equipment must meet the requirements of JAR 25.1441.

JAR 25.1441 Oxygen equipment and supply

(a) **[**If certification with supplemental oxygen equipment is requested, the equipment must meet the requirements of this paragraph and JAR 25.1443 through 25.1453.**]**

(b) The oxygen system must be free from hazards in itself, in its method of operation, and in its effect upon other components. **[ ]**

(c) **[ ]** There must be a means to allow the crew to readily determine, during flight, the quantity of oxygen available in each source of supply. **[ ]**

(d) The oxygen flow rate and the oxygen equipment for aeroplanes for which certification for operation above 40 000 ft is requested must be approved. (See ACJ 25.1441(d).)

[Amdt. 16, 01.05.03]

JAR 25.1443 Minimum mass flow of supplemental oxygen [ ]

(a) If continuous flow equipment is installed for use by flight-crew members, the minimum mass flow of supplemental oxygen required for each crew member may not be less than the flow required to maintain, during inspiration, a mean tracheal oxygen partial pressure of 149 mmHg when breathing 15 litres per minute, BTPS, and with a maximum tidal volume of 700 cc with a constant time interval between respirations.

(b) If demand equipment is installed for use by flight-crew members, the minimum mass flow of supplemental oxygen required for each crew member may not be less than the flow required to maintain, during inspiration, a mean tracheal oxygen partial pressure of 122 mmHg, up to and including a cabin pressure altitude of 35 000 ft, and 95% oxygen between cabin pressure altitudes of 35 000 and 40 000 ft, when breathing 20 litres per minute BTPS. In addition, there must be means to allow the crew to use undiluted oxygen at their discretion.

(c) For passengers and cabin crew members, the minimum mass flow of supplemental oxygen required for each person at various cabin pressure altitudes may not be less than the flow required to maintain, during inspiration and while using the

JAR 25.1443(c) (continued)

oxygen equipment (including masks) provided, the following mean tracheal oxygen partial pressures:

(1) At cabin pressure altitudes above 10 000 ft up to and including 18 500 ft, a mean tracheal oxygen partial pressure of 100 mmHg when breathing 15 litres per minute, BTPS, and with a tidal volume of 700 cc with a constant time interval between respirations.

(2) At cabin pressure altitudes above 18 500 ft up to and including 40 000 ft, a mean tracheal oxygen partial pressure of 83·8 mmHg when breathing 30 litres per minute, BTPS, and with a tidal volume of 1 100 cc with a constant time interval between respirations.

(d) If first-aid oxygen equipment is installed, the minimum mass flow of oxygen to each user may not be less than 4 litres per minute, STPD. However, there may be a means to decrease this flow to not less than 2 litres per minute, STPD, at any cabin altitude. The quantity of oxygen required is based upon an average flow rate of 3 litres per minute per person for whom first-aid oxygen is required.

(e) If portable oxygen equipment is installed for use by crew members, the minimum mass flow of supplemental oxygen is the same as specified in sub-paragraph (a) or (b) of this paragraph, whichever is applicable.

[Ch.15, 01.10.00; Amdt. 16, 01.05.03]

JAR 25.1445 Equipment standards for the oxygen distributing system

(a) When oxygen is supplied to both crew and passengers, the distribution system must be designed for either –

(1) A source of supply for the flight crew on duty and a separate source for the passengers and other crew members; or

(2) A common source of supply with means to separately reserve the minimum supply required by the flight crew on duty. **[ ]**

(3) **[** (Deleted) **]**

(b) Portable walk-around oxygen units of the continuous flow, diluter-demand, and straight demand kinds may be used to meet the crew or passenger breathing requirements.

[Amdt. 16, 01.05.03]

JAR 25.1447 Equipment standards for oxygen dispensing units

If oxygen dispensing units are installed, the following apply:

(a) There must be an individual dispensing unit for each occupant for whom supplemental oxygen is to be supplied. Units must be designed to cover the nose and mouth and must be equipped with a suitable means to retain the unit in position on the face. Flight crew masks for supplemental oxygen must have provisions for the use of communication equipment.

(b) If certification for operation up to and including 25 000 ft is requested, an oxygen supply **[** terminal and unit of oxygen dispensing equipment for the immediate use of oxygen by each crew member must be within easy reach of that crew member. For any other occupants the supply terminals and dispensing equipment must be located to allow use of oxygen as required by the operating rules. **]**

(c) **[ ]** If certification for operation above 25 000 ft is requested, there must be oxygen dispensing equipment meeting the following requirements (See ACJ 25.1447(c)):

(1) There must be an oxygen dispensing unit connected to oxygen supply terminals immediately available to each occupant, wherever seated. If certification for operation above 30 000 ft is requested, the dispensing units providing the required oxygen flow must be automatically presented to the occupants before the cabin pressure altitude exceeds 15 000 ft and the crew must be provided with a manual means to make the dispensing units immediately available in the event of failure of the automatic system. The total number of dispensing units and outlets must exceed the number of seats by at least 10%. The extra units must be as uniformly distributed throughout the cabin as practicable. (See ACJ 25.1447(c)(1).)

(2) Each flight-crew member on flight deck duty must be provided with demand equipment. In addition, each flight-crew member must be provided with a quick-donning type of oxygen dispensing unit, connected to an oxygen supply terminal, that is immediately available to him when seated at his station, and this is designed and installed so that it (see ACJ 25.1447(c)(2)) –

(i) Can be placed on the face from its ready position, properly secured, sealed, and supplying oxygen upon demand, with one hand within 5 seconds and without disturbing eyeglasses or causing delay in proceeding with emergency duties; and

JAR 25.1447(c)(2) (continued)

(ii) Allows, while in place, the performance of normal communication functions.

(3) There must be at least two outlets and units of dispensing equipment of a type similar to that required by sub-paragraph (c)(1) of this paragraph in all other compartments or work areas that may be occupied by passengers or crew members during flight, i.e. toilets, washrooms, galley work areas, etc.

(4) Portable oxygen equipment must be immediately available for each cabin crew member. (See ACJ 25.1447(c)(4).)

[Ch.15, 01.10.00; Amdt. 16, 01.05.03]

JAR 25.1449 Means for determining use of oxygen

There must be a means to allow the crew to determine whether oxygen is being delivered to the dispensing equipment. **[ ]**

[Amdt. 16, 01.05.03]

JAR 25.1450 Chemical oxygen generators **[ ]**

(a) For the purpose of this paragraph, a chemical oxygen generator is defined as a device which produces oxygen by chemical reaction.

(b) Each chemical oxygen generator must be designed and installed in accordance with the following requirements:

(1) Surface temperature developed by the generator during operation may not create a hazard to the aeroplane or to its occupants.

(2) Means must be provided to relieve any internal pressure that may be hazardous.

(c) In addition to meeting the requirements in sub-paragraph (b) of this paragraph, each portable chemical oxygen generator that is capable of sustained operation by successive replacement of a generator element must be placarded to show –

(1) The rate of oxygen flow, in litres per minute;

(2) The duration of oxygen flow, in minutes, for the replaceable generator element; and

JAR 25.1450(c) (continued)

(3) A warning that the replaceable generator element may be hot, unless the element construction is such that the surface temperature cannot exceed 100ºF.

[Amdt. 16, 01.05.03]

JAR 25.1451 Reserved

[Ch.14, 27.05.94]

JAR 25.1453 Protection of oxygen equipment from rupture
(See ACJ 25.1453.)

(a) Each element of the system must have sufficient strength to withstand the maximum pressures and temperatures in combination with any externally applied load, arising from consideration of limit structural loads that may be acting on that part of the system in service.

(b) Oxygen pressure sources and pipe lines between the sources and shut-off means must be –

(1) Protected from unsafe temperatures; and

(2) Located where the probability and hazard of rupture in a crash landing are minimised.

JAR 25.1455 Draining of fluids subject to freezing

If fluids subject to freezing may be drained overboard in flight or during ground operation, the drains must be designed and located to prevent the formation of hazardous quantities of ice on the aeroplane as a result of the drainage.

JAR 25.1457 Cockpit voice recorders
(See ACJ 25.1457)

(a) Each cockpit voice recorder required by the operating rules must be approved and must be installed so that it will record the following:

(1) Voice communications transmitted from or received in the aeroplane by radio.

(2) Voice communications of flight-crew members on the flight deck.

(3) Voice communications of flight-crew members on the flight deck, using the aeroplane's interphone system.

JAR 25.1457(a) (continued)

(4) Voice or audio signals identifying navigation or approach aids introduced into a headset or speaker.

(5) Voice communications of flight-crew members using the passenger loudspeaker system, if there is such a system and if the fourth channel is available in accordance with the requirements of sub-paragraph (c)(1)(ii) of this paragraph.

(b) The recording requirements of sub-paragraph (a)(2) of this paragraph must be met by installing a cockpit-mounted area microphone, located in the best position for recording voice communications originating at the first and second pilot stations and voice communications of other crew members on the flight deck when directed to those stations. The microphone must be so located and, if necessary, the pre-amplifiers and filters of the recorder must be so adjusted or supplemented, that the intelligibility of the recorded communications is as high as practicable when recorded under flight cockpit noise conditions and played back. Repeated aural or visual playback of the record may be used in evaluating intelligibility.

[(c) Each cockpit voice recorder must be installed so that the part of the communication or audio signals specified in sub-paragraph (a) of this paragraph obtained from each of the following sources is recorded on a separate channel:

(1) For the first channel, from each boom, mask, or hand-held microphone, headset, or speaker used at the first pilot station.

(2) For the second channel, from each boom, mask, or hand-held micro-hone, headset, or speaker used at the second pilot station.

(3) For the third channel, from the cockpit-mounted area microphone.

(4) For the fourth channel, from –

(i) Each boom, mask, or hand-held microphone, headset or speaker used at the stations for the third and fourth crew members; or

(ii) If the stations specified in sub-paragraph (c)(4)(i) of this paragraph are not required or if the signal at such a station is picked up by another channel, each microphone on the flight deck that is used with the public address system if its signals are not picked up by another channel.

(5) As far as is practicable all sounds received by the microphones listed in sub-paragraphs (c)(1), (2) and (4) of this paragraph are recorded without interruption irrespective of the position of the interphone-transmitter key switch.

JAR 25.1457(c)(5) (continued)

The design shall ensure that sidetone for the flight crew is produced only when the interphone, public address system or radio transmitters are in use. **]**

(d) Each cockpit voice recorder must be installed so that –

(1) It receives its electric power from the bus that provides the maximum reliability for operation of the cockpit voice recorder without jeopardising service to essential or emergency loads;

(2) There is an automatic means to simultaneously stop the recorder and prevent each erasure feature from functioning, within 10 minutes after crash impact; and

(3) There is an aural or visual means for pre-flight checking of the recorder for proper operation.

(e) The record container must be located and mounted to minimise the probability of rupture of the container as a result of crash impact and consequent heat damage to the record from fire. In meeting this requirement, the record container must be as far aft as practicable, but may not be where aft mounted engines may crush the container during impact. However, it need not be outside of the pressurised compartment.

(f) If the cockpit voice recorder has a bulk erasure device, the installation must be designed to minimise the probability of inadvertent operation and actuation of the device during crash impact.

(g) Each recorder container must –

(1) Be either bright orange or bright yellow;

(2) Have reflective tape affixed to its external surface to facilitate its location under water; and

(3) Have an underwater locating device, when required by the operating rules, on or adjacent to the container which is secured in such a manner that they are not likely to be separated during crash impact.

[Ch.13, 05.10.8; Amdt. 16, 01.05.03]

JAR 25.1459 Flight recorders

(a) Each flight recorder required by the operating rules must be installed so that –

(1) It is supplied with airspeed, altitude, and directional data obtained from sources that meet the accuracy requirements of JAR 25.1323, 25.1325 and 25.1327, as appropriate;

JAR 25.1459(a)(continued)

(2) The vertical acceleration sensor is rigidly attached, and located longitudinally either within the approved centre of gravity limits of the aeroplane, or at a distance forward or aft of these limits that does not exceed 25% of the aeroplane's mean aerodynamic chord;

(3) It receives its electrical power from the bus that provides the maximum reliability for operation of the flight recorder without jeopardising service to essential or emergency loads;

(4) There is an aural or visual means for preflight checking of the recorder for proper recording of data in the storage medium (see ACJ 25.1459(a)(4));

(5) Except for recorders powered solely by the engine-driven electrical generator system, there is an automatic means to simultaneously stop a recorder that has a data erasure feature and prevent each erasure feature from functioning, within 10 minutes after crash impact; and

(6) There is a means to record data from which the time of each radio transmission either to or from ATC can be determined.

(b) Each non-ejectable record container must be located and mounted so as to minimise the probability of container rupture resulting from crash impact and subsequent damage to the record from fire. In meeting this requirement the record container must be located as far aft as practicable, but need not be aft of the pressurised compartment, and may not be where aft-mounted engines may crush the container upon impact. (See ACJ 25.1459(b).)

(c) A correlation must be established between the flight recorder readings of airspeed, altitude, and heading and the corresponding readings (taking into account correction factors) of the first pilot's instruments. The correlation must cover the airspeed range over which the aeroplane is to be operated, the range of altitude to which the aeroplane is limited, and 360º of heading. Correlation may be established on the ground as appropriate.

(d) Each recorder container must –

(1) Be either bright orange or bright yellow;

(2) Have reflective tape affixed to its external surface to facilitate its location under water; and

(3) Have an underwater locating device, when required by the operating rules of this chapter, on or adjacent to the container which is secured in such a manner that they are not likely to be separated during crash impact.

JAR 25.1459 (continued)

(e) Any novel or unique design or operational characteristics of the aircraft shall be evaluated to determine if any dedicated parameters must be recorded on flight recorders in addition to or in place of existing requirements.

[Ch.12, 10.05.88; Ch.13, 05.10.89]

JAR 25.1461 Equipment containing high energy rotors

(a) Equipment containing high energy rotors must meet sub-paragraph (b), (c) or (d) of this paragraph.

(b) High energy rotors contained in equipment must be able to withstand damage caused by malfunctions, vibration, abnormal speeds, and abnormal temperatures. In addition –

(1) Auxiliary rotor cases must be able to contain damage caused by the failure of high energy rotor blades; and

(2) Equipment control devices, systems, and instrumentation must reasonably ensure that no operating limitations affecting the integrity of high energy rotors will be exceeded in service.

(c) It must be shown by test that equipment containing high energy rotors can contain any failure of a high energy rotor that occurs at the highest speed obtainable with the normal speed control devices inoperative.

(d) Equipment containing high energy rotors must be located where rotor failure will neither endanger the occupants nor adversely affect continued safe flight.

JAR 25X1499 Domestic services and appliances

(a) Domestic appliances must be so designed and installed that in the event of failures of the electrical supply or control system, the requirements of JAR 25.1309(b)(c) and (d) will be satisfied (see ACJ 25X1499(a)).

(b) The installation of galleys and cooking appliances must be such as to minimise the risk of fire (see ACJ 25X1499(b)).

(c) Domestic appliances, particularly those in galley areas, be so installed or protected as to prevent damage or contamination of other equipment or systems from fluids or vapours which may be present during normal operation or as a result of spillage, where such damage or contamination may hazard the aeroplane.

JAR 25.1499(continued)

(d) All electrical domestic appliances must be suitably bonded.

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SUBPART G – OPERATING LIMITATIONS AND INFORMATION

JAR 25.1501 General
(See ACJ 25.1501)

(a) Each operating limitation specified in JAR 25.1503 to 25.1533 and other limitations and information necessary for safe operation must be established.

(b) The operating limitations and other information necessary for safe operation must be made available to the crew members as prescribed in JAR 25.1541 to 25.1587.

(c) Supplementary information must be made available to the operator of each aeroplane as prescribed in JAR 25X1591.

[Ch.13, 05.10.89]

OPERATING LIMITATIONS

JAR 25.1503 Airspeed limitations: general

When airspeed limitations are a function of weight, weight distribution, altitude, or Mach number, limitations corresponding to each critical combination of these factors must be established.

JAR 25.1505 Maximum operating limit speed

The maximum operating limit speed (V_{MO}/M_{MO}, airspeed or Mach number, whichever is critical at a particular altitude) is a speed that may not be deliberately exceeded in any regime of flight (climb, cruise, or descent), unless a higher speed is authorised for flight test or pilot training operations. V_{MO}/M_{MO} must be established so that it is not greater than the design cruising speed V_C and so that it is sufficiently below V_D/M_D or V_{DF}/M_{DF}, to make it highly improbable that the latter speeds will be inadvertently exceeded in operations. The speed margin between V_{MO}/M_{MO} and V_D/M_D or V_{DF}/M_{DF} may not be less than that determined under JAR 25.335(b) or found necessary during the flight tests conducted under JAR 25.253.

JAR 25.1507 Manoeuvring speed

The manoeuvring speed must be established so that it does not exceed the design manoeuvring speed V_A determined under JAR 25.335(c).

JAR 25.1511 Flap extended speed

The established flap extended speed V_{FE} must be established so that it does not exceed the design flap speed V_F chosen under JAR 25.335(e) and 25.345, for the corresponding wing-flap positions and engine powers.

JAR 25.1513 Minimum control speed

[The minimum control speed V_{MC} determined under 25.149 must be established as an operating limitation.]

[Amdt. 16, 01.05.03]

JAR 25.1515 Landing gear speeds

(a) The established landing gear operating speed or speeds, V_{LO}, may not exceed the speed at which it is safe both to extend and to retract the landing gear, as determined under JAR 25.729 or by the flight characteristics. If the extension speed is not the same as the retraction speed, the two speeds must be designated as $V_{LO(EXT)}$ and $V_{LO(RET)}$, respectively.

(b) The established landing gear extended speed V_{LE} may not exceed the speed at which it is safe to fly with the landing gear secured in the fully extended position, and that determined under JAR 25.729.

[JAR 25.1516 Other speed limitations

Any other limitation associated with speed must be established.]

[Amdt. 16, 01.05.03]

JAR 25.1517 Rough air speed, V_{RA}

A rough air speed, V_{RA}, for use as the recommended [turbulence penetration airspeed must be] established, which –

(1) Is not greater than the design speed for maximum gust intensity, selected for V_B; and

(2) Is not less than the minimum value of V_B specified in JAR 25.335(d); and

(3) Is sufficiently less than V_{MO} to ensure that likely speed variation during rough air encounters will not cause the overspeed warning to operate too frequently. In the absence of a rational investigation substantiating the use of

JAR 25.1517 (continued)

other values, V_{RA} must be less than V_{MO}–35 knots (TAS).

[Ch.15, 01.10.00; Amdt. 16, 01.05.03]

JAR 25.1519 Weight, centre of gravity and weight distribution

The aeroplane weight, centre of gravity, and weight **[** distribution limitations determined under JAR **]** 25.23 to JAR 25.27 must be established as operating limitations. (See ACJ 25.1519.)

[Amdt. 16, 01.05.03]

JAR 25.1521 Powerplant limitations (See ACJ 25.1521)

(a) *General.* The powerplant limitations prescribed in this paragraph must be established so that they do not exceed the corresponding limits for which the engines or propellers are type certificated and do not exceed the values on which compliance with any other requirement of this Code is based.

(b) *Reserved.*

(c) *Turbine engine installations*. Operating limitations relating to the following must be established for turbine engine installations:

(1) Horsepower, torque or thrust, rpm, gas temperature, and time for –

(i) Maximum continuous power or thrust (relating to augmented or unaugmented operation as applicable).

(ii) Take-off power or thrust (relating to augmented or unaugmented operation as applicable).

(2) Fuel designation or specification.

(3) Any other parameter for which a limitation has been established as part of the engine type certificate except that a limitation need not be established for a parameter that cannot be exceeded during normal operation due to the design of the installation or to another established limitation.

[(d) *Ambient temperature.* An ambient temperature limitation (including limitations for winterisation installations, if applicable) must be established as the maximum ambient atmospheric temperature established in accordance with JAR 25.1043(b).**]**

[Ch.14, 27.05.94; Amdt. 16, 01.05.03]

JAR 25.1522 Auxiliary power unit limitations

If an auxiliary power unit is installed in the aeroplane, limitations established for the auxiliary power unit, including categories of operation, must be specified as operating limitations for the aeroplane.

[Ch.14, 27.05.94]

JAR 25.1523 Minimum flight crew

The minimum flight crew must be established (see ACJ 25.1523) so that it is sufficient for safe operation, considering –

(a) The workload on individual crew members;

(b) The accessibility and ease of operation of necessary controls by the appropriate crew member; and

(c) The kind of operation authorised under JAR 25.1525.

The criteria used in making the determinations required by this paragraph are set forth in Appendix D.

[Ch.15, 01.10.00]

JAR 25X1524 Systems and equipment limitations

[Deleted. **]**

[Amdt.16, 01.05.03]

JAR 25.1525 Kinds of operation

The kinds of operation to which the aeroplane is limited are established by the category in which it is eligible for certification and by the installed equipment.

JAR 25.1527 Ambient air temperature and operating altitude

The extremes of the ambient air temperature and operating altitude for which operation is allowed, as limited by flight, structural, powerplant, functional, or equipment characteristics, must be established.

JAR 25.1529 Instructions for Continued Airworthiness

The applicant must prepare instructions for Continued Airworthiness in accordance with Appendix H that are acceptable to the Authority.

JAR 25.1529 (continued)

The instructions may be incomplete at type certification if a programme exists to ensure their completion prior to delivery of the first aeroplane or issuance of a certificate of airworthiness, whichever occurs later.

[Ch.10, 19.12.83]

JAR 25.1531 Manoeuvring flight load factors

Load factor limitations, not exceeding the positive limit load factors determined from the manoeuvring diagram in JAR 25.333(b), must be established.

JAR 25.1533 Additional operating limitations

(a) Additional operating limitations must be established as follows:

(1) The maximum take-off weights must be established as the weights at which compliance is shown with the applicable provisions of this JAR–25 (including the take-off climb provisions of JAR 25.121(a) to (c), for altitudes and ambient temperatures).

(2) The maximum landing weights must be established as the weights at which compliance is shown with the applicable provisions of this JAR–25 (including the landing and approach climb provisions of JAR 25.119 and 25.121(d) for altitudes and ambient temperatures).

(3) The minimum take-off distances must be established as the distances at which compliance is shown with the applicable provisions of this JAR–25 (including the provisions of JAR 25.109 and 25.113, for weights, altitudes, temperatures, wind components, runway surface conditions (dry and wet) and runway gradients) for smooth, hard-surfaced runways. Additionally, at the option of the applicant, wet runway take-off distances may be established for runway surfaces that have been grooved or treated with a porous friction course and may be approved for use on runways where such surfaces have been designed, constructed and maintained in a manner acceptable to the Authority. (See ACJ 25.1533(a)(3).)

(b) The extremes for variable factors (such as altitude, temperature, wind, runway gradients) are those at which compliance with the applicable provisions of this JAR–25 is shown.

[Ch.9, 30.11.82; Ch.13, 05.10.89; Ch.14, 27.05.94; Ch.15, 01.10.00]

MARKINGS AND PLACARDS

JAR 25.1541 General
(See ACJ 25.1541)

(a) The aeroplane must contain –

(1) The specified markings and placards; and

(2) Any additional information, instrument markings, and placards required for the safe operation if there are unusual design, operating, or handling characteristics.

(b) Each marking and placard prescribed in sub-paragraph (a) of this paragraph –

(1) Must be displayed in a conspicuous place; and

(2) May not be easily erased, disfigured, or obscured.

JAR 25.1543 Instrument markings; general
(See ACJ 25.1543)

For each instrument –

(a) When markings are on the cover glass of the instrument, there must be means to maintain the correct alignment of the glass cover with the face of the dial; and

(b) Each instrument marking must be clearly visible to the appropriate crew member.

[Ch.14, 27.05.94]

JAR 25.1545 Airspeed limitation information

[The airspeed limitations required by JAR 25.1583(a) must be easily read and understood by the flight crew. (See ACJ 25.1545.) **]**

[Amdt. 16, 01.05.03]

JAR 25.1547 Magnetic direction indicator

(a) A placard meeting the requirements of this paragraph must be installed on, or near, the magnetic direction indicator.

(b) The placard must show the calibration of the instrument in level flight with the engines operating.

(c) **[**The placard must state whether the calibration was made with radio receivers on or off.**]**

JAR 25.1547 (continued)

(d) Each calibration reading must be in terms of magnetic heading in not more than 45º increments.

[Amdt. 16, 01.05.03]

JAR 25.1549 Powerplant instruments (See ACJ 25.1549)

[For each required powerplant instrument, as appropriate to the type of instrument either a] placard or colour markings or an acceptable combination must be provided to convey information on the maximum and (where applicable) minimum operating limits. Colour coding must comply with the following:

(a) Each maximum and, if applicable, minimum safe operating limit must be marked with a red radial or a red line;

(b) Each normal operating range must be marked with a green arc or green line, not extending beyond the maximum and minimum safe limits;

(c) Each take-off and precautionary range must be marked with a yellow arc or a yellow line; and

(d) Each engine or propeller speed range that is restricted because of excessive vibration stresses must be marked with red arcs or red lines.

[Ch.14, 27.05.94; Amdt. 16, 01.05.03]

JAR 25.1551 Oil quantity indicator

Each oil quantity indicating means must be marked to indicate the quantity of oil readily and accurately.

JAR 25.1553 Fuel quantity indicator

If the unusable fuel supply for any tank exceeds one gallon, or 5% of the tank capacity, whichever is greater, a red arc must be marked on its indicator extending from the calibrated zero reading to the lowest reading obtainable in level flight.

JAR 25.1555 Control markings

(a) Each cockpit control, other than primary flight controls and controls whose function is obvious, must be plainly marked as to its function and method of operation.

(b) Each aerodynamic control must be marked under the requirements of JAR 25.677 and 25.699.

(c) For powerplant fuel controls –

(1) Each fuel tank selector control must be marked to indicate the position corresponding to each tank and to each existing cross feed position;

(2) If safe operation requires the use of any tanks in a specific sequence, that sequence must be marked on, or adjacent to, the selector for those tanks; and

(3) Each valve control for each engine must be marked to indicate the position corresponding to each engine controlled.

(d) For accessory, auxiliary, and emergency controls –

(1) Each emergency control (including each fuel jettisoning and fluid shutoff control) must be coloured red; and

(2) Each visual indicator required by JAR 25.729(e) must be marked so that the pilot can determine at any time when the wheels are locked in either extreme position, if retractable landing gear is used.

JAR 25.1557 Miscellaneous markings and placards

(a) *Baggage and cargo compartments and ballast location*. Each baggage and cargo compartment, and each ballast location must have a placard stating any limitations on contents, including weight, that are necessary under the loading requirements. However, underseat compartments designed for the storage of carry-on articles weighing not more than 20 pounds need not have a loading limitation placard. (See ACJ 25.1557(a).)

