SECTION 1 – REQUIREMENTS

1 GENERAL

1.1 This Section 1 contains the Requirements for Normal, Utility, Aerobatic, and Commuter Category Aeroplanes.

1.2 Areas in which variations and additions to FAR Part 23 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 23 regulation is not required for JAR-23, this is so stated. (See paragraph 2.3.)

2 PRESENTATION

2.1 The requirements of JAR-23 are presented in two columns on loose pages, each page being identified [by the date of the Amendment number under which it is amended or reissued. The amendment status of individual paragraphs, if amended, is indicated below each paragraph.]

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 of 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 23X602) 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 were 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 23.1 Applicability

(a) This code prescribes airworthiness standards for the issue of type certificates, and changes to those certificates, for –

(1) Aeroplanes in the normal, utility and aerobatic categories that have a seating configuration, excluding the pilot seat(s), of nine or fewer and a maximum certificated take-off weight of 5670 kg (12 500 lb) or less; and

(2) Propeller-driven twin-engined aeroplanes in the commuter category that have a seating configuration, excluding the pilot seat(s), of nineteen or fewer and a maximum certificated take-off weight of 8618 kg (19 000 lb) or less.

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

JAR 23.2 Special retroactive requirements

Not required for JAR 23.

JAR 23.3 Aeroplane categories

(a) The normal category is limited to non-aerobatic operations. Non-aerobatic operations include –

(1) Any manoeuvre incident to normal flying;

(2) Stalls (except whip stalls); and

(3) Lazy eights, chandelles and steep turns or similar manoeuvres, in which the angle of bank is not more than 60°.

(b) The utility category is limited to any of the operations covered under sub-paragraph (a) of this paragraph; plus –

(1) Spins (if approved for the particular type of aeroplane); and

(2) Lazy eights, chandelles, and steep turns, or similar manoeuvres in which the angle of bank is more than 60° but not more than 90°.

(c) The aerobatic category is without restrictions, other than those shown to be necessary as a result of required flight tests.

(d) Commuter category operation is limited to any manoeuvre incident to normal flying, stalls (except whip stalls) and steep turns in which the angle of bank is not more than 60°.

JAR 23.3 (continued)

(e) Except for commuter category, aeroplanes may be certificated in more than one category if the requirements of each requested category are met.

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SUBPART B – FLIGHT

GENERAL

JAR 23.21 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) The following general tolerances are allowed during flight testing. However, greater tolerances may be allowed in particular tests –

Item	*Tolerance*
Weight	+5%, –10%
Critical items affected by weight	+5%, –1%
C.G.	±7% total travel

JAR 23.23 Load distribution limits

(a) Ranges of weight and centres of gravity within which the aeroplane may be safely operated must be established and must include the range for lateral centres of gravity if possible loading conditions can result in significant variation of their positions.

(b) The load distribution must 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 23.25 Weight limits

(a) *Maximum weight.* The maximum weight is the highest weight at which compliance with each applicable requirement of JAR-23 (other than those complied with at the design landing

JAR 23.25 (a) (continued)

weight) is shown. The maximum weight must be established so that it is –

(1) Not more than the least of –

(i) The highest weight selected by the applicant; or

(ii) The design maximum weight, which is the highest weight at which compliance with each applicable structural loading condition of JAR-23 (other than those complied with at the design landing weight) is shown; or

(iii) The highest weight at which compliance with each applicable flight requirement is shown, and,

(2) Assuming a weight of 77 kg (170 lb) for each occupant of each seat for normal and commuter category aeroplanes and 86 kg (190 lb) (unless otherwise placarded) for utility and aerobatic category aeroplanes, not less than the weight with –

(i) Each seat occupied, oil at full tank capacity, and at least enough fuel for one-half hour of operation at rated maximum continuous power; or

(ii) The required minimum crew, and fuel and oil to full tank capacity.

(b) *Minimum weight.* The minimum weight (the lowest weight at which compliance with each applicable requirement of JAR-23 is shown) must be established so that it is not more than the sum of –

(1) The empty weight determined under JAR 23.29;

(2) The weight of the required minimum crew (assuming a weight of 77 kg (170 lb) for each crew member); and

(3) The weight of –

(i) For turbojet powered aeroplanes, 5% of the total fuel capacity of that particular fuel tank arrangement under investigation; and

(ii) For other aeroplanes, the fuel necessary for one-half hour of operation at maximum continuous power.

JAR 23.29 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 23.959; 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 precharge water, and water intended for injection in the engines.

(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.

JAR 23.31 Removable ballast

Removable ballast may be used in showing compliance with the flight requirements of this subpart, if –

(a) The place for carrying ballast is properly designed and installed, and is marked under JAR 23.1557; and

(b) Instructions are included in the Aeroplane Flight Manual, approved manual material, or markings and placards, for the proper placement of the removable ballast under each loading condition for which removable ballast is necessary.

JAR 23.33 Propeller speed and pitch limits

(a) *General.* The propeller speed and pitch must be limited to values that will assure safe operation under normal operating conditions.

(b) *Propellers not controllable in flight.* For each propeller whose pitch cannot be controlled in flight –

(1) During take-off and initial climb at the all-engine(s)-operating climb speed specified in JAR 23.65, the propeller must limit the engine rpm, at full throttle or at maximum allowable take-off manifold pressure, to a speed not greater than the maximum allowable take-off rpm; and

JAR 23.33 (b) (continued)

(2) During a closed throttle glide at V_{NE}, the propeller may not cause an engine speed above 110% of maximum continuous speed.

(c) *Controllable pitch propellers without constant speed controls.* Each propeller that can be controlled in flight, but that does not have constant speed controls, must have a means to limit the pitch range so that –

(1) The lowest possible pitch allows compliance with sub-paragraph (b) (1) of this paragraph; and

(2) The highest possible pitch allows compliance with sub-paragraph (b) (2) of this paragraph.

(d) *Controllable pitch propellers with constant speed controls.* Each controllable pitch propeller with constant speed controls must have –

(1) With the governor in operation, a means at the governor to limit the maximum engine speed to the maximum allowable take-off rpm; and

(2) With the governor inoperative, a means to limit the maximum engine speed to 103% of the maximum allowable take-off rpm with the propeller blades at the lowest possible pitch and with take-off manifold pressure, the aeroplane stationary, and no wind.

PERFORMANCE

JAR 23.45 General

(a) Unless otherwise prescribed, the performance requirements of this subpart must be met for –

(1) Still air and standard atmosphere;

(2) Ambient atmospheric conditions, for commuter category aeroplanes, for reciprocating engine-powered aeroplanes of [more than 2 721 kg (6 000 lb) maximum] weight and for turbine engine-powered aeroplanes.

(b) Performance data must be determined over not less than the following ranges of conditions –

(1) Aerodrome altitude from sea-level to 10 000 ft; and

(2) For reciprocating engine-powered [aeroplanes of 2 721 kg (6 000 lb) or less]

JAR 23.45 (b) (continued)

maximum weight, temperatures from standard to 30°C above standard; or

(3) For reciprocating engine-powered [aeroplanes of more than 2 721 kg (6 000 lb)] maximum weight and turbine engine-powered aeroplanes, temperature from standard to 30°C above standard, or the maximum ambient atmospheric temperature at which compliance with the cooling provisions of JAR 23.1041 to 23.1047 is shown, if lower.

(c) Performance data must be determined with the cowl flaps or other means for controlling the engine cooling air supply in the position used in the cooling tests required by JAR 23.1041 to 23.1047.

(d) The available propulsive thrust must correspond to engine power, not exceeding the approved power, less –

(1) Installation losses; and

(2) The power absorbed by the accessories and services appropriate to the particular ambient atmospheric conditions and the particular flight condition.

(e) The performance as affected by engine power must be based on a relative humidity of –

(1) 80% at and below standard temperature; and

(2) 34% at and above standard [temperature plus 28°C (plus 50°F)].

Between the two temperatures listed in sub-paragraphs (e) (1) and (e) (2) of this paragraph the relative humidity must vary linearly.

(f) Unless otherwise prescribed in determining the take-off and landing distances, changes in the aeroplane's configuration, speed and power must be made in accordance with procedures established by the Applicant for operation in service. These procedures must be able to be executed consistently by pilots of average skill in atmospheric conditions reasonably expected to be encountered in service.

(g) The following, as applicable, must be determined on a smooth, dry, hard-surfaced runway –

(1) Take-off distance of JAR 23.53 (b);

(2) Accelerate-stop distance of JAR 23.55;

(3) Take-off distance and take-off run of JAR 23.59; and

(4) Landing distance of JAR 23.75.

JAR 23.45 (g) (continued)

The effect on these distances of operation on other types of surface (e.g. grass, gravel) when dry, may be determined or derived and these distances listed in accordance with JAR 23.1583 (p).

(h) For commuter category aeroplanes, the following also apply:

(1) Unless otherwise prescribed, the applicant must select the take-off, en-route, approach and landing configurations for the aeroplane;

(2) The aeroplane configuration may vary with weight, altitude and temperature, to the extent that they are compatible with the operating procedures required by sub-paragraph (h) (3) of this paragraph;

(3) Unless otherwise prescribed, in determining the critical-engine-inoperative take-off performance, take-off flight path and accelerate-stop distance, changes in the aeroplane's configuration, speed and power must be made in accordance with procedures established by the applicant for operation in service.

(4) Procedures for the execution of discontinued approaches and balked landings associated with the conditions prescribed in JAR 23.67 (c) (4) and 23.77 (c) must be established; and

(5) The procedures established under sub-paragraphs (h) (3) and (h) (4) of this paragraph must –

(i) Be able to be consistently executed by a crew of average skill in atmospheric conditions reasonably expected to be encountered in service;

(ii) Use methods or devices that are safe and reliable; and

(iii) Include allowances for any reasonably expected time delays in the execution of the procedures.

[Amdt. 1, 01.02.01]

JAR 23.49 Stalling speed

(a) V_{SO} and V_{S1} are the stalling speeds or the minimum steady flight speed, in knots (CAS), at which the aeroplane is controllable with –

(1) For reciprocating engine-powered aeroplanes, engine(s) idling, the throttle(s) closed or at not more than the power necessary

JAR 23.49 (a) (continued)

for zero thrust at a speed not more than 110% of the stalling speed; and

(2) For turbine engine-powered aeroplanes, the propulsive thrust may not be greater than zero at the stalling speed, or, if the resultant thrust has no appreciable effect on the stalling speed, with engine(s) idling and throttle(s) closed;

(3) Propeller(s) in the take-off position;

(4) The aeroplane in the condition existing in the test in which V_{SO} and V_{S1} are being used;

(5) Centre of gravity in the position which results in the highest value of V_{SO} and V_{S1}; and

(6) Weight used when V_{SO} or V_{S1} are being used as a factor to determine compliance with a required performance standard.

(b) V_{SO} and V_{S1} must be determined by flight tests using the procedure and meeting the flight characteristics specified in JAR 23.201.

(c) V_{SO} at maximum weight must not exceed 61 knots for –

(1) Single-engined aeroplanes; and

(2) Twin-engined aeroplanes of [2 721 kg (6 000 lb) or less] maximum weight that cannot meet the minimum rate of climb specified in JAR 23.67 (a) (1) with the critical engine inoperative.

(d) *Not required for JAR-23.*

[Amdt. 1, 01.02.01]

JAR 23.51 Take-off speeds

(a) For normal utility and aerobatic category aeroplanes, the rotation speed V_R, is the speed at which the pilot makes a control input with the intention of lifting the aeroplane out of contact with the runway or water surface.

(1) For twin-engined landplanes, V_R must not be less than the greater of 1·05 V_{MC} or 1·10 V_{S1};

(2) For single engined landplanes, V_R, must not be less than V_{S1}; and

(3) For seaplanes and amphibians taking off from water, V_R, may be any speed that is shown to be safe under all reasonably expected conditions, including turbulence and complete failure of the critical engine.

JAR 23.51 (continued)

(b) For normal utility and aerobatic category aeroplanes, the speed at 50 ft must not be less than –

(1) For twin-engined aeroplanes, the highest of –

(i) A speed that is shown to be safe for continued flight (or land-back, if applicable) under all reasonably expected conditions, including turbulence and complete failure of the critical engine; or

(ii) 1·10 V_{MC}; or

(iii) 1·20 V_{S1}

(2) For single-engined aeroplanes, the higher of –

(i) A speed that is shown to be safe under all reasonably expected conditions, including turbulence and complete engine failure; or

(ii) 1·20 V_{S1}.

(c) For commuter category aeroplanes the following apply.

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

(i) V_{EF} is the calibrated airspeed at which the critical engine is assumed to fail. V_{EF} must be selected by the applicant, but must not be less than 1·05 V_{MC} determined under JAR 23.149 (b).
[NOTE: V_{MCG} determined under JAR 25.149 (e)] is acceptable in lieu of 1·05 V_{MC}.

(ii) The take-off decision speed, V_1, is the calibrated airspeed on the ground at which, as a result of engine failure or other reasons, the pilot is assumed to have made a decision to continue or discontinue the take-off. The take-off decision speed, V_1, must be selected by the applicant but must 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 application of the first retarding means during the accelerate-stop determination of JAR 23.55.

(2) The rotation speed, V_R, in terms of calibrated airspeed, must be selected by the applicant and must not be less than the greatest of the following:

(i) V_1; or

JAR 23.51 (c) (continued)

(ii) 1·05 V_{MC} determined under JAR 23.149 (b); or

(iii) 1·10 V_{SI}; or

(iv) The speed that allows attaining the initial climb-out speed, V_2, before reaching a height of 35 ft above the take-off surface in accordance with JAR 23.57 (c) (2).

(3) For any given set of conditions, such as weight, altitude, temperature and configuration, a single value of V_R must be used to show compliance with both the one-engine-inoperative take-off and all-engine-operating take-off requirements.

(4) The take-off safety speed, V_2, in terms of calibrated airspeed, must be selected by the applicant so as to allow the gradient of climb required in JAR 23.67 (c) (1) and (c) (2) but must not be less than 1·10 V_{MC} or less than 1·20 V_{SI}.

(5) The one-engine-inoperative take-off distance, using a normal rotation rate at a speed 5 knots less than V_R established in accordance with sub-paragraph (c) (2) of this paragraph, must be shown not to exceed the corresponding one-engine-inoperative take-off distance determined in accordance with JAR 23.57 and 23.59 (a) (1) using the established V_R. The take-off, otherwise performed in accordance with JAR 23.57 must safely be continued from the point at which the aeroplane is 35 ft above the take-off surface, at a speed not less than the established V_2 minus 5 knots.

(6) The applicant must show, with all engines operating, that marked increases in the scheduled take-off distances determined in accordance with JAR 23.59 (a) (2) do not result from over-rotation of the aeroplane or out-of-trim conditions.

[Amdt. 1, 01.02.01]

JAR 23.53 Take-off performance

(a) For normal, utility and aerobatic category aeroplanes the take-off distance must be determined in accordance with sub-paragraph (b), using speeds determined in accordance with JAR 23.51 (a) and (b).

(b) For normal, utility and aerobatic category aeroplanes the distance required to take-off and climb to a height of 50 ft above the take-off surface must be determined for each weight, altitude and temperature within the operational limits established for take-off with –

JAR 23.53 (b) (continued)

(1) Take-off power on each engine;

(2) Wing flaps in the take-off position(s); and

(3) Landing gear extended.

(c) For commuter category aeroplanes, take-off performance as required by JAR 23.55 to JAR 23.59 must be determined with the operating engines within approved operating limitations.

JAR 23.55 Accelerate-stop distance

For each commuter category aeroplane, the accelerate-stop distance must be determined as follows:

(a) The accelerate-stop distance is the sum of the distances necessary to –

(1) Accelerate the aeroplane from a standing start to V_{EF} with all engines operating;

(2) Accelerate the aeroplane from V_{EF} to V_1, assuming the critical engine fails at V_{EF}; and

(3) Come to a full stop from the point at which V_1 is reached.

(b) Means other than wheel-brakes may be used to determine the accelerate-stop distances if that means –

(1) Is safe and reliable; and

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

(3) *Not required for JAR-23.*

JAR 23.57 Take-off path

For each commuter category aeroplane, the take-off path is as follows;

(a) The take-off path extends from a standing start to a point in the take-off at which the aeroplane is 1 500 ft above the take-off surface, at or below which height the transition from the take-off to the en-route configuration must be completed; and

(1) The take-off path must be based on the procedures prescribed in JAR 23.45;

(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

JAR 23.57 (a) (continued)

(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 must not be initiated until the aeroplane is airborne.

(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 not be negative at any point;

(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 must not be less than 1·2%; and

(4) Except for gear retraction and automatic propeller feathering, the aeroplane configuration must not be changed, and no change in power 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 to 35 ft above the take-off surface must be determined by a continuous take-off.

(e) The take-off flight path from 35 ft above the take-off surface must be determined by synthesis from segments; and

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

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

(3) The take-off flight path must be based on the aeroplane's performance without ground effect.

JAR 23.59 Take-off distance and take-off run

For each commuter category aeroplane, the take-off distance and, at the option of the applicant, the take-off run, must be determined –

JAR 23.59 (continued)

(a) The take-off distance 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 23.57; or

(2) 115% of the horizontal distance, 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, determined by a procedure consistent with JAR 23.57.

(b) The take-off run is the greater of –

(1) The horizontal distance along the take-off path from the start of the take-off to a point equidistant between the lift off point and the point at which the aeroplane is 35 ft above the take-off surface, determined under JAR 23.57; or

(2) 115% of the horizontal distance, with all engines operating, from the start of the take-off to a point equidistant between the lift-off point and the point at which the aeroplane is 35 ft above the take-off surface, determined by a procedure consistent with JAR 23.57.

JAR 23.61 Take-off flight path

For each commuter category aeroplane, the take-off flight path must be determined as follows:

(a) The take-off flight path begins 35 ft above the take-off surface at the end of the take-off distance determined in accordance with JAR 23.59 (a).

(b) The net take-off flight path data must be determined so that they represent the actual take-off flight paths, as determined in accordance with JAR 23.57 and with sub-paragraph (a) of this paragraph, reduced at each point by a gradient of climb equal to 0·8%.

(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.

JAR 23.63 Climb: general

(a) Compliance with the requirements of JAR 23.65, 23.66, 23.67, 23.69 and 23.77 must be shown –

(1) Out of ground effect; and

JAR 23.63 (a) (continued)

(2) At speeds which are not less than those at which compliance with the powerplant cooling requirements of JAR 23.1041 to 23.1047 has been demonstrated.

(3) *Not required for JAR-23.*

(b) For normal, utility and aerobatic category reciprocating engine-powered aeroplanes of [2 721 kg (6 000 lb) or less maximum weight,] compliance must be shown with JAR 23.65 (a), 23.67 (a), where appropriate and JAR 23.77 (a) at maximum take-off or landing weight, as appropriate in a standard atmosphere.

(c) For normal, utility and aerobatic category reciprocating engined aeroplanes of more than [2 721 kg (6 000 lb) maximum weight and] turbine engine-powered aeroplanes in the normal, utility and aerobatic category, compliance must be shown, at weights, as a function of aerodrome altitude and ambient temperature, within the operational limits established for take-off and landing respectively, with –

(1) JAR 23.65 (b) and 23.67 (b) (1) and (2), where appropriate, for take-off; and

(2) JAR 23.67 (b) (2), where appropriate, and JAR 23.77 (b), for landing.

(d) For commuter category aeroplanes, compliance must be shown, at weights as a function of aerodrome altitude and ambient temperature within the operational limits established for take-off and landing respectively, with –

(1) JAR 23.67 (c) (1), 23.67 (c) (2) and 23.67 (c) (3) for take-off; and

(2) JAR 23.67 (c) (3), 23.67 (c) (4) and 23.77 (c) for landing.

[Amdt. 1, 01.02.01]

JAR 23.65 Climb: all engines operating

(a) Each normal, utility and aerobatic category reciprocating engine-powered aeroplane [of 2 721 kg (6 000 lb) or less maximum weight] must have a steady gradient of climb at sea level of at least 8·3% for landplanes or 6·7% for seaplanes and amphibians with –

(1) Not more than maximum continuous power on each engine;

(2) The landing gear retracted;

(3) The wing flaps in the take-off position(s); and

JAR 23.65 (a) (continued)

(4) A climb speed not less than the greater of 1·1 V_{MC} and 1·2 V_{S1} for twin-engined aeroplanes and not less than 1·2 V_{S1} for single-engined aeroplanes.

(b) Each normal, utility and aerobatic category reciprocating engine-powered aeroplanes [of more than 2 721 kg (6 000 lb) maximum] weight and turbine engine-powered aeroplanes in the normal, utility and aerobatic category must have a steady gradient of climb after take-off of at least 4% with –

(1) Take-off power on each engine;

(2) The landing gear extended except that, if the landing gear can be retracted in not more than 7 seconds, it may be assumed to be retracted;

(3) The wing flaps in the take-off position(s); and

(4) A climb speed as specified in JAR 23.65 (a) (4).

[Amdt. 1, 01.02.01]

JAR 23.66 Take-off climb: one-engine-inoperative

For normal, utility and aerobatic category reciprocating engine-powered aeroplanes of more [than 2 721 kg (6 000 lb) maximum weight and] turbine engine-powered aeroplanes in the normal, utility and aerobatic category, the steady gradient of climb or descent must be determined at each weight, altitude and ambient temperature within the operational limits established by the applicant with –

(1) The critical engine inoperative and its propeller in the position it rapidly and automatically assumes;

(2) The remaining engine at take-off power;

(3) The landing gear extended except that, if the landing gear can be retracted in not more than 7 seconds, it may be assumed to be retracted;

(4) The wing flaps in the take-off position(s);

(5) The wings level; and

(6) A climb speed equal to that achieved at 50 ft in the demonstration of JAR 23.53.

[Amdt. 1, 01.02.01]

JAR 23.67 Climb: one-engine-inoperative

(a) For normal, utility and aerobatic category reciprocating engine-powered aeroplanes of [2 721kg (6 000 lb) or less maximum weight the] following apply:

(1) Each aeroplane with a V_{SO} of more than 61 knots must be able to maintain a steady climb gradient of at least 1·5% at a pressure altitude of 5 000 ft with –

(i) The critical engine -in-operative and its propeller in the minimum drag position;

(ii) The remaining engine at not more than maximum continuous power;

(iii) The landing gear retracted;

(iv) The wing flaps retracted; and

(v) A climb speed not less than 1·2 V_{S1}.

(2) For each aeroplane with a V_{SO} of 61 knots or less, the steady gradient of climb or descent at a pressure altitude of 5 000 ft must be determined with –

(i) The critical engine in-operative and its propeller in the minimum drag position;

(ii) The remaining engine at not more than maximum continuous power;

(iii) The landing gear retracted;

(iv) The wing flaps retracted; and

(v) A climb speed not less than 1·2 V_{S1}.

(b) For normal, utility and aerobatic category reciprocating engine-powered aeroplanes of more [than 2 721 kg (6 000 lb) maximum weight and] turbine engine-powered aeroplanes in the normal, utility and aerobatic category –

(1) The steady gradient of climb at an altitude of 400 ft above the take-off surface must be measurably positive with –

(i) The critical engine in-operative and its propeller in the minimum drag position;

(ii) The remaining engine at take-off power;

(iii) The landing gear retracted;

(iv) The wing flaps in the take-off position(s); and

JAR 23.67 (b) (continued)

(v) A climb speed equal to that achieved at 50 ft in the demonstration of JAR 23.53.

(2) The steady gradient of climb must not be less than 0·75% at an altitude of 1 500 ft above the take-off or landing surface, as appropriate with –

(i) The critical engine in-operative and its propeller in the minimum drag position;

(ii) The remaining engine at not more than maximum continuous power;

(iii) The landing gear retracted;

(iv) The wing flaps retracted; and

(v) A climb speed not less than 1·2 V_{S1}.

(c) For commuter category aeroplanes, the following apply:

(1) *Take-off: landing gear extended.* The steady gradient of climb at the altitude of the take-off surface must be measurably positive with –

(i) The critical engine inoperative and its propeller in the position it rapidly and automatically assumes;

(ii) The remaining engine at take-off power;

(iii) The landing gear extended, all landing gear doors open;

(iv) The wing flaps in the take-off position(s);

(v) The wings level; and

(vi) A climb speed equal to V_2.

(2) *Take-off: landing gear retracted.* The steady gradient of climb at an altitude of 400 ft above the take-off surface must be not less than 2·0% with –

(i) The critical engine inoperative and its propeller in the position it rapidly and automatically assumes;

(ii) The remaining engine at take-off power;

(iii) The landing gear retracted;

(iv) The wing flaps in the take-off position(s); and

(v) A climb speed equal to V_2.

(3) *En-route.* The steady gradient of climb at an altitude of 1 500 ft above the take-

JAR 23.67 (c) (continued)

off or landing surface, as appropriate, must be not less than 1·2% with –

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

(ii) The remaining engine at not more than maximum continuous power;

(iii) The landing gear retracted;

(iv) The wing flaps retracted; and

(v) A climb speed not less than 1·2 V_{S1}.

(4) *Discontinued approach.* The steady gradient of climb at an altitude of 400 ft above the landing surface must be not less than 2·1% with –

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

(ii) The remaining engine at take-off power;

(iii) The landing gear retracted;

(iv) The wing flaps in the approach position(s) in which V_{S1} for these positions(s) does not exceed 110% of the V_{S1} for the related all-engines-operating landing position(s); and

(v) A climb speed established in connection with normal landing procedures but not exceeding 1·5 V_{S1}.

[Amdt. 1, 01.02.01]

JAR 23.69 En-route climb/descent

(a) *All engines operating*

The steady gradient and rate of climb must be determined at each weight, altitude and ambient temperature within the operational limits established by the applicant with –

(1) Not more than maximum continuous power on each engine;

(2) The landing gear retracted;

(3) The wing flaps retracted; and

(4) A climb speed not less than 1·3 V_{S1}.

(b) *One-engine-inoperative*

The steady gradient and rate of climb/descent must be determined at each weight, altitude and ambient temperature within the operational limits established by the applicant with –

JAR 23.69 (b) (continued)

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

(2) The remaining engine at not more than maximum continuous power;

(3) The landing gear retracted;

(4) The wing flaps retracted; and

(5) A climb speed not less than 1·2 V_{S1}.

JAR 23.71 Glide (Single-engined aeroplanes)

The maximum horizontal distance travelled in still air, in nautical miles per 1 000 ft of altitude lost in a glide, and the speed necessary to achieve this, must be determined with the engine inoperative and its propeller in the minimum drag position, landing gear and wing flaps in the most favourable available position.

JAR 23.73 Reference landing approach speed

(a) For normal, utility and aerobatic category reciprocating engine-powered aeroplanes of [2 721 kg (6 000 lb) or less maximum weight, the] reference landing approach speed, V_{REF}, must not be less than the greater of V_{MC}, determined under JAR 23.149 (b) with the wing flaps in the most extended take-off setting, and 1·3 V_{SO}.

(b) For normal, utility and aerobatic category reciprocating engine-powered aeroplanes of more [than 2 721 kg (6 000 lb) maximum weight and] turbine engine-powered aeroplanes in the normal, utility and aerobatic category, the reference landing approach speed, V_{REF}, must not be less than the greater of V_{MC}, determined under JAR 23.149 (c), and 1·3 V_{SO}.

(c) For commuter category aeroplanes, the reference landing approach speed, V_{REF}, must not be less than the greater of 1·05 V_{MC}, determined under JAR 23.149 (c), and 1·3 V_{SO}.

[Amdt. 1, 01.02.01]

JAR 23.75 Landing distance

The horizontal distance necessary to land and come to a complete stop from a point 50 ft above the landing surface must be determined, for standard temperatures at each weight and altitude within the operational limits established for landing, as follows:

(a) A steady approach at not less than V_{REF}, determined in accordance with JAR 23.73 (a), (b)

JAR 23.75 (a) (continued)

or (c) as appropriate, must be maintained down to 50-foot height and –

(1) The steady approach must be at a gradient of descent not greater than 5·2% (3°) down to the 50-foot height.

(2) In addition, an applicant may demonstrate by tests that a maximum steady approach gradient, steeper than 5·2% (3°), down to the 50-foot height is safe. The gradient must be established as an operating limitation and the information necessary to display the gradient must be available to the pilot by an appropriate instrument.

(b) A constant configuration must be maintained throughout the manoeuvre;

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

(d) It must be shown that a safe transition to the balked landing conditions of JAR 23.77 can be made from the conditions that exist at the 50 ft height, at maximum landing weight or the maximum landing weight for altitude and temperature of JAR 23.63 (c) (2) or (d) (2), as appropriate.

(e) The brakes must not be used so as to cause excessive wear of brakes or tyres.

(f) Retardation means other than wheelbrakes may be used if that means –

(1) Is safe and reliable;

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

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

JAR 23.77 Balked landing

(a) Each normal, utility and aerobatic category reciprocating engine-powered aeroplane [of 2 721 kg (6 000 lb) or less maximum weight] must be able to maintain a steady gradient of climb at sea-level of at least 3·3% with –

(1) Take-off power on each engine;

(2) The landing gear extended;

JAR 23.77 (a) (continued)

(3) The wing flaps in the landing position, except that if the flaps may safely be retracted in two seconds or less without loss of altitude and without sudden changes of angle of attack, they may be retracted; and

(4) A climb speed equal to VREF, as defined in JAR 23.73 (a).

(b) For normal, utility and aerobatic category each reciprocating engine-powered aeroplane of [more than 2 721 kg (6 000 lb) maximum weight] and turbine engine-powered aeroplanes in the normal, utility and aerobatic category, the steady gradient of climb must not be less than 2·5% with –

(1) Not more than the power or thrust that is available 8 seconds after initiation of movement of the power controls from the minimum flight-idle position;

(2) The landing gear extended;

(3) The wing flaps in the landing position; and

(4) A climb speed equal to VREF, as defined in JAR 23.73 (b).

(c) For each commuter category aeroplane, the steady gradient of climb must not be less than 3·2% with –

(1) Not more than the power that is available 8 seconds after initiation of movement of the power controls from the minimum flight idle position;

(2) Landing gear extended;

(3) Wing flaps in the landing position; and

(4) A climb speed equal to VREF, as defined in JAR 23.73 (c).

[Amdt. 1, 01.02.01]

FLIGHT CHARACTERISTICS

JAR 23.141 General

The aeroplane must meet the requirements of JAR 23.143 to 23.253 at all practical loading conditions and all operating altitudes, not exceeding the maximum operating altitude established under JAR 23.1527, for which certification has been requested, without requiring exceptional piloting skill, alertness or strength.

CONTROLLABILITY AND MANOEUVRABILITY

JAR 23.143 General

(a) The aeroplane must be safely controllable and manoeuvrable during all flight phases including –

(1) Take-off;

(2) Climb;

(3) Level flight;

(4) Descent;

(5) Go-around; and

(6) Landing (power on and power off) with the wing flaps extended and retracted.

(b) It must be possible to make a smooth transition from one flight condition to another (including turns and slips) without danger of exceeding the limit load factor, under any probable operating condition, (including, for multi-engined aeroplanes, those conditions normally encountered in the sudden failure of any engine).

(c) If marginal conditions exist with regard to required pilot strength, the control forces required must be determined by quantitative tests. In no case may the control forces under the conditions specified in sub-paragraphs (a) and (b), exceed those prescribed in the following table:

Values in pounds force applied to the relevant control	Pitch	Roll	Yaw
For temporary application –			
Stick	60	30	–
Wheel (two hands on rim)	75	50	–
Wheel (one hand on rim)	50	25	–
Rudder pedal	–	–	150
For prolonged application –	10	5	20

JAR 23.145 Longitudinal control

(a) With the aeroplane as nearly as possible in trim at 1·3 V_{S1}, it must be possible, at speeds below the trim speed, to pitch the nose downward so that the rate of increase in airspeed allows prompt acceleration to the trim speed with –

(1) Maximum continuous power on each engine;

(2) Power off; and

JAR 23.145 (a) (continued)

(3) Wing flaps and landing gear –

(i) Retracted; and

(ii) Extended.

(b) It must be possible to carry out the following manoeuvres without requiring the application of single handed control forces exceeding those specified in JAR 23.143 (c), unless otherwise stated. The trimming controls must not be adjusted during the manoeuvres:

(1) With landing gear extended and flaps retracted and the aeroplane as nearly as possible in trim at 1·4 V_{S1}, extend the flaps as rapidly as possible and allow the airspeed to transition from 1·4 V_{S1} to 1·4 V_{SO}, with –

(i) Power off; and

(ii) Power necessary to maintain level flight in the initial condition.

(2) With landing gear and flaps extended, power off and the aeroplane as nearly as possible in trim at 1·3 V_{SO}, quickly apply take-off power and retract the flaps as rapidly as possible to the recommended go-around setting and allow the airspeed to transition from 1·3 V_{SO} to 1·3 V_{S1}. Retract the gear when a positive rate of climb is established.

(3) With landing gear and flaps extended, power for and in level flight at 1·1 V_{SO} and the aeroplane as nearly as possible in trim, it must be possible to maintain approximately level flight while retracting the flaps as rapidly as possible with simultaneous application of not more than maximum continuous power. If gated flap positions are provided, the flap retraction may be demonstrated in stages with power and trim reset for level flight at 1·1 V_{S1} in the initial configuration for each stage –

(i) From the fully extended position to the most extended gated position;

(ii) Between intermediate gated positions, if applicable; and

(iii) From the least extended gated position to the fully retracted position.

(4) With power off, flaps and landing gear retracted and the aeroplane as nearly as possible in trim at 1·4 V_{S1}, apply take-off power rapidly while maintaining the same airspeed.

(5) With power off, landing gear and flaps extended and the aeroplane as nearly as

JAR 23.145 (b) (continued)

possible in trim at VREF, obtain and maintain airspeeds between 1·1 VSO and either 1·7 VSO or VFE, whichever is lower, without requiring the application of two-handed control forces exceeding those specified in JAR 23.143 (c).

(6) With maximum take-off power, landing gear retracted, flaps in the take-off position and the aeroplane as nearly as possible in trim at VFE appropriate to the take-off flap position, retract the flaps as rapidly as possible while maintaining speed constant.

(c) At speeds above VMO/MMO and up to the maximum speed shown under JAR 23.251, a manoeuvring capability of 1·5g must be demonstrated to provide a margin to recover from upset or inadvertent speed increase.

(d) It must be possible, with a pilot control force of not more than 44·4 N (10 lb), to maintain a speed of not more than VREF during a power-off glide with landing gear and wing flaps extended.

(e) By using normal flight and power controls, except as otherwise noted in sub-paragraphs (e) (1) and (e) (2) of this paragraph, it must be possible to establish a zero rate of descent at an attitude suitable for a controlled landing without exceeding the operational and structural limitations of the aeroplane, as follows:

(1) For single-engined and twin-engined aeroplanes, without the use of the primary longitudinal control system;

(2) For twin-engined aeroplanes;

(i) Without the use of the primary directional control; and

(ii) If a single failure of any one connecting or transmitting link would affect both the longitudinal and directional primary control system, without the primary longitudinal and directional control system.

JAR 23.147 Directional and lateral control

(a) For each twin-engined aeroplane, it must be possible, while holding the wings level within 5°, to make sudden changes in heading safely in both directions. This must be shown at 1·4 VS1 with heading changes up to 15° (except that the heading change at which the rudder force corresponds to the limits specified in JAR 23.143 need not be exceeded), with the –

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

JAR 23.147 (a) (continued)

(2) Remaining engine at maximum continuous power;

(3) Landing gear –

(i) Retracted; and

(ii) Extended; and

(4) Flaps retracted.

(b) For each twin-engined aeroplane, it must be possible to regain full control of the aeroplane without exceeding a bank angle of 45°, reaching a dangerous attitude or encountering dangerous characteristics, in the event of a sudden and complete failure of the critical engine, making allowance for a delay of 2 seconds in the initiation of recovery action appropriate to the situation, with the aeroplane initially in trim, in the following conditions –

(1) Maximum continuous power on each engine;

(2) Wing flaps retracted;

(3) Landing gear retracted;

(4) Speed equal to that at which compliance with JAR 23.69 (a) has been shown;

(5) All propeller controls in the position in which compliance with JAR 23.69 (a) has been shown.

(c) For all aeroplanes, it must be shown that the aeroplane is safely controllable without the use of the primary lateral control system in any configuration and at any speed or altitude within the approved operating envelope. It must also be shown that the aeroplane's flight characteristics are not impaired below a level needed to permit continued safe flight and the ability to maintain attitudes suitable for a controlled landing without exceeding the operational and structural limitations of the aeroplane. If a single failure of any one connecting or transmitting link in the lateral control system would also cause the loss of additional control system(s), the above requirement is equally applicable with those additional systems also assumed to be inoperative.

JAR 23.149 Minimum control speed

(a) VMC 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 thereafter maintain straight flight at the same speed with an angle of bank not more than 5°. The method used to simulate critical engine

JAR 23.149 (a) (continued)

failure must represent the most critical mode of powerplant failure with respect to controllability expected in service.

(b) VMC for take-off must not exceed 1·2 VS1, (where VS1 is determined at the maximum take-off weight) and must be determined with the most unfavourable weight and centre of gravity position and with the aeroplane airborne and the ground effect negligible, for the take-off configuration(s) with –

(1) Maximum available take-off power initially on each engine;

(2) The aeroplane trimmed for take-off;

(3) Flaps in the take-off position(s);

(4) Landing gear retracted; and

(5) All propeller controls in the recommended take-off position throughout.

(c) For all aeroplanes except reciprocating [engine-powered aeroplanes of 2 721 kg (6 000] lb) or less maximum weight, the requirements of sub-paragraph (a) must also be met for the landing configuration with –

(1) Maximum available take-off power initially on each engine;

(2) The aeroplane trimmed for and approach with all engines operating at VREF at an approach gradient equal to the steepest used in the landing distance demonstration of JAR 23.75;

(3) Flaps in the landing position;

(4) Landing gear extended; and

(5) All propeller controls throughout in the position recommended for approach with all engines operating.

(d) At VMC, the rudder pedal force required to maintain control must not exceed 667·5 N (150 lb) and it must not be necessary to reduce power of the operative engine . During the manoeuvre the aeroplane must not assume any dangerous attitude and it must be possible to prevent a heading change of more than 20.

(e) *Not required for JAR-23.*

[Amdt. 1, 01.02.01]

JAR 23.151 Aerobatic manoeuvres

Each aerobatic and utility category aeroplane must be able to perform safely the aerobatic manoeuvres for which certification is requested.

JAR 23.151 (continued)

Safe entry speeds for these manoeuvres must be determined.

JAR 23.153 Control during landings

It must be possible, while in the landing configuration, to safely complete a landing without exceeding the one-hand control force limits specified in JAR 23.143 (c) following an approach to land –

(a) At a speed of VREF –5 knots;

(b) With the aeroplane in trim, or as nearly as possible in trim and without the trimming control being moved throughout the manoeuvre;

(c) At an approach gradient equal to the steepest used in the landing distance demonstration of JAR 23.75;

(d) With only those power changes, if any, which would be made when landing normally from an approach at VREF.

JAR 23.155 Elevator control force in manoeuvres

(a) The elevator control force needed to achieve the positive limit manoeuvring load factor may not be less than –

(1) For wheel controls, W/10N (where W is the maximum weight in kg) (W/100 lb (where W is the maximum weight)) or 89 N (20 lb), whichever is greater, except that it need not be greater than 222 N (50 lb); or

(2) For stick controls, W/14N (where W is the maximum weight in kg) (W/140 lb (where W is the maximum weight)) or 66·8 N (15 lb), whichever is greater, except that it need not be greater than 156 N (35 lb).

(b) The requirement of sub-paragraph (a) of this paragraph must be met with wing flaps and landing gear retracted under each of the following conditions –

(1) At 75% of maximum continuous power for reciprocating engines or maximum continuous power for turbine engines.

(2) In a turn, after the aeroplane is trimmed with wings level, at the minimum speed at which the required normal acceleration can be achieved without stalling, and at the maximum level flight trim speed except that the speed may not exceed VNE or VMO/MMO, whichever is appropriate.

JAR 23.155 (continued)

(c) There must be no excessive decrease in the gradient of the curve of stick force versus manoeuvring load factor with increasing load factor.

JAR 23.157 Rate of roll

(a) *Take–off.* It must be possible, using a favourable combination of controls, to roll the aeroplane from a steady 30° banked turn through an angle of 60°, so as to reverse the direction of the turn within –

[(1) For an aeroplane of 2 721 kg] (6 000 lb) or less maximum weight, 5 seconds from initiation of roll; and

[(2) For aeroplanes of over 2 721 kg] (6 000 lb) maximum weight,

$\frac{W+200}{590}$ but not more than 10 seconds, where W is the weight in kg,

($\frac{W+500}{1300}$ but not more than 10 seconds, where W is the weight in lb.)

(b) The requirement of sub-paragraph (a) must be met when rolling the aeroplane in each direction in the following conditions –

(1) Flaps in the take-off position;

(2) Landing gear retracted;

(3) For a single-engined aeroplane, at maximum take-off power and for a twin-engined aeroplane, with the critical engine inoperative, the propeller in the minimum drag position and the remaining engine at maximum take-off power; and

(4) The aeroplane trimmed at 1·2 V_{S1} or as nearly as possible in trim for straight flight.

(c) *Approach.* It must be possible using a favourable combination of controls, to roll the aeroplane from a steady 30° banked turn through an angle of 60°, so as to reverse the direction of the turn within –

[(1) For an aeroplane of 2 721 kg] (6 000 lb) or less maximum weight, 4 seconds from initiation of roll; and

[(2) For and aeroplane of over 2 721 kg] (6 000 lb) maximum weight,

$\frac{W+1\,300}{1\,000}$ but not more than 7 seconds where W is weight in kg.

JAR 23.157 (c) (continued)

($\frac{W+2\,800}{2\,200}$ but not more than 7 seconds where W is weight in lb.)

(d) The requirement of sub-paragraph (c) must be met when rolling the aeroplane in each direction in the following conditions –

(1) Flaps in the landing position(s);

(2) Landing gear extended;

(3) All engines operating at the power for a 3° approach; and

(4) The aeroplane trimmed at V_{REF}.

[Amdt. 1, 01.02.01]

TRIM

JAR 23.161 Trim

(a) *General.* Each aeroplane must meet the trim requirements of this section after being trimmed and without further pressure upon, or movement of, the primary controls or their corresponding trim controls by the pilot or the automatic pilot. In addition, it must be possible, in other conditions of loading, configuration, speed and power to ensure that the pilot will not be unduly fatigued or distracted by the need to apply residual control forces exceeding those for prolonged application of JAR 23.143 (c). This applies in normal operation of the aeroplane and, if applicable, to those conditions associated with the failure of one engine for which performance characteristics are established.

(b) *Lateral and directional trim.* The aeroplane must maintain lateral and directional trim in level flight with the landing gear and wing flaps retracted as follows:

(1) For normal, utility and aerobatic category aeroplanes, at a speed of 0·9 V_H, V_C or V_{MO}/M_{MO}, whichever is lowest; and

(2) For commuter category aeroplanes, at all speeds from 1·4 V_{S1} to the lesser of V_H or V_{MO}/M_{MO}.

(c) *Longitudinal trim.* The aeroplane must maintain longitudinal trim under each of the following conditions:

(1) A climb with;

(i) Take-off power, landing gear retracted, wing flaps in the take-off position(s), at the speeds used in

JAR 23.161 (c) (continued)

determining the climb performance required by JAR 23.65; and

(ii) Maximum continuous power at the speeds and in the configuration used in determining the climb performance required by JAR 23.69 (a).

(2) Level flight at all speeds from the lesser of V_H and either V_{NO} or V_{MO}/M_{MO} (as appropriate), to 1·4 V_{S1}, with the landing gear and flaps retracted.

(3) A descent at V_{NO} or V_{MO}/M_{MO}, whichever is applicable, with power off and with the landing gear and flaps retracted.

(4) Approach with landing gear extended and with –

(i) A 3° angle of descent, with flaps retracted and at a speed of 1·4 V_{S1};

(ii) A 3° angle of descent, flaps in the landing position(s) at V_{REF}; and

(iii) An approach gradient equal to the steepest used in the landing distance demonstrations of JAR 23.75, flaps in the landing position(s) at V_{REF}.

(d) In addition, each twin-engined aeroplane must maintain longitudinal and directional trim and the lateral control force must not exceed 22 N (5 lb), at the speed used in complying with JAR 23.67 (a) or (b) (2) or (c) (3) as appropriate, with –

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

(2) The remaining engine at maximum continuous power;

(3) The landing gear retracted;

(4) The wing flaps retracted; and

(5) An angle of bank of not more than 5°.

(e) In addition, each commuter category aeroplane for which, in the determination of the take-off path in accordance with JAR 23.57, the climb in the take-off configuration at V_2 extends beyond 400 ft above the take-off surface, it must be possible to reduce the longitudinal and lateral control forces to 44·5 N (10 lb) and 22 N (5 lb) respectively and the directional control force must not exceed 222 N (50 lb) at V_2 with –

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

(2) The remaining engine at take-off power;

JAR 23.161 (e) (continued)

(3) Landing gear retracted;

(4) Wing flaps in the take-off position(s); and

(5) An angle of bank not exceeding 5°.

STABILITY

JAR 23.171 General

The aeroplane must be longitudinally, directionally and laterally stable under JAR 23.173 to 23.181. In addition, the aeroplane must show suitable stability and control "feel" (static stability) in any condition normally encountered in service, if flight tests show it is necessary for safe operation.

JAR 23.173 Static longitudinal stability

Under the conditions specified in JAR 23.175 and with the aeroplane trimmed as indicated, the characteristics of the elevator control forces and the friction within the control system must be as follows:

(a) A pull must be required to obtain and maintain speeds below the specified trim speed and a push required to obtain and maintain speeds above the specified trim speed. This must be shown at any speed that can be obtained, except that speeds requiring a control force in excess of 178 N (40 lb) or speeds above the maximum allowable speed or below the minimum speed for steady unstalled flight, need not be considered.

(b) The airspeed must return to within the tolerances specified when the control force is slowly released at any speed within the speed range specified in sub-paragraph (a) of this paragraph. The applicable tolerances are –

(1) For all aeroplanes, plus or minus 10% of the original trim airspeed; and in addition;

(2) For commuter category aeroplanes, plus or minus 7·5% of the original trim airspeed for the cruising conditions specified in JAR 23.175 (b).

(c) The stick force must vary with speed so that any substantial speed change results in a stick force clearly perceptible to the pilot.

JAR 23.175 Demonstration of static longitudinal stability

Static longitudinal stability must be shown as follows:

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

(1) Flaps retracted;

(2) Landing gear retracted;

(3) Maximum continuous power ; and

(4) The aeroplane trimmed at the speed used in determining the climb performance required by JAR 23.69 (a).

(b) *Cruise.* With flaps and landing gear retracted and the aeroplane in trim with power for level flight at representative cruising speeds at high and low altitudes, including speeds up to VNO or VMO/MMO as appropriate, except that the speed need not exceed VH –

(1) For normal, utility and aerobatic category aeroplanes, the stick force curve must have a stable slope at all speeds within a range that is the greater of 15% of the trim speed plus the resulting free return speed range, or 40 knots plus the resulting free return speed range, above and below the trim speed, except that the slope need not be stable –

(i) At speeds less than 1·3 VSI; or

(ii) For aeroplanes with VNE established under JAR 23.1505 (a), at speeds greater than VNE; or

(iii) For aeroplanes with VMO/MMO established under JAR 23.1505 (c), at speeds greater than VFC/MFC.

(2) For commuter category aeroplanes, the stick force curve must have a stable slope at all speeds within a range of 50 knots plus the resulting free return speed range, above and below the trim speed, except that the slope need not be stable –

(i) At speeds less than 1·4 VSI; or

(ii) At speeds greater than VFC/MFC; or

(iii) At speeds that require a stick force greater than 222 N (50 lb).

(c) *Landing.* The stick force curve must have a stable slope at speeds between 1·1 VS1 and 1·8 VS1 with –

(1) Flaps in the landing position;

JAR 23.175 (c) (continued)

(2) Landing gear extended; and

(3) The aeroplane trimmed at –

(i) VREF, or the minimum trim speed if higher, with power off; and

(ii) VREF with enough power to maintain a 3° angle of descent.

JAR 23.177 Static directional and lateral stability

(a) The static directional stability, as shown by the tendency to recover from a sideslip with the rudder free, must be positive for any landing gear and flap position appropriate to the take-off, climb, cruise, approach and landing configurations. This must be shown with symmetrical power up to maximum continuous power and at speeds from 1·2 VS1 up to maximum allowable speed for the condition being investigated. The angle of sideslip for these tests must be appropriate to the type of aeroplane. At larger angles of sideslip up to that at which full rudder is used or a control force limit in JAR 23.143 is reached, whichever occurs first, and at speeds from 1·2 VS1 to VA the rudder pedal force must not reverse.

(b) The static lateral stability, as shown by the tendency to raise the low wing in a sideslip, must be positive for all landing gear and flap positions. This must be shown with symmetrical power up to 75% of maximum continuous power at speeds above 1·2 VS1 in the take-off configuration(s) and at speeds above 1·3 VS1 in other configurations, up to the maximum allowable speed for the configuration being investigated, in the take-off, climb, cruise and approach configurations. For the landing configuration, the power must be up to that necessary to maintain a 3° angle of descent in co-ordinated flight. The static lateral stability must not be negative at 1·2 VS1 in the take-off configuration, or at 1·3 VS1 in other configurations. The angle of sideslip for these tests must be appropriate to the type of aeroplane but in no case may the constant heading sideslip angle be less than that obtainable with 10° bank, or if less, the maximum bank angle obtainable with full rudder deflection or 667 N (150 lb) rudder force.

(c) Sub-paragraph (b) does not apply to aerobatic category aeroplanes certificated for inverted flight.

(d) In straight, steady sideslips at 1·2 VS1 for any landing gear and flap positions and for any symmetrical power conditions up to 50% of

JAR 23.177 (d) (continued)

maximum continuous power, the aileron and rudder control movements and forces must increase steadily (but not necessarily in constant proportion) as the angle of sideslip is increased up to the maximum appropriate to the type of aeroplane. At larger sideslip angles up to the angle at which full rudder or aileron control is used or a control force limit contained in JAR 23.143 is reached, the aileron and rudder control movements and forces must not reverse as the angle of sideslip is increased. Rapid entry into, or recovery from, a maximum sideslip considered appropriate for the aeroplane must not result in uncontrollable flight characteristics.

JAR 23.181 Dynamic stability

(a) Any short period oscillation not including combined lateral-directional oscillations occurring between the stalling speed and the 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, except when compliance with JAR 23.672 is shown.

(b) Any combined lateral–directional oscillations ("Dutch roll") occurring between the stalling speed and the maximum allowable speed appropriate to the configuration of the aeroplane must be damped to 1/10 amplitude in 7 cycles with the primary controls –

(1) Free; and

(2) In a fixed position, except when compliance with JAR 23.672 is shown.

(c) Any long-period oscillation of the flight path (phugoid) must not be so unstable as to cause an unacceptable increase in pilot workload or otherwise endanger the aeroplane. When, in the conditions of JAR 23.175, the longitudinal control force required to maintain speeds differing from the trimmed speed by at least plus or minus 15% is suddenly released, the response of the aeroplane must not exhibit any dangerous characteristics nor be excessive in relation to the magnitude of the control force released.

STALLS

JAR 23.201 Wings level stall

(a) It must be possible to produce and to correct roll by unreversed use of the rolling control and to produce and to correct yaw by unreversed use of the directional control, up to the time the aeroplane stalls.

(b) The wings level stall characteristics must be demonstrated in flight as follows. Starting from a speed at least 10 knots above the stall speed, the elevator control must be pulled back so that the rate of speed reduction will not exceed one knot per second until a stall is produced, as shown by either –

(1) An uncontrollable downward pitching motion of the aeroplane; or

(2) A downward pitching motion of the aeroplane which results from the activation of a device (e.g. stick pusher); or

(3) The control reaching the stop.

(c) Normal use of elevator control for recovery is allowed after the downward pitching motion of (b) (1) or (b) (2) has unmistakably been produced, or after the control has been held against the stop for not less than the longer of 2 seconds or the time employed in the minimum steady flight speed determination of JAR 23.49.

(d) During the entry into and the recovery from the manoeuvre, it must be possible to prevent more than 15° of roll or yaw by the normal use of controls.

(e) Compliance with the requirements of this section must be shown under the following conditions:

(1) *Wing flaps.* Retracted, fully extended and each intermediate normal operating position;

(2) *Landing gear.* Retracted and extended;

(3) *Cowl flaps.* Appropriate to configuration;

(4) *Power*

(i) Power off; and

(ii) 75% maximum continuous power. If the power-to-weight ratio at 75% of maximum continuous power results in extreme nose-up attitudes, the test may be carried out with the power required for level flight in the landing

JAR 23.201 (e) (continued)

configuration at maximum landing weight and a speed of 1·4 V_{S0}, but the power may not be less than 50% maximum continuous power.

(5) *Trim.* The aeroplane trimmed at a speed as near 1·5 V_{S1} as practicable.

(6) *Propeller.* Full increase rpm position for the power off condition.

JAR 23.203 Turning flight and accelerated turning stalls

Turning flight and accelerated turning stalls must be demonstrated in tests as follows:

(a) Establish and maintain a co-ordinated turn in a 30° bank. Reduce speed by steadily and progressively tightening the turn with the elevator until the aeroplane is stalled, as defined in JAR 23.201 (b). The rate of speed reduction must be constant, and –

(1) For a turning flight stall, may not exceed one knot per second; and

(2) For an accelerated turning stall, be 3 to 5 knots per second with steadily increasing normal acceleration.

(b) After the aeroplane has stalled, as defined in JAR 23.201 (b) it must be possible to regain level flight by normal use of the flight controls but without increasing power and without –

(1) Excessive loss of altitude;

(2) Undue pitch-up;

(3) Uncontrollable tendency to spin;

(4) Exceeding a bank angle of 60° in the original direction of the turn or 30° in the opposite direction, in the case of turning flight stalls;

(5) Exceeding a bank angle of 90° in the original direction of the turn or 60° in the opposite direction, in the case of accelerated turning stalls; and

(6) Exceeding the maximum permissible speed or allowable limit load factor.

(c) Compliance with the requirements of this section must be shown under the following conditions:

(1) *Wing flaps.* Retracted, fully extended and each intermediate normal operating position;

JAR 23.203 (c) (continued)

(2) *Landing gear.* Retracted and extended;

(3) *Cowl flaps.* Appropriate to configuration;

(4) *Power*

(i) Power off; and

(ii) 75% maximum continuous power. If the power-to-weight ratio at 75% of maximum continuous power results in extreme nose-up attitudes, the test may be carried out with the power required for level flight in the landing configuration at maximum landing weight and a speed of 1·4 V_{S0}, but the power may not be less than 50% maximum continuous power.

(5) *Trim.* The aeroplane trimmed at a speed as near 1·5 V_{S1} as practicable.

(6) *Propeller.* Full increase rpm position for the power off condition.

JAR 23.207 Stall warning

(a) There must be a clear and distinctive stall warning, with the flaps and landing gear in any normal position, in straight and turning flight.

(b) The stall 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.

(c) During the stall tests required by JAR 23.201 (b) and JAR 23.203 (a) (1), the stall warning must begin at a speed exceeding the stalling speed by a margin of not less than 5 knots and must continue until the stall occurs.

(d) When following the procedures of JAR 23.1585, the stall warning must not occur during a take-off with all engines operating, a take-off continued with one engine inoperative or during an approach to landing.

(e) During the stall tests required by JAR 23.203 (a) (2), the stall warning must begin sufficiently in advance of the stall for the stall to be averted by pilot action taken after the stall warning first occurs.

(f) For aerobatic category aeroplanes, an artificial stall warning may be mutable, provided that it is armed automatically during take-off and

JAR 23.207 (f) (continued)

re-armed automatically in the approach configuration.

SPINNING

JAR 23.221 Spinning

(a) *Normal Category aeroplanes.* A Single engined, normal category aeroplane must be able to recover from a one-turn spin or a three-second spin, whichever takes longer, in not more than one additional turn, after initiation of the first control action for recovery. In addition –

(1) For both the flaps-retracted and flaps-extended conditions, the applicable airspeed limit and positive limit manoeuvring load factor must not be exceeded;

(2) No control forces or characteristic encountered during the spin or recovery may adversely affect prompt recovery;

(3) It must be impossible to obtain unrecoverable spins with any use of the flight or engine power controls either at the entry into or during the spin; and

(4) For the flaps extended condition, the flaps may be retracted during the recovery but not before rotation has ceased.

(5) *Not required for JAR-23.*

(b) *Utility category aeroplanes.* A utility category aeroplane must meet the requirements of sub-paragraph (a) of this paragraph. In addition, the requirements of sub-paragraph (c) of this paragraph and JAR 23.807 (b) (7) must be met if approval for spinning is requested.

(c) *Aerobatic category aeroplanes.* An aerobatic category aeroplane must meet the requirements of sub-paragraph (a) of this paragraph and JAR 23.807 (b) (6). In addition, the following requirements must be met in each configuration for which approval for spinning is requested –

(1) The aeroplane must recover from any point in a spin up to and including six turns, or any greater number of turns for which certification is requested, in not more than one and one-half additional turns after initiation of the first control action for recovery. However, beyond three turns, the spin may be discontinued if spiral characteristics appear;

(2) The applicable airspeed limits and limit manoeuvring load factors must not be exceeded. For flaps-extended configurations

JAR 23.221 (c) (continued)

for which approval is requested, the flaps must not be retracted during the recovery;

(3) It must be impossible to obtain unrecoverable spins with any use of the flight or engine power controls either at the entry into or during the spin; and

(4) There must be no characteristics during the spin (such as excessive rates of rotation or extreme oscillatory motion) which might prevent a successful recovery due to disorientation or incapacitation of the pilot.

GROUND AND WATER HANDLING CHARACTERISTICS

JAR 23.231 Longitudinal stability and control

(a) A landplane may have no uncontrollable tendency to nose over in any reasonably expected operating condition, including rebound during landing or take-off. Wheel brakes must operate smoothly and may not induce any undue tendency to nose over.

(b) A seaplane or amphibian may not have dangerous or uncontrollable purpoising characteristics at any normal operating speed on the water.

JAR 23.233 Directional stability and control

(a) A 90° cross-component of wind velocity, demonstrated to be safe for taxying, take-off and landing must be established and must be not less than 0·2 V_{S0}.

(b) The aeroplane must be satisfactorily controllable in power-off landings at normal landing speed, without using brakes or engine power to maintain a straight path until the speed has decreased to less than 50% of the speed at touchdown.

(c) The aeroplane must have adequate directional control during taxying.

(d) *Not required for JAR-23.*

JAR 23.235 Operation on unpaved surfaces

(a) The aeroplane must be demonstrated to have satisfactory characteristics and the shock-absorbing mechanism must not damage the structure of the aeroplane when the aeroplane is taxied on the roughest ground that may

JAR 23.235 (a) (continued)

reasonably be expected in normal operation and when take-offs and landings are performed on unpaved runways having the roughest surface that may reasonably be expected in normal operation.

JAR 23.237 ***Operation on water***

Allowable water surface conditions and any necessary water handling procedures for seaplanes and amphibians must be established.

JAR 23.239 Spray characteristics

Spray may not dangerously obscure the vision of the pilots or damage the propellers or other parts of a seaplane or amphibian at any time during taxying, take-off and landing.

MISCELLANEOUS FLIGHT REQUIREMENTS

JAR 23.251 Vibration and buffeting

There must be no vibration or buffeting severe enough to result in structural damage and each part of the aeroplane must be free from excessive vibration, under any appropriate speed and power conditions up to at least the minimum value of VD allowed in JAR 23.335. In addition there must be no buffeting in any normal flight condition severe enough to interfere with the satisfactory control of the aeroplane or cause excessive fatigue to the flight crew. Stall warning buffeting within these limits is allowable.

JAR 23.253 High speed characteristics

If a maximum operating speed VMO/MMO is established under JAR 23.1505 (c), the following speed increase and recovery characteristics must be met –

(a) 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 speed up to VMO/MMO. 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 airspeed limit altitude.

(b) Allowing for pilot reaction time after occurrence of effective inherent or artificial speed warning specified in JAR 23.1303, it must be

JAR 23.253 (b) (continued)

shown that the aeroplane can be recovered to a normal attitude and its speed reduced to VMO/MMO without –

(1) Exceeding VD/MD, the maximum speed shown under JAR 23.251, or the structural limitations; or

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

(c) There may be no control reversal about any axis at any speed up to the maximum speed shown under JAR 23.251. Any reversal of elevator control force or tendency of the aeroplane to pitch, roll, or yaw must be mild and readily controllable, using normal piloting techniques.

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SUBPART C - STRUCTURE

GENERAL

JAR 23.301 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 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 on canard and tandem wing configurations must be validated by flight test measurement unless the methods used for determining those loading conditions are shown to be reliable or conservative on the configuration under consideration.

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

(d) Simplified structural design criteria may be used if they result in design loads not less than those prescribed in JAR 23.331 to 23.521. For conventional, single reciprocating engine [aeroplanes of 2 721 kg (6 000 lb) or less] maximum take-off weight, the design criteria of Appendix A of JAR-23 are an approved equivalent of JAR 23.321 to 23.459. If Appendix A is used, the entire Appendix must be substituted for the corresponding sections of this JAR-23.

[Amdt. 1, 01.02.01]

JAR 23.302 Canard or tandem wing configurations

The forward structure of a canard or tandem wing configuration must –

(a) Meet all requirements of subpart C and subpart D of JAR-23 applicable to a wing; and

(b) Meet all requirements applicable to the function performed by these surfaces.

JAR 23.303 Factor of safety

Unless otherwise provided, a factor of safety of 1·5 must be used.

JAR 23.305 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 three seconds, except local failures or structural instabilities between limit and ultimate load are acceptable only if the structure can sustain the required ultimate load for at least three seconds. However, when proof of strength is shown by dynamic tests simulating actual load conditions, the three second limit does not apply.

JAR 23.307 Proof of structure
[(See ACJ 23.307)]

(a) Compliance with the strength and deformation requirements of JAR 23.305 must be shown for each critical load 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. Dynamic tests, including structural flight tests, are acceptable if the design load conditions have been simulated.

(b) Certain parts of the structure must be tested as specified in Subpart D of JAR-23.

[Amdt. 1, 01.02.01]

FLIGHT LOADS

JAR 23.321 General
[(See ACJ 23.321 (c))]

(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 flight load factor is one in which the aerodynamic force acts upward, with respect to the aeroplane.

(b) Compliance with the flight load requirements of this subpart must be shown –

JAR 23.321 (b) (continued)

(1) At each critical altitude within the range in which the aeroplane may be expected to operate;

(2) At each weight from the design minimum weight to the design maximum weight; and

(3) For each required altitude and weight, for any practicable distribution of disposable load within the operating limitations specified in JAR 23.1583 to 23.1589.

(c) When significant the effects of compressibility must be taken into account.

[Amdt. 1, 01.02.01]

JAR 23.331 Symmetrical flight conditions

(a) The appropriate balancing horizontal tail load must be accounted for in a rational or conservative manner when determining the wing loads and linear inertia loads corresponding to any of the symmetrical flight conditions specified in JAR 23.331 to 23.341.

(b) The incremental horizontal tail loads due to manoeuvring and gusts must be reacted by the angular inertia of the aeroplane in a rational or conservative manner.

(c) Mutual influence of the aerodynamic surfaces must be taken into account when determining flight loads.

JAR 23.333 Flight envelope

(a) *General.* Compliance with the strength requirements of this subpart must be shown at any combination of airspeed and load factor on and within the boundaries of a flight envelope (similar to the one in sub-paragraph (d) of this paragraph) that represents the envelope of the flight loading conditions specified by the manoeuvring and gust criteria of sub-paragraphs (b) and (c) of this paragraph respectively.

(b) *Manoeuvring envelope.* Except where limited by maximum (static) lift coefficients, the aeroplane is assumed to be subjected to symmetrical manoeuvres resulting in the following limit load factors:

(1) The positive manoeuvring load factor specified in JAR 23.337 at speeds up to V_D;

(2) The negative manoeuvring load factor specified in JAR 23.337 at V_C; and

JAR 23.333 (b) (continued)

(3) Factors varying linearly with speed from the specified value at V_C to 0·0 at V_D for the normal and commuter category, and -1·0 at V_D for the aerobatic and utility categories.

(c) *Gust envelope*

(1) The aeroplane is assumed to be subjected to symmetrical vertical gusts in level flight. The resulting limit load factors must correspond to the conditions determined as follows:

(i) Positive (up) and negative (down) gusts of 50 fps at V_C must be considered at altitudes between sea level and 20 000 ft. The gust velocity may be reduced linearly from 50 fps at 20 000 ft to 25 fps at 50 000 ft; and

(ii) Positive and negative gusts of 25 fps at V_D must be considered at altitudes between sea level and 20 000 ft. The gust velocity may be reduced linearly from 25 fps at 20 000 ft to 12·5 fps at 50 000 ft.

(iii) In addition, for commuter category aeroplanes, positive (up) and negative (down) rough air gusts of 66 fps at V_B must be considered at altitudes between sea level and 20 000 ft. The gust velocity may be reduced linearly from 66 fps at 20 000 ft to 38 fps at 50 000 ft.

(2) The following assumptions must be made:

(i) The shape of the gust is –

$$U = \frac{U_{de}}{2}\left(1 - \cos\frac{2\pi s}{25\bar{C}}\right)$$

where –

s = Distance penetrated into gust (ft.);

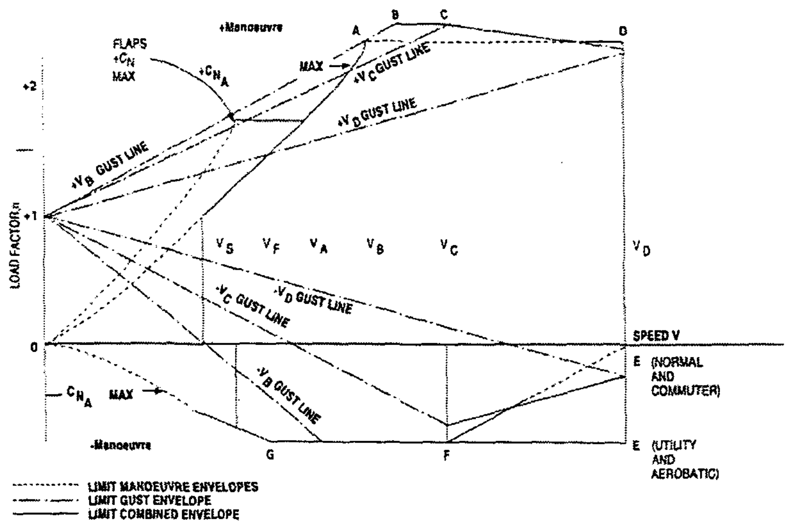
$\bar{C}$ = Mean geometric chord of wing (ft.); and

U_{de} = Derived gust velocity referred to in sub-paragraph (1) of this paragraph linearly with speed between V_C and V_D.

(ii) Gust load factors vary linearly with speed between V_C and V_D.

JAR 23.333 (continued)

(d) *Flight envelope*



Note: Point G need not be investigated when the supplementary condition specified in JAR 23.369 is investigated.

JAR 23.335 Design airspeeds

Except as provided in sub-paragraph (a) (4) of this paragraph, the selected design airspeeds are equivalent air-speeds (EAS).

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

(1) V_C (in knots) may not be less than –

(i) 33 $\sqrt{W/S}$ (for normal, utility and commuter category aeroplanes); and

(ii) 36 $\sqrt{W/S}$ (for aerobatic category aeroplanes).

where W/S = wing loading at design maximum take-off weight lb/ft^2.

(2) For values of W/S more than 20, the multiplying factors may be decreased linearly with W/S to a value of 28·6 where $W/S = 100$.

(3) V_C need not be more than 0·9 V_H at sea level.

(4) At altitudes where an M_D is established, a cruising speed M_C limited by compressibility may be selected.

[(b) *Design dive speed, V_D.* For V_D the] following apply:

(1) V_D/M_D may not be less than 1·25 V_C/M_C; and

(2) With $V_{C\ min}$, the required minimum design cruising speed, V_D (in knots) may not be less than –

(i) 1·40 $V_{C\ min}$ (for normal and commuter category aeroplanes);

(ii) 1·50 $V_{C\ min}$ (for utility category aeroplanes); and

(iii) 1·55 $V_{C\ min}$ (for aerobatic category aeroplanes).

(3) For values of W/S more than 20, the multiplying factors in sub-paragraph (2) of this paragraph may be decreased linearly with W/S to a value of 1·35 where $W/S = 100$.

(4) Compliance with sub-paragraphs (1) and (2) of this paragraph need not be shown if V_D/M_D is selected so that the minimum speed margin between V_C/M_C and V_D/M_D is the greater of the following:

(i) The speed increase resulting when, from the initial condition of stabilised flight at V_C/M_C, the aeroplane is assumed to be upset, flown for 20 seconds along a flight path 7·5° below the initial path and then pulled up with a load factor of 1·5 (0·5 g. acceleration increment). At least 75% maximum continuous power for reciprocating engines and maximum cruising power for turbines, or, if less, the power required for V_C/M_C for both kinds of engines, must be assumed until

JAR 23.335 (b) (continued)

the pull-up is initiated, at which point power reduction and pilot-controlled drag devices may be used; and

(ii) Mach 0·05 for normal, utility, and aerobatic category aeroplanes (at altitudes where M_D is established).

(iii) Mach 0·07 for commuter category aeroplanes (at altitudes where M_D is established) unless a rational analysis, including the effects of automatic systems, is used to determine a lower margin. If a rational analysis is used, the minimum speed margin must be enough to provide for atmospheric variations (such as horizontal gusts, and the penetration of jet streams or cold fronts), instrument errors, airframe production variations, and must not be less than Mach 0·05.

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

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

(i) V_S is a computed stalling speed with flaps retracted at the design weight, normally based on the maximum aeroplane normal force coefficients, C_{NA}; and

(ii) n is the limit manoeuvring load factor used in design.

(2) The value of V_A need not exceed the value of V_C used in design.