(b) *Powerplant fluid filler openings.* The following apply:

(1) Fuel filler openings must be marked at or near the filler cover with –

(i) The word ‘fuel’;

(ii) *Not required for JAR–25.*

(iii) The permissible fuel designations; and

(iv) For pressure fuelling systems, the maximum permissible fuelling supply pressure and the maximum permissible defuelling pressure.

(2) Oil filler openings must be marked at or near the filler cover with the word ‘oil’.

(3) Augmentation fluid filler openings must be marked at or near the filler cover to identify the required fluid.

JAR 25.1557 (continued)

(c) *Emergency exit placards.* Each emergency exit placard must meet the requirements of JAR 25.811.

(d) *Doors.* Each door that must be used in order to reach any required emergency exit must have a suitable placard stating that the door is to be latched in the open position during take-off and landing.

[Ch.14, 27.05.94; Ch.15, 01.10.00]

JAR 25.1561 Safety equipment

(a) Each safety equipment control to be operated by the crew in emergency, such as controls for automatic liferaft releases, must be plainly marked as to its method of operation.

(b) Each location, such as a locker or compartment, that carries any fire extinguishing, signalling, or other lifesaving equipment must be marked accordingly.

(c) Stowage provisions for required emergency equipment must be conspicuously marked to identify the contents and facilitate the easy removal of the equipment.

(d) Each liferaft must have obviously marked operating instructions.

(e) Approved survival equipment must be marked for identification and method of operation.

JAR 25.1563 Airspeed placard

A placard showing the maximum airspeeds for wing-flap extension for the take-off, approach, and landing positions must be installed in clear view of each pilot.

AEROPLANE FLIGHT MANUAL

JAR 25.1581 General
[(See ACJ 25.1581) **]**

(a) *Furnishing information.* An aeroplane Flight Manual must be furnished with each aeroplane, and it must contain the following **[ ]**:

(1) Information required by JAR 25.1583 to 25.1587.

(2) Other information that is necessary for safe operation because of design, operating, or handling characteristics.

(3) Any limitation, procedure, or other information established as a condition of

JAR 25.1581(a)(3) (continued)

[compliance with the applicable noise standards of JAR-36.**]**

(b) *Approved information.* Each part of the manual listed in JAR 25.1583 to 25.1587 that is appropriate to the aeroplane, must be furnished, verified, and approved, and must be segregated, identified, and clearly distinguished from each unapproved part of that manual.

(c) Reserved.

(d) Each aeroplane Flight Manual must include a table of contents if the complexity of the manual indicates a need for it.

[Ch.13, 05.10.89; Ch.14, 27.05.94; Amdt. 16, 01.05.03]

JAR 25.1583 Operating limitations

(a) *Airspeed limitations.* The following airspeed limitations and any other airspeed limitations necessary for safe operation must be furnished.

(1) The maximum operating limit speed V_{MO}/M_{MO} and a statement that this speed limit may not be deliberately exceeded in any regime of flight (climb, cruise, or descent) unless a higher speed is authorised for flight test or pilot training.

(2) If an airspeed limitation is based upon compressibility effects, a statement to this effect and information as to any symptoms, the probable behaviour of the aeroplane, and the recommended recovery procedures.

(3) The manoeuvring speed V_A and a statement that full application of rudder and aileron controls, as well as manoeuvres that involve angles of attack near the stall, should be confined to speeds below this value.

(4) The flap extended speeds V_{FE} and the **[** pertinent wing-flap positions and engine powers. **]**

(5) The landing gear operating speed or speeds, and a statement explaining the speeds as defined in JAR 25.1515(a).

(6) The landing gear extended speed V_{LE}, if greater than V_{LO}, and a statement that this is the maximum speed at which the aeroplane can be safely flown with the landing gear extended.

(b) *Powerplant limitations.* The following information must be furnished:

(1) Limitations required by JAR 25.1521 and JAR 25.1522.

(2) Explanation of the limitations, when appropriate.

JAR 25.1583(c) (continued)

(3) Information necessary for marking the instruments required by JAR 25.1549 to 25.1553.

(c) *Weight and loading distribution.* The weight and centre of gravity limitations established [under JAR 25.1519 must be furnished in the aeroplane Flight Manual. All of the following information, including the weight distribution limitations established under JAR 25.1519 must be presented either in the aeroplane Flight Manual or in a separate weight and balance control and loading document that is incorporated by reference in the aeroplane Flight Manual (see ACJ 25.1583(c));]

(1) The condition of the aeroplane and the items included in the empty weight as defined in accordance with JAR 25.29.

(2) Loading instructions necessary to ensure loading of the aeroplane within the weight and centre of gravity limits, and to maintain the loading within these limits in flight.

(3) If certification for more than one centre of gravity range is requested, the appropriate limitations, with regard to weight and loading procedures, for each separate centre of gravity range.

(d) *Flight crew.* The number and functions of the minimum flight crew determined under JAR 25.1523 must be furnished.

(e) *Kinds of operation.* The kinds of operation approved under JAR 25.1525 must be furnished.

(f) *Ambient air temperatures and operating altitudes.* The extremes of the ambient air temperatures and operating altitudes established [under JAR 25.1527 must be furnished.]

(g) Reserved.

(h) *Additional operating limitations.* The operating limitations established under JAR 25.1533 must be furnished.

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

(j) [Deleted]

[Ch.10, 19.12.83; Ch.13, 05.10.89; Ch.14, 27.05.94; Amdt. 16, 01.05.03]

JAR 25.1585 Operating procedures

[(a) Operating procedures must be furnished for –

(1) Normal procedures peculiar to the particular type or model encountered in connection with routine operations;

JAR 25.1585(a) (continued)

(2) Non-normal procedures for malfunction cases and failure conditions involving the use of special systems or the alternative use of regular systems; and

(3) Emergency procedures for foreseeable but unusual situations in which immediate and precise action by the crew may be expected to substantially reduce the risk of catastrophe.

(b) Information or procedures not directly related to airworthiness or not under the control of the crew, must not be included, nor must any procedure that is accepted as basic airmanship.

(c) Information identifying each operating condition in which the fuel system independence prescribed in JAR 25.953 is necessary for safety must be furnished, together with instructions for placing the fuel system in a configuration used to show compliance with that section.

(d) The buffet onset envelopes determined under JAR 25.251 must be furnished. The buffet onset envelopes presented may reflect the centre of gravity at which the aeroplane is normally loaded during cruise if corrections for the effect of different centre of gravity locations are furnished.

(e) Information must be furnished that indicates that when the fuel quantity indicator reads “zero” in level flight, any fuel remaining in the fuel tank cannot be used safely in flight.

(f) Information on the total quantity of usable fuel for each fuel tank must be furnished.]

[Ch.11, 17.03.86; Amdt. 16, 01.05.03]

JAR 25.1587 Performance information

[(a) Each aeroplane Flight Manual must contain information to permit conversion of the indicated temperature to free air temperature if other than a free air temperature indicator is used to comply with the requirements of JAR 25.1303(a)(1).]

(b) Each aeroplane Flight Manual must contain the performance information computed under the applicable provisions of this JAR–25 (including JAR 25.115, 25.123 and 25.125 for the weights, altitudes, temperatures, wind components, and runway gradients, as applicable) within the operational limits of the aeroplane, and must contain the following:

[(1) In each case, the condition of power, configuration, and speeds, and the procedures for handling the aeroplane and any system having a] significant effect on the performance information.]

[(2) V_{SR} determined in accordance with JAR 25.103.]

JAR 25.1587(b) (continued)

(3) The following gross performance information (determined by extrapolation and computed for the range of weights between the [maximum landing weight and the maximum] take-off weight) must be provided:

(i) Climb in the landing configuration.

(ii) Climb in the approach configuration.

(iii) Landing distance.

(4) Procedures established under JAR [25.101(f) and (g) that are related to the] limitations and information required by JAR 25.1533 and by this paragraph must be stated in the form of guidance material including any relevant limitation or information.

(5) An explanation of significant or unusual flight or ground handling characteristics of the aeroplane.

(6) Corrections to indicated values of airspeed, altitude and outside air temperature.

(7) An explanation of operational landing runway length factors included in the presentation of the landing distance, if appropriate. (See ACJ 25.1587(b)(7).)

[Ch.10, 19.12.83; Ch.12, 10.05.88; Ch.13, 05.10.89; Amdt. 16, 01.05.03]

SUPPLEMENTARY INFORMATION

JAR 25X1591 Supplementary performance information (See AMJ 25X1591)

(a) Supplementary performance information must be furnished by the manufacturer in an approved document, in the form of guidance material, to assist operators in developing suitable guidance, recommendations or instructions for use by their flight crews when operating on contaminated runway surface conditions.

(b) The approved document must clearly indicate the conditions used for establishing the contaminated runway performance information. It must also state to the operator that actual conditions different from those used for establishing the contaminated runway performance information, may lead to different performance.

(c) Supplementary performance information for runways contaminated with standing water, slush, loose snow, compacted snow or ice must be furnished. Information on the effect of runway contaminants on the expected performance of the

JAR 25X1591(c) (continued)

aeroplane during take-off and landing on hard-surfaced runways must be furnished. If it appears in the aeroplane Flight Manual, this information must be segregated, identified as guidance material and clearly distinguished from the additional operating limitations of JAR 25.1533 and the performance information of JAR 25.1587.

(d) The information required by sub-paragraph (a) of this paragraph may be established by calculation or by testing.

[Ch.13, 05.10.89; Ch.15, 01.10.00]

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SUBPART J – GAS TURBINE AUXILIARY POWER UNIT INSTALLATIONS

Part A – All APUs

GENERAL

JAR 25A901 Installation

(b) For each APU –

(1) The installation must comply with:

(i) The installation instructions provided under JAR–APU, and

(ii) the provisions of Part A for non-essential APUs* and the provisions of Parts A and B for essential APUs*.

(2) The components of the installation must be constructed, arranged, and installed so as to ensure their continued safe operation between normal inspections or overhauls (see ACJ 25A901(b)(2)).

(3) The installation must be accessible for necessary inspections and maintenance; and

(4) The major components of the installations must be electrically bonded to the other parts of the aeroplane (see ACJ 25A901 (b)(4)).

(c) The APU installation must comply with JAR 25.1309. Where the air-flow delivery from the APU and main engine is delivered to a common manifold system, precautions must be taken to minimise the possibility of a hazardous condition due to reverse air flow through the APU resulting from malfunctions of any component in the system.

(d) The satisfactory functioning of the APU must be demonstrated by ground and flight tests over the range of operating conditions for which certification is required and must include tests under hot climatic conditions, unless equivalent evidence can be produced (see ACJ 25A901(d)).

JAR 25A903 Auxiliary power unit

(a) Each APU must meet the requirements of JAR–APU for the corresponding category and class of operation intended.

*Definitions of non-essential APUs and essential APUs are given in JAR–APU.

JAR 25A903 (continued)

(c) *Control of APU rotation and shut-down capability*

(1) It shall be possible to shut down the APU from the flight deck in normal and emergency conditions.

(2) There must be a means for stopping the rotation of any APU individually in flight, except that the means of stopping the rotation of any APU need be provided only where continued rotation could jeopardise the safety of the aeroplane. Each component of the stopping system on the APU side of the firewall that might be exposed to fire must be at least fire-resistant.

(3) In particular, where no means is provided to prevent continued rotation, the safety of the aeroplane must be shown in the event of failure of the APU oil supply.

(d) *For APU installations:*

(1) Design precautions must be taken to minimise the hazards to the aeroplane in the event of an APU rotor failure or of a fire originating within the APU which burns through the APU casing. (See AMJ 20-128A.)

(2) The power-plant systems associated with APU control devices, systems, and instrumentation, must be designed to give reasonable assurance that those APU operating limitations that adversely affect turbine rotor structural integrity will not be exceeded in service.

[Ch.15, 01.10.00]

JAR 25A939 APU operating characteristics

(a) APU operating characteristics must be investigated in flight to determine that no adverse characteristics (such as stall, surge, or flame-out) are present, to a hazardous degree, during normal and emergency operation within the range of operation limitations of the aeroplane and of the APU. Compliance need not be shown if operation of the APU is limited to ground use only with the aeroplane stationary (see ACJ 25A939(a)).

(c) The APU air inlet system may not, as a result of air-flow distortion during normal operation, cause vibration harmful to the APU.

(d) It must be established over the range of operating conditions for which certification is required, that the APU installation vibratory conditions do not exceed the critical frequencies

JAR 25A939(d) (continued)

and amplitudes established under JAR–APU, Section 1, Appendix 1, paragraph 6.18.

[Ch.13, 05.10.89]

JAR 25A943 Negative acceleration

No hazardous malfunction of an APU or any component or system associated with the APU may occur when the aeroplane is operated at the negative accelerations within the flight envelopes prescribed in JAR 25.333. This must be shown for the greatest duration expected for the acceleration. (See ACJ 25A943.)

FUEL SYSTEM

JAR 25A952 Fuel system analysis and test

(a) Proper fuel system functioning under all probable operating conditions must be shown by analysis and those tests found necessary by the Authority. Tests, if required, must be made using the aeroplane fuel system or a test article that reproduces the operating characteristics of the portion of the fuel system to be tested.

(b) The likely failure of any heat exchanger using fuel as one of its fluids may not result in a hazardous condition.

JAR 25A953 Fuel system independence

Each fuel system must allow the supply of fuel to the APU –

(a) through a system independent of each part of the system supplying fuel to the main engines, or

(b) by any other acceptable method. (See ACJ 25A953(b).)

FUEL SYSTEM COMPONENTS

JAR 25A993 Fuel system lines and fittings

(a) Each fuel line must be installed and supported to prevent excessive vibration and to withstand loads due to fuel pressure and accelerated flight conditions.

(b) Each fuel line connected to components of the aeroplane between which relative motion could exist must have provisions for flexibility.

(c) Each flexible connection in fuel lines that may be under pressure and subject to axial loading must use flexible hose assemblies or equivalent means.

JAR 25.A993(c) (continued)

(d) Flexible hose must be approved or must be shown to be suitable for the particular application.

(e) No flexible hose that might be adversely affected by exposure to high temperatures may be used where excessive temperatures will exist during operation or after an APU shutdown.

(f) Each fuel line within the fuselage must be designed and installed to allow a reasonable degree of deformation and stretching without leakage.

JAR 25A994 Fuel system components

Fuel system components in an APU compartment or in the fuselage must be located or protected from damage which could cause the release of dangerous quantities of fuel as a result of a wheels-up landing.

JAR 25A995 Fuel valves

In addition to the requirements of JAR 25A1189 for shut-off means, each fuel valve must –

(b) Be supported so that no loads resulting from their operation or from accelerated flight conditions are transmitted to the lines attached to the valve.

JAR 25A999 Fuel system drains

(a) Drainage of the fuel system must be accomplished by the use of fuel strainer and fuel tank sump drains.

(b) Each drain required by sub-paragraph (a) of this paragraph must –

(1) Discharge clear of all parts of the aeroplane;

(2) Have manual or automatic means for positive locking in the closed position; and

(3) Have a drain valve –

(i) That is readily accessible and which can be easily opened and closed; and

(ii) That is either located or protected to prevent fuel spillage in dangerous quantities in the event of a landing with landing gear retracted.

OIL SYSTEM

JAR25A1011 General

(a) Each APU must have an independent oil system that can supply it with an appropriate quantity of oil at a temperature not above that safe for continuous operation. The oil system for the APU must comply with JAR–APU even if the oil system is not an integral part of the APU.

JAR 25A1017 Oil lines and fittings

(b) Breather lines must be arranged so that –

(1) Condensed water vapour that might freeze and obstruct the line cannot accumulate at any point;

(2) The breather discharge does not constitute a hazard if foaming occurs; or

(3) The breather does not discharge into the APU air induction system.

JAR 25A1021 Oil drains

There must be at least one accessible drain that –

(a) Allows safe drainage of the entire oil system.

JAR 25A1023 Oil radiators

(b) Each oil radiator air duct must be located so that, in case of fire, flames coming from normal openings of the APU compartment cannot impinge directly upon the radiator.

JAR 25A1025 Oil valves

(a) Each oil shut-off must meet the requirements of JAR 25A1189.

(c) Each oil valve must have positive stops or suitable index provisions in the 'on' and 'off' positions and must be supported so that no loads resulting from its operation or from accelerated flight conditions are transmitted to the lines attached to the valve.

COOLING

JAR 25A1041 General

The APU cooling provisions must be able to maintain the temperatures of APU components and fluids within the temperature limits established for these components and fluids, under ground, water and flight operating conditions, and after normal shut down.

JAR 25A1043 Cooling tests

(a) *General*. Compliance with JAR 25A1041 must be shown by tests under critical ground, water and flight operating conditions. For these tests, the following apply:

(1) If the tests are conducted under conditions deviating from the maximum ambient atmospheric temperature, the recorded APU temperatures must be corrected under sub-paragraph (c) of this paragraph.

(2) No corrected temperatures determined under sub-paragraph (1) of this paragraph may exceed established limits.

(3) The fuel used during the cooling tests must be the grade approved for the APUs. The test procedures must be as prescribed in JAR 25A1045.

(b) *Maximum ambient atmospheric temperature.* A maximum ambient atmospheric temperature corresponding to sea-level conditions must be established as a limitation on the operation of the aeroplane. The temperature lapse rate is 3·6ºF (2·0ºC) per thousand feet of altitude above sea-level until a temperature of –69·7ºF (– 56·5ºC) is reached, above which altitude, the temperature is considered constant at –69·7ºF (–56·5ºC).

(c) *Correction factor.* Unless a more rational correction applies, temperatures of APU fluids and components for which temperature limits are established, must be corrected by adding to them the difference between the maximum ambient atmospheric temperature and the temperature of the ambient air at the time of the first occurrence of the maximum component or fluid temperature recorded during the cooling test.

JAR 25A1045 Cooling test procedures

(a) Compliance with JAR 25A1041 must be shown for the take-off, climb, en-route, and landing stages of flight that correspond to the

JAR 25.A1045(a) (continued)

applicable performance requirements. The cooling tests must be conducted with the aeroplane in the configuration, and operating under the conditions that are critical relative to cooling tests, a temperature is 'stabilised' when its rate of change is less than 2ºF (1ºC) per minute.

(b) Temperatures must be stabilised under the conditions from which entry is made into each stage of flight being investigated, unless the entry condition normally is not one during which component and APU fluid temperatures would stabilise (in which case, operation through the full entry condition must be conducted before entry into the stage of flight being investigated in order to allow temperatures to reach their natural levels at the time of entry). The take-off cooling test must be preceded by a period during which the APU component and APU fluid temperatures are stabilised with the APU operating normally.

(c) Cooling tests for each stage of flight must be continued until –

(1) The component and APU fluid temperatures stabilise;

(2) The stage of flight is completed; or

(3) An operating limitation is reached.

AIR INTAKE SYSTEM

JAR 25A1091 Air intake

(a) The air intake system for the APU must supply –

(1) The air required by the APU under each operating condition for which certification is requested.

(d) *Ingestion*

(1) There must be means to prevent hazardous quantities of fuel leakage or overflow from drains, vents, or other components of flammable fluid systems from entering the APU air intake system; and

(2) If operation of a non-essential APU with water or slush on the runway, taxiway or other airport operating surface is to be approved, it must be shown that such operation will not affect the safe operation of the aeroplane.

[Ch.12, 10.05.88]

JAR 25A1093 Air intake system de-icing and anti-icing provisions

(b) (3) Each non-essential APU air intake system which does not comply with JAR 25B1093 (b)(2) will be restricted to use in non-ice conditions, unless it can be shown that the APU complete with air intake system, if subjected to icing conditions, will not affect the safe operation of the aeroplane.

[Ch.12, 10.05.88]

JAR 25A1103 Air intake system ducts

(a) Each air intake system duct upstream of the first stage of the APU compressor must have a drain to prevent the hazardous accumulation of fuel and moisture in the ground attitude. The drains may not discharge in locations that might cause a fire hazard.

(b) Each air intake system duct must be –

(1) Strong enough to prevent air intake system failures resulting from reverse flow due to APU surging; and

(2) Fireproof within the APU compartment. Outside the APU compartment the materials used to form the air intake duct and plenum chamber of the APU must be capable of resisting the maximum heat conditions likely to occur under reverse flow conditions.

(c) Each duct connected to components between which relative motion could exist must have means for flexibility.

(d) For APU bleed air systems no hazard may result if a duct rupture or failure occurs at any point between the APU port and the aeroplane unit served by the bleed air.

(e) Each APU air intake system duct must be constructed of materials that will not absorb sufficient quantities of flammable fluids such as to create a fire hazard due to ignition caused by reverse flow during surging.

[Ch.12, 10.05.88]

JAR 25A1105 Air intake system screens

If air intake system screens are used –

(c) No screen may be de-iced by alcohol alone.

[Ch.12, 10.05.88]

EXHAUST SYSTEM

JAR 25A1121 General

(a) Each exhaust system must ensure safe disposal of exhaust gases without fire hazard or carbon monoxide contamination in any personnel compartment. For test purposes, any acceptable carbon monoxide detection method may be used to show the absence of carbon monoxide.

(b) Unless suitable precautions are taken, no exhaust system part may be dangerously close to parts of any system carrying flammable fluids or vapours, or under parts of such a system that may leak.

(c) Each component that hot exhaust gases could strike, or that could be subjected to high temperatures from exhaust system parts, must be fire-proof. All exhaust system components must be separated by fireproof shields from adjacent parts of the aeroplane that are outside the APU compartment.

(d) No exhaust gases may discharge so as to cause a fire hazard with respect to any flammable fluid vent or drain.

(e) No exhaust gases may discharge where they will cause a glare seriously affecting pilot vision at night.

(f) Each exhaust system component must be ventilated to prevent points of excessively high temperature.

(g) Each exhaust shroud must be ventilated or insulated to avoid, during normal operation, a temperature high enough to ignite any flammable fluids or vapours external to the shroud.

JAR 25A1123 Exhaust piping

(a) Exhaust piping must be heat and corrosion resistant, and must have provisions to prevent failure due to expansion by operating temperatures.

(b) Piping must be supported to withstand any vibration and inertia loads to which it would be subjected in operation; and

(c) Piping connected to components between which relative motion could exist must have means for flexibility.

APU CONTROLS AND ACCESSORIES

JAR 25A1141 APU controls: general

Each APU control must be located, arranged and designed to meet the objectives of JAR 25.777 through JAR 25.781 and marked in accordance with JAR 25.1555. In addition, it must meet the following requirements:

(a) Each control must be located so that it cannot be inadvertently operated by persons entering, leaving, or moving normally in the cockpit.

(b) Each flexible control must be approved or must be shown to be suitable for the particular application.

(c) Each control must have sufficient strength and rigidity to withstand operating loads without failure and without excessive deflection.

(d) Each control must be able to maintain any set position without constant attention by flight-crew members and without creep due to control loads or vibration.

(f) Control valves –

(1) For manual valves, positive stops or, in the case of fuel valves, suitable index provisions in the open and closed positions.

(2) In the case of valves controlled from the cockpit other than by mechanical means, where the correct functioning of such a valve is essential for the safe operation of the aeroplane, a valve position indicator which senses directly that the valve has attained the position selected must be provided, unless other indications in the cockpit give the flight crew a clear indication that the valve has moved to the selected position. A continuous indicator need not be provided.

JAR 25A1163 APU accessories

(a) APU mounted accessories must be approved for installation on the APU concerned and use the provisions of the APU for mounting.

(b) Electrical equipment subject to arcing or sparking must be installed to minimise the probability of contact with any flammable fluids or vapours that might be present in a free state.

APU FIRE PROTECTION

JAR 25A1181 Designated fire zones: regions included

(a) Designated fire zones are –

(4) Any APU compartment.

(b) Each designated fire zone must meet the requirements of JAR 25A1185 through JAR 25A1203.

JAR 25A1183 Lines, fittings and components

(a) Except as provided in sub-paragraph (b) of this paragraph, each line, fitting, and other component carrying flammable fluid in any area subject to APU fire conditions, and each component which conveys or contains flammable fluid in a designated fire zone must be fire resistant, except that flammable fluid tanks and supports in a designated fire zone must be fireproof or be enclosed by a fireproof shield unless damage by fire to any non-fireproof part will not cause leakage or spillage of flammable fluid. Components must be shielded or located to safeguard against the ignition of leaking flammable fluid. An integral oil sump of less than 20 quart capacity need not be fireproof nor be enclosed by a fireproof shield.

(b) Sub-paragraph (a) of this paragraph does not apply to –

(1) Lines and fittings already approved as part of an APU, and

(2) Vent and drain lines, and their fittings, whose failure will not result in, or add to, a fire hazard.

(c) All components, including ducts, within a designated fire zone which, if damaged by fire could result in fire spreading to other regions of the aeroplane, must be fireproof. Those components within a designated fire zone, which could cause unintentional operation of, or inability to operate essential services or equipment, must be fireproof.

JAR 25A1185 Flammable fluids

(a) Except for the integral oil sumps specified in JAR 25.1013 (a), no tank or reservoir that is a part of a system containing flammable fluids or gases may be in a designated fire zone unless the fluid contained, the design of the system, the materials used in the tank, the shut-off means, and

JAR 25.A1185(a) (continued)

all connections, lines, and controls provide a degree of safety equal to that which would exist if the tank or reservoir were outside such a zone.

(b) There must be at least one-half inch of clear airspace between each tank or reservoir and each firewall or shroud isolating a designated fire zone.

(c) Absorbent materials close to flammable fluid system components that might leak must be covered or treated to prevent the absorption of hazardous quantities of fluids.

JAR 25A1187 Drainage and ventilation of fire zones

(a) There must be complete drainage of each part of each designated fire zone to minimise the hazards resulting from failure or malfunctioning of any component containing flammable fluids. The drainage means must be –

(1) Effective under conditions expected to prevail when drainage is needed; and

(2) Arranged so that no discharged fluid will cause an additional fire hazard.

(b) Each designated fire zone must be ventilated to prevent the accumulation of flammable vapours.

(c) No ventilation opening may be where it would allow the entry of flammable fluids, vapours, or flame from other zones.

(d) Each ventilation means must be arranged so that no discharged vapours will cause an additional fire hazard.

(e) Unless the extinguishing agent capacity and rate of discharge are based on maximum air flow through a zone, there must be means to allow the crew to shut off sources of forced ventilation to any fire zone.

JAR 25A1189 Shut-off means

(a) Each APU compartment specified in JAR 25A1181 (a)(4) must have a means to shut off or otherwise prevent hazardous quantities of fuel, oil, de-icer, and other flammable fluids, from flowing into, within, or through any designated fire zone, except that shut-off means are not required for –

(1) Lines forming an integral part of an APU and

(2) Oil systems for APU installations in which all external components of the oil system, including the oil tanks, are fireproof.

JAR 25.A1189 (continued)

(b) The closing of any fuel shut-off valve for any APU may not make fuel unavailable to the main engines.

(c) Operation of any shut off may not interfere with the later emergency operation of other equipment.

(d) Each flammable fluid shut-off means and control must be fireproof or must be located and protected so that any fire in a fire zone will not affect its operation.

(e) No hazardous quantity of flammable fluid may drain into any designated fire zone after shut-off.

(f) There must be means to guard against inadvertent operation of the shut-off means and to make it possible for the crew to reopen the shut-off means in flight after it has been closed.

(g) Each tank to APU shut-off valve must be located so that the operation of the valve will not be affected by the APU mount structural failure.

(h) Each shut-off valve must have a means to relieve excessive pressure accumulation unless a means for pressure relief is otherwise provided in the system.

JAR 25A1191 Firewalls

(a) Each APU must be isolated from the rest of the aeroplane by firewalls, shrouds, or equivalent means.

(b) Each firewall and shroud must be –

(1) Fireproof;

(2) Constructed so that no hazardous quantity of air, fluid, or flame can pass from the compartment to other parts of the aeroplane;

(3) Constructed so that each opening is sealed with close fitting fireproof grommets, bushings, or firewall fittings; and

(4) Protected against corrosion.

JAR 25A1193 Cowling and nacelle skin

(a) Each cowling must be constructed and supported so that it can resist any vibration, inertia, and air load to which it may be subjected in operation.

(b) Cowling must meet the drainage and ventilation requirements of JAR 25A1187.

(d) Each part of the cowling subject to high temperatures due to its nearness to exhaust system

JAR 25.A1193(d) (continued)

parts or exhaust gas impingement must be fireproof.

(e) Each aeroplane must –

(1) Be designed and constructed so that no fire originating in any APU fire zone can enter, either through openings or by burning through external skin, any other zone or region where it would create additional hazards,

(2) Meet sub-paragraph (e) (1) of this paragraph with the landing gear retracted (if applicable), and

(3) Have fireproof skin in areas subject to flame if a fire starts in the APU compartment.

JAR 25A1195 Fire extinguisher systems

(a) There must be a fire extinguisher system serving the APU compartment.

(b) The fire extinguishing system, the quantity of the extinguishing agent, the rate of discharge, and the discharge distribution must be adequate to extinguish fires. An individual 'one shot' system is acceptable. (See ACJ 25A1195 (b).)

(c) The fire-extinguishing system for an APU compartment must be able to simultaneously protect each zone of the APU compartment for which protection is provided.

JAR 25A1197 Fire extinguishing agents

(a) Fire extinguishing agents must –

(1) Be capable of extinguishing flames emanating from any burning of fluids or other combustible materials in the area protected by the fire extinguishing system; and

(2) Have thermal stability over the temperature range likely to be experienced in the compartment in which they are stored.

(b) If any toxic extinguishing agent is used, provisions must be made to prevent harmful concentrations of fluid or fluid vapours (from leakage during normal operation of the aeroplane or as a result of discharging the fire extinguisher on the ground or in flight) from entering any personnel compartment, even though a defect may exist in the extinguishing system. This must be shown by test except for built-in carbon dioxide fuselage compartment fire extinguishing systems for which –

JAR 25.A1197(b) (continued)

(1) Five pounds or less of carbon dioxide will be discharged, under established fire control procedures, into any fuselage compartment; or

(2) There is protective breathing equipment for each flight-crew member on flight deck duty.

JAR 25A1199 Extinguishing agent containers

(a) Each extinguishing agent container must have a pressure relief to prevent bursting of the container by excessive internal pressures.

(b) The discharge end of each discharge line from a pressure relief connection must be located so that discharge of the fire extinguishing agent would not damage the aeroplane. The line must be located or protected to prevent clogging caused by ice or other foreign matter.

(c) There must be a means for each fire extinguishing agent container to indicate that the container has discharged or that the charging pressure is below the established minimum necessary for proper functioning.

(d) The temperature of each container must be maintained, under intended operating conditions, to prevent the pressure in the container from –

(1) Falling below that necessary to provide an adequate rate of discharge; or

(2) Rising high enough to cause premature discharge.

(e) If a pyrotechnic capsule is used to discharge the extinguishing agent, each container must be installed so that temperature conditions will not cause hazardous deterioration of the pyrotechnic capsule.

JAR 25A1201 Fire extinguishing system materials

(a) No material in any fire extinguishing system may react chemically with any extinguishing agent so as to create a hazard.

(b) Each system component in an APU compartment must be fireproof.

JAR 25A1203 Fire-detector system

(a) There must be approved, quick acting fire or overheat detectors in each APU compartment in

JAR 25.A1203(a) (continued)

numbers and locations ensuring prompt detection of fire.

(b) Each fire detector system must be constructed and installed so that –

(1) It will withstand the vibration, inertia, and other loads to which it may be subjected in operation;

(2) There is a means to warn the crew in the event that the sensor or associated wiring within a designated fire zone is severed at one point, unless the system continues to function as a satisfactory detection system after the severing; and

(3) There is a means to warn the crew in the event of a short circuit in the sensor or associated wiring within a designated fire zone, unless the system continues to function as a satisfactory detection system after the short circuit.

(c) No fire or overheat detector may be affected by any oil, water, other fluids, or fumes that might be present.

(d) There must be means to allow the crew to check, in flight, the functioning of each fire or overheat detector electric circuit.

(e) Wiring and other components of each fire or overheat detector system in a fire zone must be at least fire-resistant.

(f) No fire or overheat detector system component for any fire zone may pass through another fire zone, unless –

(1) It is protected against the possibility of false warnings resulting from fires in zones through which it passes; or

(2) Each zone involved is simultaneously protected by the same detector and extinguishing system.

(g) Each fire detector system must be constructed so that when it is in the configuration for installation it will not exceed the alarm activation time approved for the detectors using the response time criteria specified in the appropriate Technical Standard Order or an acceptable equivalent, for the detector.

JAR 25A1207 Compliance

Compliance with the requirements of JAR 25A1181 through JAR 25A1203 must be shown by one or more of the following methods:

(a) Tests of similar gas turbine installations.

(b) Tests of components.

JAR 25.A1207 (continued)

(c) Service experience of aircraft with similar APU installations.

(d) Analysis, unless tests are specifically required.

EQUIPMENT

JAR 25A1305 APU instruments

(a) The following instruments are required:

(1) A fire warning indicator.

(2) Any other instrumentation necessary to ensure safe operation of the APU.

JAR 25A1337 APU instruments

(a) *Instruments and instrument lines*

(1) Each APU instrument line must meet the requirements of JAR 25A993 and JAR 25A1183.

(2) Each line carrying flammable fluids under pressure must –

(i) Have restricting orifices or other safety devices at the source of the pressure to prevent the escape of excessive fluid if the line fails; and

(ii) Be installed and located so that the escape of fluids would not create a hazard.

(3) Each APU instrument that utilises flammable fluids must be installed and located so that the escape of fluid would not create a hazard.

OPERATING LIMITATIONS

JAR 25A1521 APU limitations

(a) The APU limitations must be established so that they do not exceed the corresponding approved limits for the APU and its systems.

JAR 25A1527 Ambient air temperature and operating altitude

The extremes of the ambient air temperature and operating altitude for which operation is allowed, as limited by flight, structural, APU installation, functional, or equipment characteristics, must be established.

MARKINGS AND PLACARDS

JAR 25A1549 APU instruments

For each APU instrument either a placard or colour markings or an acceptable combination must be provided to convey information on the maximum and (where applicable) minimum operating limits. Colour coding must comply with the following:

(a) Each maximum and, if applicable, minimum safe operating limit must be marked with a red radial or a red line;

(b) Each normal operating range must be marked with a green arc or green line, not extending beyond the maximum and minimum safe limits;

(c) Each precautionary operating range must be marked with a yellow arc or a yellow line; and

(d) Each APU speed range that is restricted because of excessive vibration stresses must be marked with red arcs or red lines.

JAR 25A1551 Oil quantity indicator

Each oil quantity indicator must be marked with enough increments to indicate readily and accurately the quantity of oil.

AEROPLANE FLIGHT MANUAL

JAR 25A1583 Operating limitations

(b) *APU limitations.* APU limitations established under JAR 25A1521 and information to explain the instrument markings provided under JAR 25A1549 and JAR 25A1551 must be furnished.

Part B – Essential APUs*

GENERAL

JAR 25B903 Auxiliary power units

(e) *Restart capability*

(1) Means to restart any APU in flight must be provided.

(2) An altitude and airspeed envelope must be established for in-flight APU restarting, and the APU must have a restart capability within that envelope. (See ACJ 25B903(e)(2).)

FUEL SYSTEM

JAR 25B951 General

(a) Each fuel system must be constructed and arranged to ensure a flow of fuel at a rate and pressure established for proper auxiliary power unit functioning under each likely operating condition, including any manoeuvre for which certification is requested and during which the APU is permitted to be in operation.

(b) Each fuel system must be arranged so that any air which is introduced into the system will not result in –

(2) Flameout of the APU.

[(c) Each fuel system must be capable of sustained operation throughout its flow and pressure range with fuel initially saturated with water at 80°F (26·7°C) and having 0·75 cc of free water per US gallon added and cooled to the most critical condition for icing likely to be encountered in operation.]

[Ch.15, 01.10.00]

JAR 25B955 Fuel flow

(a) The fuel system must provide at least 100% of the fuel flow required under each intended operating condition and manoeuvre. Compliance must be shown as follows:

(1) Fuel must be delivered to the APU at a pressure within the limits specified in the APU type approval.

(2) The quantity of fuel in the tank may not exceed the amount established as the unusable fuel supply for that tank under the requirements of JAR 25.959 plus that necessary to show compliance with this paragraph.

* A definition of an essential APU is given in JAR–APU.

JAR 25.B955(a) (continued)

(3) Each main pump must be used that is necessary for each operating condition and attitude for which compliance with this paragraph is shown, and the appropriate emergency pump must be substituted for each main pump so used.

(4) If there is a fuel flowmeter, it must be blocked and the fuel must flow through the meter or its bypass. (See ACJ 25.955 (a)(4).)

(b) If an APU can be supplied with fuel from more than one tank, the fuel system must –

(2) For the APU, in addition to having appropriate manual switching capability, be designed to prevent interruption of fuel flow to the APU, without attention by the flight crew, when any tank supplying fuel to the APU is depleted of usable fuel during normal operation and any other tank, that normally supplies fuel to the APU alone, contains usable fuel.

[Ch.13, 05.10.89]

JAR 25B961 Fuel system hot weather operation

(a) The fuel supply of an APU must perform satisfactorily in hot weather operation. It must be shown that the fuel system from the tank outlet to the APU is pressurised under all intended operations so as to prevent vapour formation. Alternatively, it must be shown that there is no evidence of vapour lock or other malfunctioning during a climb from the altitude of the airport selected by the applicant to the maximum altitude established as an operating limitation under JAR 25.1527, with the APU operating at the most critical conditions for vapour formation but not exceeding the maximum essential load conditions. If the fuel supply is dependant on the same fuel pumps or fuel supply as the main engines, the main engines must be operated at maximum continuous power.

(5) The fuel temperature must be at least 110ºF (43ºC) at the start of the climb. (See ACJ 25B961(a)(5).)

(b) The test prescribed in sub-paragraph (a) of this paragraph may be performed in flight or on the ground under closely simulated flight conditions. If a flight test is performed in weather cold enough to interfere with the proper conduct of the test, the fuel tank surfaces, fuel lines, and other fuel system parts subject to cold air must be

JAR 25.B961(b) (continued)

insulated to simulate, insofar as practicable, flight in hot weather.

JAR 25B977 Fuel tank outlet

(a) There must be a fuel strainer for the fuel tank outlet or for the booster pump. This strainer must –

(2) For the APU, prevent the passage of any object that could restrict fuel flow or damage any fuel system component.

(c) The clear area of each fuel tank outlet strainer must be at least five times the area of the outlet line.

(d) The diameter of each strainer must be at least that of the fuel tank outlet.

(e) Each finger strainer must be accessible for inspection and cleaning.

FUEL SYSTEM COMPONENTS

JAR 25B991 Fuel pumps
(See ACJ 25B991)

(a) *Main pumps.* Each fuel pump required for proper APU operation, or required to meet the fuel system requirements of this subpart (other than those in sub-paragraph (b) of this paragraph), is a main pump. For each main pump, provision must be made to allow the bypass of each positive displacement fuel pump other than a fuel injection pump approved as part of the APU.

(b) *Emergency pumps.* There must be emergency pumps or another main pump to feed the APU immediately after failure of any main pump (other than a fuel injection pump approved as part of the APU).

JAR 25B997 Fuel strainer or filter

There must be a fuel strainer or filter between the fuel tank outlet and the inlet of either the fuel metering device or an APU driven positive displacement pump, whichever is nearer the fuel tank outlet. This fuel strainer or filter must –

(a) Be accessible for draining and cleaning and must incorporate a screen or element which is easily removable;

(b) Have a sediment trap and drain except that it need not have a drain if the strainer or filter is easily removable for drain purposes;

JAR 25.B997 (continued)

(c) Be mounted so that its weight is not supported by the connecting lines or by the inlet or outlet connections of the strainer or filter itself; and

(d) Have the capacity (with respect to operating limitations established for the APU) and the mesh to ensure that APU fuel system functioning is not impaired, with the fuel contaminated to a degree (with respect to particle size and density) that is greater than that established for the APU in JAR–APU, Section 1, Appendix 1, paragraph 6.6.

[Ch.12, 10.05.88]

OIL SYSTEM

JAR 25B1011 General

(b) The usable oil capacity may not be less than the product of the endurance of the aeroplane under critical operating conditions and the approved maximum allowable oil consumption of the APU under the same conditions, plus a suitable margin to ensure system circulation.

AIR INTAKE SYSTEM

JAR 25B1091 Air intake

(b) For APUs –

(2) The aeroplane must be designed to prevent water or slush on the runway, taxiway, or other airport operating surfaces from being directed into the APU air intake duct in hazardous quantities, and the air intake duct must be located or protected so as to minimise the ingestion of foreign matter during take-off, landing, and taxiing.

[Ch.12, 10.05.88]

JAR 25B1093 Air intake system de-icing and anti-icing provisions

(b) (2) Each air intake system of an essential APU must be such as to enable the APU to operate throughout its flight power range without adverse effect on its operation or serious loss of power, under the icing conditions specified in Appendix C (see ACJ 25B1093 (b)(2)).

[Ch.12, 10.05.88]

JAR 25B1105 Air intake system screens

(b) No screen may be in any part of the air intake system that is the only passage through which air can reach the APU unless it can be shown that the screen does not ice up to an unacceptable degree.

[Ch.12, 10.05.88]

APU CONTROLS AND ACCESSORIES

JAR 25B1163 APU accessories

(c) If continued rotation of an APU driven cabin supercharger or of any remote accessory driven by the APU is hazardous if malfunctioning occurs, there must be means to prevent rotation without interfering with the continued operation of the APU.

JAR 25B1165 APU ignition systems

(f) Each ignition system must be independent of any electrical circuit not used for assisting, controlling, or analysing the operation of that system.

EQUIPMENT

JAR 25B1305 APU instruments

(a) The following instruments are required unless it can be shown that these are unnecessary to ensure safe operation of the unit:

(1) A gas temperature indicator.

(2) A tachometer (to indicate the speed of the rotors) or over-speed warning.

(3) An oil pressure warning means.

(4) Revoked.

(5) Revoked.

(b) The following instruments are required:

(1) An indicator to indicate the functioning of the ice protection system, if such a system is installed.

(2) An indicator to indicate the proper functioning of any heater used to prevent ice clogging of fuel system components.

[Ch.15, 01.10.00]

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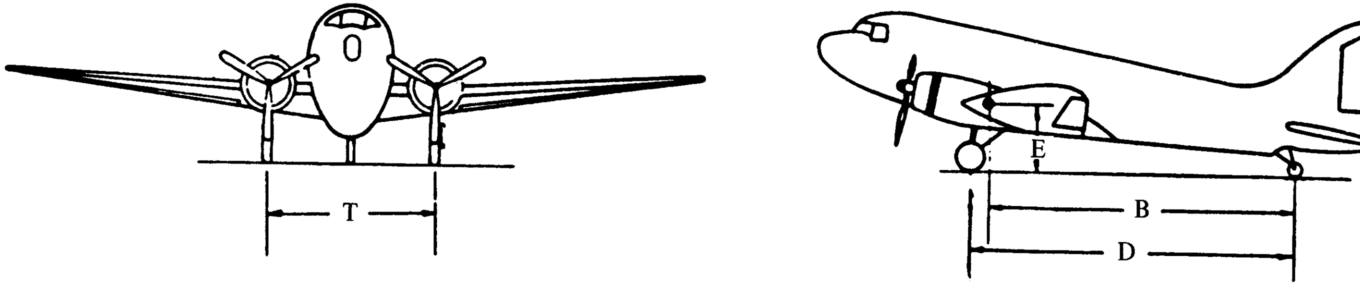
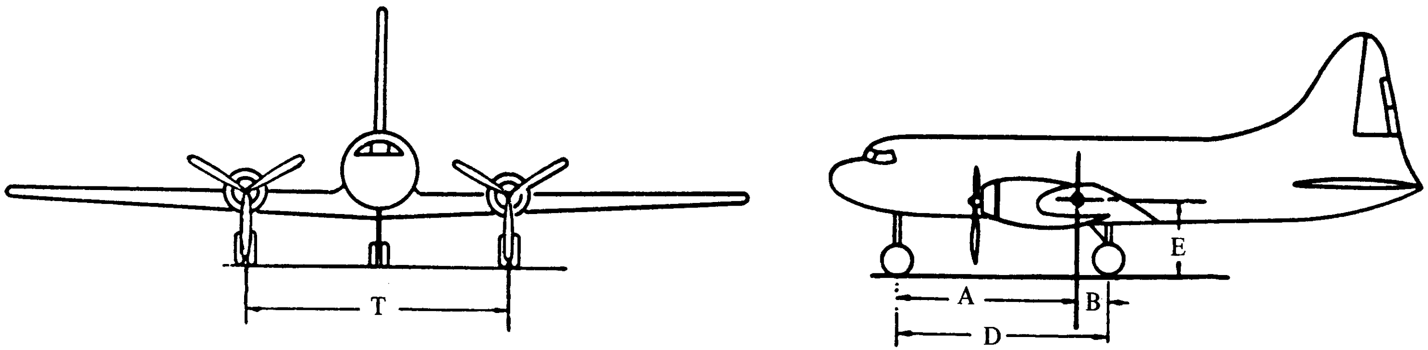
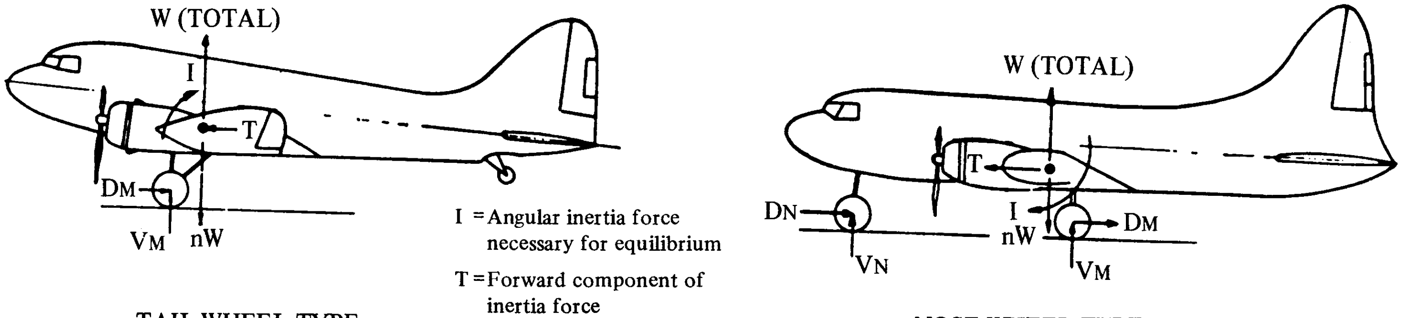


TAIL-WHEEL TYPE



NOSE-WHEEL TYPE

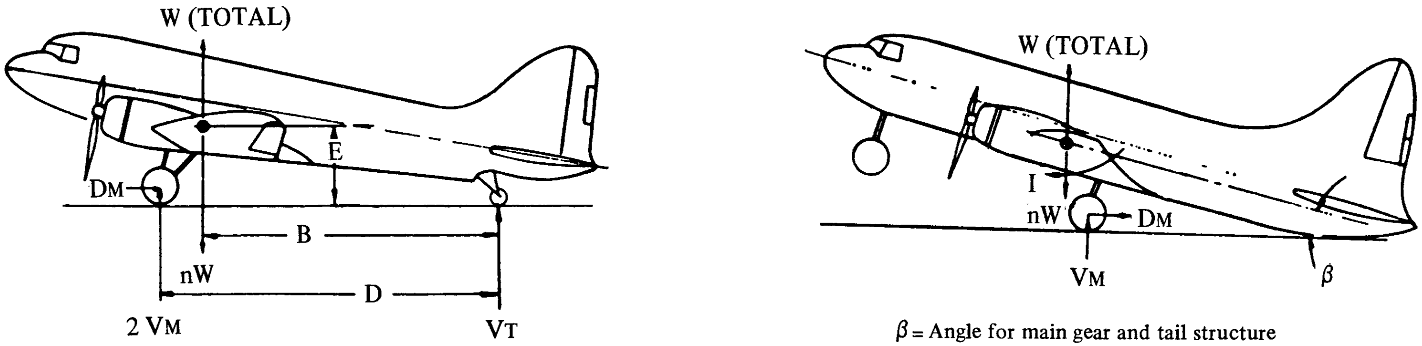
FIGURE 1 BASIC LANDING GEAR DIMENSION DATA



TAIL-WHEEL TYPE

NOSE-WHEEL TYPE

FIGURE 2 LEVEL LANDING



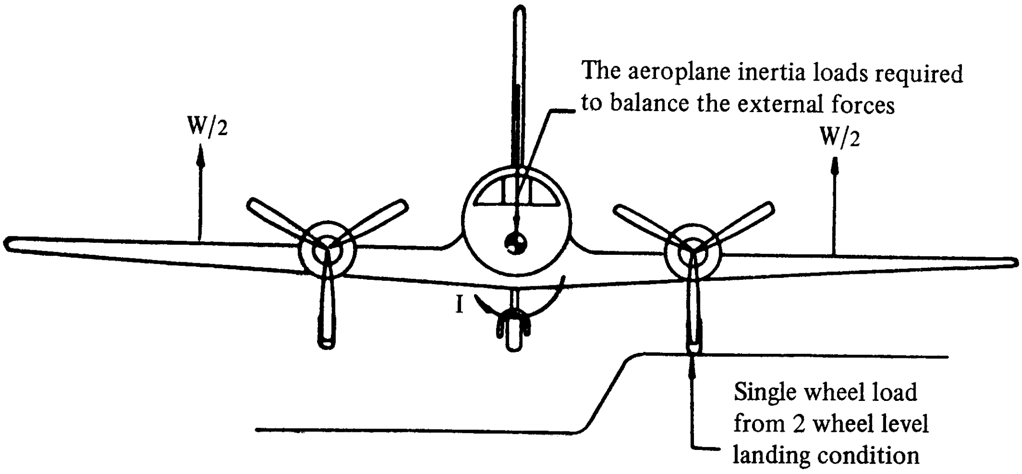
β = Angle for main gear and tail structure contacting ground except need not exceed stall angle.

TAIL-WHEEL TYPE

NOSE-WHEEL TYPE

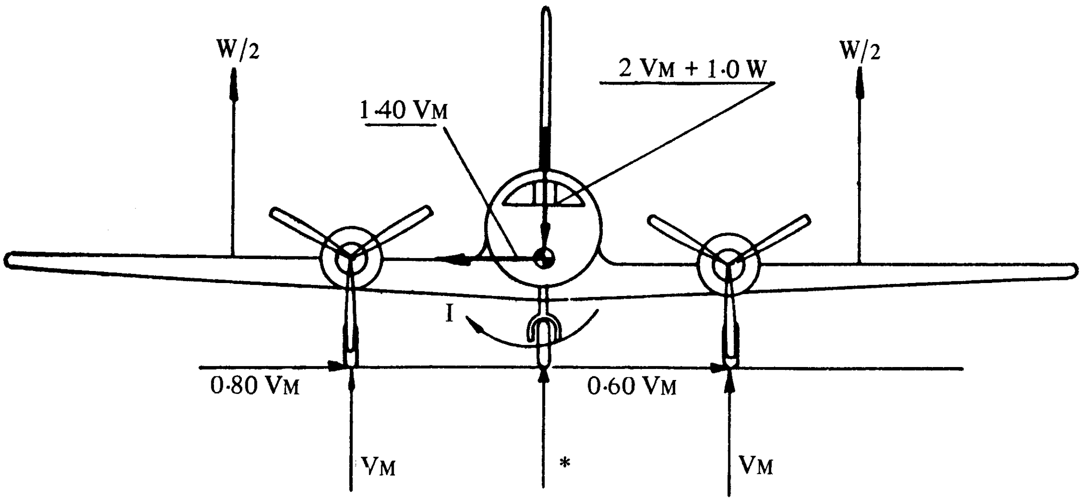
FIGURE 3 TAIL-DOWN LANDING

Appendix A (continued)



NOSE- OR TAIL-WHEEL TYPE

FIGURE 4 ONE-WHEEL LANDING



VM = One-half the maximum vertical ground reaction obtained at each main gear in the level landing conditions.