(d) *Design speed for maximum gust intensity, V_B.* For V_B, the following apply:

(1) V_B may not be less than the speed determined by the intersection of the line representing the maximum positive lift $C_{N\,MAX}$ and the line representing the rough air gust velocity on the gust V-n diagram, or $V_{S1}\sqrt{n_g}$, whichever is less, where –

(i) n_g the positive aeroplane gust load factor due to gust, at speed V_C (in accordance with JAR 23.341), and at the particular weight under consideration; and

(ii) V_{S1} is the stalling speed with the flaps retracted at the particular weight under consideration.

(2) V_B need not be greater than V_C.

[Amdt. 1, 01.02.01]

JAR 23.337 Limit manoeuvring load factors

(a) The positive limit manoeuvring load factor n may not be less than –

(1) $2{\cdot}1+\frac{24000}{W+10000}$ for normal and commuter category aeroplanes (where W = design maximum take-off weight lb), except that n need not be more than 3·8;

(2) 4·4 for utility category aeroplanes; or

(3) 6·0 for aerobatic category aeroplanes.

(b) The negative limit manoeuvring load factor may not be less than –

(1) 0·4 times the positive load factor for the normal, utility and commuter categories; or

(2) 0·5 times the positive load factor for the aerobatic category.

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

JAR 23.341 Gust load factors [(See ACJ 23.341 (b))]

(a) Each aeroplane must be designed for loads on each lifting surface resulting from gusts specified in JAR 23.333(c).

(b) The gust load for a canard or tandem wing configuration must be computed using a rational analysis, or may be computed in accordance with sub-paragraph (c) of this paragraph provided that the resulting net loads are shown to be conservative with respect to the gust criteria of JAR 23.333(c).

(c) In the absence of a more rational analysis the gust load factors must be computed as follows:

[$$n=1\pm\frac{k_g \rho_o U_{de} V a}{2(W/S)}$$]

where –

[$k_g=\frac{0.88\mu_g}{5.3+\mu_g}$ = gust alleviation factor;]

$\mu_g=\frac{2(W/S)}{\rho \bar{C} a g}$ = aeroplane mass ratio;

JAR 23.341 (c) (continued)

U_{de} = Derived gust velocities referred to in JAR 23.333 (c) (m/s);

[ρ_o = Density of air at sea-level (kg/m^3)]

[ρ = Density of air (kg/m^3) at the altitude] considered;

W/S = Wing loading due to the applicable weight of the aeroplane in the particular load case (N/m^2);

$\bar{C}$ = Mean geometric chord (m);

g = Acceleration due to gravity (m/sec^2);

V = Aeroplane equivalent speed (m/s); and

a = Slope of the aeroplane normal force coefficient curve C_{NA} per radian if the gust loads are applied to the wings and horizontal tail surfaces simultaneously by a rational method. The wing lift curve slope C_L per radian may be used when the gust load is applied to the wings only and the horizontal tail gust loads are treated as a separate condition.

[Amdt. 1, 01.02.01]

JAR 23.343 Design fuel loads [(See ACJ 23.343 (b))]

(a) The disposable load combinations must include each fuel load in the range from zero fuel to the selected maximum fuel load.

(b) If fuel is carried in the wings, the maximum allowable weight of the aeroplane without any fuel in the wing tank(s) must be established as "maximum zero wing fuel weight" if it is less than the maximum weight.

(c) *Not required for JAR-23*.

[Amdt. 1, 01.02.01]

JAR 23.345 High lift devices [(See ACJ 23.345 (d))]

(a) If flaps or similar high lift devices are to be used for take-off, approach or landing, the aeroplane, with the flaps fully extended at V_F, is assumed to be subjected to symmetrical manoeuvres and gusts within the range determined by –

JAR 23.345 (a) (continued)

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

(2) Positive and negative gust of 25 ft per second acting normal to the flight path in level flight.

(b) V_F must be assumed to be not less than 1·4 V_S or 1·8 V_{SF}, whichever is greater, where— V_S is the computed stalling speed with flaps retracted at the design weight; and V_{SF} is the computed stalling speed with flaps fully extended at the design weight.

However, if an automatic flap load limiting device is used, the aeroplane may be designed for the critical combinations of airspeed and flap position allowed by that device.

(c) In determining external loads on the aeroplane as a whole, thrust, slip-stream and pitching acceleration may be assumed to be zero.

(d) The flaps, their operating mechanism and their supporting structures, must be designed for the conditions prescribed in sub-paragraph (a) of this paragraph. In addition, with the flaps fully extended at speed V_F the following conditions, taken separately, must be accounted for:

(1) A head-on gust having a velocity of 25 ft per second (EAS), combined with propeller slipstream corresponding to 75% of maximum continuous power; and

(2) The effects of propeller slipstream corresponding to maximum take-off power.

[Amdt. 1, 01.02.01]

JAR 23.347 Unsymmetrical flight conditions [(See ACJ 23.347 (b))]

(a) The aeroplane is assumed to be subjected to the unsymmetrical flight conditions of JAR 23.349 and 23.351. 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.

(b) Aerobatic category aeroplanes certified for flick manoeuvres (snap-roll) must be designed for additional asymmetric loads acting on the wing and the horizontal tail.

[Amdt. 1, 01.02.01]

JAR 23.349 Rolling conditions

The wing and wing bracing must be designed for the following loading conditions:

(a) Unsymmetrical wing loads appropriate to the category. Unless the following values result in unrealistic loads, the rolling accelerations may be obtained by modifying the symmetrical flight conditions in JAR 23.333 (d) as follows:

(1) For the aerobatic category, in conditions A and F, assume that 100% of the semi-span wing air load acts on one side of the plane of symmetry and 60% of this load acts on the other side; and

(2) For the normal, utility and commuter categories, in condition A, assume that 100% of the semi-span wing air load acts on one side of the aeroplane and 75% of this load acts on the other side.

(b) The loads resulting from the aileron deflections and speeds specified in JAR 23.455, in combination with an aeroplane load factor of at least two thirds of the positive manoeuvring load factor used for design. Unless the following values result in unrealistic loads, the effect of aileron displacement on wing torsion may be accounted for by adding the following increment to the basic airfoil moment coefficient over the aileron portion of the span in the critical condition determined in JAR 23.333 (d).

$\Delta C_m = -0.01\delta$ where –

ΔC_m = is the moment coefficient increment; and

δ is the down aileron deflection in degrees in the critical condition.

JAR 23.351 Yawing conditions

The aeroplane must be designed for yawing loads on the vertical surfaces resulting from the loads specified in JAR 23.441 to 23.445.

JAR 23.361 Engine torque

(a) Each engine mount and its supporting structure must be designed for the effects of –

(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 23.333 (d);

JAR 23.361 (a) (continued)

(2) A limit engine torque corresponding to maximum continuous power and propeller speed acting simultaneously with the limit loads from flight condition A of JAR 23.333 (d); and

(3) For turbo-propeller installations, in addition to the conditions specified in sub-paragraphs (a) (1) and (a) (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 1g level flight loads. In the absence of a rational analysis, a factor of 1·6 must be used.

(b) For turbine-engine installations, the engine mounts and supporting structure must be designed to withstand each of the following:

(1) A limit engine torque load imposed by sudden engine stoppage due to malfunction or structural failure (such as compressor jamming); and

(2) A limit engine torque load imposed by the maximum acceleration of the engine.

(c) The limit engine torque to be considered under sub-paragraph (a) of this paragraph must be obtained by multiplying the mean torque by a factor of –

(1) 1·25 for turbo-propeller installations;

(2) 1·33 for engines with five or more cylinders; and

(3) Two, three, or four, for engines with four, three or two cylinders, respectively.

JAR 23.363 Sideload on engine mount

(a) Each engine mount and its supporting structure must be designed for a limit load factor in a lateral direction, for the sideload on the engine mount, of not less than –

(1) 1·33; or

(2) One-third of the limit load factor for flight condition A.

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

JAR 23.365 Pressurised cabin loads

For each pressurised compartment, 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 any stress concentrations, must be accounted for.

(c) If landings may be made, with the cabin 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 corresponding to the maximum relief valve setting multiplied by a factor of 1·33, omitting other loads.

(e) If a pressurised cabin has two or more compartments, separated by bulkheads or a floor, the primary structure must be designed for the effects of sudden release of pressure in any compartment with external doors or windows. This condition must be investigated for the effects of failure of the largest opening in the compartment. The effects of intercompartmental venting may be considered.

JAR 23.367 Unsymmetrical loads due to engine failure

(a) Turbopropeller aeroplanes must be designed for the unsymmetrical loads resulting from the failure of the critical engine including 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

JAR 23.367 (a) (continued)

to the particular engine-propeller combination; and

(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 2 seconds after the engine failure. The magnitude of the corrective action may be based on the limit pilot forces specified in JAR 23.397 except that lower forces may be assumed where [it is shown by analyses or test that these forces] can control the yaw and roll resulting from the prescribed engine failure conditions.

[Amdt. 1, 01.02.01]

JAR 23.369 Rear lift truss

(a) If a rear lift truss is used, it must be designed for conditions of reversed airflow at a design speed of –

$$V = 8{\cdot}7\sqrt{W/S} + 8{\cdot}7 \text{(knots)}$$

where W/S = wing loading at design maximum take-off weight (lb/ft^2).

(b) Either aerodynamic data for the particular wing section used, or a value of C_L equalling -0·8 with a chordwise distribution that is triangular between a peak at the trailing edge and zero at the leading edge, must be used.

JAR 23.371 Gyroscopic and aerodynamic loads [(See ACJ 23.371 (a))]

(a) Each engine mount and its supporting structure must be designed for the gyroscopic, inertia and aerodynamic loads that result, with the engine(s) and propeller(s), if applicable at maximum continuous rpm, under either –

(1) The conditions prescribed in JAR 23.351 and 23.423; or

(2) All possible combinations of the following:

(i) A yaw velocity of 2·5 radians per second;

(ii) A pitch velocity of 1·0 radian per second;

JAR 23.371 (a) (continued)

(iii) A normal load factor of 2·5; and

(iv) Maximum continuous thrust.

(b) In addition to the requirements of sub-paragraph (a) each engine mount and its supporting structures of an aeroplane approved for aerobatic manoeuvres must be designed for the maximum expected yaw and pitch velocities combined with the corresponding load factors during such manoeuvres.

(c) In addition, for commuter category aeroplanes the gust conditions specified in JAR 23.341 must be added to the conditions required by sub-paragraph (a).

[Amdt. 1, 01.02.01]

JAR 23.373 Speed control devices

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

(a) The aeroplane must be designed for the symmetrical manoeuvres and gusts prescribed in JAR 23.333, 23.337 and 23.341 and the yawing manoeuvres and lateral gusts in JAR 23.441 and 23.443, with the device extended at speeds up to the placard device extended speed; 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.

CONTROL SURFACE AND SYSTEM LOADS

JAR 23.391 Control surface loads

(a) The control surface loads specified in JAR 23.397 to 23.459 are assumed to occur in the conditions described in JAR 23.331 to 23.351.

JAR 23.393 Loads parallel to hinge line [(See ACJ 23.393 (a) and ACJ 23.393 (b))]

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

JAR 23.393 (continued)

(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.

[Amdt. 1, 01.02.01]

JAR 23.395 Control system loads

(a) Each flight control system and its supporting structure must be designed for loads corresponding to at least 125% of the computed hinge moments of the movable control surface in the conditions prescribed in JAR 23.391 to 23.459. In addition, the following apply:

(1) The system limit loads need not exceed the higher of the loads that can be produced by the pilot and automatic devices operating the controls. However, autopilot forces need not be added to pilot forces. The system must be designed for the maximum effort of the pilot or autopilot, whichever is higher. In addition, if the pilot and the autopilot act in opposition, the part of the system between them may be designed for the maximum effort of the one that imposes the lesser load. Pilot forces used for design need not exceed the maximum forces prescribed in JAR 23.397 (b).

(2) The design must, in any case, provide a rugged system for service use, considering jamming, ground gusts, taxying downwind, control inertia and friction. Compliance with this sub-paragraph may be shown by designing for loads resulting from application of the minimum forces prescribed in JAR 23.397 (b).

(b) A 125% factor on computed hinge movements must be used to design elevator, aileron and rudder systems. However, a factor as low as 1·0 may be used if hinge moments are based on accurate flight test data, the exact reduction depending upon the accuracy and reliability of the data.

(c) Pilot forces used for design are assumed to act at the appropriate control grips or pads as they would in flight and to react at the attachments of the control system to the control surface horns.

JAR 23.397 Limit control forces and torques

(a) 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 (b) of this paragraph. In applying this criterion, the effects of control system boost and servo-mechanisms and the effects of tabs must be considered. The automatic pilot effort must be used for design if it alone can produce higher control surface loads than the human pilot.

(b) The limit pilot forces and torques are as follows:

Control	Maximum forces or torques for design weight, weight equal to or [less than 2 268] kg (5 000 lb)[1]	Minimum forces or torques [2]
Aileron:		
Stick..............	300 N (67 l b)........	180 N (40 lb
Wheel [3]	220 DNm .... (50 D in lb)[4]	180 DNm (40 D in lb)[4]
Elevator:		
Stick..............	745 N (167 lb).......	445 N (100 lb)
Wheel (symmetrical).	890N (200 lb)........	445 N (100 lb)
Wheel (unsymmetrical) [5] ...	....	445 N (100 lb)
Rudder..........	890N (200 lb)........	667 N (150 lb)

[1] For design weight (W) more [than 2 268 kg (5 000 lb), the specified] maximum values must be increased linearly with weight to 1·18 times the specified values at a design weight of 5 670 kg (12 500 lb), and for commuter category aeroplanes, the specified values must be increased linearly with weight to 1·35 times the specified values at a design weight of 8 618 kg (19 000 lb).

[2] If the design of any individual set of control systems or surfaces makes these specified minimum forces or torques inapplicable, values corresponding to the present hinge

JAR 23.397 (b) (continued)

moments obtained under JAR 23.415, but not less than 0·6 of the specified minimum forces or torques, may be used.

[3] The critical parts of the aileron control system must also be designed for a single tangential force with a limit value of 1·25 times the couple force determined from the above criteria.

[4] D = wheel diameter ((metres)/(inches)).

[5] The unsymmetrical force must be applied at one of the normal handgrip points on the control wheel.

[Amdt. 1, 01.02.01]

JAR 23.399 Dual control system

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

(1) 0·75 times those obtained under JAR 23.395; or

(2) The minimum forces specified in JAR 23.397 (b).

(b) The control system must be designed for pilot forces applied together in the same direction, using individual pilot forces not less than 0·75 times those obtained under JAR 23.395.

JAR 23.405 Secondary control system [(See ACJ 23.405)]

Secondary controls, such as wheel brakes, spoilers and tab controls, must be designed for the maximum forces that a pilot is likely to apply to those controls.

[Amdt. 1, 01.02.01]

JAR 23.407 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. These deflections must correspond to the maximum degree of "out of trim" expected at the speed for the condition under consideration.

JAR 23.409 Tabs

Control surface tabs must be designed for the most severe combination of airspeed and tab deflection likely to be obtained within the flight envelope for any usable loading condition.

JAR 23.415 Ground gust conditions

(a) The control system must be investigated as follows for control surface loads due to ground gusts and taxying downwind:

(1) If an investigation of the control system for ground gust loads is not required by sub-paragraph (2) of this paragraph, but the applicant elects to design a part of the control system for these loads, these loads need only be carried from control surface horns through the nearest stops or gust locks and their supporting structures.

(2) If pilot forces less than the minimums specified in JAR 23.397 (b) are used for design, the effects of surface loads due to ground gusts and taxying downwind must be investigated for the entire control system according to the formula –

$H = K c S q$

where –

H = limit hinge moment (ft lbs);

c = mean chord of the control surface aft of the hinge line (ft);

S = area of control surface aft of the hinge line (sq ft);

q = dynamic pressure (psf) based on a design speed not less than $14{\cdot}6\sqrt{W/S} + 14{\cdot}6$ (fps) (where W / S = wing loading at design maximum weight [(*lbs/ft²*)) except that the] design speed need not exceed 88 (fps); and

K = limit hinge moment factor for ground gusts derived in sub-paragraph (b) of this paragraph. (For ailerons and elevators, a positive value of K indicates a moment tending to depress the surface and a negative value of K indicates a moment tending to raise the surface).

(b) The limit hinge moment factor K for ground gusts must be derived as follows:

JAR 23.415 (b) (continued)

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; + moment on one aileron, - moment on the other.
(c) (d) Elevator	±0·75	(c) Elevator full up (-). (d) Elevator full down (+).
(e) (f) Rudder	±0·75	(e) Rudder in neutral. (f) Rudder at full throw..

(c) At all weights between the Empty Weight and the maximum weight declared for tie-down stated in the appropriate Manual, any declared tie-down points and surrounding structure, control system, surfaces and associated gust locks must be designed for the limit load conditions arising when tied-down, resulting from wind speeds of up to 65 knots horizontally from any direction.

[Amdt. 1, 01.02.01]

HORIZONTAL TAIL SURFACES

JAR 23.421 Balancing loads

(a) A horizontal surface balancing load is a load necessary to maintain equilibrium in any specified flight condition with no pitching acceleration.

(b) Horizontal balancing surfaces must be designed for the balancing loads occurring at any point on the limit manoeuvring envelope and in the flap conditions specified in JAR 23.345.

JAR 23.423 Manoeuvring loads [(See ACJ 23.423)]

Each horizontal surface and its supporting structure, and the main wing of a canard or tandem wing configuration, if that surface has pitch control, must be designed for manoeuvring loads imposed by the following conditions:

(a) A sudden movement of the pitching control, at the speed V_A to the maximum aft movement, and the maximum forward movement, as limited by the control stops, or pilot effort, whichever is critical.

(b) A sudden aft movement of the pitching control at speeds above V_A, followed by a forward movement of the pitching control

JAR 23.423 (b) (continued)

resulting in the following combinations of normal and angular acceleration:

Condition	Normal acceleration (n)	Angular acceleration (radian/sec.^{2})
Nose-up pitching	1·0	$+\frac{39}{V}n_m(n_m - 1{\cdot}5)$
Nose-down pitching	n_m	$-\frac{39}{V}n_m(n_m - 1{\cdot}5)$

where -

(1) n_m = positive limit manoeuvring load factor used in the design of the aeroplane; and

(2) V = initial speed in knots.

The conditions in this paragraph involve loads corresponding to the loads that may occur in a "checked manoeuvre" (a manoeuvre in which the pitching control is suddenly displaced in one direction and then suddenly moved in the opposite direction). The deflections and timing of the "checked manoeuvre" must avoid exceeding the limit manoeuvring load factor. The total horizontal surface load for both nose-up and nose-down pitching conditions is the sum of the balancing loads at V and the specified value of the normal load factor n, plus the manoeuvring load increment due to the specified value of the angular acceleration.

[Amdt. 1, 01.02.01]

JAR 23.425 Gust loads

(a) Each horizontal surface other than a main wing, must be designed for loads resulting from –

(1) Gust velocities specified in JAR 23.333 (c) with flaps retracted; and

(2) Positive and negative gusts of 25 fps nominal intensity at V_F corresponding to the flight conditions specified in JAR 23.345 (a) (2).

(b) Reserved.

(c) When determining the total load on the horizontal surfaces for the conditions specified in sub-paragraph (a) of this paragraph, the initial balancing loads for steady unaccelerated flight at the pertinent design speeds, V_F, V_C and V_D must first be determined. The incremental load resulting from the gusts must be added to the initial balancing load to obtain the total load.

JAR 23.425 (continued)

(d) In the absence of a more rational analysis, the incremental load due to the gust must be computed as follows only on aeroplane configurations with aft-mounted, horizontal surfaces, unless its use elsewhere is shown to be conservative:

$$\Delta L_{ht} = \frac{\rho o K_g U_{de} V a_{ht} S_{ht}}{2}\left(1 - \frac{d\varepsilon}{d\alpha}\right)$$

where –

ΔL_{ht} = Incremental horizontal tail load (N);

ρo = Density of air at sea-level (kg/m^3)

K_g = Gust alleviation factor defined in JAR 23.341;

U_{de} = Derived gust velocity (m/s);

V = Aeroplane equivalent speed (m/s);

a_{ht} = Slope of aft horizontal tail lift curve (per radian);

S_{ht} = Area of aft horizontal tail (m^2); and

$\left(1 - \frac{d\varepsilon}{d\alpha}\right)$ = Downwash factor

JAR 23.427 Unsymmetrical loads

(a) Horizontal surfaces other than main wing and their supporting structure must be designed for unsymmetrical loads arising from yawing and slipstream effects, in combination with the loads prescribed for the flight conditions set forth in JAR 23.421 to 23.425.

(b) In the absence of more rational data for aeroplanes that are conventional in regard to location of engines, wings, horizontal surfaces other than main wing, and fuselage shape –

(1) 100% of the maximum loading from the symmetrical flight conditions may be assumed on the surface on one side of the plane of symmetry; and

(2) The following percentage of that loading must be applied to the opposite side:

% = 100-10 (n-1), where n is the specified positive manoeuvring load factor, but this value may not be more than 80%.

(c) For aeroplanes that are not conventional (such as aeroplanes with horizontal surfaces other than main wing having appreciable

JAR 23.427 (c) (continued)

dihedral or supported by the vertical tail surfaces) the surfaces and supporting structures must be designed for combined vertical and horizontal surface loads resulting from each prescribed flight condition taken separately.

VERTICAL SURFACES

JAR 23.441 Manoeuvring loads [(See ACJ 23.441)]

(a) At speeds up to V_A the vertical surfaces must be designed to withstand the following conditions. In computing the loads, the yawing velocity may be assumed to be zero:

(1) With the aeroplane in unaccelerated flight at zero yaw, it is assumed that the rudder control is suddenly displaced to the maximum deflection, as limited by the control stops or by limit pilot forces.

(2) With the rudder deflected as specified in sub-paragraph (1) of this paragraph, it is assumed that the aeroplane yaws to the overswing side-slip angle. In lieu of a rational analysis, an overswing angle equal to 1·5 times the static sideslip angle of sub-paragraph (3) of this paragraph may be assumed.

(3) A yaw angle of 15° with the rudder control maintained in the neutral position (except as limited by pilot strength).

(b) In addition for commuter category aeroplanes, the following manoeuvre must be considered at speeds from V_A up to V_D/M_D. In computing the tail loads, the yawing velocity may be assumed to be zero; with the aeroplane yawed to the static sideslip angle corresponding to the maximum rudder deflection, as limited by the control surface stops or the maximum available booster effort, or the maximum pilot rudder force as specified by JAR 23.397 (b) at V_A and ⅔ of the maximum pilot force specified by JAR 23.397 (b) from V_C/M_C to V_D/M_D, with linear variations between V_A and V_C/M_C, it is assumed that the rudder control is suddenly returned to neutral.

(c) The yaw angles specified in sub-paragraph (a) (3) of this paragraph may be reduced if the yaw angle chosen for a particular speed cannot be exceeded in –

(1) Steady slip conditions;

(2) Uncoordinated rolls from steep banks; or

JAR 23.441 (c) (continued)

(3) Sudden failure of the critical engine with delayed corrective action.

[Amdt. 1, 01.02.01]

JAR 23.443 Gust loads [(See ACJ 23.443)]

(a) Vertical surfaces must be designed to withstand, in unaccelerated flight at speed V_C, lateral gusts of the values prescribed for V_C in JAR 23.333 (c).

(b) In addition, for commuter category aeroplanes, the aeroplane is assumed to encounter derived gusts normal to the plane of symmetry while in unaccelerated flight at V_B, V_C, V_D and V_F. The derived gusts and aeroplane speeds corresponding to these conditions, as determined by JAR 23.341 and 23.345, must be investigated. The shape of the gust must be as specified in JAR 23.333 (c) (2) (i).

(c) In the absence of a more rational analysis, the gust load must be computed as follows:

$$L_{vt} = \frac{\rho_o K_{gt} U_{de} V a_{vt} S_{vt}}{2}$$

where –

L_{vt} = Vertical surface loads (N);

$K_{gt} = \frac{0{\cdot}88\,\mu_{gt}}{5{\cdot}3 + \mu_{gt}}$ = gust alleviation factor;

$\mu_{gt} = \frac{2W}{\rho \bar{C}_t g a_{vt} S_{vt}}\left(\frac{K}{l_{vt}}\right)^2$ lateral mass ratio;

ρ_o = Density of air at sea-level (kg/m^3)

U_{de} = Derived gust velocity (m/s);

ρ = Air density (Kg/m^3);

W = the applicable weight of the aeroplane in the particular load case (N);

S_{vt} = Area of vertical surface (m^2);

$\bar{C}_t$ = Mean geometric chord of vertical surface (m);

a_{vt} = Lift curve slope of vertical surface (per radian);

K = Radius of gyration in yaw (m);

l_{vt} = Distance from aeroplane c.g. to lift centre of vertical surface (m);

g = Acceleration due to gravity (m/sec^2); and

V = Aeroplane equivalent speed (m/s)

[Amdt. 1, 01.02.01]

JAR 23.445 Outboard fins or winglets

(a) If outboard fins or winglets are included on the horizontal surfaces or wings, the horizontal surfaces or wings must be designed for their maximum load in combination with loads induced by the fins or winglets and moment or forces exerted on horizontal surfaces or wings by the fins or winglets.

(b) If outboard fins or winglets extend above and below the horizontal surface, the critical vertical surface loading (the load per unit area as determined under JAR 23.441 and 23.443) must be applied to –

(1) The part of the vertical surfaces above the horizontal surface with 80% of that loading applied to the part below the horizontal surface; and

(2) The part of the vertical surfaces below the horizontal surface with 80% of that loading applied to the part above the horizontal surface;

(c) The endplate effects of outboard fins or winglets must be taken into account in applying the yawing conditions of JAR 23.441 and 23.443 to the vertical surfaces in sub-paragraph (b) of this paragraph.

(d) When rational methods are used for computing loads, the manoeuvring loads of JAR 23.441 on the vertical surfaces and the one-g horizontal surface load, including induced loads on the horizontal surface and moments or forces exerted on the horizontal surfaces by the vertical surfaces, must be applied simultaneously for the structural loading condition.

AILERONS AND SPECIAL DEVICES

JAR 23.455 Ailerons
[(See ACJ 23.455 (a) (2))]

(a) The ailerons must be designed for the loads to which they are subjected –

(1) In the neutral position during symmetrical flight conditions; and

(2) By the following deflections (except as limited by pilot effort), during unsymmetrical flight conditions; [ ]

(i) Sudden maximum displacement of the aileron control at V_A. Suitable allowance may be made for control system deflections.

JAR 23.455 (a) (continued)

(ii) Sufficient deflection at V_C, where V_C is more than V_A, to produce a rate of roll not less than obtained in sub-paragraph (a) (2) (i) of this paragraph.

(iii) Sufficient deflection at V_D to produce a rate of roll not less than one-third of that obtained in sub-paragraph (a) (2) (i) of this paragraph.

(b) [(Reserved).]

[Amdt. 1, 01.02.01]

JAR 23.459 Special devices

The loading for special devices using aerodynamic surfaces (such as slots and spoilers) must be determined from test data.

GROUND LOADS

JAR 23.471 General

The limit ground loads specified in this subpart are considered to be external loads and inertia forces that act upon an aeroplane structure. In each specified ground load condition, the external reactions must be placed in equilibrium with the linear and angular inertia forces in a rational or conservative manner.

JAR 23.473 Ground load conditions and assumptions

(a) The ground load requirements of this subpart must be complied with at the design maximum weight except that JAR 23.479, 23.481 and 23.483 may be complied with at a design landing weight (the highest weight for landing conditions at the maximum descent velocity) allowed under sub-paragraphs (b) and (c) of this paragraph.

(b) The design landing weight may be as low as –

(1) 95% of the maximum weight if the minimum fuel capacity is enough for at least one-half hour of operation at maximum continuous power plus a capacity equal to a fuel weight which is the difference between the design maximum weight and the design landing weight; or

(2) The design maximum weight less the weight of 25% of the total fuel capacity.

JAR 23.473 (continued)

(c) The design landing weight of a twin-engine aeroplane may be less than that allowed under sub-paragraph (b) of this paragraph if –

(1) The aeroplane meets the one-engine-inoperative climb requirements of JAR 23.67; and

(2) Compliance is shown with the fuel jettisoning system requirements of JAR 23.1001.

(d) The selected limit vertical inertia load factor at the centre of gravity of the aeroplane for the ground load conditions prescribed in this sub-part may not be less than that which would be obtained when landing with a descent velocity (V), in feet per second, equal to $4 \cdot 4\ (W/S)^{1/4}$, except that this velocity need not be more than 10 ft per second and may not be less than 7 ft per second.

(e) Wing lift not exceeding two-thirds of the weight of the aeroplane may be assumed to exist throughout the landing impact and to act through the centre of gravity. The ground reaction load factor may be equal to the inertia load factor minus the ratio of the above assumed wing lift to the aeroplane weight.

(f) If energy absorption tests are made to determine the limit load factor corresponding to the required limit descent velocities, these tests must be made under JAR 23.723 (a).

(g) No inertia load factor used for design purposes may be less than 2·67, nor may the limit ground reaction load factor be less than 2·0 at design maximum weight, unless these lower values will not be exceeded in taxying at speeds up to take-off speed over terrain as rough as that expected in service.

JAR 23.477 Landing gear arrangement

JAR 23.479 to 23.483, or the conditions in Appendix C, apply to aeroplanes with conventional arrangements of main and nose gear, or main and tail gear.

JAR 23.479 Level landing conditions

(a) For a level landing, the aeroplane is assumed to be in the following attitudes:

(1) For aeroplanes with tail wheels, a normal level flight attitude;

(2) For aeroplanes with nose wheels, attitudes in which –

JAR 23.479 (a) (continued)

(i) The nose and main wheels contact the ground simultaneously; and

(ii) The main wheels contact the ground and the nose wheel is just clear of the ground.

The attitude used in subdivision (i) of this sub-paragraph may be used in the analysis required under subdivision (ii) of this sub-paragraph.

(b) When investigating landing conditions, the drag components simulating the forces required to accelerate the tyres and wheels up to the landing speed (spin-up) must be properly combined with the corresponding instantaneous vertical ground reactions, and the forward-acting horizontal loads resulting from rapid reduction of the spin-up drag loads (spring-back) must be combined with vertical ground reactions at the instant of the peak forward load, assuming wing lift and a tyre sliding coefficient of friction of 0·8. However, the drag loads may not be less than 25% of the maximum vertical ground reaction (neglecting wing lift).

(c) In the absence of specific tests or a more rational analysis for determining the wheel spin-up and spring-back loads for landing conditions, the method set forth in Appendix D must be used. If Appendix D is used, the drag components used for design must not be less than those given by Appendix C.

(d) For aeroplanes with tip tanks or large overhung masses (such as turbo-propeller or jet engines) supported by the wing, the tip tanks and the structure supporting the tanks or overhung masses must be designed for the effects of dynamic responses under the level landing conditions of either sub-paragraph (a) (1) or (a) (2) (ii) of this paragraph. In evaluating the effects of dynamic response, an aeroplane lift equal to the weight of the aeroplane may be assumed.

JAR 23.481 Tail down landing conditions

(a) For a tail down landing, the aeroplane is assumed to be in the following attitudes:

(1) For aeroplanes with tail wheels, an attitude in which the main and tail wheels contact the ground simultaneously.

(2) For aeroplanes with nose wheels, a stalling attitude, or the maximum angle allowing ground clearance by each part of the aeroplane, whichever is less.

JAR 23.481 (continued)

(b) For aeroplanes with either tail or nose wheels, ground reactions are assumed to be vertical, with the wheels up to speed before the maximum vertical load is attained.

JAR 23.483 One-wheel landing conditions

For the one-wheel landing condition, the aeroplane is assumed to be in the level attitude and to contact the ground on one side of the main landing gear. In this attitude, the ground reactions must be the same as those obtained on that side under JAR 23.479.

JAR 23.485 Sideload conditions

(a) For the sideload condition, the aeroplane is assumed to be in a level attitude with only the main wheels contacting the ground and with the shock absorbers and tyres in their static positions.

(b) The limit vertical load factor must be 1·33, with the vertical ground reaction divided equally between the main wheels.

(c) The limit side inertia factor must be 0·83, with the side ground reaction divided between the main wheels so that –

(1) 0·5 (W) is acting inboard on one side; and

(2) 0·33 (W) is acting outboard on the other side.

(d) The side loads prescribed in sub-paragraph (c) of this paragraph are assumed to be applied at the ground contact point and the drag loads may be assumed to be zero.

JAR 23.493 Braked roll conditions

Under braked roll conditions, with the shock absorbers and tyres in their static positions, the following apply:

(a) The limit vertical load factor must be 1·33.

(b) The attitudes and ground contacts must be those described in JAR 23.479 for level landings.

(c) A drag reaction equal to the vertical reaction at the wheel multiplied by a coefficient of friction of 0·8 must be applied at the ground contact point of each wheel with brakes, except that the drag reaction need not exceed the maximum value based on limiting brake torque.

JAR 23.497 Supplementary conditions for tail wheels

In determining the ground loads on the tail wheel and affected supporting structures, the following apply:

(a) For the obstruction load, the limit ground reaction obtained in the tail down landing condition is assumed to act up and aft through the axle at 45°. The shock absorber and tyre may be assumed to be in their static positions.

(b) For the sideload, a limit vertical ground reaction equal to the static load on the tail wheel, in combination with a side component of equal magnitude, is assumed. In addition –

(1) If a swivel is used, the tail wheel is assumed to be swivelled 90° to the aeroplane longitudinal axis with the resultant ground load passing through the axle;

(2) If a lock, steering device, or shimmy damper is used, the tail wheel is also assumed to be in the trailing position with the sideload acting at the ground contact point; and

(3) The shock absorber and tyre are assumed to be in their static positions.

(c) If a tail wheel, bumper, or an energy absorption device is provided to show compliance with JAR 23.925 (b), the following apply:

(1) Suitable design loads must be established for the tail wheel, bumper, or energy absorption device; and

(2) The supporting structure of the tail wheel, bumper, or energy absorption device must be designed to withstand the loads established in sub-paragraph (c) (1) of this paragraph.

JAR 23.499 Supplementary conditions for nose wheels

In determining the ground loads on nose wheels and affected supporting structures and assuming that the shock absorbers and tyres are in their static positions, the following conditions must be met:

(a) For aft loads, the limit force components at the axle must be –

(1) A vertical component of 2·25 times the static load on the wheel; and

JAR 23.499 (a) (continued)

(2) A drag component of 0·8 times the vertical load.

(b) For forward loads, the limit force components at the axle must be –

(1) A vertical component of 2·25 times the static load on the wheel; and

(2) A forward component of 0·4 times the vertical load.

(c) For sideloads, the limit force components at ground contact must be –

(1) A vertical component of 2·25 times the static load on the wheel; and

(2) A side component of 0·7 times the vertical load.

(d) For aeroplanes with a steerable nose wheel which is controlled by hydraulic or other power, at design take-off weight with the nose wheel in any steerable position the application of 1·33 times the full steering torque combined with a vertical reaction equal to 1·33 times the maximum static reaction on the nose gear must be assumed. However, if a torque limiting device is installed, the steering torque can be reduced to the maximum value allowed by that device.

(e) For aeroplanes with a steerable nose wheel, which is directly connected mechanically to the rudder pedals, the steering torque must be designed at least for the maximum pilot forces specified in JAR 23.397 (b).