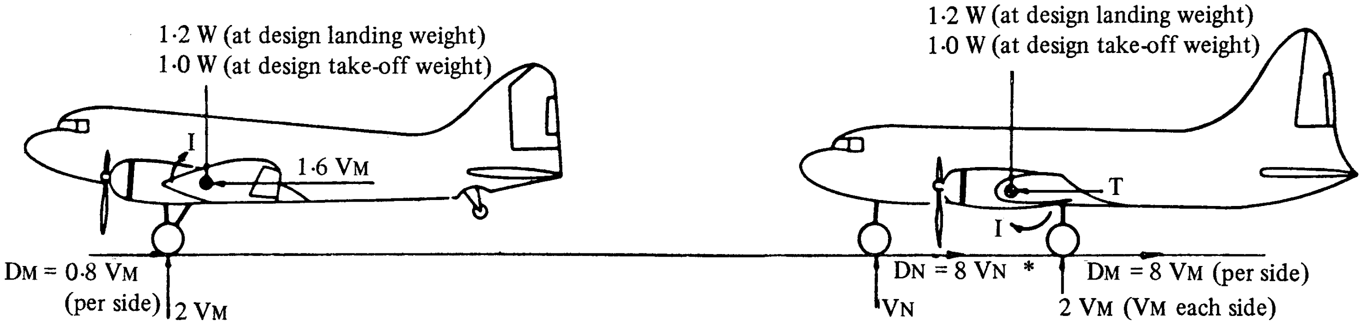
*Nose-gear ground reaction = 0

NOSE- OR TAIL-WHEEL TYPE AEROPLANE IN LEVEL ATTITUDE

FIGURE 5 LATERAL DRIFT LANDING

T = inertia force necessary to balance the wheel drag
*DN = 0 unless nose wheel is equipped with brakes

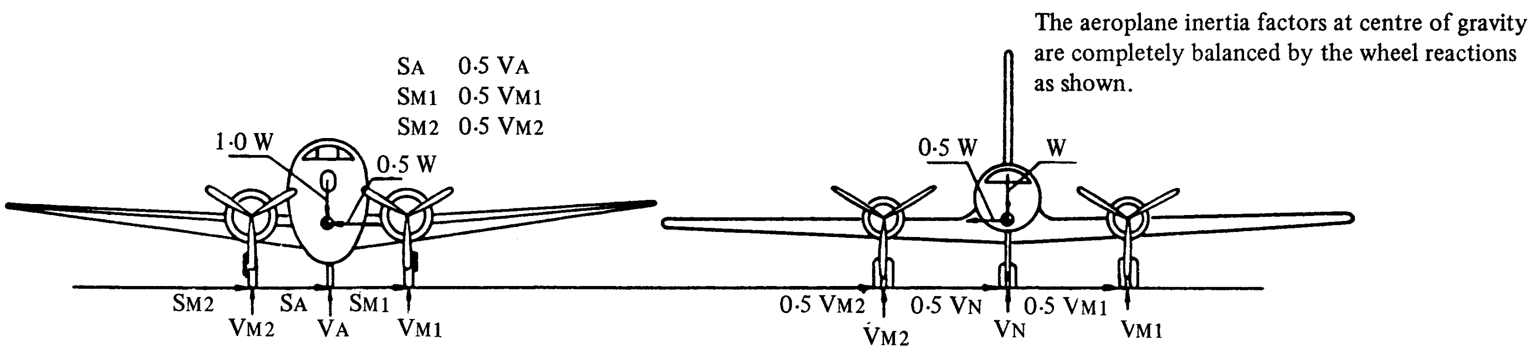
For design of main gear VN = 0
For design of nose gear I = 0



TAIL-WHEEL TYPE

NOSE-WHEEL TYPE

FIGURE 6 BRAKED ROLL

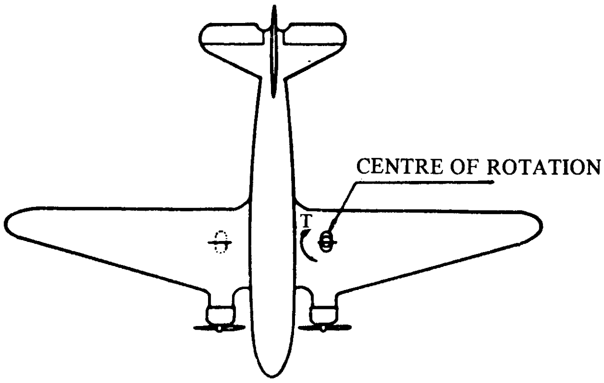


TAIL-WHEEL TYPE

NOSE-WHEEL TYPE

FIGURE 7 GROUND TURNING

Appendix A (continued)



VN AND VM ARE STATIC GROUND REACTIONS. FOR TAIL-WHEEL TYPE THE AEROPLANE IS IN THE THREE POINT ATTITUDE. PIVOTING IS ASSESSED TO TAKE PLACE ABOUT ONE MAIN LANDING GEAR UNIT.

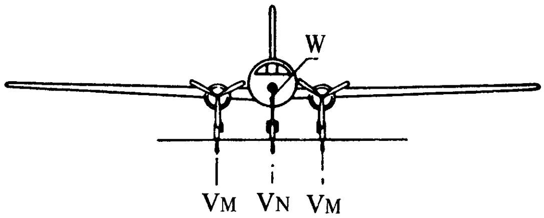


FIGURE 8 PIVOTING, NOSE- OR TAIL-WHEEL TYPE

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Appendix B

Not required for JAR–25.

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Appendix C

(a) *Continuous maximum icing.* The maximum continuous intensity of atmospheric icing conditions (continuous maximum icing) is defined by the variables of the cloud liquid water content, the mean effective diameter of the cloud droplets, the ambient air temperature, and the interrelationship of these three variables as shown in Figure 1 of this Appendix. The limiting icing envelope in terms of altitude and temperature is given in Figure 2 of this Appendix. The interrelationship of cloud liquid water content with drop diameter and altitude is determined from Figures 1 and 2. The cloud liquid water content for continuous maximum icing conditions of a horizontal extent, other than 17·4 nautical miles, is determined by the value of liquid water content of Figure 1, multiplied by the appropriate factor from Figure 3 of this Appendix.

(b) *Intermittent maximum icing.* The intermittent maximum intensity of atmospheric icing conditions (intermittent maximum icing) is defined by the variables of the cloud liquid water content, the mean effective diameter of the cloud droplets, the ambient air temperature, and the interrelationship of these three variables as shown in Figure 4 of this Appendix. The limiting icing envelope in terms of altitude and temperature is given in Figure 5 of this Appendix. The interrelationship of cloud liquid water content with drop diameter and altitude is determined from Figures 4 and 5. The cloud liquid water content for intermittent maximum icing conditions of a horizontal extent, other than 2·6 nautical miles, is determined by the value of cloud liquid water content of Figure 4 multiplied by the appropriate factor in Figure 6 of this Appendix.

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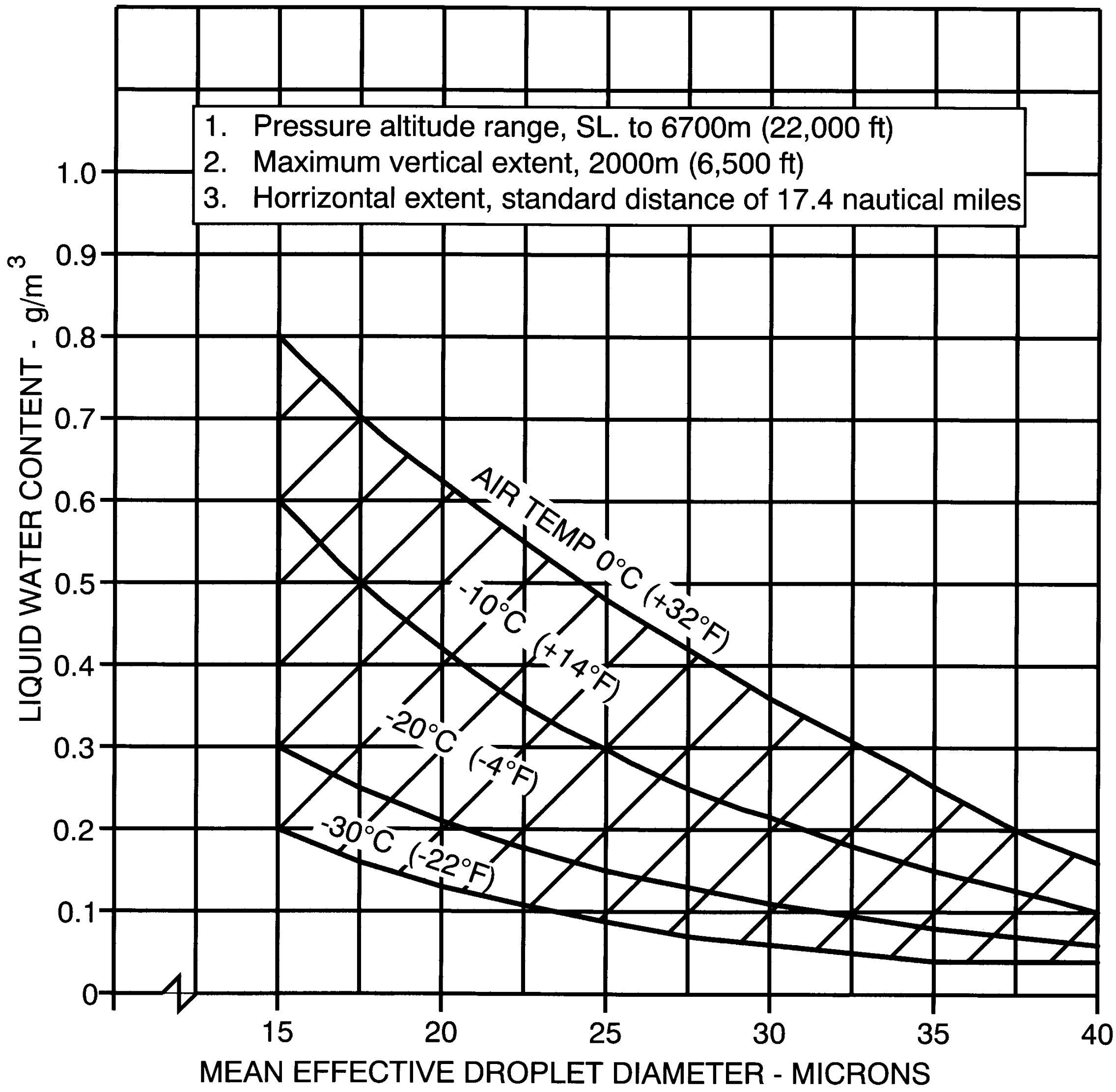

FIGURE 1

CONTINUOUS MAXIMUM (STRATIFORM CLOUDS)
ATMOSPHERIC ICING CONDITIONS
LIQUID WATER CONTENT VS MEAN EFFECTIVE DROP DIAMETER

NOTE: Source of data – NACA TN No. 1855, Class III –M, Continuous Maximum.

Appendix C (continued)

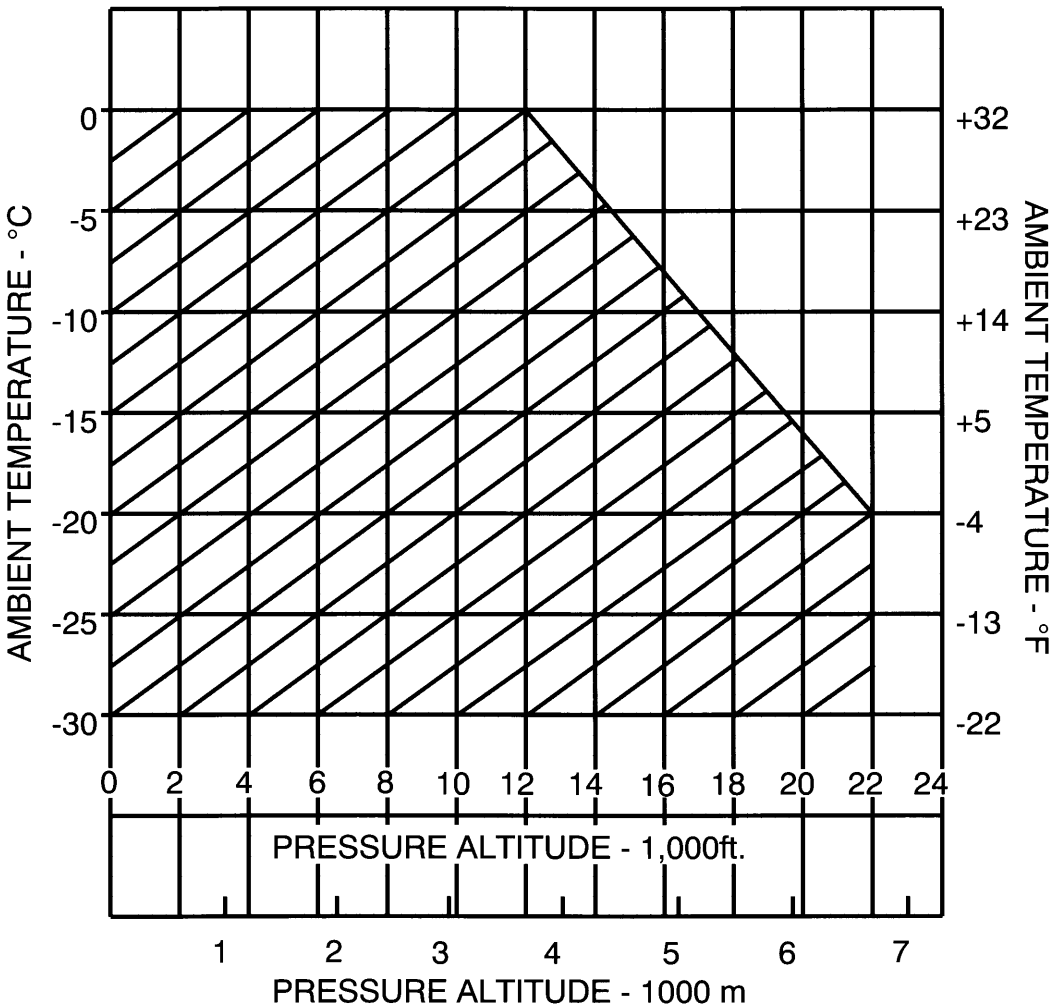

FIGURE 2

CONTINUOUS MAXIMUM (STRATIFORM CLOUDS)
ATMOSPHERIC ICING CONDITIONS
AMBIENT TEMPERATURE VS PRESSURE ALTITUDE

NOTE: Source of data – NACA TN No. 2569.

Appendix C (continued)

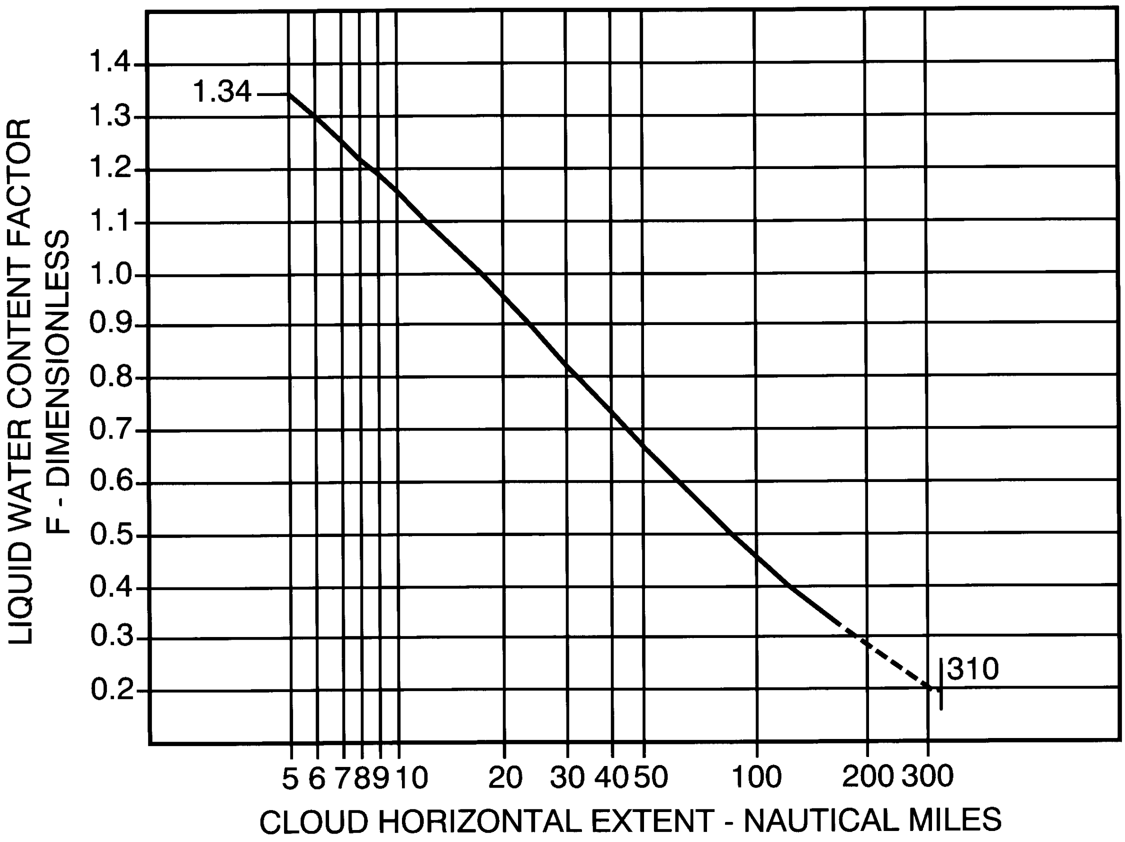

FIGURE 3

CONTINUOUS MAXIMUM (STRATIFORM CLOUDS)
ATMOSPHERIC ICING CONDITIONS
LIQUID WATER CONTENT FACTOR VS CLOUD HORIZONTAL DISTANCE

NOTE: Source of data – NACA TN No. 2738.

Appendix C (continued)

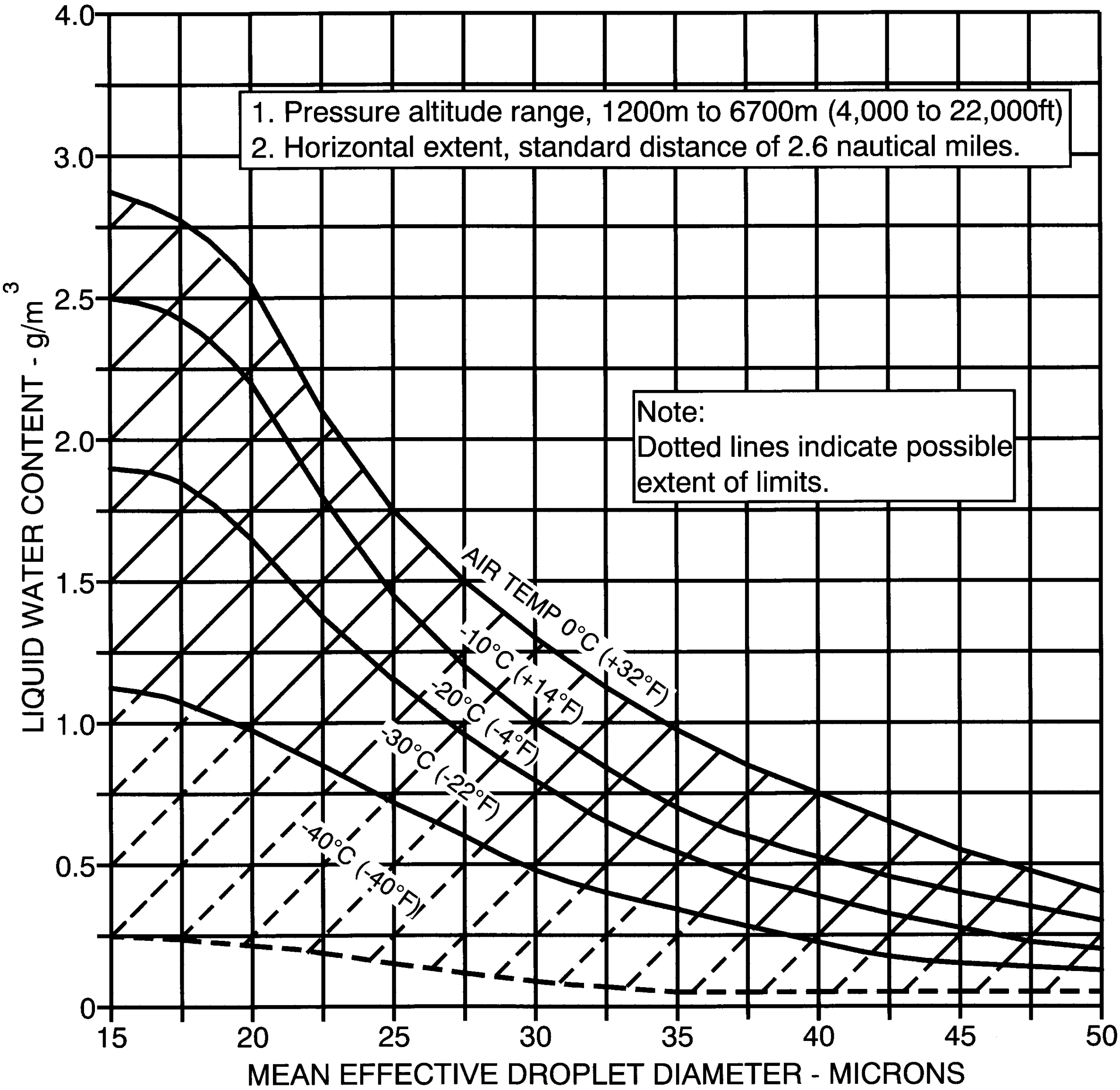

FIGURE 4

INTERMITTENT MAXIMUM (CUMULIFORM CLOUDS)
ATMOSPHERIC ICING CONDITIONS
LIQUID WATER CONTENT VS MEAN EFFECTIVE DROP DIAMETER

NOTE: Source of data – NACA TN No. 1855, Class II – M, Intermittent Maximum

Appendix C (continued)

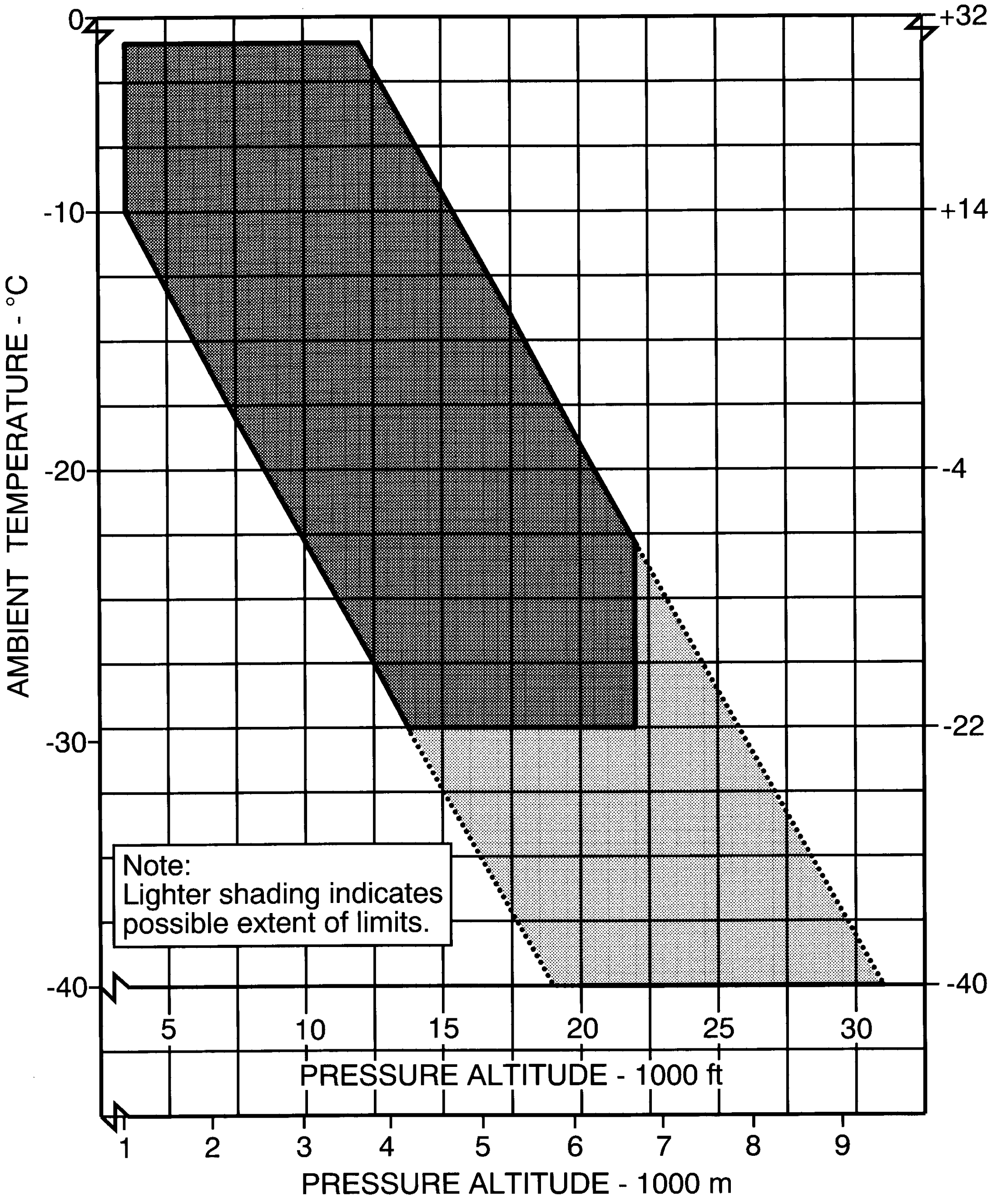

FIGURE 5

INTERMITTENT MAXIMUM (CUMULIFORM CLOUDS)
ATMOSPHERIC ICING CONDITIONS
AMBIENT TEMPERATURE VS PRESSURE ALTITUDE

NOTE: Source of data – NACA TN No. 2569.

Appendix C (continued)

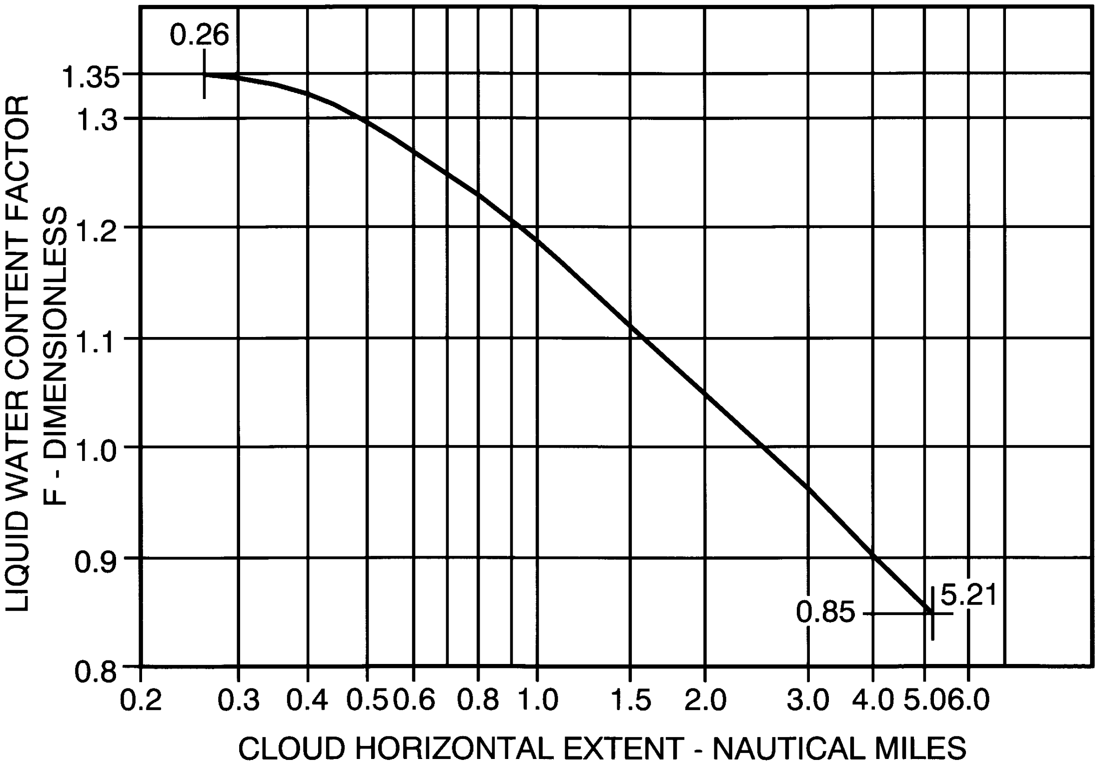

FIGURE 6

INTERMITTENT MAXIMUM (CUMULIFORM CLOUDS)
ATMOSPHERIC ICING CONDITIONS
VARIATION OF LIQUID WATER CONTENT FACTOR WITH
CLOUD HORIZONTAL EXTENT

NOTE: Source of data – NACA TN No. 2738.

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Appendix D

Criteria for determining minimum flight crew. The following are considered by the Authorities in determining the minimum flight crew under JAR 25.1523.

(a) *Basic workload functions.* The following basic workload functions are considered:

(1) Flight path control.

(2) Collision avoidance.

(3) Navigation.

(4) Communications.

(5) Operation and monitoring of aircraft engines and systems.

(6) Command decisions.

(b) *Workload factors.* The following workload factors are considered significant when analysing and demonstrating workload for minimum flight crew determination:

(1) The accessibility, ease and simplicity of operation of all necessary flight, power, and equipment controls, including emergency fuel shutoff valves, electrical controls, electronic controls, pressurisation system controls, and engine controls.

(2) [The accessibility and conspicuity of all necessary instruments and failure warning devices such as fire warning, electrical system] malfunction, and other failure or caution indicators. The extent to which such instruments or devices direct the proper corrective action is also considered.

(3) [The number, urgency, and complexity of operating procedures with particular consideration given to the specific fuel management schedule imposed by centre of gravity, structural or other considerations of an airworthiness nature, and to the ability of each engine to operate at all times from a single tank or source which is automatically replenished if fuel is also stored in other tanks.]

(4) [The degree and duration of concentrated mental and physical effort involved in normal operation and in diagnosing and coping with malfunctions and emergencies.]

(5) [The extent of required monitoring of the fuel, hydraulic, pressurisation, electrical, electronic, deicing, and other systems while en route.]

(6) The actions requiring a crew member to be unavailable at his assigned duty station, including: observation of systems, emergency operation of any control, and emergencies in any compartment.

(7) [The degree of automation provided in the aircraft systems to afford (after failures or malfunctions) automatic crossover or isolation of difficulties to minimise the need for flight crew action to guard against loss of hydraulic or electrical power to flight controls or other essential systems.]

(8) [The communications and] navigation workload.

(9) The possibility of increased workload associated with any emergency that may lead to other emergencies.

(10) Incapacitation of a flight-crew member whenever the applicable operating rule requires a minimum flight crew of at least two pilots.

(c) *Kind of operation authorised.* The determination of the kind of operation authorised requires consideration of the operating rules under which the aeroplane will be operated. Unless an applicant desires approval for a more limited kind of operation, it is assumed that each aeroplane certificated under this JAR-25 will operate under IFR conditions.

[Amdt. 16, 01.05.03]

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Appendix E

Not required for JAR–25.

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Appendix F

Part I – Test Criteria and Procedures for Showing Compliance with JAR 25.853, or 25.855

(a) *Material test criteria–*

(1) *Interior compartments occupied by crew or passengers.*

(i) Interior ceiling panels, interior wall panels, partitions, galley structure, large cabinet walls, structural flooring, and materials used in the construction of stowage compartments (other than underseat stowage compartments and compartments for stowing small items such as magazines and maps) must be self-extinguishing when tested vertically in accordance with the applicable portions of Part I of this Appendix. The average burn length may not exceed 6 inches and the average flame time after removal of the flame source may not exceed 15 seconds. Drippings from the test specimen may not continue to flame for more than an average of 3 seconds after falling.

(ii) Floor covering, textiles (including draperies and upholstery), seat cushions, padding, decorative and non-decorative coated fabrics, leather, trays and galley furnishings, electrical conduit, thermal and acoustical insulation and insulation covering, air ducting, joint and edge covering, liners of Class B and E cargo or baggage compartments, floor panels of Class B, C, D, or E cargo or baggage compartments, insulation blankets, cargo covers and transparencies, moulded and thermoformed parts, air ducting joints, and trim strips (decorative and chafing), that are constructed of materials not covered in sub-paragraph (iv) below, must be self-extinguishing when tested vertically in accordance with the applicable portions of Part I of this Appendix or other approved equivalent means. The average burn length may not exceed 8 inches <u>(203·2 mm)</u>, and the average flame time after removal of the flame source may not exceed 15 seconds. Drippings from the test specimen may not continue to flame for more than an average of 5 seconds after falling.

(iii) Motion picture film must be safety film meeting the Standard Specifications for Safety Photographic Film PHI.25 (available from the American National Standards Institute, 1430 Broadway, New York, NY 10018). If the film travels through ducts, the ducts must meet the requirements of sub-paragraph (ii) of this paragraph.

(iv) Clear plastic windows and signs, parts constructed in whole or in part of elastomeric materials, edge lighted instrument assemblies consisting of two or more instruments in a common housing, seat belts, shoulder harnesses, and cargo and baggage tiedown equipment, including containers, bins, pallets, etc, used in passenger or crew compartments, may not have an average burn rate greater than 2·5 inches <u>(63·5 mm)</u> per minute when tested horizontally in accordance with the applicable portions of this Appendix.

(v) Except for small parts (such as knobs, handles, rollers, fasteners, clips, grommets, rub strips, pulleys, and small electrical parts) that would not contribute significantly to the propagation of a fire and for electrical wire and cable insulation, materials in items not specified in paragraphs (a)(1)(i),(ii),(iii), or (iv) of Part I of this Appendix may not have a burn rate greater than 4·0 inches per minute when tested horizontally in accordance with the applicable portions of this Appendix.

(2) *Cargo and baggage compartments not occupied by crew or passengers.*

(i) Thermal and acoustic insulation (including coverings) used in each cargo and baggage compartment must be constructed of materials that meet the requirements set forth in sub-paragraph (a)(1)(ii) of Part I of this Appendix.

(ii) A cargo or baggage compartment defined in JAR 25.857 as Class B or E must have a liner constructed of materials that meet the requirements of sub-paragraph (a)(1)(ii) of Part I of this Appendix and separated from the aeroplane structure (except for attachments). In addition, such liners must be subjected to the 45 degree angle test. The flame may not penetrate (pass through) the material during application

Appendix F (continued)

of the flame or subsequent to its removal. The average flame time after removal of the flame source may not exceed 15 seconds, and the average glow time may not exceed 10 seconds.

(iii) A cargo or baggage compartment defined in JAR 25.857 as Class B, C, D, or E must have floor panels constructed of materials which meet the requirements of sub-paragraph (a)(1)(ii) of Part I of this Appendix and which are separated from the aeroplane structure (except for attachments). Such panels must be subjected to the 45 degree angle test. The flame may not penetrate (pass through) the material during application of the flame or subsequent to its removal. The average flame time after removal of the flame source may not exceed 15 seconds, and the average glow time may not exceed 10 seconds.

(iv) Insulation blankets and covers used to protect cargo must be constructed of materials that meet the requirements of sub-paragraph (a)(1)(ii) of Part I of this Appendix. Tiedown equipment (including containers, bins, and pallets) used in each cargo and baggage compartment must be constructed of materials that meet the requirements of sub-paragraph (a)(1)(v) of Part I of this Appendix.

(3) *Electrical system components.* Insulation on electrical wire or cable installed in any area of the fuselage must be self-extinguishing when subjected to the 60 degree test specified in Part I of this Appendix. The average burn length may not exceed 3 inches, (76·2 mm) and the average flame time after removal of the flame source may not exceed 30 seconds. Drippings from the test specimen may not continue to flame for more than an average of 3 seconds after falling.

(b) *Test Procedures –*

(1) *Conditioning*. Specimens must be conditioned to 70 ± 5°F (21·11 ± 3°C), and at 50% ± 5% relative humidity until moisture equilibrium is reached or for 24 hours. Each specimen must remain in the conditioning environment until it is subjected to the flame.

(2) *Specimen configuration.* Except for small parts and electrical wire and cable insulation, materials must be tested either as a section cut from a fabricated part as installed in the aeroplane or as a specimen simulating a cut section, such as a specimen cut from a flat sheet of the material or a model of the fabricated part. The specimen may be cut from any location in a fabricated part; however, fabricated units, such as sandwich panels, may not be separated for test. Except as noted below, the specimen thickness must be no thicker than the minimum thickness to be qualified for use in the aeroplane. Test specimens of thick foam parts, such as seat cushions, must be ½-inch (12·7 mm) in thickness. Test specimens of materials that must meet the requirements of sub-paragraph (a)(1)(v) of Part I of this Appendix must be no more than ⅛-inch (3·175 mm) in thickness. Electrical wire and cable specimens must be the same size as used in the aeroplane. In the case of fabrics, both the warp and fill direction of the weave must be tested to determine the most critical flammability condition. Specimens must be mounted in a metal frame so that the two long edges and the upper edge are held securely during the vertical test prescribed in sub-paragraph (4) of this paragraph and the two long edges and the edge away from the flame are held securely during the horizontal test prescribed in sub-paragraph (5) of this paragraph. The exposed area of the specimen must be at least 2 inches (50·8 mm) wide and 12 inches (304·8 mm) long, unless the actual size used in the aeroplane is smaller. The edge to which the burner flame is applied must not consist of the finished or protected edge of the specimen but must be representative of the actual cross-section of the material or part as installed in the aeroplane. The specimen must be mounted in a metal frame so that all four edges are held securely and the exposed area of the specimen is at least 8 inches by 8 inches (203·2 mm by 203·2 mm) during the 45° test prescribed in sub-paragraph (6) of this paragraph.

(3) *Apparatus*. Except as provided in sub-paragraph (7) of this paragraph, tests must be conducted in a draught-free cabinet in accordance with Federal Test Method Standard 191 Model 5903 (revised Method 5902) for the vertical test, or Method 5906 for horizontal test (available from the General Services Administration, Business Service Centre, Region 3, Seventh & D Streets SW., Washington, DC 20407). Specimens which are too large for the cabinet must be tested in similar draught-free conditions.

Appendix F (continued)

(4) *Vertical test.* A minimum of three specimens must be tested and results averaged. For fabrics, the direction of weave corresponding to the most critical flammability conditions must be parallel to the longest dimension. Each specimen must be supported vertically. The specimen must be exposed to a Bunsen or Tirril burner with a nominal ⅜-inch (9·525 mm) I.D. tube adjusted to give a flame of 1½ inches (38·1 mm) in height. The minimum flame temperature measured by a calibrated thermocouple pyrometer in the centre of the flame must be 1550°F (843·33°C). The lower edge of the specimen must be ¾-inch (19·05 mm) above the top edge of the burner. The flame must be applied to the centre line of the lower edge of the specimen. For materials covered by sub-paragraph (a)(1)(i) of Part I of this Appendix, the flame must be applied for 60 seconds and then removed. For materials covered by sub-paragraph (a)(1)(ii) of Part I of this Appendix, the flame must be applied for 12 seconds and then removed. Flame time, burn length, and flaming time of drippings, if any, may be recorded. The burn length determined in accordance with sub-paragraph (7) of this paragraph must be measured to the nearest tenth of an inch (2·54 mm).

(5) *Horizontal test.* A minimum of three specimens must be tested and the results averaged. Each specimen must be supported horizontally. The exposed surface, when installed in the aircraft, must be face down for the test. The specimen must be exposed to a Bunsen or Tirrill burner with a nominal ⅜-inch (9·525 mm) I.D. tube adjusted to give a flame of 1½ inches (38·1 mm) in height. The minimum flame temperature measured by a calibrated thermocouple pyrometer in the centre of the flame must be 1550°F (843·33°C). The specimen must be positioned so that the edge being tested is centred ¾-inch (19·05 mm) above the top of the burner. The flame must be applied for 15 seconds and then removed. A minimum of 10 inches (254 mm) of specimen must be used for timing purposes, approximately 1½ inches (38·1 mm) must burn before the burning front reaches the timing zone, and the average burn rate must be recorded.

(6) *Forty-five degree test.* A minimum of three specimens must be tested and the results averaged. The specimens must be supported at an angle of 45° to a horizontal surface. The exposed surface when installed in the aircraft must be face down for the test. The specimens must be exposed to a Bunsen or Tirrill burner with a nominal ⅜-inch (9·525 mm) I.D. tube adjusted to give a flame of 1½ inches (38·1 mm) in height. The minimum flame temperature measured by a calibrated thermocouple pyrometer in the centre of the flame must be 1550°F (843·33°C). Suitable precautions must be taken to avoid draughts. The flame must be applied for 30 seconds with one-third contacting the material at the centre of the specimen and then removed. Flame time, glow time, and whether the flame penetrates (passes through) the specimen must be recorded.

(7) *Sixty degree test.* A minimum of three specimens of each wire specification (make and size) must be tested. The specimen of wire or cable (including insulation) must be placed at an angle of 60° with the horizontal in the cabinet specified in sub-paragraph (3) of this paragraph with the cabinet door open during the test, or must be placed within a chamber approximately 2 feet (609·6 mm) high by 1 foot by 1 foot (304·8 mm by 304·8 mm), open at the top and at one vertical side (front), and which allows sufficient flow of air for complete combustion, but which is free from draughts. The specimen must be parallel to and approximately 6 inches (152·4 mm) from the front of the chamber. The lower end of the specimen must be held rigidly clamped. The upper end of the specimen must pass over a pulley or rod and must have an appropriate weight attached to it so that the specimen is held tautly throughout the flammability test. The test specimen span between lower clamp and upper pulley or rod must be 24 inches (609·6 mm) and must be marked 8 inches (203·2 mm) from the lower end to indicate the central point for flame application. A flame from a Bunsen or Tirrill burner must be applied for 30 seconds at the test mark. The burner must be mounted underneath the test mark on the specimen, perpendicular to the specimen and at an angle of 30° to the vertical plane of the specimen. The burner must have a nominal bore of ⅜-inch (9·525 mm) and be adjusted to provide a 3-inch (76·2 mm) high flame with an inner cone approximately one-third of the flame height. The minimum temperature of the hottest portion of the flame, as measured with a calibrated thermocouple pyrometer, may not be less than 1750°F (954·44°C). The burner must be positioned so that the hottest portion of the

Appendix F (continued)

flame is applied to the test mark on the wire. Flame time, burn length, and flaming time of drippings, if any, must be recorded. The burn length determined in accordance with sub-paragraph (8) of this paragraph must be measured to the nearest tenth of an inch (2·54 mm). Breaking of the wire specimens is not considered a failure.

(8) *Burn length.* Burn length is the distance from the original edge to the farthest evidence of damage to the test specimen due to flame impingement, including areas of partial or complete consumption, charring, or embrittlement, but not including areas sooted, stained, warped, or discoloured, nor areas where material has shrunk or melted away from the heat source.

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Appendix F (continued)

Part II – Flammability of Seat Cushions

(a) *Criteria for Acceptance*. Each seat cushion must meet the following criteria:

(1) At least three sets of seat bottom and seat back cushion specimens must be tested.

(2) If the cushion is constructed with a fire blocking material, the fire blocking material must completely enclose the cushion foam core material.

(3) Each specimen tested must be fabricated using the principal components (i.e. foam core, flotation material, fire blocking material, if used, and dress covering) and assembly processes (representative seams and closures) intended for use in the production articles. If a different material combination is used for the back cushion than for the bottom cushion, both material combinations must be tested as complete specimen sets, each set consisting of a back cushion specimen and a bottom cushion specimen. If a cushion, including outer dress covering, is demonstrated to meet the requirements of this Appendix using the oil burner test, the dress covering of that cushion may be replaced with a similar dress covering provided the burn length of the replacement covering, as determined by the test specified in JAR 25.853(b), does not exceed the corresponding burn length of the dress covering used on the cushion subjected to the oil burner test.

(4) For at least two-thirds of the total number of specimen sets tested, the burn length from the burner must not reach the side of the cushion opposite the burner. The burn length must not exceed 17 inches. Burn length is the perpendicular distance from the inside edge of the seat frame closest to the burner to the farthest evidence of damage to the test specimen due to flame impingement, including areas of partial or complete consumption, charring, or embrittlement, but not including areas sooted, stained, warped, or discoloured, or areas where material has shrunk or melted away from the heat source.

(5) The average percentage weight loss must not exceed 10 percent. Also, at least two-thirds of the total number of specimen sets tested must not exceed 10 percent weight loss. All droppings falling from the cushions and mounting stand are to be discarded before the after-test weight is determined. The percentage weight loss for a specimen set is the weight of the specimen set before testing less the weight of the specimen set after testing expressed as the percentage of the weight before testing.

(b) *Test Conditions.* Vertical air velocity should average 25 fpm ± 10 fpm at the top of the back seat cushion. Horizontal air velocity should be below 10 fpm just above the bottom seat cushion. Air velocities should be measured with the ventilation hood operating and the burner motor off.

(c) *Test Specimens*

(1) For each test, one set of cushion specimens representing a seat bottom and seat back cushion must be used.

(2) The seat bottom cushion specimen must be 18 ± 0·125 inches (457 ± 3 mm) wide by 20 ± 0·125 inches (508 ± 3 mm) deep by 4 ± 0·125 inches (102 ± 3 mm) thick, exclusive of fabric closures and seam overlap.

(3) The seat back cushion specimen **[**must be 18 ± 0·125 inches (457 ± 3 mm)**]** wide by 25 ± 0·125 inches (635 ± 3 mm) high by 2 ± 0·125 inches (51 ± 3 mm) thick, exclusive of fabric closures and seam overlap.

(4) The specimens must be conditioned at 70 ± 5°F (21 ± 2°C) 55% ± 10% relative humidity for at least 24 hours before testing.

(d) *Test Apparatus.* The arrangement of the test apparatus is shown in Figure 1 through 5 and must include the components described in this paragraph. Minor details of the apparatus may vary, depending on the model burner used.

(1) *Specimen Mounting Stand.* The mounting stand for the test specimens consist of steel angles, as shown in Figure 1. The length of the mounting stand legs is 12 ± 0·125 inches (305 ± 3mm). The mounting stand must be used for mounting the test specimen seat bottom and seat back, as shown in Figure 2. The mounting stand should also include a suitable drip pan lined with aluminium foil, dull side up.

(2) *Test Burner.* The burner to be used in testing must –

(i) Be a modified gun type;

(ii) Have an 80-degree spray angle nozzle nominally rated for 2·25 US gallons/hour at 100 psi;

Appendix F (continued)

(iii) Have a 12-inch (305 mm) burner cone installed at the end of the draft tube, with an opening 6 inches **[**(152 mm) high and 11 inches (280 mm)**]** wide, as shown in Figure 3; and

(iv) Have a burner fuel pressure regulator that is adjusted to deliver a nominal 2·0 US gallon/hour of # 2 Grade kerosene or equivalent required for the test.

(3) *Calorimeter*

(i) The calorimeter to be used in testing must be a 0–15·0 BTU per ft^2 sec (0–17·0 $Watts/cm^2$) calorimeter, accurate ± 3%, mounted in a 6-inch by 12-inch (152 by 305 mm) by 0·75 inch (19 mm) thick calcium silicate insulating board which is attached to a steel angle bracket for placement in the test stand during burner calibration, as shown in Figure 4.

(ii) Because crumbling of the insulating board with service can result in misalignment of the calorimeter, the calorimeter must be monitored and the mounting shimmed, as necessary, to ensure that the calorimeter face is flush with the exposed plane of the insulating board in a plane parallel to the exit of the test burner cone.

(4) *Thermocouples.* The seven thermocouples to be used for testing must be 0·0625 to 0·125 inch metal sheathed, ceramic packed, type K, grounded thermocouples with a nominal 22 to 30 American wire gauge (AWG)-size conductor (0·0253 inches (0·643 mm) to 0·010 inches (0·254 mm) diameter). The seven thermocouples must be attached to a steel angle bracket to form a thermocouple rake for placement in the test stand during burner calibration as shown in Figure 5.

(5) *Apparatus Arrangement.* The test burner must be mounted on a suitable stand to position the exit of the burner cone a distance of 4 ± 0·125 inches (102 ± 3 mm) from one side of the specimen mounting stand. The burner stand should have the capability of allowing the burner to be swung away from the specimen mounting stand during warmup periods.

(6) *Data Recording.* A recording potentiometer or other suitable calibrated instrument with an appropriate range must be used to measure and record the outputs of the calorimeter and the thermocouples.

(7) *Weight Scale.* Weighing Device – A device must be used that with proper procedures may determine the before and after test weights of each set of seat cushion specimens within 0·02 pound (9 grams). A continuous weighing system is preferred.

(8) *Timing Device.* A stopwatch or other device (calibrated to ± 1 second) must be used to measure the time of application of the burner flame and self-extinguishing time or test duration.

(e) *Preparation of Apparatus.* Before calibration, all equipment must be turned on and the burner fuel must be adjusted as specified in sub-paragraph (d)(2).

(f) *Calibration.* To ensure the proper thermal output of the burner, the following test must be made:

(1) Place the calorimeter on the test stand as shown in Figure 4 at a distance of 4 ± 0·125 inches (102 ±3 mm) from the exit of the burner cone.

(2) Turn on the burner, allow it to run for 2 minutes for warmup, and adjust the burner air intake damper to produce a reading of 10·5 ± 0·5 BTU per ft^2 sec (11·9 ± 0·6 $Watts/cm^2$) on the calorimeter to ensure steady state conditions have been achieved. Turn off the burner.

(3) Replace the calorimeter with the thermocouple rake (Figure 5).

(4) Turn on the burner and ensure that the thermocouples are reading 1900 ± 100°F (1038 ± 38°C) to ensure steady state conditions have been achieved.

(5) If the calorimeter and thermocouples do not read within range, repeat steps in sub-paragraphs 1 to 4 and adjust the burner air intake damper until the proper readings are obtained. The thermocouple rake and the calorimeter should be used frequently to maintain and record calibrated test parameters. Until the specific apparatus has demonstrated consistency, each test should be calibrated. After consistency has been confirmed, several tests may be conducted with the pre-test calibration before and a calibration check after the series.

(g) *Test Procedures.* The flammability of each set of specimens must be tested as follows:

Appendix F (continued)

(1) Record the weight of each set of seat bottom and seat back cushion specimens to be tested to the nearest 0·02 pound (9 grams).

(2) Mount the seat bottom and seat back cushion test specimens on the test stand as shown in Figure 2, securing the seat back cushion specimen to the test stand at the top.

(3) Swing the burner into position and ensure that the distance from the exit of the burner cone to the side of the seat bottom cushion specimen is 4 ± 0·125 inches (102 ± 3 mm).

(4) Swing the burner away from the test position. Turn on the burner and allow it to run for 2 minutes to provide adequate warmup of the burner cone and flame stabilization.

(5) To begin the test, swing the burner into the test position and simultaneously start the timing device.

(6) Expose the seat bottom cushion specimen to the burner flame for 2 minutes and then turn off the burner. Immediately swing the burner away from the test position. Terminate test 7 minutes after initiating cushion exposure to the flame by use of a gaseous extinguishing agent (i.e. Halon or CO_2).

(7) Determine the weight of the remains of the seat cushion specimen set left on the mounting stand to the nearest 0·02 pound (9 grams) excluding all droppings.

(h) *Test Report* With respect to all specimen sets tested for a particular seat cushion for which testing of compliance is performed, the following information must be recorded:

(1) An identification and description of the specimens being tested.

(2) The number of specimen sets tested.

(3) The initial weight and residual weight of each set, the calculated percentage weight loss of each set, and the calculated average percentage weight loss for the total number of sets tested.

(4) The burn length for each set tested.