JAR 23.505 Supplementary conditions for ski-planes

In determining ground loads for ski-planes and assuming that the aeroplane is resting on the ground with one main ski frozen at rest and the other skis free to slide, a limit side force equal to 0·036 times the design maximum weight must be applied near the tail assembly with a factor of safety of 1.

JAR 23.507 Jacking loads

(a) The aeroplane must be designed for the loads developed when the aircraft is supported on jacks at the design maximum weight assuming the following load factors for landing gear jacking points at a three-point attitude and for primary flight structure jacking points in the level attitude.

(1) Vertical load factor of 1·35 times the static reactions.

JAR 23.507 (a) (continued)

(2) Fore, aft and lateral load factors of 0·4 times the vertical static reactions.

(b) The horizontal loads at the jack points must be reacted by inertia forces so as to result in no change in the direction of the resultant loads at the jack points.

(c) The horizontal loads must be considered in all combinations with the vertical load.

JAR 23.509 Towing loads

The towing loads of this section must be applied to the design of tow fittings and their immediate attaching structure.

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

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

(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.

(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.

JAR 23.509 (c) (continued)

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

(d) The prescribed towing loads are as follows, where W is the design maximum weight:

[

Tow point	Position	Load: Magnitude	No.	Direction
Main gear		0·225 W per main gear unit	1	Forward, parallel to drag axis
			2	Forward, at 30° to drag axis
			3	Aft, parallel to drag axis
			4	Aft, at 30° to drag axis
Auxiliary Gear	Swivelled forward	0·3W	5	Forward
			6	Aft
	Swivelled Aft	0·3W	7	Forward
			8	Aft
	Swivelled 45° from forward	0·15W	9	Forward, in plane, of wheel
			10	Aft, in plane of wheel
	Swivelled 45° from aft	0·15W	11	Forward, in plane of wheel
			12	Aft, in plane of wheel

]

[Amdt. 1, 01.02.01]

JAR 23.511 Ground load; unsymmetrical loads on multiple-wheel units

(a) *Pivoting loads.* The aeroplane is [assumed to pivot about one side of the main] gear with –

(1) The brakes on the pivoting unit locked; and

(2) Loads corresponding to a limit vertical load factor of 1 and coefficient of friction of 0·8, applied to the main gear and its supporting structure.

JAR 23.511 (continued)

(b) *Unequal tyre loads.* The loads established under JAR 23.471 to 23.483 must be applied in turn, in a 60/40% distribution, to the dual wheels and tyres in each dual wheel landing gear unit.

(c) *Deflated tyre loads.* For the deflated tyre condition –

(1) 60% of the loads established under JAR 23.471 to 23.483 must be applied in turn to each wheel in a landing gear unit; and

(2) 60% of the limit drag and sideloads and 100% of the limit vertical load established under JAR 23.485 and 23.493 or lesser vertical load obtained under sub-paragraph (1) of this paragraph, must be applied in turn to each wheel in the dual wheel landing gear unit.

[Amdt. 1, 01.02.01]

WATER LOADS

JAR 23.521 Water load conditions

(a) The structure of seaplanes and amphibians must be designed for water loads developed during take-off and landing with the seaplane in any attitude likely to occur in normal operation at appropriate forward and sinking velocities under the most severe sea conditions likely to be encountered.

(b) Unless the applicant makes a rational analysis of the water loads, JAR 23.523 to 23.537 apply.

JAR 23.523 Design weights and centre of gravity positions

(a) *Design weights.* The water load requirements must be met at each operating weight up to the design landing weight except that, for the take-off condition prescribed in JAR 23.531, the design water take-off weight (the maximum weight for water taxi and take-off run) must be used.

(b) *Centre of gravity positions.* The critical centres of gravity within the limits for which certification is requested must be considered to reach maximum design loads for each part of the seaplane structure.

JAR 23.525 Application of loads

(a) Unless otherwise prescribed, the seaplane as a whole is assumed to be subjected to the loads corresponding to the load factors specified in JAR 23.527.

(b) In applying the loads resulting from the load factors prescribed in JAR 23.527, the loads may be distributed over the hull or main float bottom (in order to avoid excessive local shear loads and bending moments at the location of water load application) using pressures not less than those prescribed in JAR 23.533 (b).

(c) For twin float seaplanes, each float must be treated as an equivalent hull on a fictitious seaplane with a weight equal to one-half the weight of the twin float seaplane.

(d) Except in the take-off condition of JAR 23.531, the aerodynamic lift on the seaplane during the impact is assumed to be ²/₃ of the weight of the seaplane.

JAR 23.527 Hull and main float load factors

(a) Water reaction load factors N_W must be computed in the following manner:

(1) For the step landing case

$$n_W = \frac{C_1 V_{SO}^2}{\left(\tan^{2/3}\beta\right) W^{1/3}}$$

(2) For the bow and stern landing cases

$$n_W = \frac{C_1 V_{SO}}{\left(\tan^{2/3}\beta\right) W^{1/3}} \times \frac{K_1}{\left(1 + r_x^2\right)^{2/3}}$$

(b) The following values are used:

(1) n_W = water reaction load factor (that is, the water reaction divided by seaplane weight).

(2) C_1 = empirical seaplane operations factor equal to 0·012 (except that this factor may not be less than that necessary to obtain the minimum value of step load factor of 2·33).

(3) V_{SO} = seaplane stalling speed in knots with flaps extended in the appropriate landing position and with no slipstream effect.

(4) β = Angle of dead rise at the longitudinal station at which the load factor is being determined in accordance with figure 1 of Appendix I of JAR-23.

JAR 23.527 (b) (continued)

(5) W = seaplane design landing weight in pounds.

(6) K_1 = empirical hull station weighing factor, in accordance with figure 2 of Appendix I of JAR-23.

(7) r_x = ratio of distance, measured parallel to hull reference axis, from the centre of gravity of the seaplane to the hull longitudinal station at which the load factor is being computed to the radius of gyration in pitch of the seaplane, the hull reference axis being a straight line, in the plane of symmetry, tangential to the keel at the main step.

(c) For a twin float seaplane, because of the effect of flexibility of the attachment of the floats to the seaplane, the factor K_1 may be reduced at the bow and stern to 0·8 of the value shown in figure 2 of Appendix I of JAR-23. This reduction applies only to the design of the carry through and seaplane structure.

JAR 23.529 Hull and main float landing conditions

(a) *Symmetrical step, bow, and stern landing.* For symmetrical step, bow, and stern landings, the limit water reaction load factors are those computed under JAR 23.527. In addition –

(1) For symmetrical step landings, the resultant water load must be applied at the keel, through the centre of gravity, and must be directed perpendicularly to the keel line;

(2) For symmetrical bow landings, the resultant water load must be applied at the keel, one-fifth of the longitudinal distance from the bow to the step, and must be directed perpendicularly to the keel line; and

(3) For symmetrical stern landings the resultant water load must be applied at the keel, at a point 85% of the longitudinal distance from the step to the stern post, and must be directed perpendicularly to the keel line.

(b) *Unsymmetrical landing for hull and single float seaplanes*

Unsymmetrical step, bow, and stern landing conditions must be investigated. In addition –

(1) The loading for each condition consists of an upward component and a side component equal, respectively, to 0·75 and [0·25 tan ß times the resultant load in the]

JAR 23.529 (b) (continued)

corresponding symmetrical landing condition; and

(2) The point of application and direction of the upward component of the load is the same as that in the symmetrical condition, and the point of application of the side component is at the same longitudinal station as the upward component but is directed inward perpendicularly to the plane of symmetry at a point midway between the keel and chine lines.

(c) *Unsymmetrical landing; twin float seaplanes.* The unsymmetrical loading consists of an upward load at the step of each float of [0·75 and a side load of 0·25 tan ß at one float] times the step landing load reached under JAR 23.527. The side load is directed inboard, perpendicularly to the plane of symmetry midway between the keel and chine lines of the float, at the same longitudinal station as the upward load.

[Amdt. 1, 01.02.01]

JAR 23.531 Hull and main float take-off condition

For the wing and its attachment to the hull or main float –

(a) The aerodynamic wing lift is assumed to be zero; and

(b) A downward inertia load, corresponding to a load factor computed from the following formula, must be applied:

$$n = \frac{C_{TO}\ V_{S1}^2}{\left(\tan^{2/3}\beta\right)W^{1/3}}$$

where–

n = inertia load factor

C_{TO} = empirical seaplane operations factor equal to 0·004;

V_{S1} = seaplane stalling speed (knots) at the design take-off weight with the flaps extended in the appropriate take-off position;

β = angle of dead rise at the main step (degrees); and

W = design water take-off weight in pounds.

JAR 23.533 Hull and main float bottom pressures

(a) *General.* The hull and main float structure, including frames and bulkheads, stringers, and bottom plating, must be designed under this section.

(b) *Local pressures.* For the design of the bottom plating and stringers and their attachments to the supporting structure, the following pressure distributions must be applied:

(1) For an unflared bottom, the pressure at the chine is 0·75 times the pressure at the keel, and the pressures between the keel and chine vary linearly, in accordance with figure 3 of Appendix I of JAR-23. The pressure at the keel (psi) is computed as follows:

$$[\ P_k = \frac{C_2 K_2\ V_{S1}^2}{\tan\beta_k}\ ]$$

where–

P_k = pressure (psi) at the keel;

C_2 = 0·00213;

K_2 = hull station weighing factor, in accordance with figure 2 of Appendix I of JAR-23;

V_{S1} = seaplane stalling speed (knots) at the design water take-off weight with flaps extended in the appropriate take-off position; and

β_k = angle of dead rise at keel, in accordance with figure 1 of Appendix I of JAR-23.

(2) For a flared bottom, the pressure at the beginning of the flare is the same as that for an unflared bottom, and the pressure between the chine and the beginning of the flare varies linearly, in accordance with figure 3 of Appendix I of JAR-23. The pressure distribution is the same as that prescribed in sub-paragraph (b)(1) of this paragraph for an unflared bottom except that the pressure at the chine is computed as follows:

$$[\ P_{ch} = \frac{C_3 K_2\ V_{S1}^2}{\tan\beta}\ ]$$

where –

P_{ch} = pressure (psi) at the chine;

C_3 = 0·0016;

JAR 23.533 (b) (continued)

K_2 = hull station weighing factor, in accordance with figure 2 of Appendix I of JAR-23;

V_{S1} = seaplane stalling speed (knots) at the design water take-off weight with flaps extended in the appropriate take-off position; and

β = angle of dead rise at appropriate station.

The area over which these pressures are applied must simulate pressures occurring during high localised impacts on the hull or float, but need not extend over an area that would induce critical stresses in the frames or in the overall structure.

(c) *Distributed pressures.* For the design of the frames, keel, and chine structure, the following pressure distributions apply:

(1) Symmetrical pressures are computed as follows:

$$[\ P = \frac{C_4 K_2 V_{S0}^2}{\tan\beta}\ ]$$

where –

P = pressure (psi);

C_4 = 0·078 C_1 (with C_1 computed under JAR 23.527);

K_2 = hull station weighing factor, determined in accordance with figure 2 of Appendix I of JAR-23;

V_{S0} = seaplane stalling speed (knots) with landing flaps extended in the appropriate position and with no slipstream effect; and

β = angle of dead rise at appropriate station.

(2) The unsymmetrical pressure distribution consists of the pressures prescribed in sub-paragraph (c) (1) of this paragraph on one side of the hull or main float centreline and one-half of that pressure on the other side of the hull or main float centreline, in accordance with figure 3 of Appendix I of JAR-23.

These pressures are uniform and must be applied simultaneously over the entire hull or main float bottom. The loads obtained must be carried into the sidewall structure of the hull proper, but need not be transmitted in a fore and aft direction as shear and bending loads.

[Amdt. 1, 01.02.01]

JAR 23.535 Auxiliary float loads

(a) *General.* Auxiliary floats and their attachments and supporting structures must be designed for the conditions prescribed in this section. In the cases specified in sub-paragraphs (b) to (e) of this paragraph, the prescribed water loads may be distributed over the float bottom to avoid excessive local loads, using bottom pressures not less than those prescribed in sub-paragraph (g) of this paragraph.

(b) *Step loading.* The resultant water load must be applied in the plane of symmetry of the float at a point three-quarters of the distance from the bow to the step and must be perpendicular to the keel. The resultant limit load is computed as follows, except that the value of L need not exceed three times the weight of the displaced water when the float is completely submerged;

$$L = \frac{C_5 V_{S0}^2 W^{2/3}}{\tan^{2/3}\beta_s (1 + r_y^2)^{2/3}}$$

where –

L = limit load (lb.);

C_5 = 0·0053;

V_{S0} = seaplane stalling speed (knots) with landing flaps extended in the appropriate position and with no slipstream effect;

W = seaplane design landing weight in pounds;

β_s = angle of dead rise at a station ¾ of the distance from the bow to the step, but need not be less than 15°; and

r_y = ratio of the lateral distance between the centre of gravity and the plane of symmetry of the float to the radius of gyration in roll.

(c) *Bow loading.* The resultant limit load must be applied in the plane of symmetry of the float at a point one-quarter of the distance from the bow to the step and must be perpendicular to the tangent to the keel line at that point. The magnitude of the resultant load is that specified in sub-paragraph (b) of this paragraph.

(d) *Unsymmetrical step loading.* The resultant water load consists of a component equal to 0·75 times the load specified in sub-paragraph (a) of this paragraph and a side component equal to 3·25 tan β times the load specified in sub-paragraph (b) of this paragraph.

JAR 23.535 (d) (continued)

The side load must be applied perpendicularly to the plane of symmetry of the float at a point midway between the keel and the chine.

(e) *Unsymmetrical bow loading.* The resultant water load consists of a component equal to 0·75 times the load specified in sub-paragraph (b) of this paragraph and a side component equal to 0·25 tan β times the load specified in sub-paragraph (c) of this paragraph. The side load must be applied perpendicularly to the plane of symmetry at a point midway between the keel and the chine.

(f) *Immersed float condition.* The resultant load must be applied at the centroid of the cross section of the float at a point one-third of the distance from the bow to the step. The limit load components are as follows:

$$[\text{ vertical} = \rho g V]$$

$$[\text{aft} = \frac{C_x \rho V^{2/3} (K V s0)^2}{2}]$$

$$[\text{side} = \frac{C_y \rho V^{2/3} (K V s0)^2}{2}]$$

where –

ρ = mass density of water (slugs/ft^3)

V = volume of float (ft.^{3});

C_x = coefficient of drag force, equal to 0·133;

C_y = coefficient of side force, equal to 0·106;

K = 0·8, except that lower values may be used if it is shown that the floats are incapable of submerging at a speed of 0·8 Vso in normal operations;

Vso = seaplane stalling speed (knots) with landing flaps extended in the appropriate position and with no slipstream effect; and

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

(g) *Float bottom pressures.* The float bottom pressures must be established under JAR 23.533, except that the value of K_2 in the formulae may be taken as 1·0. The angle of dead rise to be used in determining the float bottom pressures is set forth in sub-paragraph (b) of this paragraph.

[Amdt. 1, 01.02.01]

JAR 23.537 Seawing loads

Seawing design loads must be based on applicable test data.

EMERGENCY LANDING CONDITIONS

JAR 23.561 General

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

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

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

(2) The occupant experiences the static inertia loads corresponding to the following ultimate load factors:

(i) Upward, 3·0g for normal, utility, and commuter category aeroplanes, or 4·5g for aerobatic category aeroplanes;

(ii) Forward, 9·0g;

(iii) Sideward, 1·5g; and

(3) The items of mass within the cabin, that could injure an occupant, experience the static inertia loads corresponding to the following ultimate load factors:

(i) Upward, 3·0g;

(ii) Forward, 18·0g; and

(iii) Sideward, 4·5g.

(c) Each aeroplane with retractable landing gear must be designed to protect each occupant in a landing –

(1) With the wheels retracted;

(2) With moderate descent velocity; and

(3) Assuming, in the absence of a more rational analysis –

(i) A downward ultimate inertia force of 3g; and

(ii) A coefficient of friction of 0·5 at the ground.

JAR 23.561 (continued)

(d) If it is not established that a turnover is unlikely during an emergency landing, the structure must be designed to protect the occupants in a complete turnover as follows:

(1) The likelihood of a turnover may be shown by an analysis assuming the following conditions:

(i) The most adverse combination of weight and centre of gravity position;

(ii) Longitudinal load factor of 9·0g;

(iii) Vertical load factor of 1·0g; and

(iv) For aeroplanes with tricycle landing gear, the nose wheel strut failed with the nose contacting the ground.

(2) For determining the loads to be applied to the inverted aeroplane after a turnover, an upward ultimate inertia load factor of 3·0g and a coefficient of friction with the ground of 0·5 must be used.

(e) Except as provided in JAR 23.787 (c) the supporting structure must be designed to restrain, under loads up to those specified in sub-paragraph (b) (3) of this paragraph, each item of mass that could injure an occupant if it came loose in a minor crash landing.

JAR 23.562 Emergency landing dynamic conditions [(See ACJ 23.562)]

(a) Each seat/restraint system must be designed to protect each occupant during an emergency landing when –

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

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

(b) Each seat/restraint system, for crew or passenger occupancy during take off and landing, must successfully complete dynamic tests or be demonstrated by rational analysis supported by dynamic tests, in accordance with each of the following conditions. These tests must be conducted with an occupant simulated by an anthropomorphic test dummy (ATD), as specified in Appendix J or an approved equivalent with a nominal weight of 77 kg (170 lb) and seated in the normal upright position.

JAR 23.562 (b) (continued)

(1) For the first test, the change in velocity may not be less than 31 ft per second. The seat/restraint system must be oriented in its nominal position with respect to the aeroplane and with the horizontal plane of the aeroplane pitched up 60°, with no yaw, relative to the impact vector. For seat/restraint systems to be installed in the first row of the aeroplane, peak deceleration must occur in not more than 0·05 seconds after impact and must reach a minimum of 19g. For all other seat/restraint systems, peak deceleration must occur in not more than 0·06 seconds after impact and must reach a minimum of 15g.

(2) For the second test, the change in velocity may not be less than 42 ft per second. The seat/restraint system must be oriented in its nominal position with respect to the aeroplane and with the vertical plane of the aeroplane yawed 10°, with no pitch, relative to the impact vector in a direction that results in the greatest load on the shoulder harness. For seat/restraint systems to be installed in the first row of the aeroplane, peak deceleration must occur in not more than 0·05 seconds after impact and must reach a minimum of 26g. For all other seat/restraint systems, peak deceleration must occur in not more than 0·06 seconds after impact and must reach a minimum of 21g.

(3) To account for floor warpage, the floor rails of attachment devices used to attach the seat/restraint system to the airframe structure must be preloaded to misalign with respect to each other by at least 10° vertically (i.e. pitch out of parallel) and one of the rails or attachment devices must be preloaded to misalign by 10° in roll prior to conducting the test defined by sub-paragraph (b) (2) of this paragraph.

(c) Compliance with the following requirements must be shown during the dynamic tests conducted in accordance with sub-paragraph (b) of this paragraph.

(1) The seat/restraint system must restrain the ATD although seat/restraint system components may experience deformation, elongation, displacement, or crushing intended as part of the design.

(2) The attachment between the seat/restraint system and the test fixture must remain intact, although the seat structure may have deformed.

JAR 23.562 (c) (continued)

(3) Each shoulder harness strap must remain on the ATD's shoulder during the impact.

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

(5) The results of the dynamic tests must show that the occupant is protected from serious head injury.

(i) When contact with adjacent seats, structure or other items in the cabin can occur, protection must be provided so that head impact does not exceed a head injury criteria (HIC) of 1 000.

(ii) The value of HIC is defined as –

$$HIC=\left\{(t2-t1)\left[\frac{1}{(t2-t1)}\int_{t1}^{t2} a(t)dt\right]^{2.5}\right\}_{MAX}$$

Where –

t_1 is the initial integration time, expressed in seconds,

t_2 is the final integration time, expressed in seconds,

(t_2-t_1) is the time duration of the major head impact, expressed in seconds, and

a(t) is the resultant deceleration at the centre of gravity of the head form expressed as a multiple of g (units of gravity).

(iii) Compliance with the HIC limit must be demonstrated by measuring the head impact during dynamic testing as prescribed in sub-paragraphs (b) (1) and (b) (2) of this paragraph or by a separate showing of compliance with the head injury criteria using test or analysis procedures.

(6) Loads in individual shoulder harness straps may not exceed 794 kg (1 750 lb). If dual straps are used for retaining the upper torso, the total strap loads may not exceed 907 kg (2 000 lb).

(7) The compression load measured between the pelvis and the lumbar spine of the ATD may not exceed 680 kg (1 500 lb).

(d) An alternate approach that achieves an equivalent, or greater, level of occupant protection to that required by this section may be used if substantiated on a rational basis.

JAR 23.562 (continued)

(e) *Not required for JAR-23.*

[Amdt. 1, 01.02.01]

FATIGUE EVALUATION

JAR 23.571 Metallic pressurised cabin structures [(See ACJ 23.571)]

(a) The strength, detail design and fabrication of the pressure cabin structure must be evaluated under one of the following:

(1) A fatigue strength investigation, in which the structure is shown by tests or by analysis, supported by test evidence, to be able to withstand the repeated loads of variable magnitude expected in service; or

(2) A fail-safe strength investigation, in which it is shown by analysis, tests, or both that catastrophic failure of the structure is not probable after fatigue failure, or obvious partial failure, of a principal structural element and that the remaining structures are able to withstand a static ultimate load factor of 75% of the limit load factor at V_C, considering the combined effects of normal operating pressures, expected external aerodynamic pressures and flight loads. These loads must be multiplied by a factor of 1·15 unless the dynamic effect of failure under static load are otherwise considered.

[(3)] The damage tolerance evaluation of JAR 23.573 (b).

(b) *Inspections.* Based on 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 paragraph of the Instructions for] Continued Airworthiness required by JAR 23.1529.

[(c) Removed]

[Amdt. 1, 01.02.01]

JAR 23.572 Metallic wing, empennage and associated structures [(See ACJ 23.572)]

(a) The strength, detail design and fabrication of those parts of the airframe structure whose failure would be catastrophic, must be evaluated under one of the following unless it is shown that the structure, operating

JAR 23.572 (a) (continued)

stress level, materials and expected uses are comparable, from a fatigue standpoint, to a similar design that has had extensive satisfactory service experience;

(1) A fatigue strength investigation in which the structure is shown by tests, or by analysis supported by test evidence to be able to withstand the repeated loads of variable magnitude expected in service; or

(2) A fail-safe strength investigation in which it is shown by analysis, tests, or both, that catastrophic failure of the structure is not probable after fatigue failure, or obvious partial failure, of a principal structural element, and that the remaining structure is able to withstand a static ultimate load factor of 75% of the critical limit load at V_C. These loads must be multiplied by a factor of 1·15 unless the dynamic effects of failure under static load are otherwise considered, or

(3) The damage tolerance evaluation of JAR 23.573 (b).

(b) Each evaluation required by this paragraph must –

(1) Include typical loading spectra (e.g. taxi, ground-air-ground cycles, manoeuvre, gust);

(2) Account for any significant effects due to the mutual influence of aerodynamic surfaces; and

(3) Consider any significant effects from propeller slipstream loading and buffet from vortex impingements.

(c) *Inspections.* Based on 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 paragraph of the Instructions for] Continued Airworthiness required by JAR 23.1529.

[Amdt. 1, 01.02.01]

JAR 23.573 Damage tolerance and fatigue evaluation of structure

[(See ACJ 23.573 (a) (1) & (3) and ACJ 23.573 (b))]

(a) *Composite airframe structure.* Composite airframe structures must be evaluated under this paragraph instead of JAR 23.571 and

JAR 23.573 (a) (continued)

23.572. The applicant must evaluate the composite airframe structure, the failure of which would result in catastrophic loss of the aeroplane, in each wing (including canards, tandem wings, and winglets), empennage, their carry through and attaching structure, moveable control surfaces and their attaching structure, fuselage, and pressure cabin using the damage-tolerance criteria prescribed in sub-paragraphs (1) to (4) of this paragraph unless shown to be impractical. If the applicant establishes that damage-tolerance criteria is impractical for a particular structure, the structure must be evaluated in accordance with sub-paragraphs (1) and (6) of this paragraph. Where bonded joints are used, the structure must also be evaluated in accordance with sub-paragraph (5) of this [paragraph.]

The effects of material variability and environmental conditions on the strength and durability properties of the composite materials must be accounted for in the evaluations required by this paragraph.

(1) It must be demonstrated by test, or by analysis supported by tests, that the structure is capable of carrying ultimate load with damage up to the threshold of detectability considering the inspection procedures employed.

(2) The growth rate or no-growth of damage that may occur from fatigue, corrosion, manufacturing flaws or impact damage under repeated loads expected in service, must be established by tests or analysis supported by tests.

(3) The structure must be shown by residual strength tests, or analysis supported by residual strength tests, to be able to withstand critical limit flight loads (considered as ultimate loads) with the extent of detectable damage consistent with the results of the damage tolerance evaluations. For pressurised cabins the following loads must be withstood:

(i) Critical limit flight loads with the combined effects of normal operating pressure and expected external aerodynamic pressures.

(ii) The expected external aerodynamic pressures in 1g flight combined with a cabin differential pressure equal to 1·1 times the normal operating differential pressure without any other load.

JAR 23.573 (a) (continued)

(4) The damage growth, between initial detectability and the value selected for residual strength demonstrations, factored to obtain inspection intervals, must allow development of an inspection program suitable for application by operation and maintenance personnel.

(5) The limit load capacity of each bonded joint the failure of which would result in catastrophic loss of the aeroplane must be substantiated by one of the following methods:

(i) The maximum disbonds of each bonded joint consistent with the capability to withstand the loads in sub-paragraph (3) of this paragraph must be determined by analysis, tests, or both. Disbonds of each bonded joint greater than this must be prevented by design features; or

(ii) Proof testing must be conducted on each production article that will apply the critical limit design load to each critical bonded joint; or

(iii) Repeatable and reliable non-destructive inspection techniques must be established which assure the strength of each joint.

(6) Structural components for which the damage tolerance method is shown to be impractical must be shown by component fatigue tests or analysis supported by tests to be able to withstand the repeated loads of variable magnitude expected in service. Sufficient component, sub component, element, or coupon tests must be done to establish the fatigue scatter factor and the environmental effects. Damage up to the threshold of detectability and ultimate load residual strength capability must be considered in the demonstration.

(b) *Metallic airframe structures.* If the applicant elects in accordance with JAR [23.571 (a) (3) or 23.572 (a) (3) to use the] damage tolerance investigation, then this 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 fatigue 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

JAR 23.573 (b) (continued)

evidence. The extent of damage for residual strength evaluation at any time within the operational life of the airplane 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 23.337 and 23.423 both at the specified speeds, but only up to V_C, and in JAR 23.345.

(2) The limit vertical gust conditions specified in JAR 23.341 and 23.425 both at the specified speeds, but only up to V_C, and in JAR 23.345.

(3) The limit rolling conditions specified in JAR 23.349 and the limit unsymmetrical conditions specified in JAR 23.367 and 23.427 all at the specified speeds, but only up to V_C.

(4) The limit lateral gust conditions specified in JAR 23.443 and 23.445 at the specified speeds.

(5) The limit yaw manoeuvring conditions specified in JAR 23.441 and 23.445 at the specified speeds.

(6) For pressurised cabins –

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

(ii) The expected external aerodynamic pressures in 1g flight combined with a cabin differential pressure equal to 1·1 times the normal operating differential pressure without any other load.

(c) *Inspections.* Based on 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 paragraph of the Instructions for] Continued Airworthiness required by JAR 23.1529.

[Amdt. 1, 01.02.01]

[JAR 23.574 Metallic damage tolerance and fatigue evaluation of commuter category aeroplanes

Not required for JAR-23.]

[JAR 23.575 Inspections and other procedures

Not required for JAR-23.]

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SUBPART D - DESIGN AND CONSTRUCTION

GENERAL

JAR 23.601 General

The suitability of each questionable design detail and part having an important bearing on safety in operations, must be established by tests.

JAR 23.603 Materials and workmanship [(See ACJ 23.603)]

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

(1) Be established by experience or tests;

(2) Meet approved specifications that ensure their having the strength and other properties assumed in the design data; and

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

(b) Workmanship must be of a high standard.

[Amdt. 1, 01.02.01]

JAR 23.605 Fabrication methods

(a) The methods of fabrication used must produce consistently sound structures. 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.

JAR 23.607 Fasteners [(See ACJ 23.607 (b))]

(a) Each non-self-locking bolt, screw, nut, pin or other fastener must, if its loss would preclude continued safe flight and landing, incorporate an additional locking devices.

(b) Fasteners and their locking devices must not be adversely affected by the environmental conditions associated with the particular installation such as temperature or vibration.

(c) No self-locking nut may be used on any bolt subject to rotation in operation unless a non-

JAR 23.607 (c) (continued)

friction locking device is used in addition to the self-locking device.

[Amdt. 1, 01.02.01]

JAR 23.609 Protection of structure

Each part of the structure must –

(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 adequate provisions for ventilation and drainage.

JAR 23.611 Accessibility provisions [(See ACJ 23.611)]

Means must be provided to allow inspection (including inspection of principal structural elements and control systems), replacement of parts, maintenance, adjustment and lubrication as necessary for continued airworthiness. The inspection means for each item must be appropriate to the inspection interval for the item.

[Amdt. 1, 01.02.01]

JAR 23.613 Material strength properties and design values [(See ACJ 23.613)]

(a) Material strength properties must be based on enough tests of material meeting specifications to establish design values on a statistical basis.

(b) The design values must be chosen to minimise the probability of structural failure due to material variability. Except as provided in sub-paragraph (e) of this paragraph, compliance with this paragraph must be shown by selecting design values that 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

JAR 23.613 (b) (continued)

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 design of structure must minimise the probability of catastrophic fatigue failure, particularly at points of stress concentration.

(e) Design values greater than the guaranteed minimum's required by this section may be used where only guaranteed minimum values are normally allowed 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 the particular item will equal or exceed those used in design.

[Amdt. 1, 01.02.01]

JAR 23.619 Special factors

The factor of safety prescribed in JAR 23.303 must be multiplied by the highest pertinent special factors of safety prescribed in JAR 23.621 to 23.625 for each part of the structure whose strength is –

(1) Uncertain;

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

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

JAR 23.621 Casting factors

(a) *General.* The factors, tests and inspections specified in sub-paragraphs (b) to (d) of this paragraph must be applied in addition to those necessary to establish foundry quality control. The inspections must meet approved specifications. Sub-paragraphs (c) and (d) of this paragraph apply to any structural castings except castings that are pressure tested as parts of hydraulic or other fluid systems and do not support structural loads.

(b) *Bearing stresses and surfaces.* The casting factors specified in sub-paragraphs (c) and (d) of this paragraph –

(1) Need not exceed 1·25 with respect to bearing stresses regardless of the method of inspection used; and

JAR 23.621 (b) (continued)

(2) Need not be used with respect to the bearing surfaces of a part whose bearing factor is larger than the applicable casting factor.

(c) *Critical castings.* For each casting whose failure would preclude continued safe flight and landing of the aeroplane or result in serious injury to occupants, the following apply:

(1) Each critical casting must either –

(i) Have a casting factor of not less than 1·25 and receive 100% inspection by visual, radiographic and either magnetic particle, penetrant or other approved equivalent non-destructive inspection method or

(ii) Have a casting factor of not less than 2·0 and receive 100% visual inspection and 100% approved non-destructive inspection. When an approved quality control procedure is established and an acceptable statistical analysis supports reduction, non-destructive inspection may be reduced from 100%, and applied on a sampling basis.

(2) For each critical casting with a casting factor less than 1·50, three sample castings must be static tested and shown to meet –

(i) The strength requirements of JAR 23.305 at an ultimate load corresponding to a casting factor of 1·25; and

(ii) The deformation requirements of JAR 23.305 at a load of 1·15 times the limit load.

(3) Examples of these castings are structural attachment fittings, parts of flight control systems, control surface hinges and balance weight attachments, seat, berth, safety belt and fuel and oil tank supports and attachments and cabin pressure valves.

(d) *Non critical castings.* For each casting other than those specified in sub-paragraph (c) or (e) of this paragraph, the following apply:

(1) Except as provided in sub-paragraph (2) and (3) of this paragraph, the casting factors and corresponding inspections must meet the following table:

JAR 23.621 (d) (continued)

Casting factor	Inspection
2·0 or more	100% visual.
Less than 2·0 but more than 1·5	100% visual and magnetic particle or penetrant or equivalent non-destructive inspection methods.
1·25 to 1·50	100% visual, magnetic particle or penetrant and radiographic or approved equivalent non-destructive inspection methods.

(2) The percentage of castings inspected by non-visual methods may be reduced below that specified in sub-paragraph (1) of this paragraph when an approved quality control procedure is established.

(3) For castings procured to a specification that guarantees the mechanical properties of the material in the casting and provides for demonstration of these properties by test of coupons cut from the castings on a sampling basis –

(i) A casting factor of 1·0 may be used; and

(ii) The castings must be inspected as provided in sub-paragraph (1) of this paragraph for casting factors of "1·25 to 1·50" and tested under sub-paragraph (c) (2) of this paragraph.

(e) *Non-structural castings.* Castings used for non-structural purposes do not require evaluation, testing or close inspection.

JAR 23.623 Bearing factors

(a) 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) For control surface hinges and control system joints, compliance with the factors prescribed in JAR 23.657 and 23.693 respectively, meets paragraph (a) of this paragraph.

JAR 23.625 Fitting factors

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

JAR 23.625 (continued)

(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 for joint designs based on comprehensive test data (such as continuous joints in metal plating, welded joints and scarf joints in wood).

(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, its attachment to the structure must be shown, by analysis, tests, or both, to be able to withstand the inertia forces prescribed in JAR 23.561 multiplied by a fitting factor of 1·33.

JAR 23.627 Fatigue strength

The structure must be designed, as far as practicable, to avoid points of stress concentration where variable stresses above the fatigue limit are likely to occur in normal service.

JAR 23.629 Flutter
[(See ACJ 23.629)]

(a) It must be shown by the methods of (b) and either (c) or (d) of this paragraph, that the aeroplane is free from flutter, control reversal and divergence for any condition of operation within the limit V~n envelope and at all speeds up to the speed specified for the selected method. In addition –

(1) Adequate tolerances must be established for quantities which affect flutter; including speed, damping, mass balance and control system stiffness; and

(2) The natural frequencies of main structural components must be determined by vibration tests or other approved methods.

(b) Flight flutter tests must be made to show that the aeroplane is free from flutter, control reversal and divergence and to show by these tests that –

(1) Proper and adequate attempts to induce flutter have been made within the speed range up to V_D;

JAR 23.629 (b) (continued)

(2) The vibratory response of the structure during the test indicates freedom from flutter;

(3) A proper margin of damping exists at VD; and

(4) There is no large and rapid reduction in damping as VD is approached.

(c) Any rational analysis used to predict freedom from flutter, control reversal and divergence must cover all speeds up to 1·2 VD.