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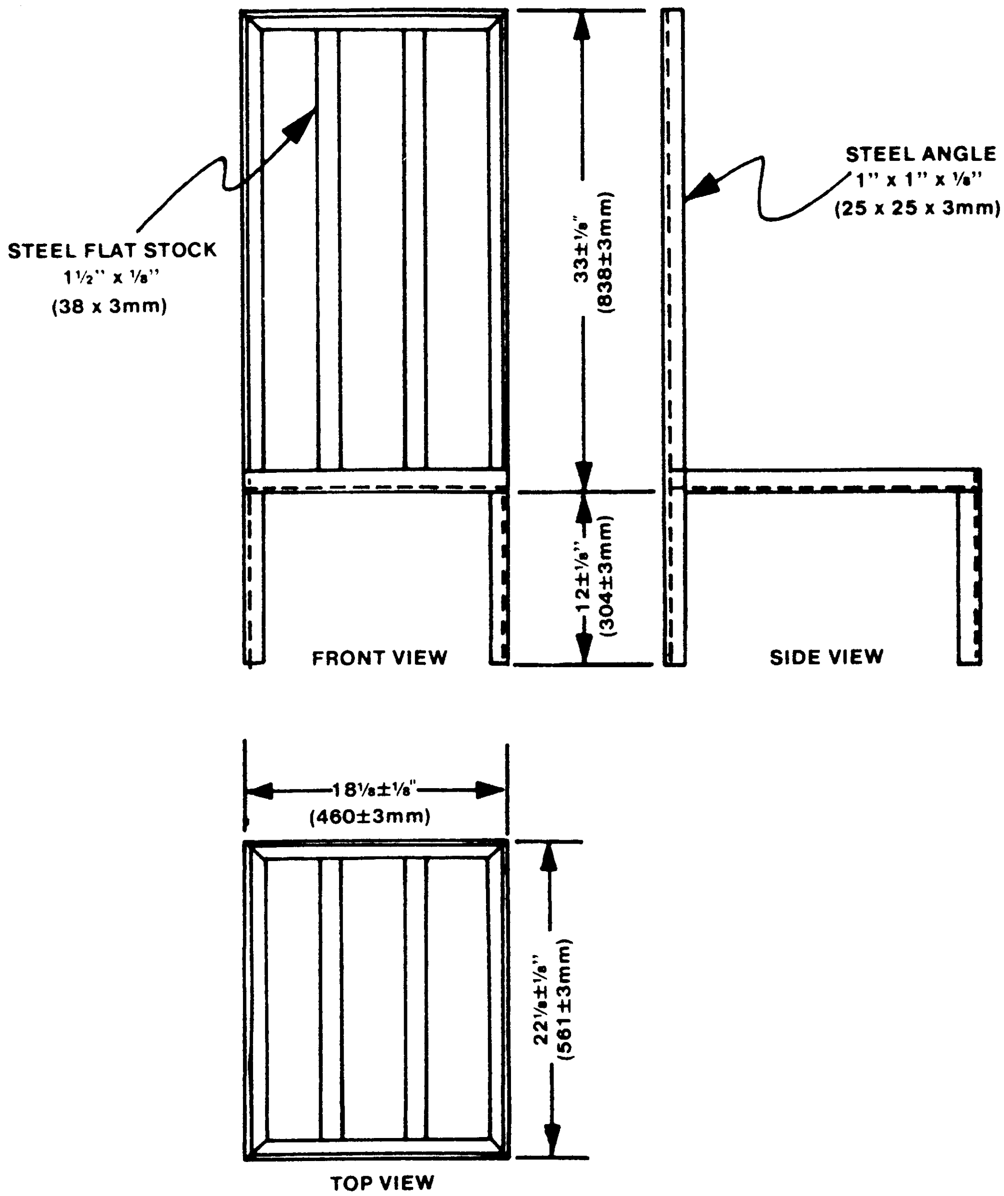
Appendix F (continued)



NOTE:
ALL JOINTS WELDED
FLAT STOCK BUTT WELDED
ALL MEASUREMENTS INSIDE

FIGURE 1

Appendix F (continued)

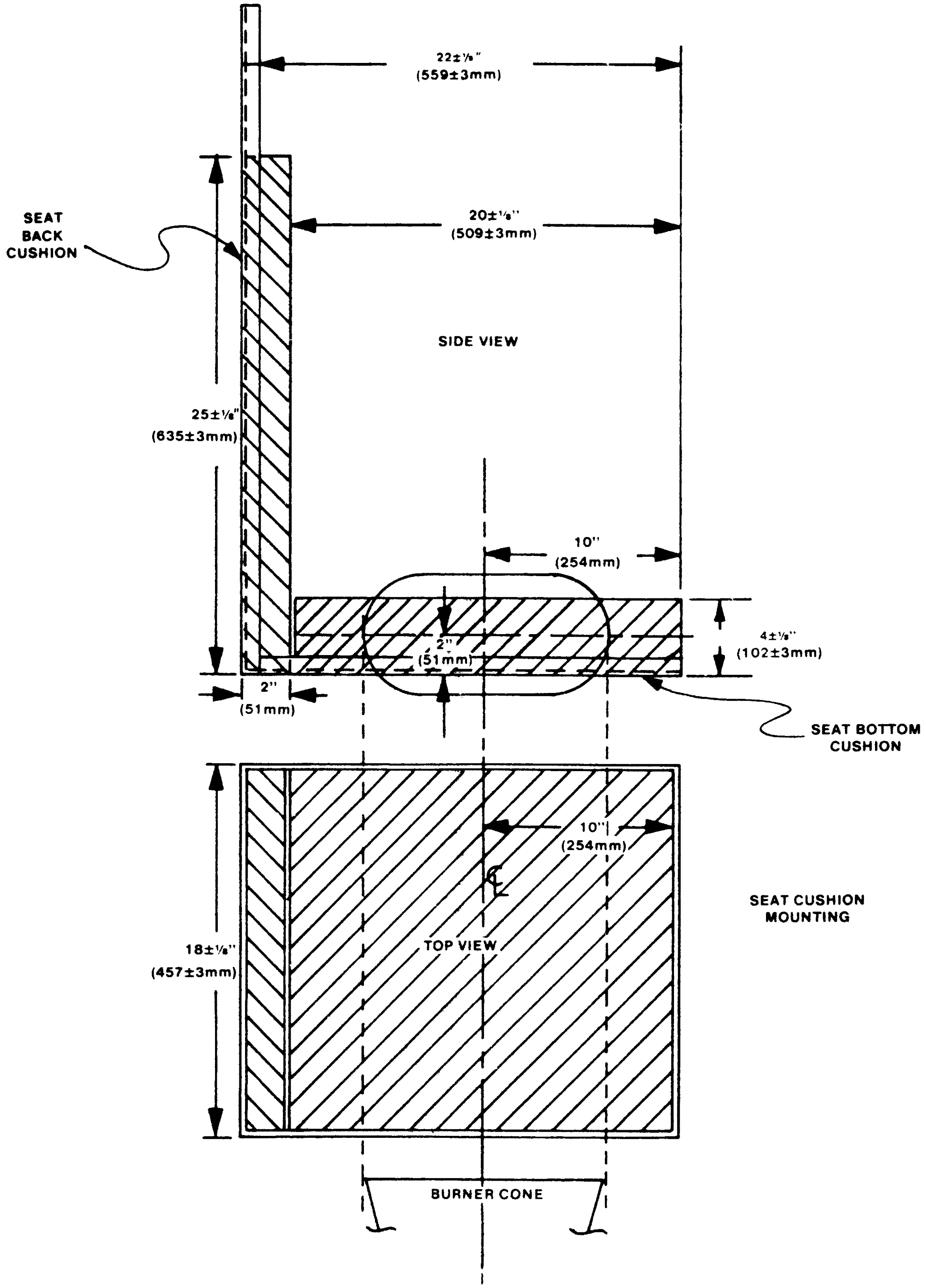


FIGURE 2

Appendix F (continued)

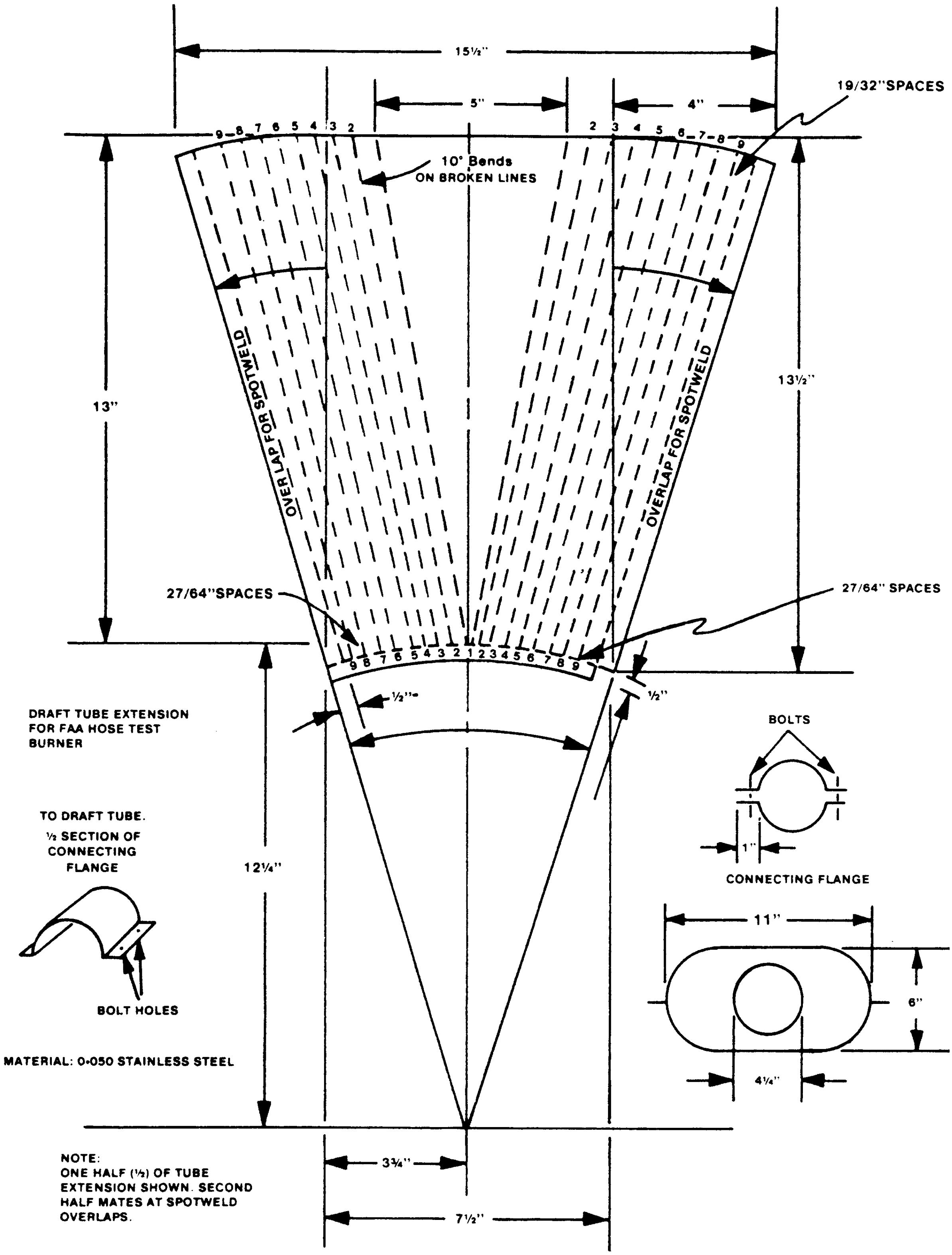


FIGURE 3

Appendix F (continued)

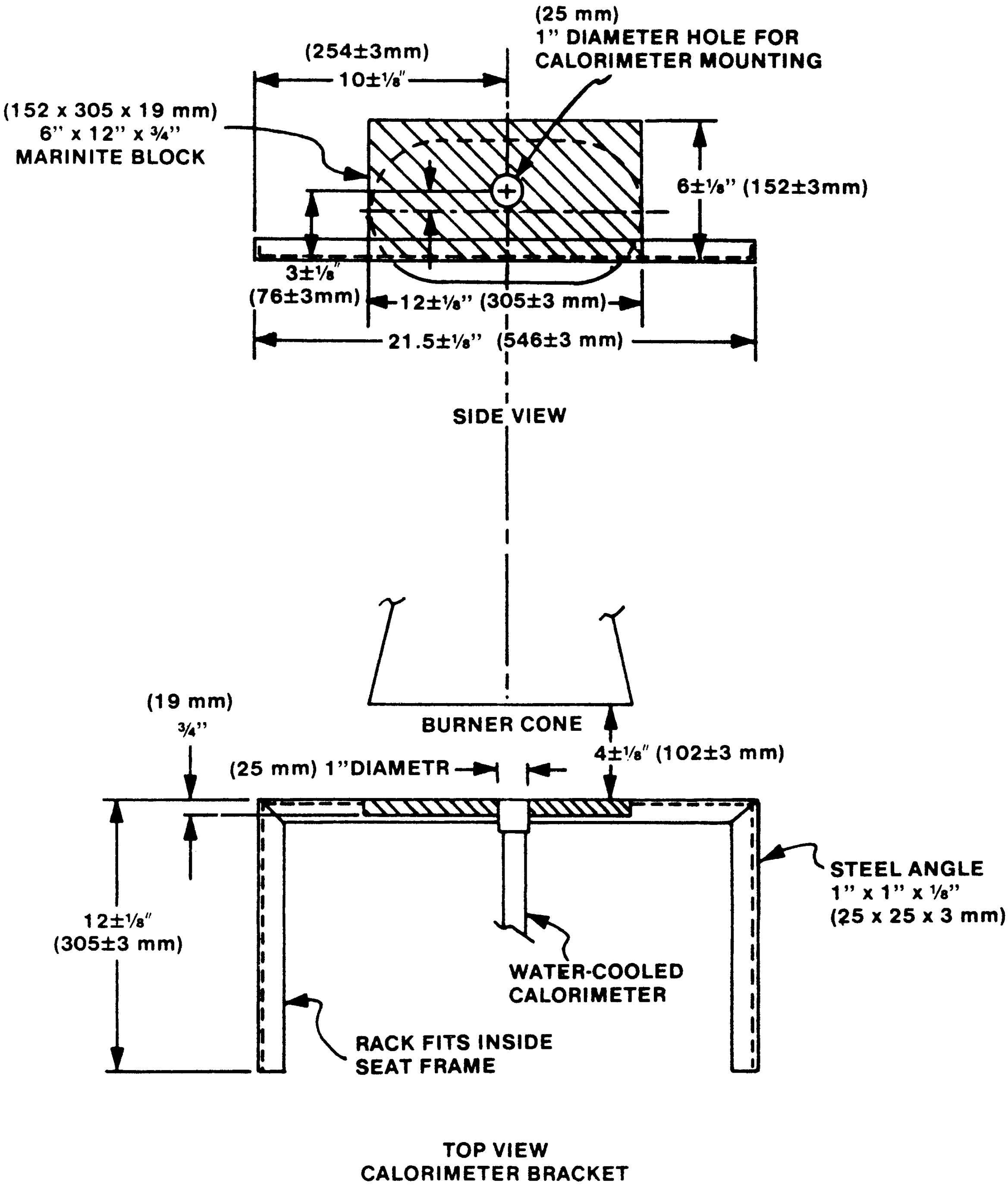


FIGURE 4

Appendix F (continued)

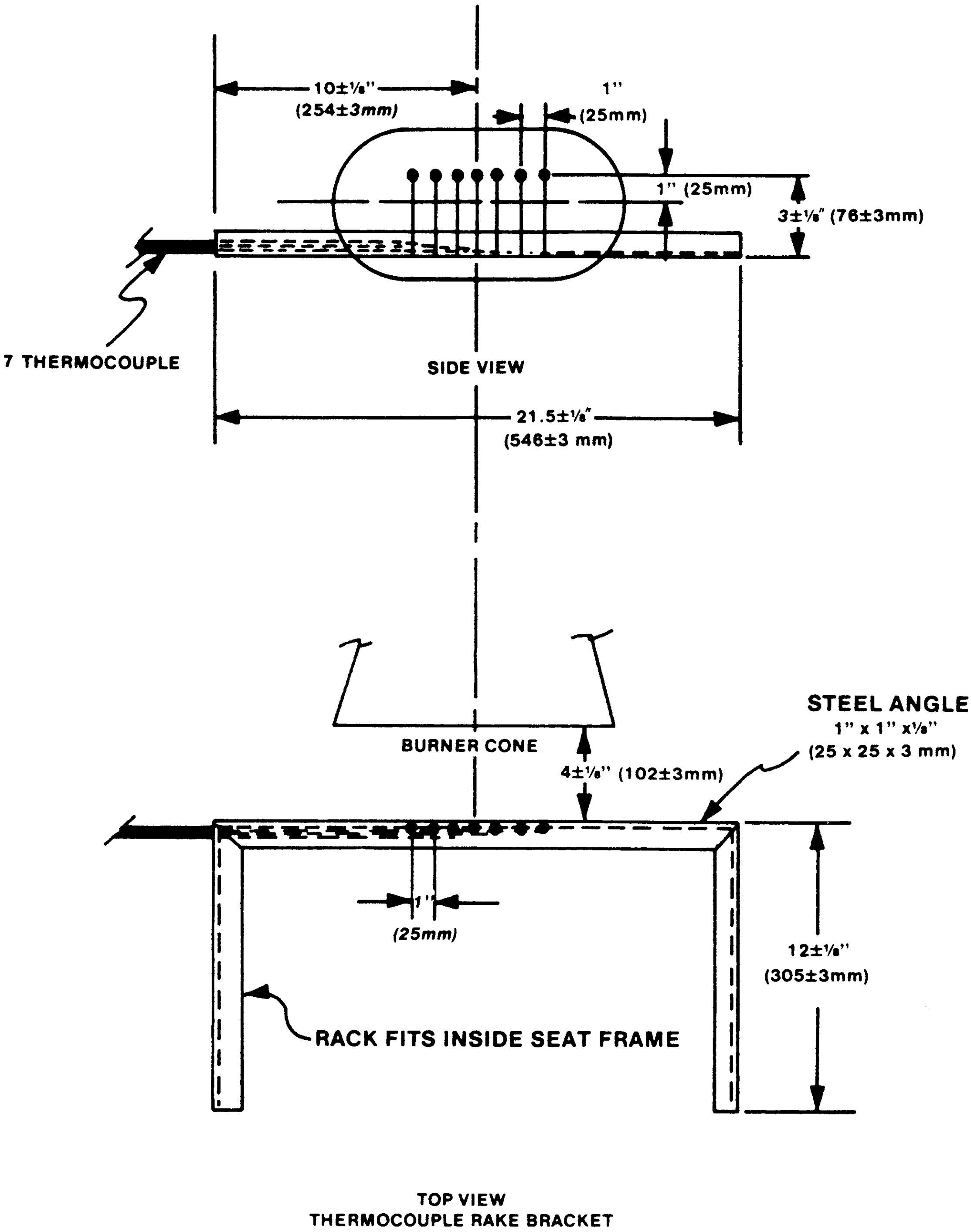


FIGURE 5

Appendix F (continued)

Part III – Test Method to Determine Flame Penetration Resistance of Cargo Compartment Liners

(a) *Criteria for Acceptance*

(1) At least three specimens of cargo compartment sidewall or ceiling liner panels must be tested.

(2) Each specimen tested must simulate the cargo compartment sidewall or ceiling liner panel, including any design features, such as joints, lamp assemblies, etc., the failure of which would affect the capability of the liner to safely contain a fire.

(3) There must be no flame penetration of any specimen within 5 minutes after application of the flame source, and the peak temperature measured at 4 inches above the upper surface of the horizontal test sample must not exceed 400ºF.

(b) *Summary of Method.* This method provides a laboratory test procedure for measuring the capability of cargo compartment lining materials to resist flame penetration within a 2 US gallons/hour # 2 Grade kerosene or equivalent burner fire source. Ceiling and sidewall liner panels may be tested individually provided a baffle is used to simulate the missing panel. Any specimen that passes the test as a ceiling liner panel may be used as a sidewall liner panel.

(c) *Test Specimens*

(1) The specimen to be tested must measure 16 ± 0·125 inches (406 ± 3 mm) by 24 ± 0·125 inches (610 ± 3 mm).

(2) The specimens must be conditioned at 70ºF ± 5ºF (21ºC ± 2ºC) and 55% ± 5% humidity for at least 24 hours before testing.

(d) *Test Apparatus*. The arrangement of the test apparatus, which is shown in Figure 3 of Part II and Figures 1 through 3 of this Part of Appendix F, must include the components described in this paragraph. Minor details of the apparatus may vary, depending on the model of the burner used.

(1) *Specimen Mounting Stand.* The mounting stand for the test specimens consists of steel angles as shown in Figure 1.

(2) *Test Burner.* The burner to be used in testing must –

(i) Be a modified gun type.

(ii) Use a suitable nozzle and maintain fuel pressure to yield a 2 US gallons/hour fuel flow. For example: an 80 degree nozzle nominally rated at 2·25 US gallons/hour and operated at 85 pounds per square inch (PSI) gauge to deliver 2·03 US gallons/hour.

(iii) Have a 12 inch (305 mm) burner extension installed at the end of the draft tube with an opening 6 inches (152 mm) high and 11 inches (280 mm) wide as shown in Figure 3 of Part II of this Appendix.

(iv) Have a burner fuel pressure regulator that is adjusted to deliver a nominal 2·0 US gallons/hour of # 2 Grade kerosene or equivalent.

(3) *Calorimeter*

(i) The calorimeter to be used in testing must be a total heat flux Foil Type Gardon Gauge of an appropriate range, approximately 0 to 15·0 BTU per ft^2 sec (0–17·0 Watts/cm^2). The calorimeter must be mounted in a 6 inch by 12 inch (152 by 305 mm) by 0·75 of an inch (19 mm) thick insulating block which is attached to a steel angle bracket for placement in the test stand during burner calibration as shown in Figure 2 of this Part of this Appendix.

(ii) The insulating block must be monitored for deterioration and the mounting shimmed as necessary to ensure that the calorimeter face is parallel to the exit plane of the test burner cone.

(4) *Thermocouples.* The seven thermocouples to be used for testing must be 0·0625 of an inch ceramic sheathed, type K, grounded thermocouples with a nominal 30 American wire gauge (AWG)-size conductor (0·010 inches (0·254 mm) diameter). The seven thermocouples must be attached to a steel angle bracket to form a thermocouple rake for placement in the stand during burner calibration as shown in Figure 3 of this Part of this Appendix.

(5) *Apparatus Arrangement.* The test burner must be mounted on a suitable stand to position the exit of the burner cone a distance of 8 inches from the ceiling liner panel and 2 inches from the sidewall liner panel. The burner stand should have the capability of allowing the burner to be swung away from the

Appendix F (continued)

test specimen during warm-up periods.

(6) *Instrumentation*. A recording potentiometer or other suitable instrument with an appropriate range must be used to measure and record the outputs of the calorimeter and the thermocouples.

(7) *Timing Device.* A stopwatch or other device must be used to measure the time of flame application and the time of flame penetration, if it occurs.

(e) *Preparation of Apparatus.* Before calibration, all equipment must be turned on and allowed to stabilize, and the burner fuel flow must be adjusted as specified in sub-paragraph (d)(2).

(f) *Calibration.* To ensure the proper thermal output of the burner the following test must be made:

(1) Remove the burner extension from the end of the draft tube. Turn on the blower portion of the burner without turning the fuel or igniters on. Measure the air velocity using a hot wire anemometer in the centre of the draft tube across the face of the opening. Adjust the damper such that the air velocity is in the range of 1550 to 1800 ft/min. If tabs are being used at the exit of the draft tube, they must be removed prior to this measurement. Reinstall the draft tube extension cone.

(2) Place the calorimeter on the test stand as shown in Figure 2 at a distance of 8 inches (203 mm) from the exit of the burner cone to simulate the position of the horizontal test specimen.

(3) Turn on the burner, allow it to run for 2 minutes for warm-up, and adjust the damper to produce a calorimeter reading of 8·0 ± 0·5 BTU per ft^2 sec (9·1 ± 0·6 Watts/cm^2).

(4) Replace the calorimeter with the thermocouple rake (see Figure 3).

(5) Turn on the burner and ensure that each of the seven thermocouples reads 1700ºF ± 100ºF (927ºC ± 38ºC) to ensure steady state conditions have been achieved. If the temperature is out of this range, repeat steps 2 through 5 until proper readings are obtained.

(6) Turn off the burner and remove the thermocouple rake.

(7) Repeat (f)(1) to ensure that the burner is in the correct range.

(g) *Test Procedure*

(1) Mount a thermocouple of the same type as that used for calibration at a distance of 4 inches (101 mm) above the horizontal (ceiling) test specimen. The thermocouple should be centred over the burner cone.

(2) Mount the test specimen on the test stand shown in Figure 1 in either the horizontal or vertical position. Mount the insulating material in the other position.

(3) Position the burner so that flames will not impinge on the specimen, turn the burner on, and allow it to run for 2 minutes. Rotate the burner to apply the flame to the specimen and simultaneously start the timing device.

(4) Expose the test specimen to the flame for 5 minutes and then turn off the burner. The test may be terminated earlier if flame penetration is observed.

(5) When testing ceiling liner panels, record the peak temperature measured 4 inches above the sample.

(6) Record the time at which flame penetration occurs if applicable.

(h) *Test Report.* The test report must include the following:

(1) A complete description of the materials tested including type, manufacturer, thickness, and other appropriate data.

(2) Observations of the behaviour of the test specimens during flame exposure such as delamination, resin ignition, smoke, etc., including the time of such occurrence.

(3) The time at which flame penetration occurs, if applicable, for each of three specimens tested.

(4) Panel orientation (ceiling or sidewall).