(d) Compliance with the rigidity and mass balance criteria (pages 4-12), in Airframe and Equipment Engineering Report No. 45 (as corrected) "Simplified Flutter Prevention Criteria" (published by the Federal Aviation Administration) may be accomplished to show that the aeroplane is free from flutter, control reversal, or divergence if –

(1) VD/MD for the aeroplane is less than 260 knots (EAS) and less than Mach 0·5;

(2) The wing and aileron flutter prevention criteria, as represented by the wing torsional stiffness and aileron balance criteria, are limited to use to aeroplanes without large mass concentrations (such as engines, floats, or fuel tanks in outer wing panels) along the wing span; and

(3) The aeroplane –

(i) Does not have a T-tail or other unconventional tail configurations;

(ii) Does not have unusual mass distributions or other unconventional design features that affect the applicability of the criteria; and

(iii) Has fixed-fin and fixed-stabiliser surfaces.

(e) For turbo-propeller powered aeroplanes, the dynamic evaluation must include –

(1) Whirl mode degree of freedom which takes into account the stability of the plane of rotation of the propeller and significant elastic, inertial and aerodynamic forces; and

(2) Propeller, engine, engine mount and aeroplane structure stiffness and damping variations appropriate to the particular configuration.

(f) Freedom from flutter, control reversal and divergence up to VD/MD must be shown as follows:

JAR 23.629 (f) (continued)

(1) For aeroplanes that meet the criteria of sub-paragraphs (d) (1) to (d) (3) of this paragraph, after the failure, malfunction, or disconnection of any single element in any tab control system.

(2) For aeroplanes other than those described in sub-paragraph (f) (1) of this paragraph, after the failure, malfunction, or disconnection of any single element in the primary flight control system, any tab control system, or any flutter damper.

(g) For aeroplanes showing compliance with the fail-safe criteria of JAR 23.571 and 23.572, the aeroplane must be shown by analysis to be free from flutter up to VD/MD after fatigue failure, or obvious partial failure of a principal structural element.

(h) For aeroplanes showing compliance with the damage-tolerance criteria of JAR 23.573, the aeroplane must be shown by analysis to be free from flutter up to VD/MD with the extent of damage for which residual strength is demonstrated.

(i) For modifications to the type design which could affect the flutter characteristics compliance with sub-paragraph (a) of this paragraph must be shown, except that analysis alone, which is based on previously approved data, may be used to show freedom from flutter, control reversal and divergence for all speeds up to the speed specified for the selected method.

[Amdt. 1, 01.02.01]

WINGS

JAR 23.641 Proof of strength

The strength of stressed skin wings must be proven by load tests or by combined structural analysis and load tests.

CONTROL SURFACES

JAR 23.651 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) In structural analyses, rigging loads due to wire bracing must be accounted for in a rational or conservative manner.

JAR 23.655 Installation

(a) Movable surfaces must be installed so that there is no interference between any surfaces, their bracing or adjacent fixed structure, when one surface is held in its most critical clearance positions and the others are operated through their full movement.

(b) If an adjustable stabiliser is used, it must have stops that will limit its range of travel to that allowing safe flight and landing.

JAR 23.657 Hinges

(a) Control surface hinges, except ball and roller bearing hinges, must have a factor of safety of not less than 6·67 with respect to the ultimate bearing strength of the softest material used as a bearing.

(b) For ball or roller bearing hinges, the approved rating of the bearing may not be exceeded.

JAR 23.659 Mass balance

The supporting structure and the attachment of concentrated mass balance weights used on control surfaces must be designed for –

(a) 24g normal to the plane of the control surface;

(b) 12g fore and aft; and

(c) 12g parallel to the hinge line.

CONTROL SYSTEMS

JAR 23.671 General [(See ACJ 23.671)]

(a) Each control must operate easily, smoothly and positively enough to allow proper performance of its functions.

(b) Controls must be arranged and identified to provide for convenience in operation and to prevent the possibility of confusion and subsequent inadvertent operation.

[Amdt. 1, 01.02.01]

JAR 23.672 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 JAR-23, such systems must comply with JAR 23.671 and the following:

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

(b) The design of the stability augmentation system or of any other automatic or power-operated system must permit initial counteraction of failures 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;

(2) The controllability and manoeuvrability requirements of JAR-23 are met within a practical operational flight envelope (for example, speed, altitude, normal acceleration, and aeroplane configuration) that 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 23.673 Primary flight controls

(a) Primary flight controls are those used by the pilot for the immediate control of pitch, roll and yaw.

JAR 23.675 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 23.677 Trim systems

(a) Proper precautions must be taken to prevent inadvertent, improper, or abrupt trim tab operation. There must be means near the trim control to indicate to the pilot the direction of trim control movement relative to aeroplane motion. In addition, there must be means to indicate to the pilot the position of the trim device with respect to both the range of adjustment and, in the case of lateral and directional trim, the neutral position. This means must be visible to the pilot and must be located and designed to prevent confusion.

The pitch trim indicator must be clearly marked with a position or range within which it has been demonstrated that take-off is safe for all centre of gravity positions and each flap position approved for take-off.

(b) Trimming devices must be designed so that, when any one connecting or transmitting element in the primary flight control system fails, adequate control for safe flight and landing is available with –

(1) For single-engine aeroplanes, the longitudinal trimming devices; or

(2) For twin-engine aeroplanes, the longitudinal and directional trimming devices.

(c) Tab controls must be irreversible unless the tab is properly balanced and has no unsafe flutter characteristics. Irreversible tab systems must have adequate rigidity and reliability in the portion of the system from the tab to the attachment of the irreversible unit to the aeroplane structure.

(d) It must be demonstrated that the aeroplane is safely controllable and that the pilot can perform all the manoeuvres and operations necessary to effect a safe landing following any probable powered trim system runaway that

JAR 23.677 (d) (continued)

reasonably might be expected in service, allowing for appropriate time delay after pilot recognition of the trim system runaway. The demonstration must be conducted at the critical aeroplane weights and centre of gravity positions.

JAR 23.679 Control system locks

If there is a device to lock the control system –

(a) It must give an unmistakable warning when the lock is engaged; and

(b) There must be a means to –

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

(2) Limit the operation of the aeroplane, when the device is engaged, in a manner that is apparent to the pilot prior to take-off.

(c) The device must have a means to preclude the possibility of it becoming inadvertently engaged in flight.

JAR 23.681 Limit load static tests

(a) Compliance with the limit load requirements of JAR-23 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 23.683 Operation tests [(See ACJ 23.683)]

(a) It must be shown by operation tests that, when the controls are operated from the pilot compartment with the system loaded as prescribed in sub-paragraph (b) of this paragraph, the system is free from –

(1) Jamming;

(2) Excessive friction;

(3) Excessive deflection.

JAR 23.683 (continued)

(b) The prescribed test loads are –

(1) For the entire system, loads corresponding to the limit air loads on the appropriate surface, or the limit pilot forces in JAR 23.397 (b), whichever are less; and

(2) For secondary controls, loads not less than those corresponding to the maximum pilot effort established under JAR 23.405.

[Amdt. 1, 01.02.01]

JAR 23.685 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.

(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) Each element of the flight control system must have design features, or must be distinctively and permanently marked, to minimise the possibility of incorrect assembly that could result in malfunctioning of the control system.

JAR 23.687 Spring devices

The reliability of any spring device used in the control system must be established by tests simulating service conditions unless failure of the spring will not cause flutter or unsafe flight characteristics.

JAR 23.689 Cable systems

(a) Each cable, cable fitting, turn-buckle, splice and pulley used must meet approved specifications. In addition –

[(1) No cable smaller than 3·2 mm (1/8] in) diameter may be used in primary control systems;

(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; and

(3) There must be means for visual inspection at each fairlead, pulley, terminal and turnbuckle.

JAR 23.689 (continued)

(b) Each kind and size of pulley must correspond to the cable with which it is used. Each pulley must have closely fitted guards to prevent the cables from being misplaced or fouled, even when slack. 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 3°.

(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) Tab control cables are not part of the primary control system and may be less than 1/8 inch diameter in aeroplanes that are safely controllable with the tabs in the most adverse positions.

[Amdt. 1, 01.02.01]

[JAR 23.691 Artificial stall barrier system

Not required for JAR-23]

JAR 23.693 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 materialused 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 23.697 Wing flap controls

(a) Each wing flap control must be designed so that, when the flap has been placed in any position upon which compliance with the performance requirements of JAR-23 is based, the flap will not move from that position unless the control is adjusted or is moved by the automatic operation of a flap load limiting device.

(b) The rate of movement of the flaps in response to the operation of the pilot's control or automatic device must give satisfactory flight and performance characteristics under steady or

JAR 23.697 (b) (continued)

changing conditions of airspeed, engine power and attitude.

(c) If compliance with JAR 23.145 (b) (3) necessitates wing flap retraction to position(s) which are not fully retracted, then the wing flap control lever settings corresponding to those positions must be positively located such that a definite change of direction of movement of the lever is necessary to select settings beyond those settings.

JAR 23.699 Wing flap position indicator

There must be a wing flap position indicator for –

(a) Flap installations with only the retracted and fully extended position, unless –

(1) A direct operating mechanism provides a sense of "feel" and position (such as when a mechanical linkage is employed; or

(2) The flap position is readily determined without seriously detracting from other piloting duties under any flight condition, day or night; and

(b) Flap installation with intermediate flap positions if –

(1) Any flap position other than retracted or fully extended is used to show compliance with the performance requirements of JAR-23; and

(2) The flap installation does not meet the requirements of sub-paragraph (a) (1) of this paragraph.

JAR 23.701 Flap interconnection

(a) The main wing flaps and related movable surfaces as a system must –

(1) Be synchronised by mechanical interconnection between the movable flap surfaces that is independent of the flap drive system or by an approved equivalent means; or

(2) Be designed so that the occurrence of any failure of the flap system that would result in an unsafe flight characteristic of the aeroplane is extremely improbable; or

(b) The aeroplane must be shown to have safe flight characteristics with any combination of extreme positions of individual movable surfaces (mechanically interconnected surfaces are to be considered as a single surface).

JAR 23.701 (continued)

(c) If an interconnection is used in twin-engine aeroplanes, it must be designed to account for the unsymmetrical loads resulting from flight with the engine on one side of the plane of symmetry inoperative and the remaining engine at take-off power. For single-engine aeroplanes and twin-engine aeroplanes with no slipstream effects on the flaps, it may be assumed that 100% of the critical air load acts on one side and 70% on the other.

JAR 23.703 Take-off warning system

For commuter category aeroplanes, unless it can be shown that a lift or longitudinal trim device which affects the take-off performance of the aircraft would not give an unsafe take-off configuration when selected out of an approved take-off position, 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 that would not allow a safe take-off. The warning must continue until –

(1) The configuration is changed to allow safe take-off, or

(2) Action is taken by the pilot to abandon the take-off roll.

(b) 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.

LANDING GEAR

JAR 23.721 General

For commuter category aeroplanes that have a passenger seating configuration, excluding pilot seats, of 10 or more, the following general requirements for the landing gear apply:

(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 in the upward and aft directions), the failure mode is not likely to cause the spillage of enough fuel from any part of the fuel system to constitute a fire hazard.

JAR 23.721 (continued)

(b) Each aeroplane 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 section may be shown by analysis or test, or both.

JAR 23.723 Shock absorption tests

(a) It must be shown that the limit load factors selected for design in accordance with JAR 23.473 for take-off and landing weights, respectively, will not be exceeded. This must be shown by energy absorption tests except that analysis based on tests conducted on a landing gear system with identical energy absorption characteristics may be used for increases in previously approved take-off and landing weights.

(b) The landing gear may not fail, but may yield, in a test showing its reserve energy absorption capacity, simulating a descent velocity of 1·2 times the limit descent velocity, assuming wing lift equal to the weight of the aeroplane.

JAR 23.725 Limit drop tests

(a) If compliance with JAR 23.723 (a) is shown by free drop tests, these tests must be made on the complete aeroplane, or on units consisting of wheel, tyre and shock absorber, in their proper relation, from free drop heights not less than those determined by the following formula:

$h \text{ (inches)} = 3{\cdot}6\, (W/S)^{1/2}$

However, the free drop height may not be less than 9·2 inches and need not be more than 18·7 inches.

(b) If the effect of wing lift is provided for in free drop tests, the landing gear must be dropped with an effective weight equal to –

$$W_e = W\frac{h+(1-L)d}{h+d}$$

where –

W_e = the effective weight to be used in the drop test (lb);

h = specified free drop height (inches);

JAR 23.725 (b) (continued)

d = deflection under impact of the tyre (at the approved inflation pressure) plus the vertical component of the axle travel relative to the drop mass (inches);

W = W_M for main gear units (lb), equal to the static weight on that unit with the aeroplane in the level attitude (with the nose wheel clear in the case of the nose wheel type aeroplanes);

W = W_T for tail gear units (lb), equal to the static weight on the tail unit with the aeroplane in the tail-down attitude;

W = W_N for nose wheel units (lb), equal to the vertical component of the static reaction that would exist at the nose wheel, assuming that the mass of the aeroplane acts at the centre of gravity and exerts a force of 1·0g downward and 0·33g forward; and

L = the ratio of the assumed wing lift to the aeroplane weight, but not more than 0·667.

(c) The limit inertia load factor must be determined in a rational or conservative manner, during the drop test, using a landing gear unit attitude and applied drag loads, that represent the landing conditions.

(d) The value of d used in the computation of W_e in sub-paragraph (b) of this paragraph may not exceed the value actually obtained in the drop test.

(e) The limit inertia load factor must be determined from the drop test in sub-paragraph (b) of this paragraph according to the following formula:

$$n = n_j\frac{W_e}{W} + L$$

where –

n_j = the load factor developed in the drop test (that is, the acceleration (dv/dt) in g's recorded in the drop test) plus 1·0; and

W_e, W and L are the same as in the drop test computation.

(f) The value of n determined in accordance with sub-paragraph (e) may not be more than the limit inertia load factor used in the landing conditions in JAR 23.473.

JAR 23.726 Ground load dynamic tests

(a) If compliance with the ground load requirements of JAR 23.479 to 23.483 is shown dynamically by drop test, one drop test must be conducted that meets JAR 23.725 except that the drop height must be –

(1) 2·25 times the drop height prescribed in JAR 23.725 (a); or

(2) Sufficient to develop 1·5 times the limit load factor.

(b) The critical landing condition for each of the design conditions specified in JAR 23.479 to 23.483 must be used for proof of strength.

JAR 23.727 Reserve energy absorption drop tests

(a) If compliance with the reserve energy absorption requirements in JAR 23.723 (b) is shown by free drop tests, the drop height may not be less than 1·44 times that specified in JAR 23.725.

(b) If the effect of wing lift is provided for, the units must be dropped with an effective mass equal to

[$W_e = W\left(\frac{h}{h+d}\right)$, when the symbols]

and other details are the same as in JAR 23.725.

[Amdt. 1, 01.02.01]

JAR 23.729 Landing gear extension and retraction system [(See ACJ 23.729 (g)]

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

(1) Each landing gear retracting mechanism and its supporting structure must be designed for maximum flight load factors with the gear retracted and must be designed for the combination of friction, inertia, brake torque and air loads, occurring during retraction at any airspeed up to 1·6 V_{S1} with flaps retracted and for any load factor up to those specified in JAR 23.345 for the flaps-extended condition.

(2) The landing gear and retracting mechanism, including the wheel well doors, must withstand flight loads, including loads resulting from all yawing conditions specified in JAR 23.351, with the landing gear extended at any speed up to at least 1·6 V_{S1} with the flaps retracted.

JAR 23.729 (continued)

(b) *Landing gear lock.* There must be positive means (other than the use of hydraulic pressure) to keep the landing gear extended.

(c) *Emergency operation.* For a landplane having retractable landing gear that cannot be extended manually, there must be means to extend the landing gear in the event of either –

(1) Any reasonably probable failure in the normal landing gear operation system; or

(2) Any reasonably probable failure in a power source that would prevent the operation of the normal landing gear operation system.

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

(e) *Position indicator.* If a retractable landing gear is used, there must be a landing gear position indicator (as well as necessary switches to actuate the indicator) or other means to inform the pilot that each gear is secured in the extended (or retracted) position. If switches are used, they must be located and coupled to the landing gear mechanical system in a manner that prevents an erroneous indication of either "down and locked" if each gear is not in the fully extended position, or of "up and locked" if each landing gear is not in the fully retracted position.

(f) *Landing gear warning.* For land-planes, the following aural or equally effective landing gear warning devices must be provided:

(1) A device that functions continuously when one or more throttles are closed beyond the power settings normally used for landing approach if the landing gear is not fully extended and locked. A throttle stop may not be used in place of an aural device. If there is a manual shut-off for the warning device prescribed in this paragraph, the warning system must be designed so that, when the warning has been suspended after one or more throttles are closed, subsequent retardation of any throttle to or beyond the position for normal landing approach will activate the warning device.

(2) A device that functions continuously when the wing flaps are extended beyond the maximum approach flap position, using a normal landing procedure, if the landing gear is not fully extended and locked. There may not be a manual shut-off for this warning device. The flap position sensing unit may be installed at any suitable location. The system for this device may use any part of the

JAR 23.729 (f) (continued)

system (including the aural warning device) for the device required in sub-paragraph (1) of this paragraph.

(g) *Equipment located in the landing gear bay.* If the landing gear bay is used as the location for equipment other than the landing gear, that equipment must be designed and installed to minimise damage.

[Amdt. 1, 01.02.01]

JAR 23.731 Wheels

(a) 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.

(b) 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 JAR-23.

JAR 23.733 Tyres

(a) Each landing gear wheel must have a tyre whose approved tyre ratings (static and dynamic) are not exceeded –

(1) By a load on each main wheel tyre (to be compared to the static rating approved for such tyres) equal to the corresponding static ground reaction under the design maximum weight and critical centre of gravity; and

(2) By a load on nose wheel tyres (to be compared with the dynamic rating approved for such tyres) equal to the reaction obtained at the nose wheel, assuming the mass of the aeroplane to be concentrated at the most critical centre of gravity and exerting a force of 1·0 W downward and 0·31 W forward (where W is the design maximum weight), with the reactions distributed to the nose and main wheels by the principles of statics and with the drag reaction at the ground applied only at wheels with brakes.

(b) If specially constructed tyres are used, the wheels must be plainly and conspicuously marked to that effect. The markings must include the make, size, number of plies and identification marking of the proper tyre.

(c) 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

JAR 23.733 (c) (continued)

adequate to prevent contact between the tyre and any part of the structure or systems.

JAR 23.735 Brakes
[(See ACJ 23.735 (c))]

(a) Brakes must be provided. The landing brake kinetic energy capacity rating of each main wheel brake assembly must not be less than the kinetic energy absorption requirements determined under either of the following methods:

(1) The brake kinetic energy absorption requirements must be based on a conservative rational analysis of the sequence of events expected during landing at the design landing weight.

(2) Instead of a rational analysis, the kinetic energy absorption requirements for each main wheel brake assembly may be derived from the following formula:

$$KE = 0{\cdot}0443\ WV^2/N$$

where –

KE	=	Kinetic energy per wheel (ft lb);
W	=	Design landing weight (lb);
V	=	Aeroplane speed in knots. V must be not less than V_{SO}, the power off stalling speed of the aeroplane at sea level, at the design landing weight, and in the landing configuration; and
N	=	Number of main wheels with brakes.

(b) Brakes must be able to prevent the wheels from rolling on a paved runway with take-off power in the critical engine, but need not prevent movement of the aeroplane with wheels locked.

(c) During the landing distance determination required by JAR 23.75, the pressure in the wheel braking system must not exceed the pressure specified by the brake manufacturer.

(d) If anti-skid devices are installed, the devices and associated systems must be designed so that no single probable malfunction or failure will result in a hazardous loss of braking ability or directional control of the aeroplane.

(e) In addition, for commuter category aeroplanes, the rejected take-off brake kinetic energy capacity rating of each mainwheel brake assembly must not be less than the kinetic energy absorption requirements determined under either of the following methods:

JAR 23.735 *(e) (continued)*

(1) The brake kinetic energy absorption requirements must be based on a conservative rational analysis of the sequence of events expected during a rejected take-off at the design take-off weight.

(2) Instead of a rational analysis, the kinetic energy absorption requirements for each mainwheel brake assembly may be derived from the following formula:

$$KE = 0{\cdot}0443\ WV^2/N$$

where –

KE	=	Kinetic energy per wheel (ft lb)
W	=	Design take-off weight (lb)
V	=	Ground speed associated with the maximum value of V_1 selected in accordance with JAR 23.51 (c) (1)
N	=	Number of main wheels with brakes

[Amdt. 1, 01.02.01]

JAR 23.737 Skis

The maximum limit load rating for each ski must equal or exceed the maximum limit load determined under the applicable ground load requirements of JAR-23.

JAR 23.745 Nose/tail-wheel steering

(a) If nose/tail-wheel steering is installed, it must be demonstrated that its use does not require exceptional pilot skill during take-off and landing, in cross-winds and in the event of an engine failure or its use must be limited to low speed manoeuvring.

(b) Movement of the pilots steering control must not interfere with correct retraction or extension of the landing gear.

FLOATS AND HULLS

JAR 23.751 Main float buoyancy

(a) Each main float must have –

(1) A buoyancy of 80% in excess of the buoyancy required by that float to support its portion of the maximum weight of the seaplane or amphibian in fresh water; and

(2) Enough watertight compartments to provide reasonable assurance that the seaplane or amphibian will stay afloat without capsizing if any two compartments of any main float are flooded.

(b) Each main float must contain at least four watertight compartments approximately equal in volume.

JAR 23.753 Main float design

Each seaplane main float must meet the requirements of JAR 23.521.

JAR 23.755 Hulls

(a) The hull of a hull seaplane or amphibian of 680 kg (1 500 lb) or more maximum weight must have watertight compartments designed and arranged so that the hull, auxiliary floats and tyres (if used), will keep the aeroplane afloat without capsizing in fresh water when –

(1) For aeroplanes of 2 268 kg (5 000 lb) or more maximum weight, any two adjacent compartments are flooded; and

(2) For aeroplanes of 680 kg (1 500 lb) up to, but not including 2 268 kg (5 000 lb) maximum weight, any single compartment is flooded.

(b) Watertight doors in bulkheads may be used for communication between compartments.

JAR 23.757 Auxiliary floats

Auxiliary floats must be arranged so that when completely submerged in fresh water, they provide a righting movement of at least 1·5 times the upsetting moment caused by the seaplane or amphibian being tilted.

PERSONNEL AND CARGO ACCOMMODATIONS

JAR 23.771 Pilot compartment

For each pilot compartment –

(a) The compartment and its equipment must allow each pilot to perform his duties without unreasonable concentration or fatigue;

(b) Where the flightcrew are separated from the passengers by a partition, an opening or openable window or door must be provided to facilitate communication between flightcrew and the passengers; and

JAR 23.771 (continued)

(c) The aerodynamic controls listed in JAR 23.779, excluding cables and control rods, must be located with respect to the propellers so that no part of the pilot or 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 5° forward or aft of the plane of rotation of the propeller.

JAR 23.773 Pilot compartment view [(See ACJ 23.773)]

(a) Each pilot compartment must be –

(1) Arranged with sufficiently extensive clear and undistorted view to enable the pilot to safely taxi, take-off, approach, land and perform any manoeuvres within the operating limitations of the aeroplane.

(2) Free from glare and reflections that could interfere with the pilot's vision. Compliance must be shown in all operations for which certification is requested; and

(3) Designed so that each pilot is protected from the elements so that moderate rain conditions do not unduly impair the pilot's view of the flight path in normal flight and while landing.

(b) Each pilot compartment must have a means to either remove or prevent the formation of fog or frost on an area of the internal portion of the windshield and side windows sufficiently large to provide the view specified in sub-paragraph (a) (1) of this paragraph. Compliance must be shown under all expected external and internal ambient operating conditions, unless it can be shown that the windshield and side windows can be easily cleared by the pilot without interruption of normal pilot duties.

[Amdt. 1, 01.02.01]

JAR 23.775 Windshields and windows [(See ACJ 23.775 and ACJ 23.775 (f) & (g))]

(a) The internal panels of windshields and windows must be constructed of a nonsplintering material, such as nonsplintering safety glass.

(b) The design of windshields, windows and canopies in pressurised aeroplanes must be based on factors peculiar to high altitude operation, including –

(1) The effects of continuous and cyclic pressurisation loadings;

JAR 23.775 (b) (continued)

(2) The inherent characteristics of the material used; and

(3) The effects of temperatures and temperature gradients.

(c) On pressurised aeroplanes, if certification for operation up to and including 25 000 ft is requested, an enclosure canopy including a representative part of the installation must be subjected to special tests to account for the combined effects of continuous and cyclic pressurisation loadings and flight loads, or compliance with the fail-safe requirement of sub-paragraph (d) of this paragraph must be shown.

(d) If certification for operation above 25 000 ft is requested, the windshields, window panels and canopies must be strong enough to withstand the maximum cabin pressure differential loads combined with critical aerodynamic pressure and temperature effects after failure of any load-carrying element of the windshield, window panel or canopy.

(e) The windshield and side windows forward of the pilot's back when he is seated in the normal flight position must have a luminous transmittance value of not less than 70% .

(f) In the event of any probable single failure, a transparency heating system must be incapable of raising the temperature of any windshield or window to a point where there would be a danger of fire or structural failure so as to adversely affect the integrity of the cabin .

(g) In addition for commuter category aeroplanes, the following applies:

(1) Windshield panes directly in front of the pilot(s) in the normal conduct of their duties, and the supporting structures for these panes must withstand, without penetration, the impact of a 0·91 kg (2 lb) bird when the velocity of the aeroplane relative to the bird along the aeroplane's flight path is equal to the aeroplane's maximum approach flap speed.

(2) The windshield panels in front of the pilot(s) 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.

[Amdt. 1, 01.02.01]

JAR 23.777 Cockpit controls

(a) Each cockpit control must be located and (except where its function is obvious) identified to

JAR 23.777 (a) (continued)

provide convenient operation and to prevent confusion and inadvertent operation.

(b) The controls must be located and arranged so that the pilot, when seated, has full and unrestricted movement of each control without interference from either his clothing or the cockpit structure.

(c) Powerplant controls must be located –

(1) For twin-engined aeroplanes, on the pedestal or overhead at or near the centre of the cockpit;

(2) For single and tandem seated single-engine aeroplanes, on the left side console or instrument panel;

(3) For other single-engine aeroplanes at or near the centre of the cockpit, on the pedestal, instrument panel, or overhead; and

(4) For aeroplanes with side-by-side pilot seats and with two sets of powerplant controls, on left and right consoles.

(d) The control location order from left to right must be power (thrust) lever, propeller (rpm control) and mixture control (condition lever and fuel cut-off for turbine-powered aeroplanes). Power (thrust) levers must be at least one inch higher or longer to make them more prominent than propeller (rpm control) or mixture controls. Carburettor heat or alternate air control must be to the left of the throttle or at least eight inches from the mixture control when located other than on a pedestal. Carburettor heat or alternate air control, when located on a pedestal must be aft or below the power (thrust) lever. Supercharger controls must be located below or aft of the propeller controls. Aeroplanes with tandem seating or single-place aeroplanes may utilise control locations on the left side of the cabin compartment; however, location order from left to right must be power (thrust) lever, propeller (rpm control) and mixture control.

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

(1) Conventional twin-engine powerplant controls must be located so that the left control(s) operates the left engine and the right control(s) operates the right engine.

(2) On twin-engine aeroplanes with front and rear engine locations (tandem), the left powerplant controls must operate the front engine and the right powerplant controls must operate the rear engine.

JAR 23.777 (continued)

(f) Wing flap and auxiliary lift device controls must be located –

(1) Centrally, or to the right of the pedestal or powerplant throttle control centreline; and

(2) Far enough away from the landing gear control to avoid confusion.

(g) The landing gear control must be located to the left of the throttle centreline or pedestal centreline.

(h) Each fuel feed selector control must comply with JAR 23.995 and be located and arranged so that the pilot can see and reach it without moving any seat or primary flight control when his seat is at any position in which it can be placed.

(1) For a mechanical fuel selector;

(i) The indication of the selected fuel valve position must be by means of a pointer and must provide positive identification and feel (detent, etc.,) of the selected position.

(ii) The position indicator pointer must be located at the part of the handle that is the maximum dimension of the handle measured from the centre of rotation.

(2) For electrical or electronic fuel selector;

(i) Digital controls or electrical switches must be properly labelled.

(ii) Means must be provided to indicate to the flightcrew the tank or function selected. Selector switch position is not acceptable as a means of indication. The "off" or "closed" position must be indicated in red.

(3) If the fuel valve selector handle or electrical or digital selection is also a fuel shut-off selector, the off position marking must be coloured red. If a separate emergency shut-off means is provided, it also must be coloured red.

JAR 23.779 Motion and effect of cockpit controls

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

JAR 23.779 (continued)

(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 or up for Flaps up or auxiliary device stowed; rearward or down for flaps down or auxiliary device deployed.
Trim tabs (or equivalent)	Switch motion or mechanical rotation or control to produce similar rotation of the aeroplane about an axis parallel to the axis control. Axis of roll trim control may be displaced to accommodate comfortable actuation by the pilot. For single-engined aeroplanes, direction of pilot's hand movement must be in the same sense as aeroplane response for rudder trim if only a portion of a rotational element is accessible.

(b) Powerplant and auxiliary controls

(1) Powerplant

Controls	*Motion and effect*
Power (thrust) lever)	Forward to increase forward thrust and rearward to increase rearward thrust.
Propellers	Forward to increase rpm.
Mixture	Forward or upward for rich.
Fuel	Forward for open.
Carburettor air heat or alternate air	Forward or upward for cold.
Supercharger	Forward or upward for low blower.

JAR 23.779 (b) (continued)

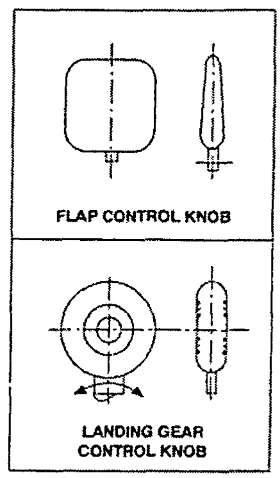
Turbosuper-chargers	Forward, upward, or clockwise to increase pressure.
Rotary controls	Clockwise from off to full on.

(2) *Auxiliary*

Controls	*Motion and effect*
Fuel tank selector	Right for right tanks, left for left tanks.
Landing gear	Down to extend.
Speed brakes	Aft to extend.

JAR 23.781 Cockpit control knob shape

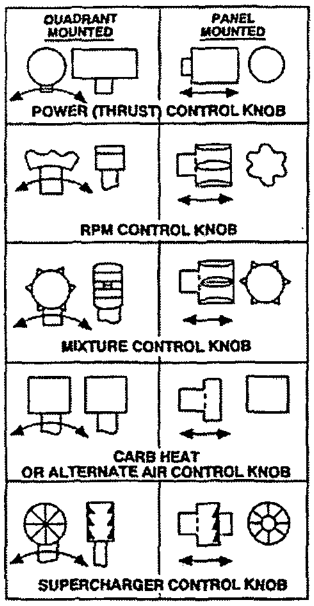
(a) Flap and landing gear control knobs must conform to the general shapes (but not necessarily the exact sizes or specific proportions) in the following figure:



(b) Powerplant control knobs must conform to the general shapes (but not necessarily the exact sizes of specific proportions) in the following figures:

INTENTIONALLY LEFT BLANK

JAR 23.781 (b) (continued)



JAR 23.783 Doors
[(See ACJ 23.783 (b))]

(a) Each closed cabin with passenger accommodations must have at least one adequate and easily accessible external door.

(b) Passenger doors must not be located with respect to any propeller disc or any other potential hazard so as to endanger persons using that door.

(c) Each external passenger or crew door must comply with the following requirements:

(1) There must be means to lock and safeguard the door against inadvertent opening during flight by persons, by cargo, or as a result of mechanical failure.

(2) The door must be openable from the inside and the outside when the internal locking mechanism is in the locked position.

(3) There must be a means of opening which is simple and obvious and is arranged and marked inside and outside so that the door can be readily located, unlocked, and opened, even in darkness.

(4) The door must meet the marking requirements of JAR 23.811.

(5) The door must be reasonably free from jamming as a result of fuselage deformation in an emergency landing.

(6) Auxiliary locking devices that are actuated externally to the aeroplane may be used but such devices must be overridden by the normal internal opening means.

JAR 23.783 (continued)

(d) In addition, each external passenger or crew door, for a commuter category aeroplane, must comply with the following requirements:

(1) Each door must be openable from both the inside and outside, even though persons may be crowded against the door on the inside of the aeroplane.

(2) If inward opening doors are used, there must be a means to prevent occupants from crowding against the door to the extent that would interfere with opening the door.

(3) Auxiliary locking devices may be used.

(e) Each external door on a commuter category aeroplane, each external door forward of any engine or propeller on a normal, utility, or aerobatic category aeroplane, and each door of the pressure vessel on a pressurised aeroplane must comply with the following requirements:

(1) There must be a means to lock and safeguard each external door, including cargo and service type doors, against inadvertent opening in flight, by persons, by cargo, or as a result of mechanical failure or failure of a single structural element, either during or after closure.

(2) There must be a provision for direct visual inspection of the locking mechanism to determine if the external door, for which the initial opening movement is not inward, is fully closed and locked. The provisions must be discernible, under operating lighting conditions, by a crew member using a flashlight or an equivalent lighting source.

(3) There must be a visual warning means to signal a flight-crew member if the external door is not fully closed and locked. The means must be designed so 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) If lavatory doors are installed, they must be designed to preclude an occupant from becoming trapped inside the lavatory. If a locking mechanism is installed, it must be capable of being unlocked from the outside of the lavatory.

(g) *Not required for JAR-23.*

[Amdt. 1, 01.02.01]

JAR 23.785 Seats, berths, litters, safety belts and shoulder harnesses

There must be a seat or berth for each occupant that meets the following:

(a) Each seat/restraint system and the supporting structure must be designed to support occupants weighing at least 98 kg (215 lb) when subjected to the maximum load factors corresponding to the specified flight and ground load conditions, as defined in the approved operating envelope of the aeroplane. In addition, these loads must be multiplied by a factor of 1·33 in determining the strength of all fittings and the attachment of –

(1) Each seat to the structure; and

(2) Each safety belt and shoulder harness to the seat or structure.

(b) Each forward-facing or aft-facing seat/ restraint system in normal, utility, or aerobatic category aeroplanes must consist of a seat, safety belt and shoulder harness as required by JAR 23.1413 that are designed to provide the occupant protection provisions required in JAR 23.562. Other seat orientations must provide the same level of occupant protection as a forward-facing or aft-facing seat with a safety belt and shoulder harness, and must provide the protection provisions of JAR 23.562.

(c) For commuter category aeroplanes the supporting structure of each seat must be designed for occupants weighing at least 77 kg (170 lb) when subjected to the inertia loads resulting from the ultimate static load factors prescribed in JAR 23.561 (b) (2), and each seat/restraint system must be designed to provide the occupant protection provisions required in JAR 23.562; and each occupant must be protected from serious head injury when subjected to the loads resulting from the emergency landing dynamic conditions by a safety belt and shoulder harness for the front seats; and a safety belt, or a safety belt and shoulder harness, for each seat other than the front seats.

(d) Each restraint system must have a single-point release for occupant evacuation.

(e) The restraint system for each crew member must allow the crew member, when seated with the safety belt and shoulder harness fastened, to perform all functions necessary for flight operations.

(f) Each pilot seat must be designed for the reactions resulting from the application of pilot forces to the primary flight controls as prescribed in JAR 23.395.

JAR 23.785 (continued)

(g) There must be a means to secure each safety belt and shoulder harness, when not in use, to prevent interference with the operation of the aeroplane and with rapid occupant egress in an emergency.

(h) Unless otherwise placarded, each seat in a utility or aerobatic category aeroplane must be designed to accommodate an occupant wearing a parachute.

(i) The cabin area surrounding each seat, including the structure, interior walls, instrument panel, control wheel, pedals, and seats, within striking distance of the occupant's head or torso (with the restraint system fastened) must be free of potentially injurious objects, sharp edges, protuberances, and hard surfaces. If energy absorbing designs or devices are used to meet this requirement, they must protect the occupant from serious injury when the occupant is subjected to the inertia loads resulting from the ultimate static load factors prescribed in JAR 23.561 (b) (2), or they must comply with the occupant protection provisions of JAR 23.562, as required in sub-paragraphs (b) and (c) of this paragraph.

(j) Each seat track must be fitted with stops to prevent the seat from sliding off the track.

(k) Each seat/restraint system may use design features, such as crushing or separation of certain components, to reduce occupant loads when showing compliance with the requirements of JAR 23.562; otherwise, the system must remain intact.

(l) For the purposes of this section, a front seat is a seat located at a flight crew member station or any seat located alongside such a seat.

(m) Each berth, or provisions for a litter, installed parallel to the longitudinal axis of the aeroplane, must be designed so that the forward part has a padded end-board, canvas diaphragm, or equivalent means that can withstand the load reactions from a 98 kg (215 lb) occupant when subjected to the inertia loads resulting from the ultimate static load factors of JAR 23.561 (b) (3). In addition –

(1) Each berth or litter must have an occupant restraint system and may not have corners or other parts likely to cause serious injury to a person occupying it during emergency landing conditions; and

(2) Occupant restraint system attachments for the berth or litter must withstand the inertia loads resulting from the ultimate static load factors of JAR 23.561 (b) (3).

JAR 23.785 (continued)

(n) Proof of compliance with the static strength requirements of this section for seats and berths approved as part of the type design and for seat and berth installations may be shown by –

(1) Structural analysis, if the structure conforms to conventional aeroplane types for which existing methods of analysis are known to be reliable;

(2) A combination of structural analysis and static load tests to limit load; or

(3) Static load tests to ultimate loads.

JAR 23.787 Baggage and cargo compartments

(a) Each baggage or cargo compartment must –

(1) Be designed for its placarded maximum weight of contents and for the critical load distributions at the appropriate maximum load factors corresponding to the flight and ground load conditions of JAR-23.

(2) Have means to prevent the contents of any compartment from becoming a hazard by shifting, and to protect any controls, wiring, lines, equipment, or accessories whose damage or failure would affect safe operations.

(3) Have a means to protect occupants from injury by the contents of any compartment, located aft of the occupants and separated by structure, when the ultimate forward inertia load factor is 9g and assuming the maximum allowed baggage or cargo weight for the compartment.

(b) Designs which provide for baggage or cargo to be carried in the same compartment as passengers must have a means to protect the occupants from injury when the cargo is subjected to the inertia loads resulting from the ultimate static load factors of JAR 23.561 (b) (3), assuming the maximum allowed baggage or cargo weight for the compartment.

(c) For aeroplanes that are used only for the carriage of cargo, the flight crew emergency exits must meet the requirements of JAR 23.807 under any cargo loading conditions.

JAR 23.791 Passenger information signs

For those commuter category aeroplanes where the flight crew members can not observe the other occupants seats or where the crew compartment is separated from the passenger compartment, there must be at least one illuminated sign (using either letters or symbols) notifying all passengers when safety belts must be fastened. Signs which notify when seat belts should be fastened must –

(a) When illuminated, be legible to each person seated in the passenger compartment under all probable lighting conditions; and

(b) Be installed so that a flight-crew member can, when seated at his station, turn the illumination on and off.

JAR 23.803 Emergency evacuation

For commuter category aeroplanes, an evacuation demonstration must be conducted utilising the maximum number of occupants for which certification is desired. The demonstration must be conducted under simulated night conditions using only the emergency exits on the most critical side of the aeroplane. The participants must be representative of average airline passengers with no prior practice or rehearsal for the demonstration. Evacuation must be completed within 90 seconds .

[JAR 23.805 Flight crew emergency exits

Not required for JAR 23.]

JAR 23.807 Emergency exits

(a) *Number and location.* Emergency exits must be located to allow escape without crowding in any probable crash attitude. The aeroplane must have at least the following emergency exits:

(1) For all aeroplanes with a seating capacity of two or more, excluding aeroplanes with canopies, at least one emergency exit on the opposite side of the cabin from the main door specified in JAR 23.783.

(2) Reserved

(3) If the pilot compartment is separated from the cabin by a door that is likely to block the pilot's escape in a minor crash, there must be an exit in the pilot's compartment. The number of exits required by sub-paragraph (1) of this paragraph must then be separately determined for the passenger compartment, using the seating capacity of that compartment.

(4) Emergency exits must not be located with respect to any propeller disc or any other potential hazard so as to endanger persons using that exit.

JAR 23.807 (continued)

(b) *Type and operation.* Emergency exits must be movable windows, panels, canopies, or external doors, openable from both inside and outside the aeroplane, that provide a clear unobstructed opening large enough to admit a 482·6-by-660·4 mm (19-by-26 in) ellipse. Auxiliary locking devices used to secure the aeroplane must be designed to overridden by the normal internal opening means. In addition, each emergency exit must –

(1) Be readily accessible, requiring no exceptional agility to be used in emergencies;

(2) Have a method of opening that is simple and obvious;

(3) Be arranged and marked for easy location and operation, even in darkness;

(4) Have reasonable provisions against jamming by fuselage deformation;

(5) The inside handles of emergency exits which open outwards must be adequately protected against inadvertent operation; and

(6) In the case of aerobatic category aeroplanes, allow each occupant to abandon the aeroplane at any speed between V_{SO} and V_D.

(7) In the case of utility category aeroplanes certificated for spinning, allow each occupant to abandon the aeroplane at the highest speed likely to be achieved in the manoeuvre for which the aeroplane is certificated.

(c) *Tests.* The proper functioning of each emergency exit must be shown by tests.

(d) *Doors and exits.* In addition, for commuter category aeroplanes the following requirements apply:

(1) The passenger entrance door must qualify as a floor level emergency exit. If an integral stair is installed at such a passenger entry door, the stair must be designed so that when subjected to the inertia forces specified in JAR 23.561, and following the collapse of one or more legs of the landing gear, it will not interfere to an extent that will reduce the effectiveness of emergency egress through the passenger entry door. Each additional required emergency exit, except floor level exits, must be located over the wing or must be provided with acceptable means to assist the occupants in descending to the ground. In addition to the passenger entrance door –

(i) For a total passenger seating capacity of 15 or less, an emergency exit as defined in paragraph (b) of this

JAR 23.807 (d) (continued)

paragraph is required on each side of the cabin; and

(ii) For a total passenger seating capacity of 16 to 19, three emergency exits, as defined in paragraph (b) of this paragraph, are required with one on the same side as the door and two on the side opposite the door.

(2) A means must be provided 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, a means for direct visual inspection of the locking mechanism must be provided to determine that each emergency exit for which the initial opening movement is outward is fully locked.

(3) *Not required for JAR-23.*

(4) *Not required for JAR-23.*

JAR 23.811 Emergency exit marking

(a) Each emergency exit and external door in the passenger compartment must be externally marked and readily identifiable from outside the aeroplane by –

(1) A conspicuous visual identification scheme; and

(2) A permanent decal or placard on or adjacent to the emergency exit which shows the means of opening the emergency exit, including any special instructions, if applicable.

(b) In addition, for commuter category aeroplanes, these exits and doors must be internally marked with the word "exit" by a sign which has white letters 25 mm (1 in) high on a red background 50 mm (2 in) high, be self-illuminated or independently, internally-electrically illuminated, and have a minimum brightness of at least 160 microlamberts. The colour may be reversed if the passenger compartment illumination is essentially the same.

(c) *Not required for JAR-23.*

[JAR 23.812 Emergency lighting

Not required for JAR-23.]

JAR 23.813 Emergency exit access

For commuter category aeroplanes, access to window-type emergency exits may not be obstructed by seats or seat backs.

JAR 23.815 Width of aisle

a) For commuter category aeroplanes, the width of the main passenger aisle at any point between seats must equal or exceed the values in the following table:

Number of Passenger Seats	Minimum main passenger aisle width	
	Less than 635 mm (25 in) from floor mm (in)	635 mm (25 in) and more from floor mm (in)
10 to 19.......	229 (9)	381 (15)

b) *Not required for JAR-23.*

JAR 23.831 Ventilation

(a) Each passenger and crew compartment must be suitably ventilated. Carbon monoxide concentration may not exceed one part in 20 000 parts of air.

(b) For pressurised aeroplanes, the ventilating air in the flight crew and passenger compartments must be free of harmful or hazardous concentrations of gases and vapours in normal operations and in the event of reasonably probable failures or malfunctioning of the ventilating, heating, pressurisation, or other systems and equipment. 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 depressurising beyond safe limits.

PRESSURISATION

JAR 23.841 Pressurised cabins

(a) 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 event of any probable failure or malfunction in the pressurisation system.

JAR 23.841 (continued)

(b) Pressurised cabins must have at least the following valves, controls and indicators, for controlling cabin pressure.

(1) Two pressure relief valves to automatically limit the positive pressure differential to a predetermined value 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 equivalent) to automatically prevent a negative pressure differential that would damage the structure. However, one valve is enough 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 pressure and airflow rates.

(5) Instruments to indicate to the pilot the pressure differential, the cabin pressure altitude and the rate of change of cabin pressure altitude.

(6) Warning indication at the pilot station to indicate when the safe or pre-set pressure differential is exceeded and when a cabin pressure altitude of 10 000 ft is exceeded.

(7) A warning placard for the pilot if the structure is not designed for pressure differentials up to the maximum relief valve setting in combination with landing loads.

(8) A means to stop rotation of the compressor or to divert airflow from the cabin if continued rotation of an engine-driven cabin compressor or continued flow of any compressor bleed air will create a hazard if a malfunction occurs.

JAR 23.843 Pressurisation tests

(a) *Strength test.* The complete pressurised cabin, including doors, windows, canopy and valves, must be tested as a pressure vessel for the pressure differential specified in JAR 23.365 (d).

JAR 23.843 (continued)

(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 (3) of this paragraph.

FIRE PROTECTION

JAR 23.851 Fire extinguishers [(See ACJ 23.851 (c))]

For commuter category aeroplanes, the following apply:

(a) At least one hand fire extinguisher must be readily accessible in the pilot compartment; and

(b) At least one hand fire extinguisher must be located conveniently in the passenger compartment.

(c) For hand fire extinguishers, the following apply:

(1) The types and quantities of each extinguishing agent used must be appropriate to the kinds of fire likely to occur where that agent is to be used.

(2) Each extinguisher for use in a personnel compartment must be designed to minimise the hazard of toxic gas concentrations.

[Amdt. 1, 01.02.01]

JAR 23.853 Passenger and crew compartment interiors

For each compartment to be used by the crew or passengers –

(a) The materials must be at least flame-resistant;

(b) Reserved.

(c) If smoking is to be prohibited, there must be a placard so stating and if smoking is to be allowed –

(1) There must be an adequate number of self-contained, removable ashtrays; and

(2) Where the crew compartment is separated from the passenger compartment, there must be at least one illuminated sign (using either letters or symbols) notifying all passengers when smoking is prohibited. Signs which notify when smoking is prohibited must –

(i) When illuminated, be legible to each passenger seated in the passenger cabin under all probable lighting conditions; and

(ii) Be so constructed that the crew can turn the illumination on and off.

(d) In addition, for commuter category aeroplanes the following requirements apply:

(1) Each disposal receptacle for towels, paper, or waste must be fully enclosed and constructed of at least fire resistant materials and must contain fires likely to occur in it under normal use. The ability of the disposal receptacle to contain those fires under all probable conditions of wear, misalignment, and ventilation expected in service must be demonstrated by test. A placard containing the legible words "No Cigarette Disposal" must be located on or near each disposal receptacle door.

(2) Lavatories must have "No Smoking" or "No Smoking in Lavatory" placards located conspicuously on each side of the entry door and self-contained, removable ashtrays located conspicuously on or near the entry side of each lavatory door, except that one ashtray may serve more than one lavatory door if it can be seen from the cabin side of each lavatory door served. The placards must have red letters at least 12·7 mm (½ in) high on [a white background at least 25·4 mm (1 in)] high (a "No Smoking" symbol may be included on the placard).

JAR 23.853 (d) (continued)

(3) Materials (including finishes or decorative surfaces applied to the materials used in each compartment occupied by the crew or passengers must meet the following test criteria as applicable:

(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 Appendix F of JAR-23 or by other equivalent methods. The average [burn length may not exceed 152·4 mm] (6 in) 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, cargo compartment liners, insulation brakes, 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 (d) (3) (iv) of this paragraph must be self extinguishing when tested vertically in accordance with the applicable portions of Appendix F of JAR-23 or other approved equivalent methods. The average burn length may [not exceed 203·2 mm (8 in) 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 meeting the Standard Specifications for Safety Photographic Film PH1.25 (available from the American National Standards Institute, 1430 Broadway, New York, N.Y. 10018) or an FAA approved equivalent. If the film travels through ducts, the ducts must

JAR 23.853 (d) (continued)

meet the requirements of sub-paragraph (d) (3) (ii) of this paragraph.

(iv) Acrylic 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 63·5 mm (2·5 in)] per minute when tested horizontally in accordance with the applicable portions of Appendix F of JAR-23 or by other approved equivalent methods.

(v) Except for electrical wire cable insulation, and for small parts (such as knobs, handles, rollers, fasteners, clips, grommets, rub strips, pulleys, and small electrical parts) that the Authority finds would not contribute significantly to the propagation of a fire, materials in items not specified in (d) (3) (i), (ii), (iii) or (iv) of this paragraph may not have a [burn rate greater than 101·6 mm (4 in)] per minute when tested horizontally in accordance with the applicable portions of Appendix F of JAR-23 or by other approved equivalent methods.

(e) Lines, tanks, or equipment containing fuel, oil, or other flammable fluids may not be installed in such compartments unless adequately shielded, isolated, or otherwise protected so that any breakage or failure of such an item would not create a hazard.

(f) Aeroplane materials located on the cabin side of the firewall must be self-extinguishing or be located at such a distance from the firewall, or other-wise protected, so that ignition will not occur if the firewall is subjected to a flame temperature of not less than 1 093°C (2 000°F) for 15 minutes. For self-extinguishing materials (except electrical wire and cable insulation and small parts that the Authority finds would not contribute significantly to the propagation of a fire), a vertical self-extinguishing test must be conducted in accordance with Appendix F of JAR-23 or an equivalent method approved by the Authorities. The average burn length of the [material may not exceed 152·4 mm (6 in) and] the average flame time after removal of the flame source may not exceed 15 seconds. Drippings from the material test specimen may not continue

JAR 23.853 (f) (continued)

to flame for more than an average of 3 seconds after falling.

[Amdt. 1, 01.02.01]

JAR 23.855 Cargo and baggage compartment fire protection

(a) Sources of heat within the compartment which are capable of igniting the cargo or baggage must be shielded or insulated to prevent such ignition.

(b) For normal, utility and aerobatic category aeroplanes, each cargo and baggage compartment must be constructed of materials which are at least flame resistant.

(c) In addition, for commuter category aeroplanes, each cargo and baggage compartment must meet the provisions of JAR 23.853 (d) (3), and either –

(1) Be located where the presence of a fire would easily be discovered by a pilot while at his station, or be equipped with a separate smoke detector or fire detector system to give warning at the pilot station, and provide sufficient access in flight to enable a pilot to reach any part of the compartment with the contents of a hand-held fire extinguisher, or

(2) Be equipped with a separate smoke detector or fire detector system to give warning at the pilot station and have floor panels and ceiling and sidewall liner panels constructed of materials which have been tested at a 45° angle in accordance with the applicable portions of Appendix F of JAR-23. The flame must 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 must not exceed 15 seconds and the average glow time must not exceed 10 seconds. The compartment must be so constructed as to provide fire protection not less than that required of its individual panels, or

(3) Be constructed and sealed to contain any fire within the compartment.

JAR 23.859 Combustion heater fire protection

(a) *Combustion heater fire regions.* The following combustion heater fire regions must be protected from fire in accordance with the applicable provisions of JAR 23.1182 to 23.1191 and 23.1203:

JAR 23.859 (a) (continued)

(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 vapour to enter this region.

(3) The part of the ventilating air passage that surrounds the combustion chamber.

(b) *Ventilating air ducts.* Each ventilating air duct passage through any fire region 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 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.

JAR 23.859 (continued)

(e) *Heater safety controls*

(1) Each combustion heater must have the following safety controls:

(i) Means independent of the components for the normal continuous control of air temperature, airflow and fuel flow must be provided 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:

(A) The heat exchanger temperature exceeds safe limits.

(B) The ventilating air temperature exceeds safe limits.

(C) The combustion airflow becomes inadequate for safe operation.

(D) The ventilating airflow becomes inadequate for safe operation.

(ii) 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 (i) of this paragraph.

(2) The means for complying with sub-paragraph (1) (i) of this paragraph for any individual heater must –

(i) Be independent of components serving any other heater whose heat output is essential for safe operations; and

(ii) Keep the heater off until restarted by the crew.

(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.

(g) *Heater exhaust.* Heater exhaust systems must meet the provisions of JAR 23.1121 and 23.1123. 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;

JAR 23.859 (g) (continued)

(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) Restrictions in the exhaust system to relieve 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 of 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 condition.

JAR 23.863 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 hazard if ignition does occur.

(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.

(3) Possible ignition sources, including electrical faults, over-heating 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 safely of flight to withstand fire and heat.

JAR 23.863 (continued)

(c) If action by the flightcrew is required to prevent or counteract a fluid fire (e.g. equipment shut-down 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.

JAR 23.865 Fire protection of flight controls, engine mounts and other flight structure [(See ACJ 23.865)]

Flight controls, engine mounts, and other flight structure located in the engine compartment must be constructed of fireproof material or be shielded so that they are capable of withstanding the effects of a fire. Engine vibration isolators must incorporate suitable features to ensure that the engine is retained if the non-fireproof portions of the isolators deteriorate from the effects of a fire.

[Amdt. 1, 01.02.01]

ELECTRICAL BONDING AND LIGHTNING PROTECTION

JAR 23.867 Electrical bonding and protection against lightning and static electricity

(a) The aeroplane must be protected against catastrophic effects from lightning.

(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 –

(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.

MISCELLANEOUS

JAR 23.871 Levelling means

There must be means for determining when the aeroplane is in a level position on the ground.

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SUBPART E - POWERPLANT

GENERAL

JAR 23.901 Installation

(a) For the purpose of JAR-23, the aeroplane powerplant installation includes each component that –

(1) Is necessary for propulsion; and

(2) Affects the safety of the major propulsive units.

(b) Each powerplant installation must be constructed and arranged to –

(1) Ensure safe operation to the maximum altitude for which approval is requested.

(2) Be accessible for necessary inspections and maintenance.

(c) Engine cowls and nacelles must be easily removable or openable by the pilot to provide adequate access to and exposure of the engine compartment for pre-flight checks.

(d) Each turbine engine installation must be constructed and arranged to –

(1) Result in carcass vibration characteristics that do not exceed those established during the type certification of the engine.

(2) Provide continued safe operation without a hazardous loss of power or thrust while being operated in rain for at least 3 minutes with the rate of water ingestion being not less than 4% by weight, of the engine induction airflow rate at the maximum installed power or thrust approved for take-off and at flight idle.

(e) The powerplant installation must comply with –

(1) The installation instructions provided under –

(i) The engine type certificate, and

(ii) The propeller type certificate or equivalent approval.

(2) The applicable provisions of this subpart.

(f) Each auxiliary power unit installation must meet the applicable portions of JAR-23.

JAR 23.903 Engines and auxiliary power units
[(See ACJ 23.903 (a) (1) and ACJ 23.903 (f))]

(a) *Engine type certificate*

(1) Each engine must have a type certificate.

(2) In addition each turbine engine must either –

(i) Comply with JAR E-790 and [JAR E-800, or]

(ii) Be shown to have a foreign object ingestion service history in similar installation locations which has not resulted in any unsafe condition.

(b) *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 inside the engine which burns through the engine case.

(2) The powerplant systems associated with engine control devices, systems and instrumentation must be designed to give reasonable assurance that those operating limitations that adversely affect turbine rotor structural integrity will not be exceeded in service.

(c) *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 the failure or malfunction (including destruction by fire in the engine compartment) of any system that can affect an 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 of the remaining engine.

(d) *Starting and stopping (piston engine)*

(1) The design of the installation must be such that risk of fire or mechanical damage to the engine or aeroplane, as a result of starting the engine in any conditions in which starting is to be permitted, is reduced to a minimum. Any techniques and associated limitations for engine starting must be established and included in the Aeroplane

JAR 23.903 (d) (continued)

Flight Manual or applicable operating placards. Means must be provided for –

(i) Restarting any engine in flight, and

(ii) Stopping any engine in flight, after engine failure, if continued engine rotation would cause a hazard to the aeroplane.

(2) In addition, for commuter category aeroplanes, the following apply:

(i) 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.

(ii) 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.

(e) *Starting and stopping (turbine engine).* Turbine engine installations must comply with the following:

(1) The design of the installation must be such that risk of fire or mechanical damage to the engine or the aeroplane, as a result of starting the engine in any conditions in which starting is to be permitted, is reduced to a minimum. Any techniques and associated limitations must be established and included in the Aeroplane Flight Manual, or applicable operating placards.

(2) There must be means for stopping combustion of any engine and for stopping the rotation of any engine if continued rotation would cause a hazard to the aeroplane. Each component of the engine stopping system located in any fire zone must be fire resistant. If hydraulic propeller feathering systems are used for stopping the engine, the hydraulic feathering lines or hoses must be fire resistant.

(3) It must be possible to restart any engine in flight. Any techniques and associated limitations must be established and included in the Aeroplane Flight Manual, or applicable operating placards.

(4) It must be demonstrated in flight that when restarting engines following a false start, all fuel or vapour is discharged in such a way that it does not constitute a fire hazard.

(f) *Restart envelope.* An altitude and airspeed envelope must be established for the aeroplane for in-flight engine restarting and each installed engine must have a restart capability within that envelope.

JAR 23.903 (f) (continued)

(g) *Restart capability.* For turbine engine-powered aeroplanes, if the minimum windmilling speed of the engines, following the in-flight shutdown of all engines, is insufficient to provide the necessary electrical power for engine ignition, a power source independent of the engine-driven electrical power generating system must be provided to permit in-flight engine ignition for restarting.

(h) *Auxiliary power units.* Each APU must meet the requirements of JAR-APU.

[Amdt. 1, 01.02.01]

JAR 23.904 Automatic power reserve system

Not required for JAR-23.

JAR 23.905 Propellers [(See ACJ 23.905 (a) and ACJ 23.905 (e) and ACJ 23.905 (g))]

(a) Each propeller must have a type certificate or equivalent approval.

(b) Engine power and propeller shaft rotational speed may not exceed the limits for which the propeller is certificated.

(c) Each featherable propeller must have a means to unfeather it in flight.

(d) Each component of the propeller blade pitch control system must meet the requirements of JAR-P (P200).

(e) All areas of the aeroplane forward of the pusher propeller that are likely to accumulate and shed ice into the propeller disc during any operating condition must be suitably protected to prevent ice formation, or it must be shown that any ice shed into the propeller disc will not create a hazardous condition.

(f) Each pusher propeller must be marked so that the disc is conspicuous under normal daylight ground conditions.

(g) If the engine exhaust gases are discharged into the pusher propeller disc, it must be shown by tests, or analysis supported by tests, that the propeller is capable of continuous safe operation.

(h) All engine cowlings, access doors, and other removable items must be designed to ensure

JAR 23.905 (h) (continued)

that they will not separate from the aeroplane and contact the pusher propeller.

[Amdt. 1, 01.02.01]

JAR 23.907 Propeller vibration [(See ACJ 23.907 (a))]

(a) Each propeller other than a conventional fixed pitch wooden propeller must be shown to have vibration stresses, in normal operating conditions, that do not exceed values that have been shown by the propeller manufacturer to be safe for continuous operation. This must be shown by –

(1) Measurement of stresses through direct testing of the propeller;

(2) Comparison with similar installations for which these measurements have been made; or

(3) Any other acceptable test method or service experience that proves the safety of the installation.

(b) Proof of safe vibration characteristics for any type of propeller, except for conventional, fixed-pitch, wood propellers must be shown where necessary.

[Amdt. 1, 01.02.01]

JAR 23.909 Turbo charger systems [(See ACJ 23.909 (a) (1))]

(a) Each turbo charger must be approved under the engine type certificate or it must be shown that the turbo charger system, while in its normal engine installation and operating in the engine environment –

(1) Can withstand, without defect, an endurance test that meets the applicable requirements of JAR-E 440, and

(2) Will have no adverse effect upon the engine.

(b) Control system malfunctions, vibrations and abnormal speeds and temperatures expected in service may not damage the turbo charger compressor or turbine.

(c) Each turbo charger case must be able to contain fragments of a compressor or turbine that fails at the highest speed that is obtainable with normal speed control devices in-operative.

(d) Each intercooler installation, where provided, must comply with the following:

JAR 23.909 (d) (continued)

(1) The mounting provisions of the intercooler must be designed to withstand the loads imposed on the system;

(2) It must be shown that, under the installed vibration environment, the intercooler will not fail in a manner allowing portions of the intercooler to be ingested by the engine, and

(3) Airflow through the intercooler must not discharge directly on any aeroplane component (e.g. windshield) unless such discharge is shown to cause no hazard to the aeroplane under all operating conditions.

(e) Engine power, cooling characteristics, operating limits, and procedures affected by the turbocharger system installations must be evaluated. Turbocharger operating procedures and limitations must be included in the Aeroplane Flight Manual in accordance with JAR 23.1581.

[Amdt. 1, 01.02.01]

JAR 23.925 Propeller clearance

Propeller clearances with the aeroplane at the most adverse combination of weight and 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 177·8 mm (7 in) (for each aeroplane with nose wheel landing gear) or [228·6 mm (9 in) (for each aeroplane with tail] wheel landing gear) between each propeller and the ground with the landing gear statically deflected and in the level, normal take-off, or taxying attitude, whichever is the most critical. In addition, for each aeroplane with conventional landing gear struts using fluid or mechanical means for absorbing landing shocks, there must be positive clearance between the propeller and the ground in the level take-off attitude with the critical tyre completely deflated and the corresponding landing gear strut bottomed. Positive clearance for aeroplanes using leaf spring struts is shown with a deflection corresponding to 1·5g.

(b) *Aft mounted propellers.* In addition to the clearance specified in sub-paragraph (a) of this paragraph an aeroplane with an aft mounted propeller must be designed such that the propeller will not contact the runway surface when the aeroplane is in the maximum pitch attitude attainable during normal take-off and landings.

(c) *Water clearance.* There must be a [clearance of at least 457·2 mm (18 in) between]

JAR 23.925 (c) (continued)

each propeller and the water, unless compliance with JAR 23.239 can be shown with a lesser clearance.

(d) *Structural clearance.* There must be –

[(1) At least 25·4 mm (1 in) radial] clearance between the blade tips and the aeroplane structure, plus any additional radial clearance necessary to prevent harmful vibration;

[(2) At least 12·7 mm (½ in)] longitudinal clearance between the 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.

[Amdt. 1, 01.02.01]

JAR 23.929 Engine installation ice protection [(See ACJ 23.929)]

Propellers and other components of complete engine installations must be protected against the accumulation of ice as necessary to enable satisfactory functioning without appreciable loss of thrust when operated in the icing conditions for which certification is requested.

[Amdt. 1, 01.02.01]

JAR 23.933 Reversing systems [(See ACJ 23.933 (a) (1) (ii) and ACJ 23933 (b) (2))]

(a) *For turbojet and turbofan 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; or

(ii) The aeroplane is capable of continued safe flight and landing under any possible position of the thrust reverser.

(2) Each system intended for in-flight use must be designed so that no unsafe condition will result during normal operation of the system, or from any failure (or

JAR 23.933 (a) (continued)

reasonably likely combination of failures) of the reversing system, under any anticipated condition of operation of the aeroplane 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 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 sub-paragraph (b) (1) of 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 for the propeller and associated installation components.

(3) For turbopropeller-powered, commuter category aeroplanes the requirements of sub-paragraph (a) (2) of this paragraph apply. Compliance with this section must be shown by failure analysis, testing, or both, for propeller systems that allow the propeller blades to move from the flight low-pitch position to a position thatis substantially less than that at normal flight, low-pitch stop position. The analysis may include, or be supported by, the analysis made to show compliance for the type certification of the propeller and associated installation components.

[Amdt. 1, 01.02.01]

JAR 23.934 Turbojet and turbofan engine thrust reverser system tests

Thrust reverser systems of turbojet or turbofan engines must meet the appropriate requirements of JAR-E 650 and JAR-E 890.

JAR 23.937 Turbopropeller-drag limiting systems

(a) Turbopropeller-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 the structural requirements of JAR-23. Failure of structural elements of the drag limiting systems need not be considered if the probability of this kind of failure is extremely remote.

(b) As used in this section, drag limiting systems include manual or automatic devices that, when actuated after engine power loss can move the propeller blades toward the feather position to reduce windmilling drag to a safe level.

JAR 23.939 Powerplant operating characteristics

(a) Turbine engine powerplant operating characteristics must be investigated in flight to determine that no adverse characteristics (such as stall, surge, or flameout) are present, to a hazardous degree, during normal and emergency operations within the range of operating limitations of the aeroplane and of the engine.

(b) Turbocharged reciprocating engine operating characteristics must be investigated in flight to assure that no adverse characteristics, as a result of an inadvertent overboost, surge, flooding, or vapour lock, are present during normal or emergency operation of the engine(s) throughout the range of operating limitations of both aeroplane and engine.

(c) For turbine engines, the air inlet system must not, as a result of airflow distortion during normal operation, cause vibration harmful to the engine.

JAR 23.943 Negative acceleration [(See ACJ 23.943)]

No hazardous malfunction of an engine, an auxiliary power unit approved for use in flight, or any component or system associated with the powerplant or auxiliary power unit may occur

JAR 23.943 (continued)

when the aeroplane is operated at the negative accelerations within the flight envelopes prescribed in JAR 23.333. This must be shown for the greatest value and duration of the acceleration expected in service.

[Amdt. 1, 01.02.01]

FUEL SYSTEM

JAR 23.951 General

(a) Each fuel system must be constructed and arranged to ensure fuel flow at a rate and pressure established for proper engine and auxiliary power unit functioning under each likely operating condition, including any manoeuvre for which certification is requested and during which the engine or auxiliary power unit is permitted to be in operation.

(b) Each fuel system must be arranged so that –

(1) No fuel pump can draw fuel from more than one tank at a time; or

(2) There are means to prevent introducing air into the system.

(c) Each fuel system for a turbine engine must be capable of sustained operation throughout its flow and pressure range with fuel initially saturated with water at 27°C (80°F) and having 0·75cc of free water per US-gallon added and cooled to the most critical condition for icing likely to be encountered in operation.

(d) *Not required for JAR-23.*

JAR 23.953 Fuel system independence

(a) Each fuel system for a twin-engine aeroplane must be arranged so that, in at least one system configuration, the failure of any one component will not result in the loss of power of more than one engine or require immediate action by the pilot to prevent the loss of power of more than one engine.

(b) *Not required for JAR-23.*

JAR 23.954 Fuel system lightning protection

The fuel system must be designed and arranged to prevent the ignition of fuel vapour within the system by –

JAR 23.954 (continued)

(a) Direct lightning strikes to areas having a high probability of stroke attachment;

(b) Swept lightning strokes on areas where swept strokes are highly probable; and

(c) Corona or streamering at fuel vent outlets.

JAR 23.955 Fuel flow

(a) *General.* The ability of the fuel system to provide fuel at the rates specified in this section and at a pressure sufficient for proper engine operation must be shown in the attitude that is most critical with respect to fuel feed and quantity of unusable fuel. These conditions may be simulated in a suitable mock-up. In addition –

(1) The quantity of fuel in the tank may not exceed the amount established as the unusable fuel supply for that tank under JAR 23.959 (a) plus that necessary to show compliance with this section;

(2) If there is a fuel flowmeter, it must be blocked during the flow test and the fuel must flow through the meter or its by-pass.

(3) If there is a flowmeter without a by-pass, it must not have any probable failure mode that would restrict fuel flow below the level required in this fuel flow demonstration;

(4) The fuel flow must include that flow needed for vapour return flow, jet pump drive flow and for all other purposes for which fuel is used.

(b) *Gravity systems.* The fuel flow rate for gravity systems (main and reserve supply) must be 150% of the take-off fuel consumption of the engine.

(c) *Pump systems*

(1) The fuel flow rate for each pump system (main and reserve supply) for each reciprocating engine, must be 125% of the fuel flow required by the engine at the maximum take-off power approved under JAR-23.

(i) This flow rate is required for each main pump and each emergency pump, and must be available when the pump is operating as it would during take-off;

(ii) For each hand-operated pump, this rate must occur at not more than 60 complete cycles (120 single strokes) per minute.

JAR 23.955 (c) (continued)

(2) The fuel pressure, with main and emergency pumps operating simultaneously, must not exceed the fuel inlet pressure limits of the engine, unless it can be shown that no adverse effect occurs.

(d) *Auxiliary fuel systems and fuel transfer systems.* Sub-paragraphs (b), (c) and (f) of this paragraph apply to each auxiliary and transfer system, except that –

(1) The required fuel flow rate must be established upon the basis of maximum continuous power and engine rotational speed, instead of take-off power and fuel consumption; and

(2) If there is a placard providing operating instructions, a lesser flow rate may be used for transferring fuel from any auxiliary tank into a larger main tank. This lesser flow rate must be adequate to maintain maximum continuous power but the flow rate must not overfill the main tank at lower engine power.

(e) *Multiple fuel tanks.* For reciprocating engines that are supplied with fuel from more than one tank, if engine power loss becomes apparent due to fuel depletion from the tank selected, it must be possible after switching to any full tank, in level flight, to obtain 75% maximum continuous power on that engine in not more than –

(1) 10 seconds for naturally aspirated single-engine aeroplanes;

(2) 20 seconds for turbocharged single-engine aeroplanes, provided that 75% maximum continuous naturally aspirated power is regained within 10 seconds; or

(3) 20 seconds for twin-engine aeroplanes.

(f) *Turbine engine fuel systems.* Each turbine engine fuel system must provide at least 100% of the fuel flow required by the engine under each intended operation condition and manoeuvre. The conditions may be simulated in a suitable mock-up. This flow must –

(1) Be shown with the aeroplane in the most adverse fuel feed condition (with respect to altitudes, attitudes and other conditions) that is expected in operation; and

(2) For twin-engine aeroplanes, notwithstanding the lower flow rate allowed by sub-paragraph (d) of this paragraph, be automatically uninterrupted with respect to any engine until all the fuel scheduled for use by that engine has been consumed. In addition –

JAR 23.955 (f) (continued)

(i) For the purposes of this section, "fuel scheduled for the use by that engine" means all fuel in any tank intended for use by a specific engine.