Appendix F (continued)

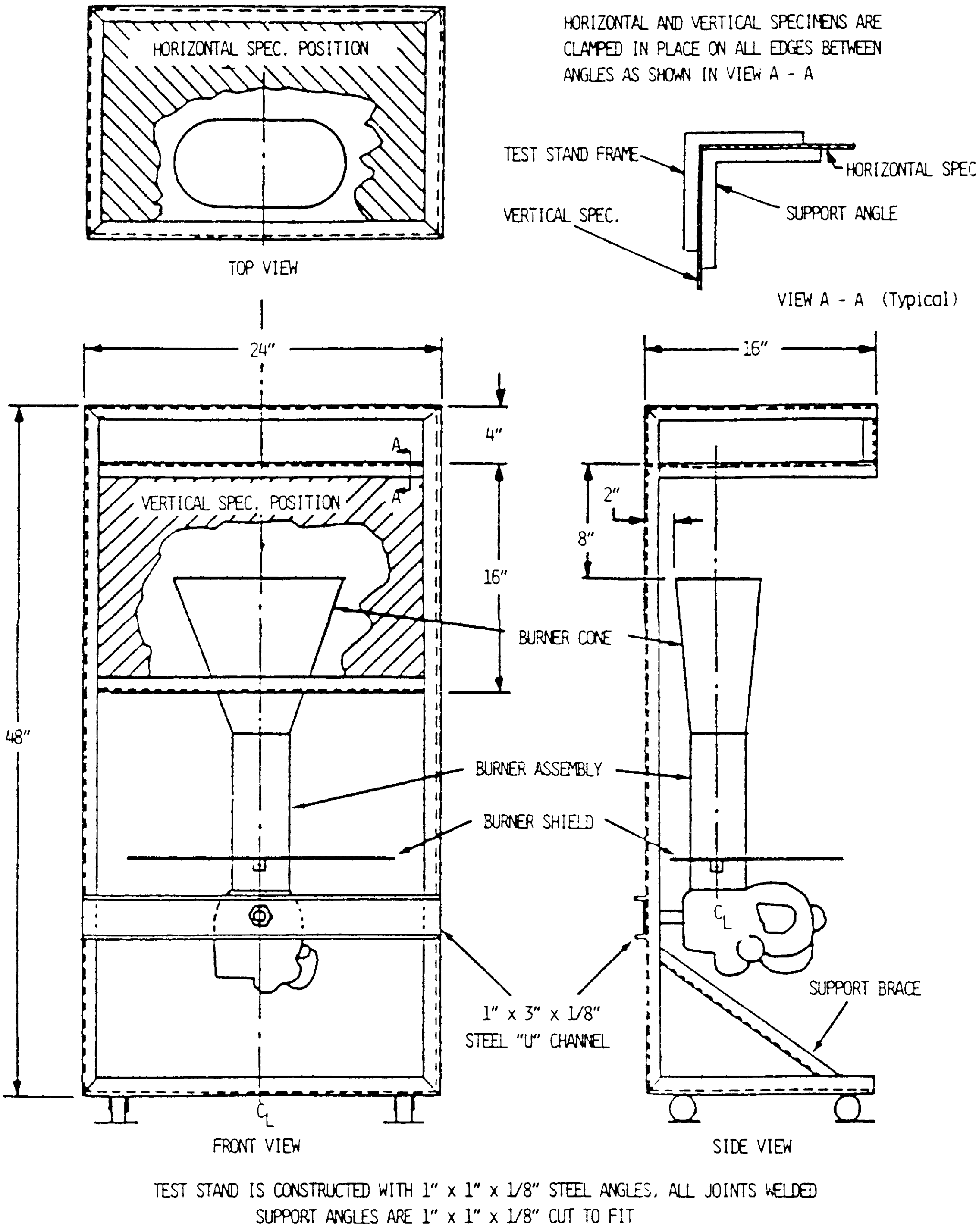


FIGURE 1 TEST APPARATUS FOR HORIZONTAL AND VERTICAL MOUNTING

Appendix F (continued)

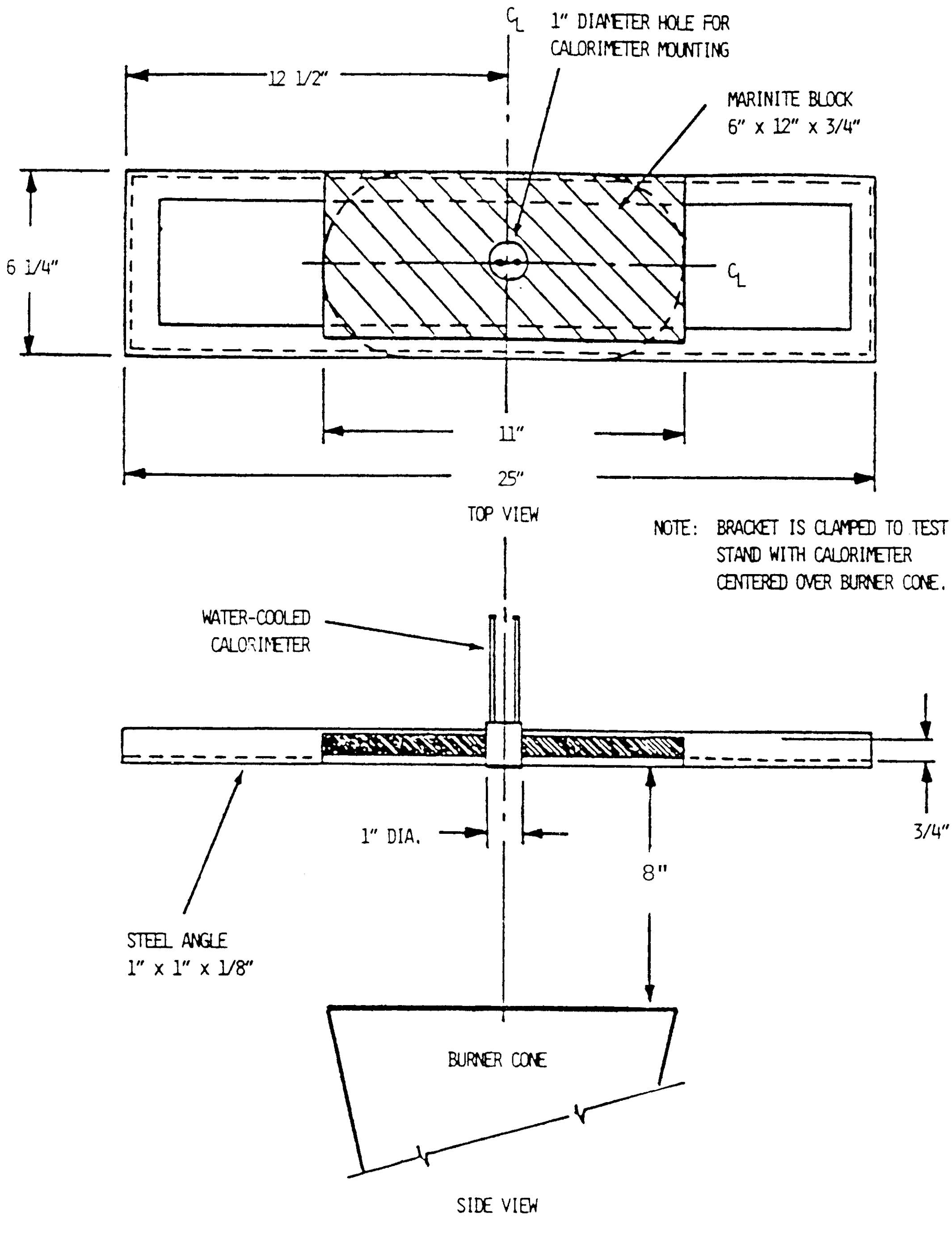


FIGURE 2 CALORIMETER BRACKET

Appendix F (continued)

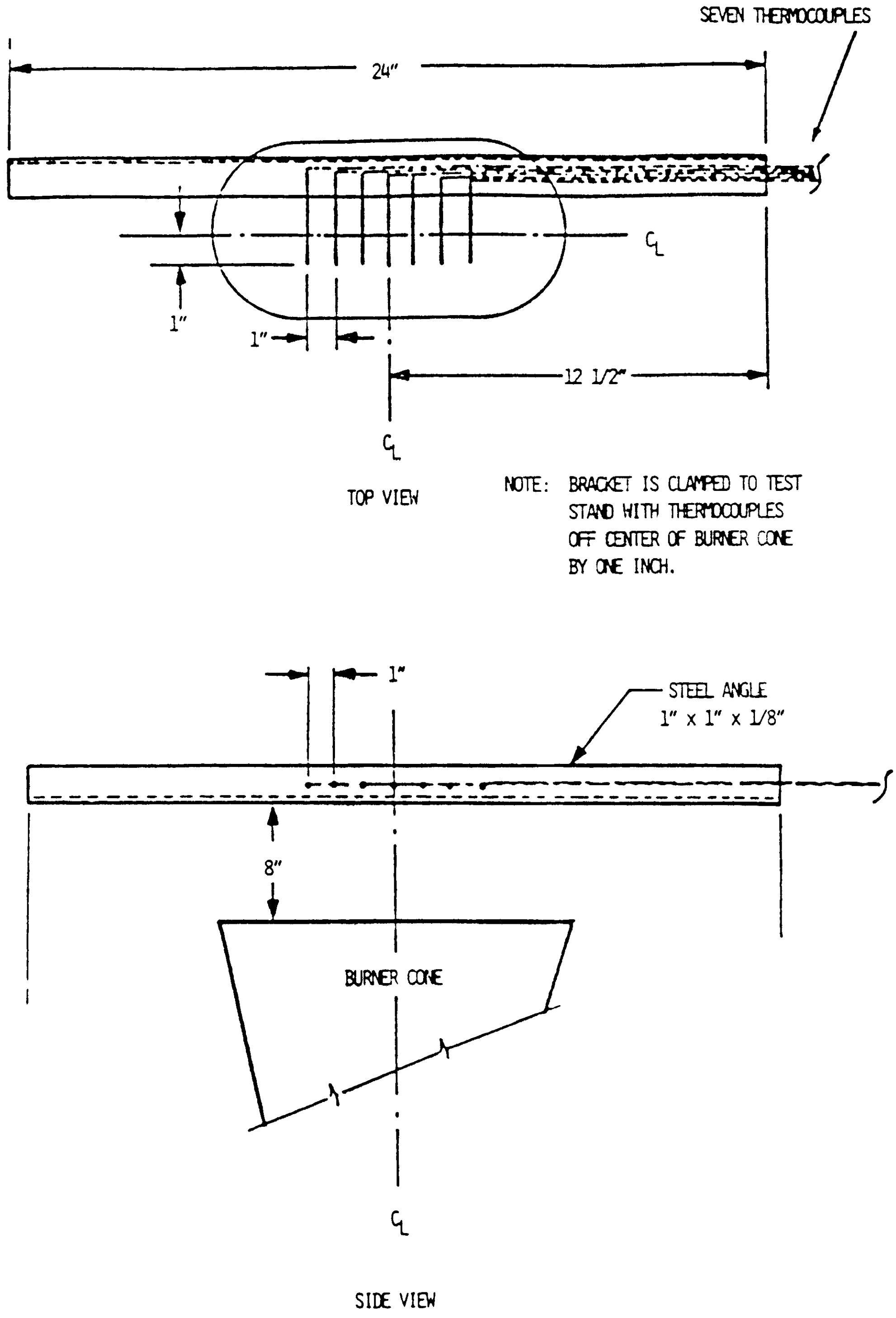


FIGURE 3 THERMOCOUPLE RAKE BRACKET

Appendix F (continued)

Part IV – Test Method to Determine the Heat Release Rate From Cabin Materials Exposed to Radiant Heat
(See ACJ Appendix F, Part IV)

(a) *Summary of Method*

(1) The specimen to be tested is injected into an environmental chamber through which a constant flow of air passes. The specimen's exposure is determined by a radiant heat source adjusted to produce the desired total heat flux on the specimen of 3·5 Watts/cm^2, using a calibrated calorimeter. The specimen is tested so that the exposed surface is vertical. Combustion is initiated by piloted ignition. The combustion products leaving the chamber are monitored in order to calculate the release rate of heat.

(b) *Apparatus.* The Ohio State University (OSU) rate of heat release apparatus as described below, is used. This is a modified version of the rate of heat release apparatus standardised by the American Society of Testing and Materials (ASTM), ASTM E-906.

(1) This apparatus is shown in Figure 1. All exterior surfaces of the apparatus, except the holding chamber, shall be insulated with 25 mm thick, low density, high-temperature, fibreglass board insulation. A gasketed door through which the sample injection rod slides forms an airtight closure on the specimen hold chamber.

(2) *Thermopile.* The temperature difference between the air entering the environmental chamber and that leaving is monitored by a thermopile having five hot and five cold, 24 gauge Chromel-Alumel junctions. The hot junctions are spaced across the top of the exhaust stack 10 mm below the top of the chimney. One thermocouple is located in the geometric centre, with the other four located 30 mm from the centre along the diagonal toward each of the corners (Figure 5). The cold junctions are located in the pan below the lower air distribution plate (see sub-paragraph (b)(4)). Thermopile hot junctions must be cleared of soot deposits as needed to maintain the calibrated sensitivity.

(3) *Radiation Source.* A radiant heat source for generating a flux up to 100 kW/m^2, using four silicon carbide elements, Type LL, 20 inches (50·8 cm) long by 0·625 inch (15·8 mm) O.D., nominal resistance 1·4 ohms, is shown in Figures 2A and 2B. The silicon carbide elements are mounted in the stainless steel panel box by inserting them through 15·9 mm holes in 0·8 mm thick ceramic fibre board. Location of the holes in the pads and stainless steel cover plates are shown in Figure 2B. The diamond shaped mask of 19 gauge stainless steel is added to provide uniform heat flux over the area occupied by the 150 by 150 mm vertical sample.

(4) *Air Distribution System.* The air entering the environmental chamber is distributed by a 6·3 mm thick aluminium plate having eight, No. 4 drill holes, 51 mm from sides on 102 mm centres, mounted at the base of the environmental chamber. A second plate of 18 gauge steel having 120, evenly spaced, No. 28 drill holes is mounted 150 mm above the aluminium plate. A well-regulated air supply is required. The air supply manifold at the base of the pyramidal section has 48, evenly spaced, No. 26 drill holes located 10 mm from the inner edge of the manifold so that 0·03 m^3/second of air flows between the pyramidal sections and 0·01 m^3/second flows through the environmental chamber when total air flow to apparatus is controlled at 0·04 m^3/second.

(5) *Exhaust Stack.* An exhaust stack, 133 mm by 70 mm in cross section, and 254 mm long, fabricated from 28 gauge stainless steel, is mounted on the outlet of the pyramidal section. A 25 mm by 76 mm plate of 31 gauge stainless steel is centred inside the stack, perpendicular to the air flow, 75 mm above the base of the stack.

(6) *Specimen Holders.* The 150 mm x 150 mm specimen is tested in a vertical orientation. The holder (Figure 3) is provided with a specimen holder frame, which touches the specimen (which is wrapped with aluminium foil as required by sub-paragraph (d)(3)) along only the 6 mm perimeter, and a "V" shaped spring to hold the assembly together. A detachable 12 mm x 12 mm x 150 mm drip pan and two 0·020 inch stainless steel wires (as shown in Figure 3) should be used for testing of materials prone to melting and dripping. The positioning of the spring and frame may be changed to accommodate different specimen thicknesses by inserting the retaining rod in different holes on the specimen holder.

Since the radiation shield described in ASTM E-906 is not used, a guide pin is added to the injection mechanism. This fits into a slotted metal plate on the injection mechanism outside of the holding chamber and can be used to provide accurate positioning of the specimen face after injection. The front surface of the specimen shall be 100 mm from the closed radiation doors after injection.

The specimen holder clips onto the mounted bracket (Figure 3). The mounting bracket is attached to the injection rod by three screws which pass through a wide area washer welded onto a 13 mm nut. The end of the injection rod is threaded to screw into the nut and a 5.1 mm thick wide area washer is held between two 13 mm nuts which are adjusted to tightly cover the hole in the radiation doors through which the injection rod or calibration calorimeter pass.

(7) *Calorimeter.* A total-flux type calorimeter must be mounted in the centre of a 13 mm Kaowool "M" board inserted in the sample holder must be used to measure the total heat flux. The calorimeter must have a view angle of 180º and be calibrated for incident flux. The calorimeter calibration must be acceptable to the Authority.

(8) *Pilot-Flame Positions.* Pilot ignition of the specimen must be accomplished by simultaneously exposing the specimen to a lower pilot burner and an upper pilot burner, as described in sub-paragraphs (b)(8)(i) and (b)(8)(ii), respectively. The pilot burners must remain lighted for the entire 5-minute duration of the test.

(i) *Lower Pilot Burner.* The pilot-flame tubing must be 6·3 mm O.D., 0·8 mm wall, stainless steel tubing. A mixture of 120 cm^3/min. of methane and 850 cm^3/min. of air must be fed to the lower pilot flame burner. The normal position of the end of the pilot burner tubing is 10 mm from and perpendicular to the exposed vertical surface of the specimen. The centreline at the outlet of the burner tubing must intersect the vertical centreline of the sample at a point 5 mm above the lower exposed edge of the specimen.

(ii) *Upper Pilot Burner.* The pilot burner must be a straight length of 6·3 mm O.D., 0·8 mm wall, stainless steel tubing 360 mm long. One end of the tubing shall be closed, and three No. 40 drill holes shall be drilled into the tubing, 60 mm apart, for gas ports, all radiating in the same direction. The first hole must be 5 mm from the closed end of the tubing. The tube is inserted into the environmental chamber through a 6·6 mm hole drilled 10 mm above the upper edge of the window frame. The tube is supported and positioned by an adjustable "Z" shaped support mounted outside the environmental chamber, above the viewing window. The tube is positioned above and 20 mm behind the exposed upper edge of the specimen. The middle hole must be in the vertical plane perpendicular to the exposed surface of the specimen which passes through its vertical centreline and must be pointed toward the radiation source. The gas supplied to the burner must be methane adjusted to produce flame lengths of 25 mm.

(iii) Not required.

(c) *Calibration of Equipment*

(1) *Heat Release Rate.* A burner as shown in Figure 4 must be placed over the end of the lower pilot flame tubing using a gas-tight connection. The flow of gas to the pilot flame must be at least 99% methane and must be accurately metered. Prior to usage, the wet test meter is properly levelled and filled with distilled water to the tip of the internal pointer while no gas is flowing. Ambient temperature and pressure of the water, are based on the internal wet test meter temperature. A baseline flow rate of approximately 1 litre/min. is set and increased to higher preset flows of 4, 6, 8, 6 and 4 litres/min. The rate is determined by using a stopwatch to time a complete revolution of the west test meter for both the baseline and higher flow, with the flow returned to baseline before changing to the next higher flow. The thermopile baseline voltage is measured. The gas flow to the burner must be increased to the higher preset flow and allowed to burn for 2·0 minutes, and the thermopile voltage must be measured. The sequence is repeated until all five values have been determined. The average of the five values must be used as the calibration factor. The procedure must be repeated if the percent relative standard deviation is greater than 5%. Calculations are shown in paragraph (f).

(2) *Flux Uniformity.* Uniformity of flux over the specimen must be checked periodically and after each heating element change to determine if it is within acceptable limits of ± 5%.

(3) Not required.

Appendix F (continued)

(d) *Sample Preparation*

(1) The standard size for vertically mounted specimens is 150 x 150 mm with thicknesses up to 45 mm.

(2) *Conditioning*. Specimens must be conditioned as described in Part 1 of this Appendix.

(3) *Mounting*. Only one surface of a specimen will be exposed during a test. A single layer of 0·025 mm aluminium foil is wrapped tightly on all unexposed sides.

(e) *Procedure*

(1) The power supply to the radiant panel is set to produce a radiant flux of 3·5 Watts/cm^2. The flux is measured at the point which the centre of the specimen surface will occupy when positioned for test. The radiant flux is measured after the air flow through the equipment is adjusted to the desired rate. The sample should be tested in its end use thickness.

(2) The pilot flames are lighted and their position, as described in sub-paragraph (b)(8), is checked.

(3) The air flow to the equipment is set at 0·04 ± 0·001 m^3/s at atmospheric pressure. Proper air flow may be set and monitored by either: (1) An orifice meter designed to produce a pressure drop of at least 200 mm of the manometric fluid, or by (2) a rotometer (variable orifice meter) with a scale capable of being read to ± 0·0004 m^3/s. The stop on the vertical specimen holder rod is adjusted so that the exposed surface of the specimen is positioned 100 mm from the entrance when injected into the environmental chamber.

(4) The specimen is placed in the hold chamber with the radiation doors closed. The airtight outer door is secured, and the recording devices are started. The specimen must be retained in the hold chamber for 60 seconds ± 10 seconds, before injection. The thermopile "zero" value is determined during the last 20 seconds of the hold period.

(5) When the specimen is to be injected, the radiation doors are opened, the specimen is injected into the environmental chamber, and the radiation doors are closed behind the specimen.

(6) Reserved.

(7) Injection of the specimen and closure of the inner door marks time zero. A continuous record of the thermopile output with at least one data point per second must be made during the time the specimen is in the environmental chamber.

(8) The test duration time is five minutes.

(9) A minimum of three specimens must be tested.

(f) *Calculations*

(1) The calibration factor is calculated as follows:

$$K_h = \frac{(F_1 - F_0)}{(V_1 - V_0)} \times \frac{(210 \cdot 8 - 22)\text{kcal}}{\text{mole}} \times \frac{273}{T_a} \times \frac{P - P_v}{760} \times \frac{\text{mole CH4STP}}{22 \cdot 41} \times \frac{\text{WATT.min}}{\cdot 01433\text{kcal}} \times \frac{\text{kW}}{1000\text{W}}$$

F_0 = Flow of methane at baseline (1pm)

F_1 = Higher preset flow of methane (1pm)

V_0 = Thermopile voltage at baseline (mv)

V_1 = Thermopile voltage at higher flow (mv)

T_a = Ambient temperature (K)

P = Ambient pressure (mm Hg)

P_v = Water vapour pressure (mm Hg)

(2) Heat release rates may be calculated from the reading of the thermopile output voltage at any instant of time as:

$$\text{HRR} = \frac{V_m - V_b}{\cdot 02323\text{m}^2} \times K_h$$

HRR = Heat Release Rate kW/m^2

V_m = Measured thermopile voltage (mv)

V_b = Baseline voltage (mv)

K_h = Calibration Factor (kW/mv)

(3) The integral of the heat release rate is the total heat release as a function of time and is calculated by multiplying the rate by the data sampling frequency in minutes and summing the time from zero to two minutes.

(g) *Criteria*. The total positive heat release over the first two minutes of exposure for each of the three or more samples tested must be averaged, and the peak heat release rate for each of the samples must be averaged. The average total heat release must not exceed 65 kilowatt-minutes per square metre, and the average peak heat release rate must not exceed 65 kilowatts per square metre.

Appendix F (continued)

(h) *Report*. The test report must include the following for each specimen tested:

(1) Description of the specimen.

(2) Radiant heat flux to the specimen, expressed in Watts/cm^2.

(3) Data giving release rates of heat (in kW/m^2) as a function of time, either graphically or tabulated at intervals no greater than 10 seconds. The calibration factor (Kh) must be recorded.

(4) If melting, sagging, delaminating, or other behaviour that affects the exposed surface area or the mode of burning occurs, these behaviours must be reported, together with the time at which such behaviours were observed.

(5) The peak heat release and the 2 minute integrated heat release rate must be reported.

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Appendix F (continued)

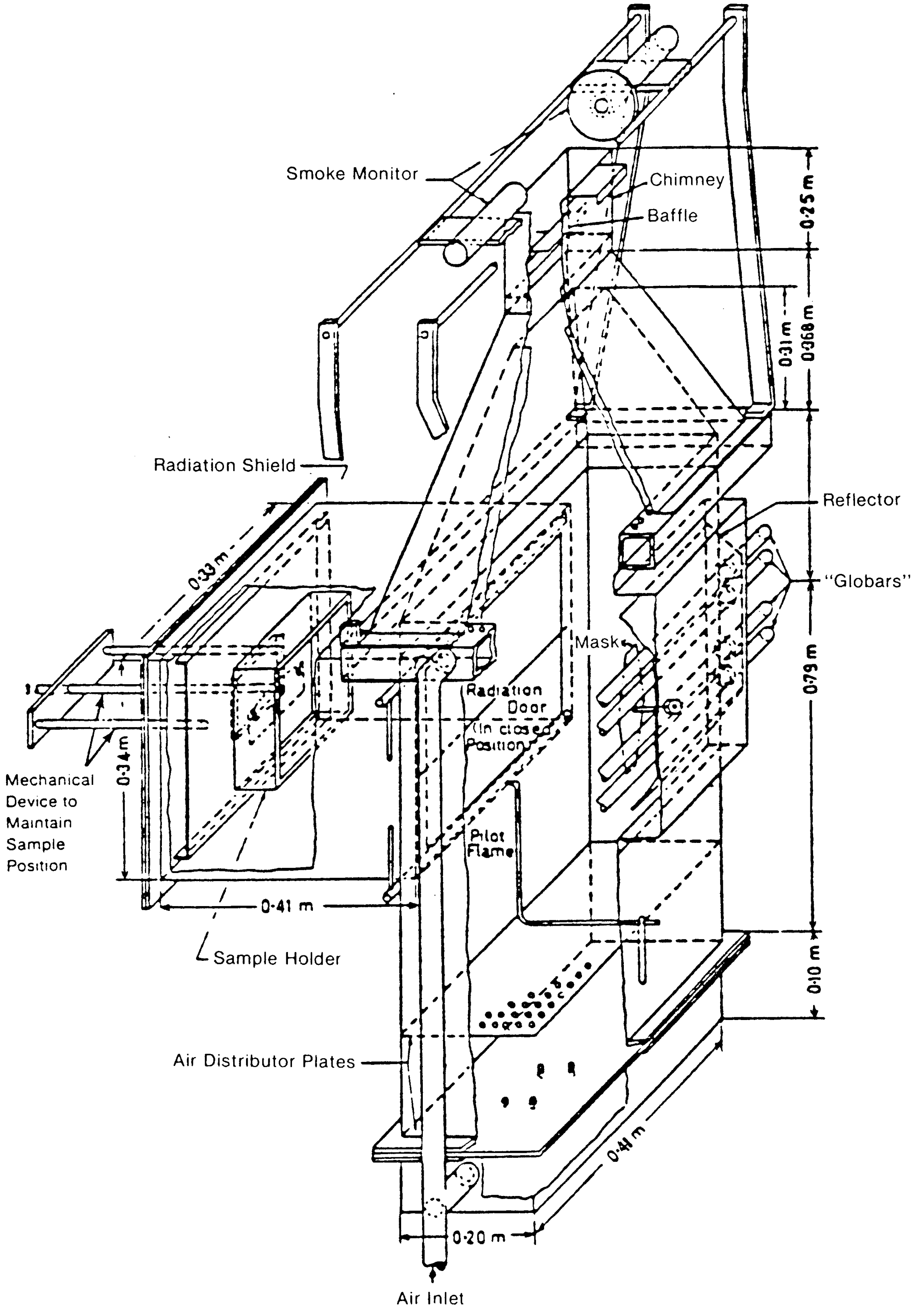
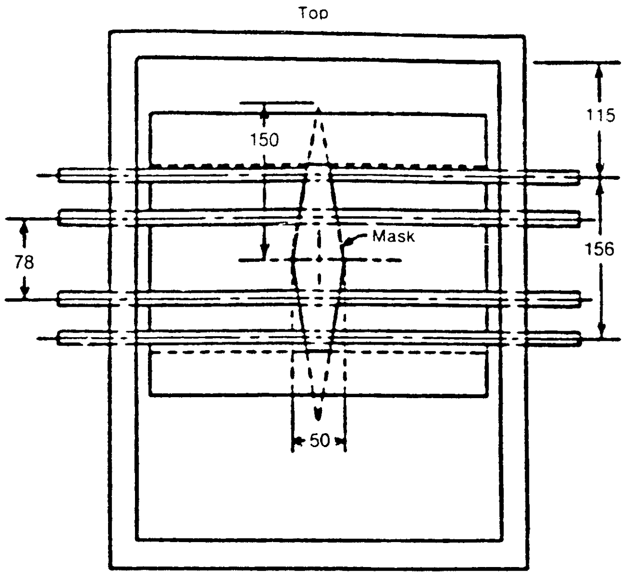


FIGURE 1. RELEASE RATE APPARATUS

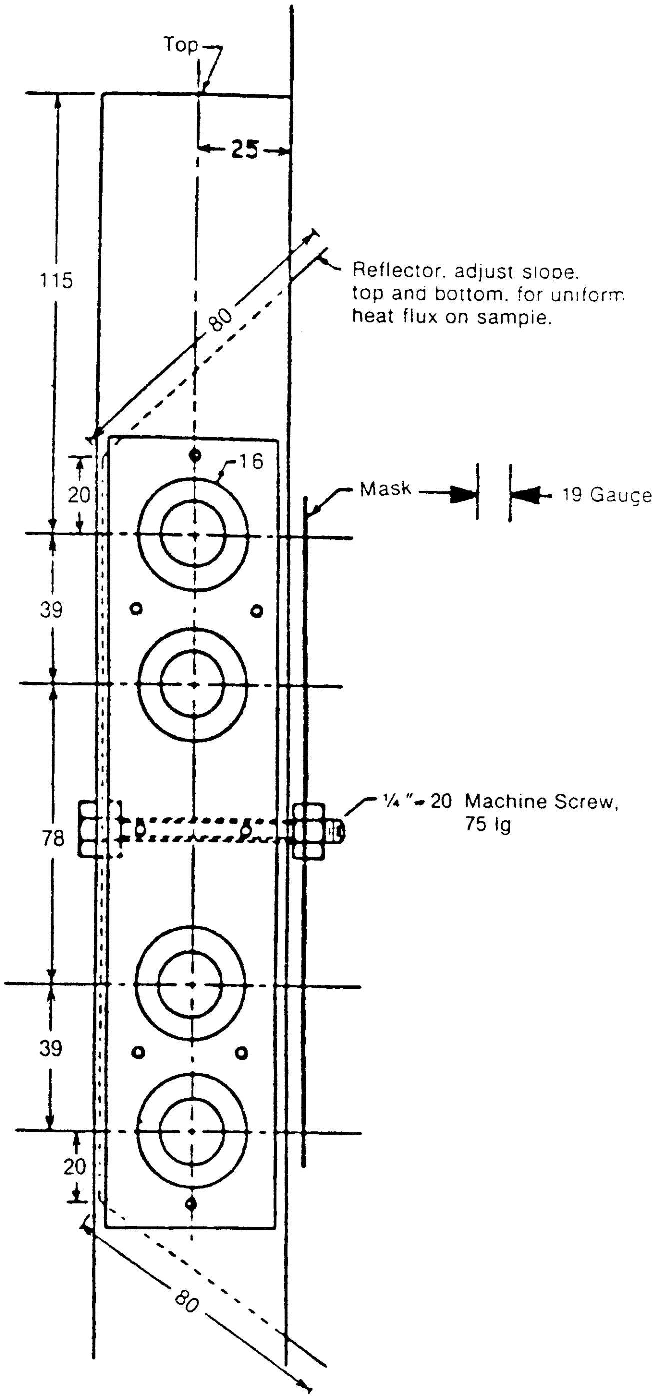
Appendix F (continued)



(Unless denoted otherwise, all dimensions are in millimetres.)