(ii) The fuel system design must clearly indicate the engine for which fuel in any tank is scheduled.

(iii) Compliance with this paragraph must require no pilot action after completion of the engine starting phase of operations.

(3) For single engine aeroplanes, require no pilot action after completion of the engine starting phase of operations unless means are provided that unmistakenly alert the pilot to take any needed action at least five minutes prior to the needed action; such pilot action must not cause any change in engine operation; and such pilot action must not distract pilot attention from essential flight duties during any phase of operations for which the aeroplane is approved.

JAR 23.957 Flow between interconnected tanks

(a) It must be impossible, in a gravity feed system with interconnected tank outlets, for enough fuel to flow between the tanks to cause an overflow of fuel from any tank vent under the conditions in JAR 23.959, except that full tanks must be used.

(b) 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 any aeroplane component can occur because of overfilling of any tank.

JAR 23.959 Unusable fuel supply [(See ACJ 23.959 (a))]

(a) The unusable fuel supply for each tank must be established as not less than that quantity at which the first evidence of malfunctioning occurs under the most adverse fuel feed condition occurring under each intended operation and flight manoeuvre involving that tank. Fuel system component failures need not be considered.

(b) In addition, the effect on the unusable fuel quantity as a result of a failure of any pump shall be determined.

[Amdt. 1, 01.02.01]

JAR 23.961 Fuel system hot weather operation [(See ACJ 23.961)]

Each fuel system conducive to vapour formation must be free from vapour lock when using fuel at a temperature of 43°C (110°F) under critical operating conditions.

[Amdt. 1, 01.02.01]

JAR 23.963 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.

(b) Each flexible fuel tank liner must be shown to be suitable for the particular application.

(c) Each integral fuel tank must have adequate facilities for interior inspection and repair.

(d) The total usable capacity of the fuel tanks must be enough for at least ½ hour of operation at maximum continuous power.

(e) Each fuel quantity indicator must be adjusted, as specified in JAR 23.1337 (b), to account for the unusable fuel supply determined under JAR 23.959 (a).

(f) For commuter category aeroplanes, 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 23.561. In addition, these tanks must be in a protected position so that exposure of the tanks to scraping action with the ground is unlikely.

JAR 23.965 Fuel tank tests

(a) Each fuel tank must be able to withstand the following pressures without failure or leakage:

(1) For each conventional metal tank and non-metallic tank with walls not supported by the aeroplane structure, a pressure of 24·12 kPa (3·5 psi), or that pressure developed during maximum ultimate acceleration with a full tank, whichever is greater.

(2) For each integral tank, the pressure developed during the maximum limit acceleration of the aeroplane with a full tank, with simultaneous application of the critical limit structural loads.

JAR 23.965 (a) (continued)

(3) For each non-metallic tank with walls supported by the aeroplane structure and constructed in an acceptable manner using acceptable basic tank material and with actual or simulated support conditions, a pressure of 13·78 kPa (2 psi) for the first tank of a specific design. The supporting structure must be designed for the critical loads occurring in the flight or landing strength conditions combined with the fuel pressure loads resulting from the corresponding accelerations.

(b) Each fuel tank with large, unsupported, or unstiffened flat surfaces, whose failure or deformation could cause fuel leakage, must be able to withstand the following test without leakage, failure or excessive deformation of the tank walls:

(1) Each complete tank assembly and its support must be vibration tested while mounted to simulate the actual installation.

(2) Except as specified in sub-paragraph (b) (4) of this paragraph, the tank assembly must be vibrated for 25 hours at a total displacement of not less than 0·8 of a mm (1/32 in) (unless another displacement is substantiated) while 2/3 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 or propeller speeds is critical, the test frequency of vibration is the number of cycles per minute obtained by multiplying the maximum continuous propeller speed in rpm by 0·9 for propeller-driven aeroplanes, except that for non-propeller driven aeroplanes, the test frequency of vibration is 2 000 cycles per minute.

(ii) If only one frequency of vibration resulting from any rpm within the normal operating range of engine or propeller speeds is critical, that frequency must be the test frequency.

(iii) If more than one frequency of vibration resulting from any rpm within the normal operating range of engine or propeller speeds is critical, the most critical of these frequencies must be the test frequency.

(4) Under sub-paragraph (3) (ii) and (iii) of this paragraph, the time of test must be adjusted to accomplish the same number of

JAR 23.965 (b) (continued)

vibration cycles that would be accomplished in 25 hours at the frequency specified in sub-paragraph (3) (i) of this paragraph.

(5) During the test, the tank assembly must be rocked at a rate of 16 to 20 complete cycles per minute, through an angle of 15° on either side of the horizontal (30° total), about an axis parallel to the axis of the fuselage, for 25 hours.

(c) Each integral tank using methods of construction and sealing not previously proven to be adequate by test data or service experience must be able to withstand the vibration test specified in sub-paragraphs (1) to (4) of paragraph (b).

(d) Each tank with a non-metallic liner must be subjected to the sloshing test outlined in sub-paragraph (5) of paragraph (b) of this paragraph, with the fuel at room temperature. In addition, a specimen liner of the same basic construction as that to be used in the aeroplane must, when installed in a suitable test tank, withstand the sloshing test with fuel at a temperature of 43°C (110°F).

JAR 23.967 Fuel tank installation

(a) Each fuel tank must be supported so that tank loads are not concentrated. In addition –

(1) There must be pads, if necessary, to prevent chafing between each tank and its supports;

(2) Padding must be non-absorbent or treated to prevent the absorption of fuel;

(3) If a flexible tank liner is used, it must be supported so that it is not required to withstand fluid loads;

(4) Interior surfaces adjacent to the liner must be smooth and free from projections that could cause wear, unless –

(i) Provisions are made for protection of the liner at those points; or

(ii) The construction of the liner itself provides such protection.

(5) A positive pressure must be maintained within the vapour space of each bladder cell under all conditions of operation except for a particular condition for which it is shown that a zero or negative pressure will not cause the bladder cell to collapse; and

(6) Siphoning of fuel (other than minor spillage) or collapse of bladder fuel cells may

JAR 23.967 (a) (continued)

not result from improper securing or loss of the fuel filler cap.

(b) Each tank compartment must be ventilated and drained to prevent the accumulation of flammable fluids or vapours. Each compartment adjacent to a tank that is an integral part of the aeroplane structure must also be ventilated and drained.

(c) No fuel tank may be on the engine side of the firewall. There must be at least 12·7 mm (½ in) of clearance between the fuel tank and the firewall. No part of the engine nacelle skin that lies immediately behind a major air opening from the engine compartment may act as the wall of an integral tank.

(d) Each fuel tank must be isolated from personnel compartments by a fume-proof and fuel-proof enclosure that is vented and drained to the exterior of the aeroplane. The required enclosure must sustain any personnel compartment pressurisation loads without permanent deformation or failure under the conditions of JAR 23.365 and 23.843. A bladder type fuel cell, if used, must have a retaining shell at least equivalent to a metal fuel tank in structural integrity.

(e) Fuel tanks must be designed, located and installed –

(1) So as to retain fuel when subjected to the inertia loads resulting from the ultimate static load factors prescribed in JAR 23.561 (b) (2); and

(2) So as to retain fuel under conditions likely to occur when an aeroplane lands on a paved runway at a normal landing speed under each of the following conditions:

(i) The aeroplane in a normal landing attitude and its landing gear retracted.

(ii) The most critical landing gear leg collapsed and the other landing gear legs extended.

In showing compliance with sub-paragraph (e) (2) of this paragraph, the tearing away of an engine mount must be considered unless all the engines are installed above the wing or on the tail or fuselage of the aeroplane.

JAR 23.969 Fuel tank expansion space

Each fuel tank must have an expansion space of not less than 2% of the tank capacity, unless the tank vent discharges clear of the aeroplane (in

JAR 23.969 (continued)

which case no expansion space is required). It must be impossible to fill the expansion space inadvertently with the aeroplane in the normal ground attitude.

JAR 23.971 Fuel tank sump

(a) Each fuel tank must have a drainable sump with an effective capacity, in the normal ground and flight attitudes, of 0·25% of the tank capacity, or 0·24 litres (0·05 Imperial gallon/1/16 US-gallon), whichever is greater.

(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 normal ground attitude.

(c) Each reciprocating engine fuel system must have a sediment bowl or chamber that is [accessible for drainage; has a capacity of 28 cm^3] (1 oz) for every 75·7 litres (16·7 Imperial gallon/20 US-gallon) of fuel tank capacity; and each fuel tank outlet is located so that, in the normal flight attitude, water will drain from all parts of the tank except the sump to the sediment bowl or chamber.

(d) Each sump, sediment bowl and sediment chamber drain required by sub-paragraphs (a), (b) and (c) of this paragraph must comply with the drain provisions of JAR 23.999 (b) (1) and (2).

[Amdt. 1, 01.02.01]

JAR 23.973 Fuel tank filler connection

(a) Each fuel tank filler connection must be marked as prescribed in JAR 23.1557 (c).

(b) Spilled fuel must be prevented from entering the fuel tank compartment or any part of the aeroplane other than the tank itself.

(c) Each filler cap must provide a fuel-tight seal for the main filler opening. However, there may be small openings in the fuel tank cap for venting purposes or for the purpose of allowing passage of a fuel gauge through the cap provided such openings comply with the requirements of JAR 23.975 (a).

(d) Each fuel filling point, except pressure fuelling connection points, must have a provision for electrically bonding the aeroplane to ground fuelling equipment.

(e) For aeroplanes with engines requiring gasoline as the only permissible fuel, the inside diameter of the fuel filler opening must be no [larger than 60 mm (2·36 in).]

JAR 23.973 (continued)

(f) For aeroplanes with turbine engines, the inside diameter of the fuel filler opening must be [no smaller than 75 mm (2·95 in).]

[Amdt. 1, 01.02.01]

JAR 23.975 Fuel tank vents and carburettor vapour vents

(a) Each fuel tank must be vented from the top part of the expansion space. In addition –

(1) Each vent outlet must be located and constructed in a manner that minimises the possibility of its being obstructed by ice or other foreign matter;

(2) Each vent must be constructed to prevent siphoning of fuel during normal operation;

(3) The venting capacity must allow the rapid relief of excessive differences of pressure between the interior and exterior of the tank;

(4) Airspaces of tanks with inter-connected outlets must be inter-connected;

(5) There may be no points in any vent line where moisture can accumulate with the aeroplane in either the ground or level flight attitudes unless drainage is provided.

(6) No vent may terminate at a point where the discharge of fuel from the vent outlet will constitute a fire hazard or from which fumes may enter personnel compartments; and

(7) Vents must be arranged to prevent the loss of fuel, except fuel discharged because of thermal expansion, when the aeroplane is parked in any direction on a ramp having a 1% slope.

(b) Each carburettor with vapour elimination connections and each fuel injection engine employing vapour return provisions must have a separate vent line to lead vapours back to the top of one of the fuel tanks. If there is more than one tank and it is necessary to use these tanks in a definite sequence for any reason, the vapour vent line must lead back to the fuel tank to be used first, unless the relative capacities of the tanks are such that return to another tank is preferable.

(c) For aerobatic category aeroplanes, excessive loss of fuel during aerobatic manoeuvres, including short periods of inverted flight, must be prevented. It must be impossible for fuel to siphon from the vent when normal flight has been resumed after any aerobatic manoeuvre for which certification is requested.

JAR 23.977 Fuel tank outlet

(a) There must be a fuel strainer for the fuel tank outlet or for the booster pump. This strainer must –

(1) For reciprocating engine-powered aeroplanes, have 8 to 16 meshes per inch; and

(2) For turbine engine-powered aeroplanes, prevent the passage of any object that could restrict fuel flow or damage any fuel system component.

(b) The clear area of each fuel tank outlet strainer must be at least five times the area of the outlet line.

(c) The diameter of each strainer must be at least that of the fuel tank outlet.

(d) Each strainer must be accessible for inspection and cleaning.

JAR 23.979 Pressure fuelling systems

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.

(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) For commuter category aeroplanes, provide indication at each fuelling station, of failure of the shut-off means to stop fuel flow at the maximum level.

(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) All parts of the fuel system up to the tank which are subjected to fuelling pressures must have a proof pressure of 1·33 times and an ultimate pressure of at least 2·0 times, the surge pressure likely to occur during fuelling.

FUEL SYSTEM COMPONENTS

JAR 23.991 Fuel pumps

(a) *Main pumps.* For main pumps, the following apply:

(1) For reciprocating engine installations having fuel pumps to supply fuel to the engine, at least one pump for each engine must be directly driven by the engine and must meet JAR 23.955. This pump is a main pump.

(2) For turbine engine installations, 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. In addition –

(i) There must be at least one main pump for each turbine engine;

(ii) The power supply for the main pump for each engine must be independent of the power supply for each main pump for any other engine; and

(iii) For each main pump, provision must be made to allow the by-pass of each positive displacement fuel pump other than a fuel injection pump approved as part of the engine.

(b) *Emergency pumps.* There must be an emergency pump immediately available to supply fuel to the engine if any main pump (other than a fuel injection pump approved as part of an engine) fails. The power supply for each emergency pump must be independent of the power supply for each corresponding main pump.

(c) *Warning means.* If both the main pump and emergency pump operate continuously, there must be a means to indicate to the appropriate flight-crew members a malfunction of either pump.

(d) Operation of any fuel pump may not affect engine operation so as to create a hazard, regardless of the engine power or thrust setting or the functional status of any other fuel pump.

JAR 23.993 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.

JAR 23.993 (continued)

(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 subjected to axial loading must use flexible hose assemblies.

(d) Each flexible hose 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 shut-down of an engine or auxiliary power unit.

JAR 23.994 Fuel system components

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.

JAR 23.995 Fuel valves and controls

(a) There must be a means to allow appropriate flight-crew members to rapidly shut off, in flight, the fuel to each engine individually.

(b) No shut-off valve may be on the engine side of any firewall. In addition, there must be means to –

(1) Guard against inadvertent operation of each shut-off valve; and

(2) Allow appropriate flight-crew members to reopen each valve rapidly after it has been closed.

(c) Each valve and fuel system control must be supported so that loads resulting from its operation or from accelerated flight conditions are not transmitted to the lines connected to the valve.

(d) Each valve and fuel system control must be installed so that gravity and vibration will not affect the selected position.

(e) Each fuel valve handle and its connections to the valve mechanism must have design features that minimise the possibility of incorrect installation.

(f) Each valve must be constructed, or otherwise incorporate provisions, to preclude incorrect assembly or connection of the valve.

(g) Fuel tank selector valves must –

JAR 23.995 (g) (continued)

(1) Require a separate and distinct action to place the selector in the "OFF" position; and

(2) Have the tank selector positions located in such a manner that it is impossible for the selector to pass through the "OFF" position when changing from one tank to another.

JAR 23.997 *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 during its type certification.

(e) In addition, for commuter category aeroplanes, unless means are provided in the fuel system to prevent the accumulation of ice on the filter, a means must be provided automatically to maintain the fuel flow if ice clogging of the filter occurs.

JAR 23.999 Fuel system drains

(a) There must be at least one drain to allow safe drainage of the entire fuel system with the aeroplane in its normal ground attitude.

(b) Each drain required by sub-paragraph (a) of this paragraph and JAR 23.971 must –

(1) Discharge clear of all parts of the aeroplane;

(2) Have a drain valve –

JAR 23.999 (b) (continued)

(i) That has manual or automatic means for positive locking in the closed position;

(ii) That is readily accessible;

(iii) That can be easily opened and closed;

(iv) That allows the fuel to be caught for examination;

(v) That can be observed for proper closing; and

(vi) That is either located or protected to prevent fuel spillage in the event of a landing with landing gear retracted.

JAR 23.1001 Fuel jettisoning system

(a) If the design landing weight is less than that permitted under the requirements of JAR 23.473 (b), the aeroplane must have a fuel jettisoning system installed that is able to jettison enough fuel to bring the maximum weight down to the design landing weight. The average rate of fuel jettisoning must be at least 1% of the maximum weight per minute, except that the time required to jettison the fuel need not be less than 10 minutes.

(b) Fuel jettisoning must be demonstrated at maximum weight with flaps and landing gear up and in –

(1) A power-off glide at 1·4 V_{S1}; and

(2) A climb at the one-engine inoperative best rate of climb speed, with the critical engine inoperative and the remaining [engine at maximum continuous power; and]

(3) Level flight at 1·4 V_{S1}, if the results of the tests in the conditions specified in sub-paragraphs (1) and (2) of this paragraph show that this condition could be critical.

(c) During the flight tests prescribed in sub-paragraph (b) 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; and

(4) The jettisoning operation does not adversely affect the controllability of the aeroplane.

JAR 23.1001 (continued)

(d) For reciprocating engine powered aeroplanes, the jettisoning system must be designed so that it is not possible to jettison the fuel in the tanks used for take-off and landing below the level allowing 45 minutes flight at 75% maximum continuous power. However, if there is an auxiliary control independent of the main jettisoning control, the system may be designed to jettison all the fuel.

(e) For turbine engine-powered aeroplanes, the jettisoning system must be designed so that it is not possible to jettison 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.

(f) The fuel jettisoning valve must be designed to allow flight-crew members to close the valve during any part of the jettisoning operation.

(g) 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.

(h) 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.

[Amdt. 1, 01.02.01]

OIL SYSTEM

JAR 23.1011 General [(See ACJ 23.1011 (b))]

(a) Each engine and auxiliary power unit 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 tank capacity may not be less than the product of the endurance of the aeroplane under critical operating conditions and the maximum oil consumption of the engine under the same conditions, plus a suitable margin to ensure adequate circulation and cooling.

(c) For an oil system without an oil transfer system, only the usable oil tank capacity may be considered. The amount of oil in the engine oil lines, the oil radiator and the feathering reserve, may not be considered.

(d) If an oil transfer system is used and the transfer pump can pump some of the oil in the transfer lines into the main engine oil tanks, the amount of oil in these lines that can be pumped by the transfer pump may be included in the oil capacity.

[Amdt. 1, 01.02.01]

JAR 23.1013 Oil tanks

(a) *Installation.* Each oil tank must be installed to –

(1) Meet the requirements of JAR 23.967 (a) and (b); and

(2) Withstand any vibration, inertia and fluid loads expected in operation.

(b) *Expansion space.* Oil tank expansion space must be provided so that –

(1) Each oil tank used with a reciprocating engine has an expansion space of not less than the greater of 10% of the tank capacity or 1·9 litres (0·42 Imperial gallon/0·5 US-gallon) and each oil tank used with a turbine engine has an expansion space of not less than 10% of the tank capacity; and

(2) It is impossible to fill the expansion space inadvertently with the aeroplane in the normal ground attitude.

(c) *Filler connection.* Each oil tank filler connection must be marked as specified in JAR 23.1557 (c). Each recessed oil tank filler connection of an oil tank used with a turbine engine, that can retain any appreciable quantity of oil, must have provisions for fitting a drain.

(d) *Vent.* Oil tanks must be vented as follows:

(1) Each oil tank must be vented to the engine from the top part of the expansion space so that the vent connection is not covered by oil 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.

(3) For aerobatic category aeroplanes, there must be means to prevent hazardous loss of oil during aerobatic manoeuvres, including short periods of inverted flight.

JAR 23.1013 (continued)

(e) *Outlet.* 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. No oil tank outlet diameter may be less than the diameter of the engine oil pump inlet. Each oil tank used with a turbine engine must have 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. There must be a shut-off valve at the outlet of each oil tank used with a turbine engine, unless the external portion of the oil system (including oil tank supports) is fire-proof.

(f) *Flexible liners.* Each flexible oil tank liner must be of an acceptable kind.

(g) Each oil tank filler cap of an oil tank that is used with an engine must provide an oil tight seal.

JAR 23.1015 Oil tank tests

Each oil tank must be tested under JAR 23.965, except that –

(a) The applied pressure must be 34·45 kPa (5 psi) for the tank construction instead of the pressures specified in JAR 23.965 (a).

(b) For a tank with a non-metallic liner the test fluid must be oil rather than fuel as specified in JAR 23.965 (d) and the slosh test on a specimen liner must be conducted with the oil at 120°C (250°F); and

(c) For pressurised tanks used with a turbine engine, the test pressure may not be less than 34·45 kPa (5 psi) plus the maximum operating pressure of the tank.

JAR 23.1017 Oil lines and fittings

(a) *Oil lines.* Oil lines must meet JAR 23.993 and must accommodate a flow of oil at a rate and pressure adequate for proper engine functioning under any normal operating conditions.

(b) *Breather lines.* Breather lines must be arranged so that –

(1) Condensed water vapour or oil that might freeze and obstruct the line cannot accumulate at any point;

(2) The breather discharge will not constitute a fire hazard if foaming occurs, or cause emitted oil to strike the pilot's windshield;

JAR 23.1017 (b) (continued)

(3) The breather does not discharge into the engine air induction system;

(4) For aerobatic category aeroplanes, there is no excessive loss of oil from the breather during aerobatic manoeuvres, including short periods of inverted flight; and

(5) The breather outlet is protected against blockage by ice or foreign matter.

JAR 23.1019 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 by-pass 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 for its type certification.

(3) The oil strainer or filter, unless it is installed at an oil tank outlet, must incorporate a means to indicate contamination before it reaches the capacity established in accordance with sub-paragraph (2) of this paragraph.

(4) The by-pass of a strainer or filter must be constructed and installed so that the release of collected contaminants is minimised by appropriate location of the by-pass to ensure that collected contaminants are not in the by-pass flow path.

(5) An oil strainer or filter that has no by-pass, except one that is installed at an oil tank outlet, must have a means to connect it to the warning system required in JAR 23.1305 (u).

(b) Each oil strainer or filter in a powerplant installation using reciprocating engines 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 element completely blocked.

JAR 23.1021 Oil system drains

A drain or drains must be provided to allow safe drainage of the oil system. Each drain must –

(a) Be accessible;

(b) Have drain valves, or other closures, employing manual or automatic shut-off means for positive locking in the closed position; and

(c) Be located or protected to prevent inadvertent operation.

JAR 23.1023 Oil radiators

Each oil radiator and its supporting structures must be able to withstand the vibration, inertia and oil pressure loads to which it would be subjected in operation.

JAR 23.1027 Propeller feathering system

(a) If the propeller feathering system uses engine oil and that oil supply can become depleted due to failure of any part of the oil system, a means must be incorporated to reserve enough oil to operate the feathering system.

(b) The amount of reserved oil must be enough to accomplish feathering and must be available only to the feathering pump.

(c) The ability of the system to accomplish feathering with the reserved oil must be shown.

(d) Provision must be made to prevent sludge or other foreign matter from affecting the safe operation of the propeller feathering system.

COOLING

JAR 23.1041 General
[(See ACJ 23.1041)]

The powerplant and auxiliary power unit cooling provisions must maintain the temperatures of powerplant components and engine fluids and auxiliary power unit components and fluids within the limits established for those components and fluids under the most adverse ground, water and flight operations to the maximum altitude and maximum ambient atmospheric temperature conditions for which approval is requested, and after normal engine and auxiliary power unit shutdown.

[Amdt. 1, 01.02.01]

JAR 23.1043 Cooling tests
[(See ACJ 23.1043 (a) (3))]

(a) *General.* Compliance with JAR 23.1041 must be shown on the basis of tests, for which the following apply:

(1) If the tests are conducted under ambient atmospheric temperature conditions deviating from the maximum for which approval is requested, the recorded powerplant temperatures must be corrected under sub-paragraphs (c) and (d) of this paragraph, unless a more rational correction method is applicable.

(2) Corrected temperatures determined under sub-paragraph (a) (1) of this paragraph must not exceed established limits.

(3) The fuel used during the cooling tests must be of the minimum grade approved for the engine(s) and, for reciprocating engines the mixture settings must be the leanest recommended for climb.

(4) For turbocharged engines, each turbocharger must be operated through that part of the climb profile for which operation with the turbocharger is requested.

(b) *Maximum ambient atmospheric temperature.* A maximum ambient atmospheric temperature corresponding to sea-level conditions of at least 38°C (100°F) must be established. The [assumed temperature lapse rate is 2°C (3·6°F)] per thousand feet of altitude above sea-level until a temperature of -56·5°C (-69·7°F) is reached, above which altitude the temperature is considered constant at -56·5°C (-69·7°F). However, for winterisation installations, the applicant may select a maximum ambient atmospheric temperature corresponding to sea-level conditions of less than 38°C (100°F).

(c) *Correction factor (except cylinder barrels).* Temperatures of engine fluids and powerplant components (except cylinder barrels) for which temperature limits are established, must be corrected by adding to them the difference between the maximum ambient atmospheric temperature for the relevant altitude for which approval has been requested and the temperature of the ambient air at the time of the first occurrence of the maximum fluid or component temperature recorded during the cooling test.

(d) *Correction factor for cylinder barrel temperatures.* Cylinder barrel temperatures must be corrected by adding to them 0·7 times the difference between the maximum ambient atmospheric temperature for the relevant altitude

JAR 23.1043 (d) (continued)

for which approval has been requested and the temperature of the ambient air at the time of the first occurrence of the maximum cylinder barrel temperature recorded during the cooling test.

[Amdt. 1, 01.02.01]

JAR 23.1045 Cooling test procedures for turbine engine-powered aeroplanes [(See ACJ 23.1045 (a) and ACJ 23.1045 (b))]

(a) Compliance with JAR 23.1041 must be shown for all phases of operation. The aeroplane must be flown in the configurations, at the speeds and following the procedures recommended in the Aeroplane Flight Manual for the relevant stage of flight, corresponding to the applicable performance requirements, which are critical relative to cooling.

(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; or

(2) The stage of flight is completed; or

(3) An operating limitation is reached.

[Amdt. 1, 01.02.01]

JAR 23.1047 Cooling test procedures for reciprocating engine-powered aeroplanes [(See ACJ 23.1047)]

Compliance with JAR 23.1041 must be shown for the climb (or descent, for twin-engined aeroplanes with negative one-engine-inoperative rates of climb) stage of flight. The aeroplane must be flown in the configurations, at the speeds and following the procedures recommended in the Aeroplane Flight Manual, corresponding to the

JAR 23.1047 (continued)

applicable performance requirements, which are critical relative to cooling.

[Amdt. 1, 01.02.01]

LIQUID COOLING

JAR 23.1061 Installation

(a) *General.* Each liquid-cooled engine must have an independent cooling system (including coolant tank) installed so that –

(1) Each coolant tank is supported so that tank loads are distributed over a large part of the tank surface;

(2) There are pads or other isolation means between the tank and its supports to prevent chafing; and

(3) Pads or any other isolation means that is used must be non-absorbent or must be treated to prevent absorption of flammable fluids; and

(4) No air or vapour can be trapped in any part of the system, except the coolant tank expansion space, during filling or during operation.

(b) *Coolant tank.* The tank capacity must be at least 3·8 litres (0·83 Imperial gallon/1 US-gallon), plus 10% of the cooling system capacity. In addition –

(1) Each coolant tank must be able to withstand the vibration, inertia and fluid loads to which it may be subjected in operation;

(2) Each coolant tank must have an expansion space of at least 10% of the total cooling system capacity; and

(3) It must be impossible to fill the expansion space inadvertently with the aeroplane in the normal ground attitude.

(c) *Filler connection.* Each coolant tank filler connection must be marked as specified in JAR 23.1557 (c). In addition –

(1) Spilled coolant must be prevented from entering the coolant tank compartment or any part of the aeroplane other than the tank itself; and

(2) Each recessed coolant filler connection must have a drain that discharges clear of the entire aeroplane.

(d) *Lines and fittings.* Each coolant system line and fitting must meet the requirements of

JAR 23.1061 (d) (continued)

JAR 23.993, except that the inside diameter of the engine coolant inlet and outlet lines may not be less than the diameter of the corresponding engine inlet and outlet connections.

(e) *Radiators.* Each coolant radiator must be able to withstand any vibration, inertia and coolant pressure load to which it may normally be subjected. In addition –

(1) Each radiator must be supported to allow expansion due to operating temperatures and prevent the transmittal of harmful vibration to the radiator; and

(2) If flammable coolant is used, the air intake duct to the coolant radiator must be located so that (in case of fire) flames from the nacelle cannot strike the radiator.

(f) *Drains.* There must be an accessible drain that –

(1) Drains the entire cooling system (including the coolant tank, radiator and the engine) when the aeroplane is in the normal ground attitude;

(2) Discharges clear of the entire aeroplane; and

(3) Has means to positively lock it closed.

JAR 23.1063 Coolant tank tests

Each coolant tank must be tested under JAR 23.965, except that –

(a) The test required by JAR 23.965 (a) (1) must be replaced with a similar test using the sum of the pressure developed during the maximum ultimate acceleration with a full tank or a pressure of 24·12 kPa (3·5 psi), whichever is greater, plus the maximum working pressure of the system; and

(b) For a tank with a non-metallic liner the test fluid must be coolant rather than fuel as specified in JAR 23.965 (d) and the slosh test on a specimen liner must be conducted with the coolant at operating temperature.

INDUCTION SYSTEM

JAR 23.1091 Air induction system

(a) The air induction system for each engine and auxiliary power unit and their accessories must supply the air required by that engine and

JAR 23.1091 (a) (continued)

auxiliary power unit under the operating conditions for which certification is requested.

(b) Each reciprocating engine installation must have at least two separate air intake sources and must meet the following:

(1) Primary air intakes may open within the cowling if that part of the cowling is isolated from the engine accessory section by a fire-resistant diaphragm or if there are means to prevent the emergence of backfire flames.

(2) Each alternate air intake must be located in a sheltered position and may not open within the cowling if the emergence of backfire flames will result in a hazard.

(3) The supplying of air to the engine through the alternate air intake system may not result in a loss of excessive power in addition to the power loss due to the rise in air temperature.

(4) Each automatic alternate air door must have an override means accessible to the flight crew.

(5) Each automatic alternate air door must have a means to indicate to the flight crew when it is not closed.

(c) For turbine engine-powered aeroplanes –

(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 or auxiliary power unit and their accessories intake system; and

(2) The aeroplane must be designed to prevent water or slush on the runway, taxi way, or other airport operating surfaces from being directed into the engine or auxiliary power unit 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.

JAR 23.1093 Induction system icing protection

(a) *Reciprocating engines.* Each reciprocating engine air induction system must have means to prevent and eliminate icing. Unless this is done by other means, it must be shown that, in air free of visible moisture at a temperature of -1°C (30°F) –

(1) Each aeroplane with sea-level engines using conventional venturi carburettors has a preheater that can provide a heat rise of

JAR 23.1093 (a) (continued)

50°C (90°F) with the engines at 75% of maximum continuous power;

(2) Each aeroplane with altitude engines using conventional venturi carburettors has a preheater that can provide a heat rise of 67°C (120°F) with the engines at 75% of maximum continuous power;

(3) Each aeroplane with altitude engines using carburettors tending to prevent icing has a preheater that, with the engines at 60% of maximum continuous power, can provide a heat rise of –

(i) 56°C (100°F); or

(ii) 22°C (40°F), if a fluid de-icing system meeting the requirements of JAR 23.1095 to 23.1099 is installed;

(4) Each single-engine aeroplane with a sea-level engine using a carburettor tending to prevent icing has a sheltered alternate source of air with a preheat of not less than that provided by the engine cooling air downstream of the cylinders; and

(5) Each twin-engined aeroplane with sea-level engines using a carburettor tending to prevent icing has a preheater that can provide a heat rise of 50°C (90°F) with the engines at 75% of maximum continuous power.

(6) *Not required for JAR-23.*

(b) *Turbine engines*

(1) Each turbine engine and its air inlet system must operate throughout the flight power range of the engine (including idling), without the accumulation of ice on engine or inlet system components that would adversely affect engine operation or cause a serious loss of power or thrust –

(i) Under the icing conditions specified in JAR-1; and

(ii) In snow, both falling and blowing, within the limitations established for the aeroplane.

(2) Each turbine 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 -9° and -1°C (between 15° and 30°F) 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 momentary operation at take-off power or thrust. During the 30 minutes of idle

JAR 23.1093 (b) (continued)

operation, the engine may be run up periodically to a moderate power or thrust setting in a manner acceptable to the Authority.

(c) *Supercharger (reciprocating engines).* For aeroplanes with reciprocating engines having superchargers to pressurise the air before it enters the carburettor, the heat rise in the air caused by that supercharging at any altitude may be utilised in determining compliance with sub-paragraph (a) of this paragraph if the heat rise utilised is that which will be available, automatically, for the applicable altitudes and operating condition because of supercharging.

JAR 23.1095 Carburettor de-icing fluid flow rate

(a) If a carburettor de-icing fluid system is used, it must be able to simultaneously supply each engine with a rate of fluid flow, expressed in pounds per hour, of not less than 2·5 times the square root of the maximum continuous power of the engine.

(b) The fluid must be introduced into the air induction system –

(1) Close to, and upstream of, the carburettor; and

(2) So that it is equally distributed over the entire cross section of the induction system air passages.

JAR 23.1097 Carburettor de-icing fluid system capacity

(a) The capacity of each carburettor de-icing fluid system –

(1) May not be less than the greater of –

(i) That required to provide fluid at the rate specified in JAR 23.1095 for a time equal to 3% of the maximum endurance of the aeroplane; or

(ii) 20 minutes at that flow rate; and

(2) Need not exceed that required for two hours of operation.

(b) If the available preheat exceeds 28°C (50°F) but is less than 56°C (100°F), the capacity of the system may be decreased in proportion to the heat rise available in excess of 28°C (50°F).

JAR 23.1099 Carburettor de-icing fluid system detail design

Each carburettor de-icing fluid system must meet the applicable requirements for the design of a fuel system, except as specified in JAR 23.1095 and 23.1097.

JAR 23.1101 Induction air preheater design

Each exhaust-heated, induction air preheater must be designed and constructed to –

(a) Ensure ventilation of the preheater when the induction air preheater is not being used during engine operation.

(b) Allow inspection of the exhaust manifold parts that it surrounds; and

(c) Allow inspection of critical parts of the preheater itself.

JAR 23.1103 Induction system ducts

(a) Each induction system duct must have a drain to prevent the accumulation of fuel or moisture in the normal ground and flight attitudes. No drain may discharge where it will cause a fire hazard.

(b) Each duct connected to components between which relative motion could exist must have means for flexibility.

(c) *Not required for JAR-23.*

(d) *Not required for JAR-23.*

(e) *Not required for JAR-23.*

(f) *Not required for JAR-23.*

JAR 23.1105 Induction system screens

If induction system screens are used on reciprocating engines –

(a) Each screen must be upstream of the carburettor or fuel injection system;

(b) No screen may be in any part of the induction system that is the only passage through which air can reach the engine, unless –

(1) The available preheat is at least 56°C (100°F); and

(2) The screen can be de-iced by heated air;

(c) No screen may be de-iced by alcohol alone; and

JAR 23.1105 (continued)

(d) It must be impossible for fuel to strike any screen.

JAR 23.1107 Induction system filters

If an air filter, is used to protect the engine against foreign material particles in the induction air supply, it must be capable of withstanding the effects of temperature extremes, rain, fuel, oil, and solvents to which it is expected to be exposed in service and maintenance.

JAR 23.1109 Turbocharger bleed air system

The following applies to turbocharged bleed air systems used for cabin pressurisation:

(a) The cabin air system may not be subject to hazardous contamination following any probable failure of the turbocharger or its lubrication system.