FIGURE 2A. "GLOBAR" RADIANT PANEL

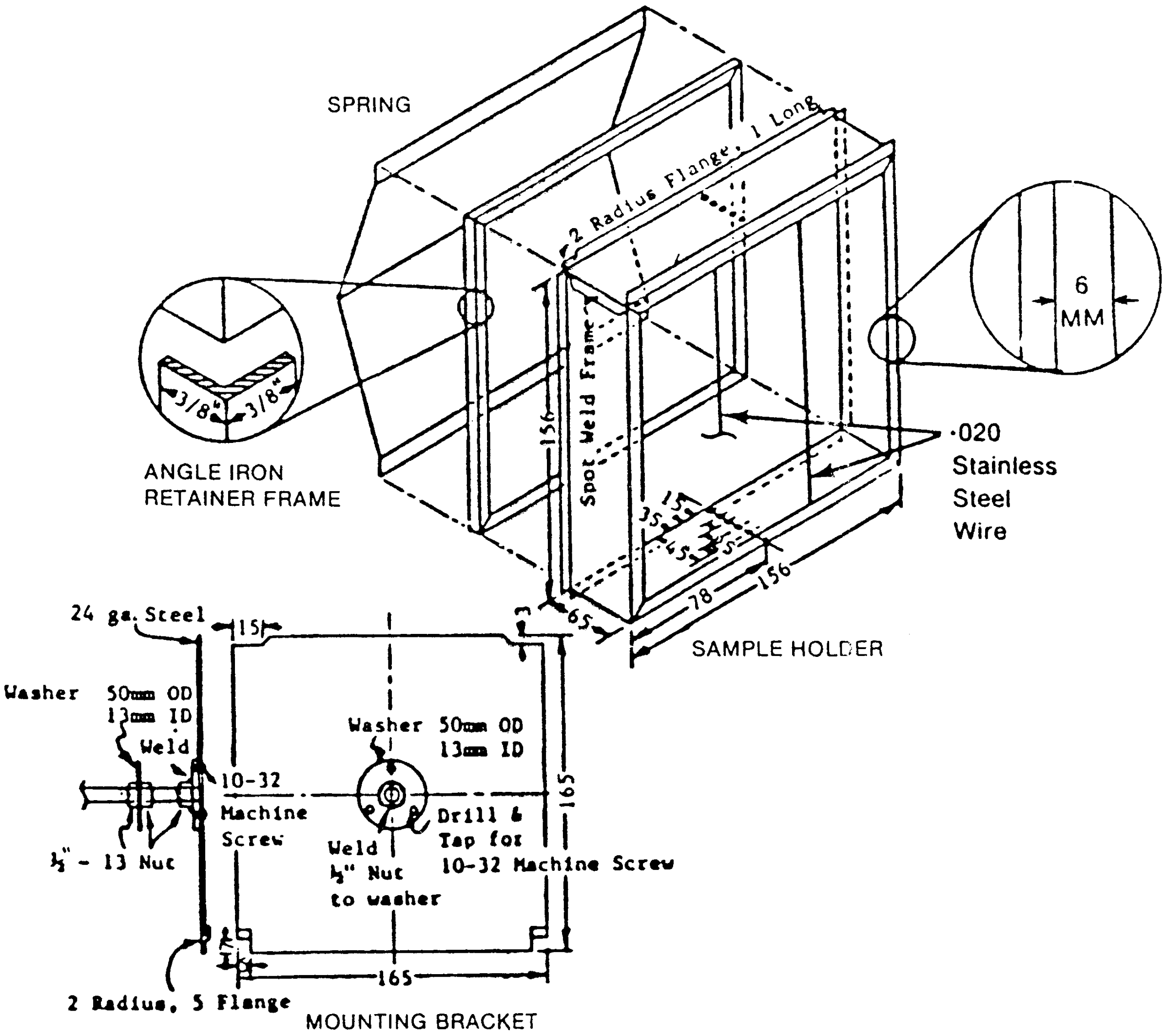
Appendix F (continued)



(Unless denoted otherwise, all dimensions are in millimetres.)

FIGURE 2B. "GLOBAR" RADIANT PANEL

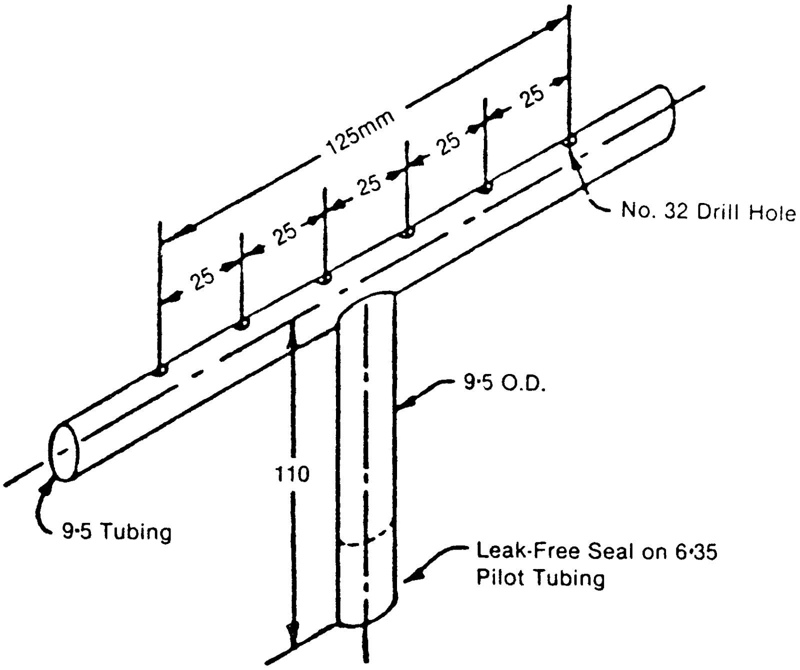
Appendix F (continued)



(Unless denoted otherwise, all dimensions are in millimetres.)

FIGURE 3.

Appendix F (continued)



(Unless denoted otherwise, all dimensions are in millimetres.)

FIGURE 4.

Appendix F (continued)

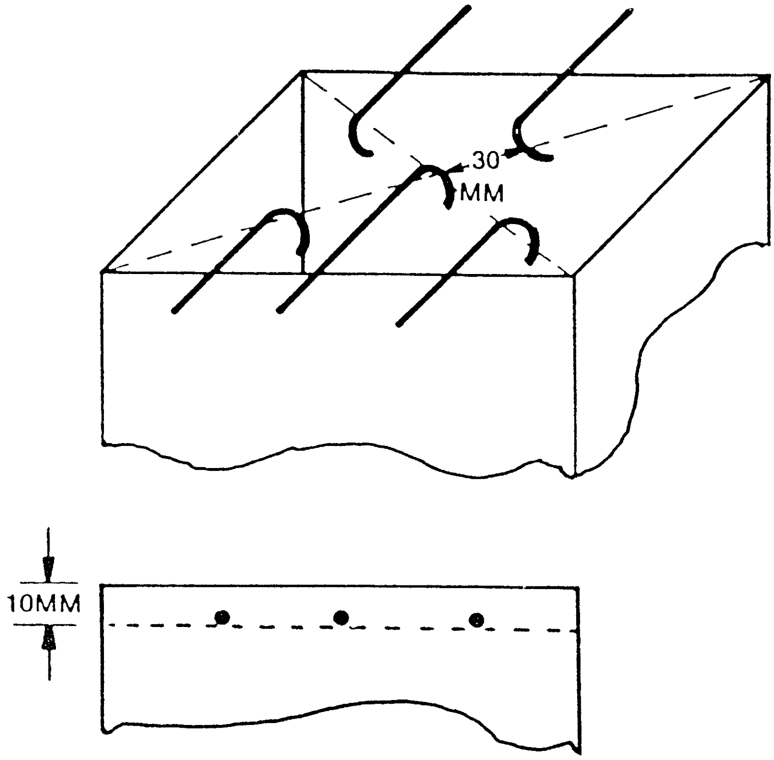


FIGURE 5. THERMOCOUPLE POSITION

Appendix F (continued)

Part V – Test Method to Determine the Smoke Emission Characteristics of Cabin Materials

(a) *Summary of Method.* The specimens must be constructed, conditioned, and tested in the flaming mode in accordance with American Society of Testing and Materials (ASTM) Standard Test Method ASTM F814-83.

(b) *Acceptance Criteria.* The specific optical smoke density (Ds) which is obtained by averaging the reading obtained after 4 minutes with each of the three specimens, shall not exceed 200.

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Appendix G

Continuous Gusts Design Criteria

Not required for JAR–25.

[Ch.10, 19.12.83]

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Appendix H

Instructions for Continued Airworthiness

H25.1 General

(a) This Appendix specifies requirements for the preparation of Instructions for Continued Airworthiness as required by JAR 25.1529.

(b) The Instructions for Continued Airworthiness for each aeroplane must include the Instructions for Continued Airworthiness for each engine and propeller (hereinafter designated 'products'), for each appliance required by this JAR-25 and any required information relating to the interface of those appliances and products with the aeroplane. If Instructions for Continued Airworthiness are not supplied by the manufacturer of an appliance or product installed in the aeroplane, the Instructions for Continued Airworthiness for the aeroplane must include the information essential to the continued airworthiness of the aeroplane.

(c) The applicant must submit to the Authority a programme to show how changes to the Instructions for Continued Airworthiness made by the applicant or by the manufacturers of products and appliances installed in the aeroplane will be distributed.

H25.2 Format

(a) The Instructions for Continued Airworthiness must be in the form of a manual or manuals as appropriate for the quantity of data to be provided.

(b) The format of the manual or manuals must provide for a practical arrangement.

H25.3 Content

The contents of the manual or manuals must be prepared in a language acceptable to the Authority. The Instructions for Continued Airworthiness must contain the following manuals or sections, as appropriate, and information:

(a) *Aeroplane maintenance manual or section*

(1) Introduction information that includes an explanation of the aeroplane's features and data to the extent necessary for maintenance or preventive maintenance.

(2) A description of the aeroplane and its systems and installations including its engines, propellers, and appliances.

(3) Basic control and operation information describing how the aeroplane components and systems are controlled and how they operate, including any special procedures and limitations that apply.

(4) Servicing information that covers details regarding servicing points, capacities of tanks, reservoirs, types of fluids to be used, pressures applicable to the various systems, location of access panels for inspection and servicing, locations of lubrication points, lubricants to be used, equipment required for servicing, tow instructions and limitations, mooring, jacking, and levelling information.

(b) *Maintenance Instructions*

(1) Scheduling information for each part of the aeroplane and its engines, auxiliary power units, propellers, accessories, instruments, and equipment that provides the recommended periods at which they should be cleaned, inspected, adjusted, tested, and lubricated, and the degree of inspection, the applicable wear tolerances, and work recommended at these periods. However, the applicant may refer to an accessory, instrument or equipment manufacturer as the source of this information if the applicant shows that the item has an exceptionally high degree of complexity requiring specialised maintenance techniques, test equipment, or expertise. The recommended overhaul periods and necessary cross references to the Airworthiness Limitations section of the manual must also be included. In addition, the applicant must include an inspection programme that includes the frequency and extent of the inspections necessary to provide for the continued airworthiness of the aeroplane.

(2) Troubleshooting information describing probable malfunctions, how to recognise those malfunctions, and the remedial action for those malfunctions.

(3) Information describing the order and method of removing and replacing products and parts with any necessary precautions to be taken.

H25.3 (continued)

(4) Other general procedural instructions including procedures for system testing during ground running, symmetry checks, weighing and determining the centre of gravity, lifting and shoring, and storage limitations.

(c) Diagrams of structural access plates and information needed to gain access for inspections when access plates are not provided.

(d) Details for the application of special inspection techniques including radiographic and ultrasonic testing where such processes are specified.

(e) **[** Information needed to apply protective treatments to the structure after inspection. **]**

(f) All data relative to structural fasteners such as identification, discard recommendations, and torque values.

(g) A list of special tools needed.

[Ch.10, 19.12.83; Ch.12, 10.05.88; Amdt.16, 01.05.03]

H25.4 Airworthiness Limitations section

The Instructions for Continued Airworthiness must contain a section titled Airworthiness Limitations that is segregated and clearly distinguishable from the rest of the document. This section must set forth each mandatory replacement time, structural inspection interval, and related structural inspection procedure approved under JAR 25.571. If the Instructions for Continued Airworthiness consist of multiple documents, the section required by this paragraph must be included in the principal manual. This section must contain a legible statement in a prominent location that reads: 'The Airworthiness Limitations Section is approved and variations must also be approved'.

[Ch.10, 19.12.83; Amdt. 16, 01.05.03]

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Appendix I

[Automatic Takeoff Thrust Control System (ATTCS)]
(See JAR 25X20 (c)

I 25.1 General

(a) This Appendix specifies additional requirements and limitations for aeroplanes equipped with an engine control system that automatically resets thrust or power on the operating engine(s) when any engine fails during take-off, and for which performance credit is limited to that of paragraph 25.3 (b) of this Appendix. When performance credit is not so limited, Special Conditions will apply.

(b) With the ATTCS system and associated systems functioning normally as designed, all applicable requirements of JAR-25, except as provided in this Appendix, must be met without requiring any action by the crew to increase thrust or power.

[Ch.13, 05.10.89]

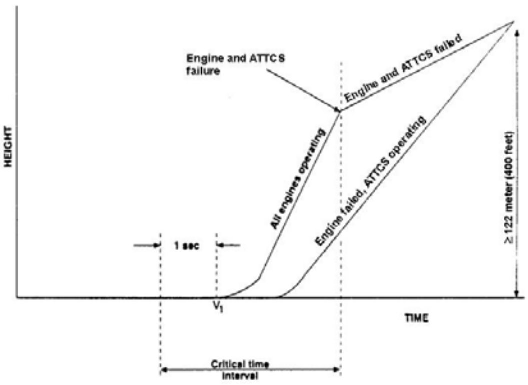
I 25.2 Definitions

(a) *Automatic Takeoff Thrust Control (ATTCS) System*. An ATTCS system is defined as a system which automatically resets thrust or power on the operating engine(s) when any engine fails during take-off. For the purpose of the requirements in this Appendix, the ATTCS system comprises all elements of equipment necessary for the control and performance of each intended function, including all devices both mechanical and electrical that sense engine failure, transmit signals and actuate fuel controls or power levers of the operating engine(s) to achieve scheduled thrust or power increases, the engine control system and devices which furnish cockpit information on system operation.

(b) *Critical Time Interval.* When conducting an ATTCS take-off, the critical time interval is between one second before reaching V_1, and the point on the gross take-off flight path with all engines operating where, assuming a simultaneous engine and ATTCS system failure, the resulting flight path thereafter intersects the gross flight path, determined in accordance with JAR 25.115, at not less than 400 feet above the take-off surface. This definition is shown in the following figure:

[Ch.13, 05.10.89]

I 25.2 (continued)



I 25.3 Performance requirements

All applicable performance requirements of JAR-25 must be met with the ATTCS system functioning normally as designed, except that the propulsive thrust obtained from each operating engine after failure of the critical engine during take-off, and the thrust at which compliance with the one-engine-inoperative climb requirements in JAR 25.121 (a) and (b) is shown, must be assumed to be not greater than the lesser of –

(a) The actual propulsive thrust resulting from the initial setting of power or thrust controls with the ATTCS system functioning normally as designed, without requiring any action by the crew to increase thrust or power until the aeroplane has achieved a height of 400 feet above the take-off surface; or

(b) 111 percent of the propulsive thrust which would have been available at the initial setting of power or thrust controls in the event of failure of the ATTCS system to reset thrust or power, without any action by the crew to increase thrust or power until the aeroplane has achieved a height of 400 feet above the take-off surface.

Note 1. The limitation of performance credit for ATTCS system operation to 111 percent of the thrust provided at the initial setting is intended to –

(i) Assure an adequate level of climb performance with all engines operating at the initial setting of power or thrust controls, and

(ii) Limit the degradation of performance in the event of a critical engine failure combined with failure of

I 25.3(b) (continued)

the ATTCS system to operate as designed.

Note 2. For propeller-driven aeroplanes, propulsive thrust means the total effective propulsive force obtained from an operating engine and its propeller.

[Ch.13, 05.10.89]

I 25.4 Reliability requirements (See JAR 25.1309 and AMJ 25.1309)

(a) The occurrence of an ATTCS system failure or a combination of failures in the ATTCS system during the critical time interval which –

(1) Prevents the insertion of the required thrust or power, must be shown to be Improbable;

(2) Results in a significant loss or reduction in thrust or power, must be shown to be Extremely Improbable.

(b) The concurrent existence of an ATTCS system failure and an engine failure during the critical time interval must be shown to be Extremely Improbable.

(c) The inadvertent operation of the ATTCS system must be shown either to be Remote or to have no more than a minor effect.

[Ch.13, 05.10.89]

I 25.5 Thrust or power setting

The initial setting of thrust or power controls on each engine at the beginning of the take-off roll may not be less than the lesser of –

(a) That required to permit normal operation of all safety-related systems and equipment dependent upon engine thrust or power lever position; or

(b) That shown to be free of hazardous engine response characteristics when thrust or power is increased from the initial take-off thrust or power level to the maximum approved take-off thrust or power.

[Ch.13, 05.10.89; Ch.14, 27.05.94]

I 25.6 Powerplant controls

(a) *General*

(1) In addition to the requirements of JAR 25.1141, no single failure or malfunction, or probable combination thereof, of the ATTCS system, including associated systems, may cause the failure of any powerplant function necessary for safety.

(2) The ATTCS system must be designed to perform accurately its intended function without exceeding engine operating limits under all reasonably expected conditions.

(b) *Thrust or Power Lever Control.* The ATTCS system must be designed to permit manual decrease or increase in thrust or power up to the maximum thrust or power approved for use following engine failure during take-off through the use of the normal thrust or power controls, except that, for aeroplanes equipped with limiters that automatically prevent engine operating limits from being exceeded, other means may be used to increase thrust or power provided that the means is located in an accessible position on or close to the thrust or power levers, is easily identified, and operated under all operating conditions by a single action of either pilot with the hand that is normally used to actuate the thrust or power levers.

(c) *System Control and Monitoring.* The ATTCS system must be designed to provide –

(1) A means for checking prior to take-off that the system is in an operable condition; and

(2) A means for the flight crew to de-activate the automatic function. This means must be designed to prevent inadvertent de-activation.

[Ch.13, 05.10.89]

I 25.7 Powerplant instruments

(a) *System Control and Monitoring.* A means must be provided to indicate when the ATTCS system is in the armed or ready condition.

(b) *Engine Failure Warning.* If the inherent flight characteristics of the aeroplane do not provide adequate warning that an engine has failed, a warning system which is independent of the ATTCS system must be provided to give the pilot a clear warning of engine failure during take-off.

[Ch.13, 05.10.89]

Appendix J

Emergency Demonstration

The following test criteria and procedures must be used for showing compliance with JAR 25.803:

(a) The emergency evacuation must be conducted either during the dark of the night or during daylight with the dark of night simulated. If the demonstration is conducted indoors during daylight hours, it must be conducted with each window covered and each door closed to minimise the daylight effect. Illumination on the floor or ground may be used, but it must be kept low and shielded against shining into the aeroplane's windows or doors.

(b) The aeroplane must be in a normal attitude with landing gear extended.

(c) Unless the aeroplane is equipped with an off-wing descent means, stands or ramps may be used for descent from the wing to the ground. Safety equipment such as mats or inverted life rafts may be placed on the floor or ground to protect participants. No other equipment that is not part of the aeroplane's emergency evacuation equipment may be used to aid the participants in reaching the ground.

(d) Except as provided in paragraph (a) of this Appendix, only the aeroplane's emergency lighting system may provide illumination.

(e) All emergency equipment required for the planned operation of the aeroplane must be installed.

(f) Each external door and exit, and each internal door or curtain, must be in the take-off configuration.

(g) Each crew member must be seated in the normally assigned seat for take-off and must remain in the seat until receiving the signal for commencement of the demonstration. Each crew member must be a person having knowledge of the operation of exits and emergency equipment and, if compliance with the applicable National Operating Rules is also being demonstrated, each cabin crew member must be a member of a regularly scheduled line crew.

(h) A representative passenger load of persons in normal health must be used as follows:

(1) At least 40% of the passenger load must be females.

(2) At least 35% of the passenger load must be over 50 years of age.

(3) At least 15% of the passenger load must be female and over 50 years of age.

(4) Three life-size dolls, not included as part of the total passenger load, must be carried by passengers to simulate live infants 2 years old or younger.

(5) Crew members, mechanics, and training personnel, who maintain or operate the aeroplane in the normal course of their duties, may not be used as passengers.

(i) No passenger may be assigned a specific seat except as the Authorities may require. Except as required by sub-paragraph (g) of this Appendix, no employee of the applicant may be seated next to an emergency exit.

(j) Seat belts and shoulder harnesses (as required) must be fastened.

(k) Before the start of the demonstration, approximately one-half of the total average amount of carry-on baggage, blankets, pillows, and other similar articles must be distributed at several locations in aisles and emergency exit access ways to create minor obstructions.

(l) No prior indication may be given to any crew member or passenger of the particular exits to be used in the demonstration.

(m) The applicant may not practise, rehearse, or describe the demonstration for the participants nor may any participant have taken part in this type of demonstration within the preceding 6 months.

(n) The pre take-off passenger briefing required by the applicable National Operating Rules may be given. The passengers may also be advised to follow directions of crew members but not be instructed on the procedures to be followed in the demonstration.

(o) If safety equipment as allowed by sub-paragraph (c) of this Appendix is provided, either all passenger and cockpit windows must be blacked out or all of the emergency exits must have safety equipment in order to prevent disclosure of the available emergency exits.

(p) Not more than 50% of the emergency exits in the sides of the fuselage of an aeroplane that meets all of the requirements applicable to the required emergency exits for that aeroplane may be used for the demonstration. Exits that are not to be used in the demonstration must have the exit handle deactivated or must be indicated by red lights, red tape, or other acceptable means placed outside the exits to indicate fire or other reason why they are unusable. The exits to be used must be representative of all of the emergency exits on

Appendix J (continued)

the aeroplane and must be designated by the applicant, subject to approval by the Authorities. At least one floor level exit must be used.

(q) Except as provided in sub-paragraph (c) of this paragraph, all evacuees must leave the aeroplane by a means provided as part of the aeroplane's equipment.

(r) The applicant's approved procedures must be fully utilised, except the flight-crew must take no active role in assisting others inside the cabin during the demonstration.

(s) The evacuation time period is completed when the last occupant has evacuated the aeroplane and is on the ground. Provided that the acceptance rate of the stand or ramp is no greater than the acceptance rate of the means available on the aeroplane for descent from the wing during an actual crash situation, evacuees using stands or ramps allowed by sub-paragraph (c) of this Appendix are considered to be on the ground when they are on the stand or ramp.

[Ch.14, 27.05.94; Ch.15, 01.10.00]

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Appendix K (No equivalent in FAR Part 25)

Element of System	Strength Value		Remarks
	Proof	Ultimate	
Rigid pipes and ducts	$1{\cdot}5\ P_W$	$3{\cdot}0\ P_W$	
Couplings	$1{\cdot}5\ P_W$	$3{\cdot}0\ P_W$	
Flexible hoses	$2{\cdot}0\ P_W$	$4{\cdot}0\ P_W$	
Return line elements	–	$1{\cdot}5\ P_f$	P_f The maximum pressure applied during failure conditions.
Components other than pipes, couplings, ducts or pressure vessels	$1{\cdot}5\ P_W$	$2{\cdot}0\ P_W$	
Pressure vessels fabricated from metallic materials. (For non-metallic materials see **[** JAR 25X1436(b)(7)) **]**			
Pressure vessels connected to a line source of pressure	$3{\cdot}0\ P_L$ or $1{\cdot}5\ P_L$	$4{\cdot}0\ P_L$ or $2{\cdot}0\ P_L$	The lower values are conditional upon justification by a fatigue endurance test from which a permissible fatigue life is declared, and upon the ultimate load test being made on the test specimen used for the fatigue life test.
Pressure vessels not connected to a line source of pressure, e.g. emergency vessels inflated from a ground source	$2{\cdot}5\ P_L$ or $1{\cdot}5\ P_L$	$3{\cdot}0\ P_L$ or $2{\cdot}0\ P_L$	The lower values are conditional upon justification by a life endurance test of a suitably factored permissible number of inflation/deflation cycles, including temperature fluctuation results in a signficant pressure variation, and upon the ultimate load test being made on the test specimen used for the life endurance test. For all pressure vessels: (1) The minimum acceptable conditions for storage, handling and inspection are to be defined in the appropriate manual. See JAR 25.1529(h). (2) The proof factor is to be sustained for at least three minutes. (3) The ultimate factor is to be sustained for at least one minute. The factor having been achieved, the pressure vessel may be isolated from the pressure source for the remaining portion of the test period.

[Ch.14, 27.05.94; Amdt. 16, 01.05.03]

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