(b) The turbocharger supply air must be taken from a source where it cannot be contaminated by harmful or hazardous gases or vapours following any probable failure or malfunction of the engine exhaust, hydraulic, fuel, or oil system.

JAR 23.1111 Turbine engine bleed air system

For turbine engine bleed air systems, the following apply:

(a) No hazard may result if duct rupture or failure occurs anywhere between the engine port and the aeroplane unit served by the bleed air.

(b) The effect on aeroplane and engine performance of using maximum bleed air must be established.

(c) Hazardous contamination of cabin air systems may not result from failures of the engine lubricating system.

EXHAUST SYSTEM

JAR 23.1121 General

For powerplant and auxiliary power unit installations, the following apply:

(a) Each exhaust system must ensure safe disposal of exhaust gases without fire hazard or

JAR 23.1121 (a) (continued)

carbon monoxide contamination in any personnel compartment.

(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.

(c) Each exhaust system must be separated by fireproof shields from adjacent flammable parts of the aeroplane that are outside of the engine and auxiliary power unit compartment.

(d) No exhaust gases may discharge dangerously near any fuel or oil system drain.

(e) No exhaust gases may be discharged 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) If significant traps exist, each turbine engine and auxiliary power unit exhaust system must have drains discharging clear of the aeroplane, in any normal ground and flight attitude, to prevent fuel accumulation after the failure of an attempted engine or auxiliary power unit start.

(h) Each exhaust heat exchanger must incorporate means to prevent blockage of the exhaust port after any internal heat exchanger failure.

(i) For the purposes of compliance with JAR 23.603 the failure of any part of the exhaust system will adversely affect safety.

JAR 23.1123 Exhaust system

(a) Each exhaust system must be fireproof and corrosion-resistant and must have means to prevent failure due to expansion by operating temperatures.

(b) Each exhaust system must be supported to withstand the vibration and inertia loads to which it may be subjected in operation.

(c) Parts of the system connected to components between which relative motion could exist must have means for flexibility.

JAR 23.1125 Exhaust heat exchangers

For reciprocating engine-powered aeroplanes the following apply:

(a) Each exhaust heat exchanger must be constructed and installed to withstand the vibration, inertia and other loads that it may be subjected to in normal operation. In addition –

(1) Each exchanger must be suitable for continued operation at high temperatures and resistant to corrosion from exhaust gases;

(2) There must be means for inspection of critical parts of each exchanger; and

(3) Each exchanger must have cooling provisions wherever it is subject to contact with exhaust gases.

(b) Each heat exchanger used for heating ventilating air must be constructed so that exhaust gases may not enter the ventilating air.

POWERPLANT CONTROLS AND ACCESSORIES

JAR 23.1141 Powerplant controls: general [(See ACJ 23.1041 (g) (2))]

(a) Powerplant controls must be located and arranged under JAR 23.777 and marked under JAR 23.1555 (a).

(b) Each flexible control must be shown to be suitable for the particular application.

(c) Each control must be able to maintain any necessary position without –

(1) Constant attention by flight-crew members; or

(2) Tendency to creep due to control loads or vibration.

(d) Each control must be able to withstand operating loads without failure or excessive deflection.

(e) For turbine engine-powered aeroplanes, no single failure or malfunction, or probable combination thereof, in any powerplant control system may cause the failure of any powerplant function necessary for safety.

(f) The portion of each powerplant control located in the engine compartment that is required to be operated in the event of fire must be at least fire resistant.

JAR 23.1141 (continued)

(g) 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 position; and

(2) For power-assisted valves, a means to indicate to the flight crew when the valve –

(i) Is in the fully open or fully closed position; or

(ii) Is moving between the fully open and fully closed position.

[Amdt. 1, 01.02.01]

JAR 23.1142 Auxiliary power unit controls

Means must be provided on the flight deck for the starting, stopping, monitoring, and emergency shutdown of each installed auxiliary power unit.

JAR 23.1143 Engine controls [(See ACJ 23.1143 (g))]

(a) There must be a separate power or thrust control for each engine and a separate control for each supercharger that requires a control.

(b) Power, thrust and supercharger controls must be arranged to allow –

(1) Separate control of each engine and each supercharger; and

(2) Simultaneous control of all engines and all superchargers.

(c) Each power, thrust or supercharger control must give a positive and immediate responsive means of controlling its engine or supercharger.

(d) The power, thrust or supercharger controls for each engine or supercharger must be independent of those for every other engine or supercharger.

(e) For each fluid injection (other than fuel) system and its controls not provided as part of the engine, the applicant must show that the flow of the injection fluid is adequately controlled.

(f) If a power or thrust control, or a fuel control (other then a mixture 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

JAR 23.1143 (f) (continued)

(2) Require a separate and distinct operation to place the control in the shut-off position.

(g) For reciprocating single-engine aeroplanes, each power or thrust control must be designed so that if the control separates at the engine fuel metering device, the aeroplane is capable of continuing safe flight.

[Amdt. 1, 01.02.01]

JAR 23.1145 Ignition switches

(a) Ignition switches must control and shut off each ignition circuit on each engine.

(b) There must be means to quickly shut off all ignition on twin-engine aeroplanes by the groupings of switches or by a master ignition control.

(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.

JAR 23.1147 Mixture controls [(See ACJ 23.1147 (b))]

(a) If there are mixture controls, each engine must have a separate control and each mixture control must have guards or must be shaped or arranged to prevent confusion by feel with other controls.

(1) The controls must be grouped and arranged to allow –

(i) Separate control of each engine; and

(ii) Simultaneous control of all engines.

(2) The control must require a separate and distinct operation to move the control towards lean or shut-off position.

(b) Each manual engine mixture control must be designed so that, if the control separates at the engine fuel metering device, the aeroplane is capable of continuing safe flight.

[Amdt. 1, 01.02.01]

JAR 23.1149 Propeller speed and pitch controls

(a) If there are propeller speed or pitch controls, they must be grouped and arranged to allow –

(1) Separate control of each propeller; and

(2) Simultaneous control of all propellers.

(b) The controls must allow ready synchronisation of all propellers on twin-engine aeroplanes.

JAR 23.1153 Propeller feathering controls

If there are propeller feathering controls, whether or not they are separate from the propeller speed and pitch controls, it must be possible to feather each propeller separately. Each control must have means to prevent inadvertent operation.

JAR 23.1155 *Turbine engine reverse thrust* and propeller pitch settings below the flight regime

For turbine engine installations, each control for reverse thrust and for propeller pitch settings below the flight regime must have means to prevent its inadvertent operation. The means must have a positive lock or stop at the flight idle position and must require a separate and distinct operation by the crew to displace the control from the flight regime (forward thrust regime for turbojet powered aeroplanes).

JAR 23.1157 Carburettor air temperature controls

There must be a separate carburettor air temperature control for each engine.

JAR 23.1163 Powerplant accessories

(a) Each engine mounted accessory must –

(1) Be approved for mounting on the engine involved and use the provisions on the engines for mounting; or

(2) Have torque limiting means on all accessory drives in order to prevent the torque limits established for those drives from being exceeded; and

JAR 23.1163 (a) (continued)

(3) In addition to sub-paragraphs (a) (1) or (a) (2) of this paragraph, 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) Each generator rated at or more than 6 kilowatts must be designed and installed to minimise the probability of a fire hazard in the event it malfunctions.

(d) If the continued rotation of any accessory remotely driven by the engine is hazardous when malfunctioning occurs, a means to prevent rotation without interfering with the continued operation of the engine must be provided.

(e) Each accessory driven by a gearbox that is not approved as part of the powerplant driving the gearbox must –

(1) Have torque limiting means to prevent the torque limits established for the affected drive from being exceeded;

(2) Use the provisions on the gearbox for mounting; and

(3) Be sealed to prevent contamination of the gearbox oil system and the accessory system.

JAR 23.1165 *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 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.

JAR 23.1165 (continued)

(d) There must be means to warn appropriate crew members if malfunctioning of any part of the electrical system is causing the continuous discharge of any battery used for engine ignition.

(e) Each turbine engine ignition system must be independent of any electrical circuit that is not used for assisting, controlling or analysing the operation of that system.

(f) In addition, for commuter category aeroplanes, each turbopropeller ignition system must be an essential electrical load.

POWERPLANT FIRE PROTECTION

JAR 23.1181 Designated fire zones; regions included

Designated fire zones are –

(a) For reciprocating engines –

(1) The power section;

(2) The accessory section;

(3) Any complete powerplant compartment in which there is no isolation between the power section and the accessory section.

(b) For turbine engines –

(1) The compressor and accessory sections;

(2) The combustor, turbine and tailpipe sections that contain lines or components carrying flammable fluids or gases.

(3) Any complete powerplant compartment in which there is no isolation between compressor, accessory, combustor, turbine and tailpipe sections.

(c) Any auxiliary power unit compartment; and

(d) Any fuel burning heater and other combustion equipment installation described in JAR 23.859.

JAR 23.1182 Nacelle areas behind firewalls [(See ACJ 23.1182)]

Components, lines and fittings, except those subject to the provisions of JAR 23.1351 (e), located behind the engine compartment firewall must be constructed of such materials and located at such distances from the firewall that they will not suffer damage sufficient to endanger the aeroplane if a portion of the engine side of the firewall is subjected to a flame temperature of not less than 1 100°C (2 000°F) for 15 minutes.

[Amdt. 1, 01.02.01]

JAR 23.1183 Lines, fittings and components

(a) Except as provided in sub-paragraph (b) of this paragraph, each component, line and fitting carrying flammable fluids, gas or air in any area subject to engine fire conditions must be at least fire resistant, except that flammable fluid tanks and supports which are part of and attached to the engine 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 so as to safeguard against the ignition of leaking flammable fluid. Flexible hose assemblies (hose and end fittings) must be shown to be suitable for the particular application. An integral oil sump of less than 23·7 Litres (5·2 Imperial gallon/25 US-quarts) capacity on a reciprocating engine need not be fireproof nor be enclosed by a fireproof shield.

(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.

JAR 23.1189 Shut-off means [(See ACJ 23.1189 (a) (5))]

(a) For each twin-engined aeroplane the following apply:

(1) Each engine installation must have means to shut off or otherwise prevent hazardous quantities of fuel, oil, de-icing fluid and other flammable liquids from flowing into, within, or through any engine compartment, except in lines, fittings and components forming an integral part of an engine.

(2) The closing of the fuel shut-off valve for any engine may not make any fuel unavailable to the remaining engine that would be available to that engine with that valve open.

(3) Operation of any shut-off means may not interfere with the later emergency

JAR 23.1189 (a) (continued)

operation of other equipment such as propeller feathering devices.

(4) Each shut-off must be outside of the engine compartment unless an equal degree of safety is provided with the shut-off inside the compartment.

(5) No hazardous amount of flammable fluid may drain into the engine compartment after shut-off .

(6) There must be means to guard against inadvertent operations of each shut-off means and to make it possible for the crew to reopen the shut-off means in flight after it has been closed.

(b) Turbine engine installations need not have an engine oil system shut-off if –

(1) The oil tank is integral with, or mounted on, the engine; and

(2) All oil system components external to the engine are fireproof or located in areas not subject to engine fire conditions.

(c) Power-operated valves must have means to indicate to the flight crew when the valve has reached the selected position and must be designed so that the valve will not move from the selected position under vibration conditions likely to exist at the valve location.

[Amdt. 1, 01.02.01]

JAR 23.1191 Firewalls

(a) Each engine, auxiliary power unit, fuel burning heater and other combustion equipment must be isolated from the rest of the aeroplane by firewalls, shrouds or equivalent means.

(b) Each firewall or shroud must be constructed, so that no hazardous quantity of liquid, gas or flame can pass from that compartment to other parts of the aeroplane.

(c) Each opening in the firewall or shroud must be sealed with close fittings, fireproof grommets, bushings or firewall fittings.

(d) Reserved.

(e) Each firewall and shroud must be fireproof and protected against corrosion.

(f) Compliance with the criteria for fireproof materials or components must be shown as follows:

(1) The flame to which the materials or components are subjected must be 1 100 ± 67°C (2 000 ± 150°F).

JAR 23.1191 (f) (continued)

(2) Sheet materials approximately [6 452 mm^2 (10 in square) must be subjected] to the flame from a suitable burner.

(3) The flame must be large enough to maintain the required test temperature over an [area approximately 3 226 mm^2 (5 in square).]

(g) Firewall material and fittings must resist flame penetration for at least 15 minutes.

(h) The following materials may be used in firewalls or shrouds without being tested as required by this section:

(1) Stainless steel sheet, 0·38 mm (0·015 in) thick.

(2) Mild steel sheet (coated with aluminium or otherwise protected against corrosion) 0·45 mm (0·018 in) thick.

(3) Terne plate, 0·45 mm (0·018 in) thick.

(4) Monel metal, 0·45 mm (0·018 in) thick.

(5) Steel or copper base alloy firewall fittings.

(6) Titanium sheet, 0·4 mm (0·016 in) thick.

[Amdt. 1, 01.02.01]

JAR 23.1192 Engine accessory compartment diaphragm

For air-cooled radial engines, the engine power section and all portions of the exhaust system must be isolated from the engine accessory compartment by a diaphragm that meets the firewall requirements of JAR 23.1191.

JAR 23.1193 Cowling and nacelle

(a) Each cowling must be constructed and supported so that it can resist any vibration, inertia and air loads to which it may be subjected in operation.

(b) There must be means for rapid and complete drainage of each part of the cowling in the normal ground and flight attitudes. No drain may discharge where it will cause a fire hazard.

(c) Cowling must be at least fire-resistant.

(d) Each part behind an opening in the engine compartment cowling must be at least fire-[resistant for a distance of at least 609·6 mm] (24 in) aft of the opening.

JAR 23.1193 (continued)

(e) Each part of the cowling subjected to high temperatures due to its nearness to exhaust system ports or exhaust gas impingement, must be fire-proof.

(f) Each nacelle of a twin-engine aeroplane with turbocharged engines must be designed and constructed so that with the landing gear retracted, a fire in the engine compartment will not burn through a cowling or nacelle and enter a nacelle area other than the engine compartment.

(g) In addition for commuter category aeroplanes, the aeroplane must be designed so that no fire originating in any engine compartment can enter, either through openings or by burn-through, any other region where it would create additional hazards.

[Amdt. 1, 01.02.01]

JAR 23.1195 Fire extinguishing systems

(a) For commuter category aeroplanes, fire-extinguishing systems must be installed and compliance shown with the following:

(1) Except for combustor, turbine and tailpipe sections of turbine engine installations that contain lines or components carrying flammable fluids or gases for which a fire originating in these sections is shown to be controllable, there must be a fire extinguisher system serving each designated fire zone.

(2) 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 may be used.

(3) The fire extinguishing system for a nacelle must be able to simultaneously protect each zone of the nacelle for which protection is provided.

(b) If an auxiliary power unit is installed in any aeroplane certificated to JAR-23, that auxiliary power unit compartment must be served by a fire extinguishing system meeting the requirements of sub-paragraph (a) (2) of this paragraph.

JAR 23.1197 Fire extinguishing agents

For commuter category aeroplanes, the following apply:

(a) Fire extinguishing agents must –

(1) Be capable of extinguishing flames emanating from any burning 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) Protective breathing equipment is available for each flight crew member on flight deck duty.

JAR 23.1199 Extinguishing agent containers

For commuter category aeroplanes, the following apply:

(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) A means must be provided 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.

JAR 23.1199 (continued)

(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 23.1201 Fire extinguishing system materials

For commuter category aeroplanes, the following apply:

(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 23.1203 Fire detector system

(a) There must be means that ensures the prompt detection of a fire in –

(1) Each designated fire zone of –

(i) Twin-engine turbine powered aeroplanes;

(ii) Twin-engine reciprocating engine powered aeroplanes incorporating turbochargers;

(iii) Aeroplanes with engine(s) located where they are not readily visible from the cockpit; and

(iv) All commuter category aeroplanes.

(2) The auxiliary power unit compartment of any aeroplane incorporating an auxiliary power unit.

(b) Each fire or overheat detector system must be constructed and installed to withstand the vibration, inertia and other loads to which it may be subjected in operation.

(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 designated fire zone must be at least fire-resistant.

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SUBPART F – EQUIPMENT

GENERAL

JAR 23.1301 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;

(c) Be installed according to limitations specified for that equipment;

(d) Function properly when installed.

JAR 23.1303 Flight and navigation instruments [(See ACJ 23.1303 (a) (5))]

(a) The following are the minimum required flight and navigational instruments:

(1) An airspeed indicator.

(2) An altimeter.

(3) A non-stabilised magnetic direction indicator .

(4) For reciprocating engine-powered [aeroplanes of more than 2 721 kg (6 000 lb)] maximum weight and turbine engine-powered aeroplanes, a free air temperature indicator or an air temperature indicator which provides indications that are convertible to free air.

(5) A speed warning device for –

(i) Turbine engine-powered aeroplanes; and

(ii) Other aeroplanes for which VMO/MMO and VD/MD are established under JAR 23.335 (b) (4) and 23.1505 (c) if VMO/MMO is greater than 0·8 VD/MD.

The speed warning device must give effective aural warning (differing distinctively from aural warnings used for other purposes) to the pilots whenever the speed exceeds VMO plus 6 knots or MMO + 0·01. The upper limit of the production tolerance for the warning device may not exceed the prescribed warning speed and the lower limit must be set to minimise nuisance warnings.

(b) When an attitude display is installed the instrument design must not provide any means, accessible to the flight crew, of adjusting the relative positions of the attitude reference symbol

JAR 23.1303 (b) (continued)

and the horizon line beyond that necessary for parallax correction.

(c) *Not required for JAR-23.*

[Amdt. 1, 01.02.01]

JAR 23.1305 Powerplant instruments

The following are required powerplant instruments:

(a) A fuel quantity indicator for each fuel tank. See JAR 23.1337 (b) (6).

(b) An oil pressure indicator for each engine and for each turbo-supercharger oil system that is separate from other oil systems.

(c) An oil temperature indicator for each engine and for each turbo-supercharger oil system that is separate from other oil systems.

(d) A tachometer for each reciprocating engine.

(e) A tachometer (to indicate the speed of the rotors with established limiting speeds) for each turbine engine.

(f) A cylinder head temperature indicator for –

(1) Each air-cooled engine with cowl flaps.

(2) Each reciprocating engine in a commuter category aeroplane.

(g) A fuel pressure indicator for pump-fed engines.

(h) A manifold pressure indicator for each altitude reciprocating engine, and for each reciprocating engine with a controllable propeller.

(i) An oil quantity indicator for each oil tank.

(j) A gas temperature indicator for each turbine engine.

(k) A fuel flowmeter for –

(1) Each turbine engine or fuel tank, if pilot action is required to maintain fuel flow within limits, and

(2) Each turbine engine in a commuter category aeroplane.

(l) An indicator to indicate engine thrust or to indicate a gas stream pressure that can be related to thrust, for each turbojet engine, JAR 23.1305 (l) (continued)

including a free air temperature indicator if needed for this purpose.

[(m) A torque indicator for each turbo] propeller engine.

(n) A blade position indicating means for each turbo-propeller engine propeller to provide an indication to the flightcrew when the propeller blade angle is below the flight low pitch position. The required indicator must begin indicating before the blade moves more than 8° below the flight low pitch stop. The source of indication must directly sense the blade position.

(o) A position indicating means to indicate to the flightcrew when the thrust reverser is in the revrse thrust position for each turbojet engine.

(p) For turbo-supercharger installations, if limitations are established for either carburettor air inlet temperature or exhaust gas temperature, indicators must be furnished for each temperature for which the limitation is established unless it is shown that the limitation will not be exceeded in all intended operations.

(q) A low oil pressure warning means for each turbine engine.

[(r) An induction system air temperature] indicator for each engine equipped with a preheater and having induction air temperature limitations which can be exceeded with preheat.

(s) For each turbine engine, an indicator to indicate the functioning of the powerplant ice protection system.

(t) For each turbine engine, an indicator for the fuel strainer or filter required by JAR 23.997 to indicate the occurrence of contamination of the strainer or filter before it reaches the capacity established in accordance with JAR 23.997 (d).

(u) For each turbine engine, a warning means for the oil strainer or filter required by JAR 23.1019, if it has no by-pass, 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 23.1019 (a) (2).

(v) An indicator to indicate the functioning of any heater used to prevent ice clogging of fuel system components.

(w) A fire warning indicator for those aeroplanes required to comply with JAR 23.1203.

[Amdt. 1, 01.02.01]

JAR 23.1307 Miscellaneous equipment

Not required for JAR-23.

JAR 23.1309 Equipment, systems and installations

(a) Each item of equipment, each system, and each installation –

(1) When performing its intended function, may not adversely affect the response, operation, or accuracy of any –

(i) Equipment essential to safe operation; or

(ii) Other equipment unless there is a means to inform the pilot of the effect.

(2) In a single-engine aeroplane, must be designed to minimise hazards to the aeroplane in the event of a probable malfunction or failure.

(3) In a twin-engine aeroplane, must be designed to prevent hazards to the aeroplane in the event of a probable malfunction or failure.

(4) *Not required for JAR-23.*

(b) The design of each item of equipment, each system, and each installation must be examined separately and in relationship to other aeroplane systems and installations to determine if the aeroplane is dependent upon its function for continued safe flight and landing and, for aeroplanes not limited to VFR conditions, if failure of a system would significantly reduce the capability of the aeroplane or the ability of the crew to cope with adverse operating conditions. Each item of equipment, each system, and each installation identified by this examination as one upon which the aeroplane is dependent for proper functioning to ensure continued safe flight and landing, or whose failure would significantly reduce the capability of the aeroplane or the ability of the crew to cope with adverse operating conditions, must be designed to comply with the following additional requirements:

(1) It must perform its intended function under any foreseeable operating condition.

(2) When systems and associated components are considered separately and in relation to other systems –

(i) The occurrence of any failure condition that would prevent the continued safe flight and landing of the

JAR 23.1309 (b) (continued)

aeroplane must be extremely improbable; and

(ii) The occurrence of any other failure condition that would significantly reduce the capability of the aeroplane or the ability of the crew to cope with adverse operating conditions must be improbable.

(3) Warning information must be provided to alert the crew to unsafe system operating conditions and to enable them to take appropriate corrective action. Systems, controls, and associated monitoring and warning means must be designed to minimise crew errors that could create additional hazards.

(4) Compliance with the requirements of sub-paragraph (b) (2) of this paragraph may be shown by analysis and, where necessary, by appropriate ground, flight, or simulator test. The analysis must consider –

(i) Possible modes of failure, including malfunctions and damage from external sources;

(ii) The probability of multiple failures, and the probability of undetected faults;

(iii) The resulting effects on the aeroplane and occupants, considering the stage of flight and operating conditions; and

(iv) The crew warning cues, corrective action required, and the crew's capability of determining faults.

(c) Each item of equipment, each system, and each installation whose functioning is required for certification 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:

(1) Loads connected to the power distribution system with the system functioning normally.

(2) Essential loads after failure of –

(i) Any one engine on two-engine aeroplanes; or

(ii) Any power converter or energy storage device.

(3) Essential loads for which an alternate source of power is required, as

JAR 23.1309 (c) (continued)

applicable, by the operating rules of this chapter, after any failure or malfunction in any one power supply system, distribution system, or other utilisation system.

(d) In determining compliance with sub-paragraph (c) (2) of this paragraph, the power loads may be assumed to be reduced under a monitoring procedure consistent with safety in the kinds of operations authorised.

(e) In showing compliance with this section with regard to the electrical power system and to equipment design and installation, critical environmental and atmospheric conditions, including radio frequency energy and the effects (both direct and indirect) of lightning strikes, must be considered. For electrical generation, distribution, and utilisation equipment required by or used in complying with this chapter, the ability to provide continuous, safe service under foreseeable environmental conditions may be shown by environmental tests, design analysis, or reference to previous comparable service experience on other aeroplanes.

(f) As used in this section, "systems" refers to all pneumatic systems, fluid systems, electrical systems, mechanical systems, and powerplant systems included in the aeroplane design, except for the following:

(1) Powerplant systems provided as part of the certificated engine.

(2) The flight structure (such as wing, empannage, control surfaces and their systems, the fuselage, engine mounting, and landing gear and their related primary attachments) whose requirements are specific in Subparts C and D of JAR-23.

INSTRUMENTS: INSTALLATION

JAR 23.1311 Electronic display instrument systems

(a) Electronic display indicators, including those with features that make isolation and independence between powerplant instrument systems impractical, must –

(1) Meet the arrangement and visibility requirements of JAR 23.1321;

(2) Be easily legible under all lighting conditions encountered in the cockpit, including direct sunlight, considering the expected electronic display brightness level at the end of an electronic display indicator's

JAR 23.1311(a) (continued)

useful life. Specific limitations on display system useful life must be addressed in the Instructions for Continued Airworthiness requirements of JAR 23.1529;

(3) Not inhibit the primary display of attitude, airspeed, altitude, or powerplant parameters needed by any pilot to set power within established limitations, in any normal mode of operation.

(4) Not inhibit the primary display of engine parameters needed by any pilot to properly set or monitor powerplant limitations during the engine starting mode of operation;

(5) Have independent secondary mechanical altimeter, airspeed indicator, magnetic direction indicator, and attitude instrument, or individual electronic display indicators for the altimeter, airspeed, and attitude indicator that are independent from the aeroplane's primary electrical power system. These secondary instruments may be installed in panel positions that are displaced from the primary positions specified by JAR 23.1321 (d), but must be located where they meet the pilot's visibility requirements of JAR 23.1321 (a).

(6) Incorporate sensory cues for the pilot that are equivalent to those in the instrument being replaced by the electronic display indicators; and

(7) Incorporate visual displays of instrument markings, required by JAR 23.1541 to 23.1553, or visual displays that alert the pilot to abnormal operational values or approaches to established limitation values, for each parameter required to be displayed by JAR-23.

(b) The electronic display indicators, including their systems and installations, and considering other aeroplane systems, must be designed so that one display of information essential for continued safe flight and landing will remain available to the crew, without need for immediate action by any pilot for continued safe operation, after any single failure or probable combination of failures.

(c) As used in this section "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). As used in this section "primary" display refers to

JAR 23.1311 (c) (continued)

the display of a parameter that is located in the instrument panel such that the pilot looks at it first when wanting to view that parameter.

JAR 23.1321 Arrangement and visibility

(a) Each flight, navigation and powerplant instrument for use by any required pilot during take-off, initial climb, final approach, and landing must be located so that any pilot seated at the controls can monitor the aeroplane's flight path and these instruments with minimum head and eye movement. The powerplant instruments for these flight conditions are those needed to set power within powerplant limitations.

(b) For each twin-engined aeroplane, identical powerplant instruments must be located so as to prevent confusion as to which engine each instrument relates.

(c) Instrument panel vibration may not damage, or impair the accuracy of, any instrument.

(d) For each aeroplane the flight instruments required by JAR 23.1303 and, as applicable, by the Operating Rules 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 –

(1) The instrument that most effectively indicates the 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, other than the magnetic direction indicator required by JAR 23.1303 (a) (3), must be adjacent to and directly below the instrument in the top centre position.

(5) Electronic display indicators may be used for compliance with sub-paragraphs (d) (1) to (d) (4) of this paragraph when such displays comply with requirements in JAR 23.1311.

(e) If a visual indicator is provided to indicate malfunction of an instrument, it must be

JAR 23.1321 (e) (continued)

effective under all probable cockpit lighting conditions.

JAR 23.1322 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.

(e) Effective under all probable cockpit lighting conditions.

JAR 23.1323 Airspeed indicating system [(See ACJ 23.1323 (g))]

(a) Each airspeed indicating instrument 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 airspeed system must be calibrated in flight to determine the system error. The system error, including position error, but excluding the airspeed indicator instrument calibration error, may not exceed 3% of the calibrated airspeed or 5 knots, whichever is greater, throughout the following speed ranges:

(1) 1·3 V_{S1} to V_{MO}/M_{MO} or V_{NE}, whichever is appropriate with flaps retracted.

(2) 1·3 V_{S1} to V_{FE} with flaps extended.

(c) In addition, for commuter category aeroplanes, the airspeed indicating system must be calibrated to determine the system error during the accelerate take-off ground run. The ground run calibration must be obtained between 0·8 of the minimum value of V_1 and 1·2 times the maximum value of V_1, considering the approved ranges of altitude and weight. The ground run

JAR 23.1323 (c) (continued)

calibration must be determined assuming an engine failure at the minimum value of V_1.

(d) Reserved

(e) If required by the operating rules, or if certification for instrument flight rules or flight in icing conditions is requested, each airspeed system must have a heated pitot tube of an approved type or an equivalent means of preventing malfunction due to icing.

(f) The design and installation of each airspeed indicating system must provide positive drainage of moisture from the pitot static plumbing.

(g) For commuter category aeroplanes, 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.

[Amdt. 1, 01.02.01]

JAR 23.1325 Static pressure system

(a) Each instrument provided with static pressure case connections must be so vented that the influence of aeroplane speed, the opening and closing of windows, airflow variations, moisture, or other foreign matter will least affect the accuracy of the instruments except as noted in sub-paragraph (b) (3) of this paragraph.

(b) If a static pressure system is necessary for the functioning of instruments, systems, or devices, it must comply with the provisions of sub-paragraphs (1) to (3) of this paragraph.

(1) The design and installation of a static pressure system must be such that –

(i) Positive drainage of moisture is provided;

(ii) Chafing of the tubing and excessive distortion or restriction at bends in the tubing, is avoided; and

(iii) The materials used are durable, suitable for the purpose intended and protected against corrosion.

(2) 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 aircraft elevation at the time of the test. Without

JAR 23.1325 (b) (continued)

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 a pressure differential equivalent to the maximum cabin pressure differential for which the aeroplane is type certificated is 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.

(3) If a static pressure system is provided for any instrument, device, or system required by the operating rules, each static pressure port must be designed or located in such a manner that the correlation between air pressure in the static pressure system and true ambient atmospheric static pressure is not altered when the aeroplane encounters icing conditions. An anti-icing means or an alternate source of static pressure may be used in showing compliance with this requirement. If the reading of the altimeter, when on the alternate static pressure system differs from the reading of the altimeter when on the primary static system by more than 50 ft, a correction card must be provided for the alternate static system.

(c) Except as provided in sub-paragraph (d) 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.

(d) For unpressurised aeroplanes, sub-paragraph (c) (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.

(e) Each static pressure system must be calibrated in flight to determine the system error. The system error, in indicated pressure altitude, at sea-level, with a standard atmosphere, excluding instrument calibration error, may not exceed ± 30 ft per 100 knot speed for the appropriate configuration in the speed range between 1·3 V_{SO} with flaps extended and 1·8 V_{S1} with flaps

JAR 23.1325 (e) (continued)

retracted. However, the error need not be less than ± 30 ft.

(f) Reserved.

(g) For aeroplanes prohibited from flight under Instrument Flight Rules (IFR) or known icing conditions in accordance with JAR 23.1525, sub-paragraph (b) (3) of this paragraph does not apply.

JAR 23.1326 Pitot heat indication systems

For commuter category aeroplanes, 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 :

(a) The indication provided must be designed to alert the flight crew if either of the following conditions exists:

(1) The pitot heating system is switched "off".

(2) The pitot heating system is switched "on" and any pitot tube heating element is inoperative.

(b) *Not required for JAR-23*

JAR 23.1327 Magnetic direction indicator

(a) Except as provided in sub-paragraph (b) of this paragraph –

(1) Each magnetic direction indicator must be installed so that its accuracy is not excessively affected by the aeroplane's vibration or magnetic fields; and

(2) The compensated installation may not have a deviation, in level flight, greater than 10° on any heading.

(b) A magnetic non-stabilised direction indicator may deviate more than 10° due to the operation of electrically powered systems such as electrically heated windshields if either a magnetic stabilised direction indicator, which does not have a deviation in level flight greater than 10° on any heading, or a gyroscopic direction indicator is installed. Deviations of a magnetic non-stabilised direction indicator of more than 10° must be placarded in accordance with JAR 23.1547 (c).

JAR 23.1329 Automatic pilot system

If an automatic pilot system is installed, it must meet the following:

(a) Each system must be designed so that the automatic pilot can –

(1) Be quickly and positively disengaged by the pilots to prevent it from interfering with their control of the aeroplane; or

(2) Be sufficiently over-powered by one pilot to let him control the aeroplane.

(b) If the provisions of sub-paragraph (a) (1) of this paragraph are applied, the quick release (emergency) control must be located on the control wheel (both control wheels if the aeroplane can be operated from either pilot seat) on the side opposite the throttles, or on the stick control (both stick controls if the aeroplane can be operated from either pilot seat), such that it can be operated without moving the hand from its normal position on the control.

(c) 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.

(d) Each manually-operated control for the system operation must be readily accessible to the pilot. Each control must operate in the same plane and sense of motion as specified in JAR 23.779 for cockpit controls. The direction of motion must be plainly indicated on or near each control.

(e) Each system must be designed and adjusted so that, within the range of adjustment available to the pilot, it cannot produce hazardous loads on the aeroplane or create hazardous deviations in the flight path, under any flight condition 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.

(f) Each system must be designed so that a single malfunction will not produce a hardover signal in more than one control axis. If the automatic pilot integrates signals from auxiliary controls or furnishes signals for operation of other equipment, positive interlocks and sequencing of engagement to prevent improper operation are required.

(g) There must be protection against adverse interaction of integrated components, resulting from a malfunction.

(h) If the automatic pilot system can be coupled to airborne navigation equipment, means must be provided to indicate to the flightcrew the current mode of operation. Selector switch position is not acceptable as a means of indication.

JAR 23.1331 Gyroscopic instruments using a power supply

(a) For each aeroplane –

(1) Each gyroscopic instrument must derive its energy from power sources adequate to maintain its function and required accuracy throughout the full range of aeroplane and engine operating conditions.

(2) Each gyroscopic instrument must be installed so as to prevent malfunction due to rain, oil and other detrimental elements; and

(3) There must be a means to indicate the adequacy of the power being supplied to the instruments.

(b) For each twin-engined aeroplane and for single engined aeroplanes in respect of instruments required by the operating rules –

(1) There must be at least two independent sources of power (not driven by the same engine), a manual or an automatic means to select each power source and a means to indicate the adequacy of the power being supplied by each source; and

(2) The installation and power supply systems must be designed so that –

(i) The failure of one instrument will not interfere with the proper supply of energy to the remaining instruments; and

(ii) The failure of the energy supply from one source will not interfere with the proper supply of energy from any other source.

JAR 23.1335 Flight director systems

If a flight director system is installed, means must be provided to indicate to the flightcrew its current mode of operation. Selector switch position is not acceptable as a means of indication.

JAR 23.1337 Powerplant instruments installation

(a) *Instruments and instrument lines*

(1) Each powerplant and auxiliary power unit instrument line must meet the requirements of JAR 23.993.

(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 and auxiliary power unit 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 of usable fuel in each tank during flight. An indicator calibrated in appropriate units and clearly marked to indicate those units, must be used.

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 23.959 (a);

(2) Each exposed sight gauge used as a fuel quantity indicator must be protected against damage;

(3) Each sight gauge that forms a trap in which water can collect and freeze must have means to allow drainage on the ground;

(4) There must be a means to indicate the amount of usable fuel in each tank when the aeroplane is on the ground (such as by a stick gauge).

(5) Tanks with interconnected outlets and airspaces may be considered as one tank and need not have separate indicators; and

(6) No fuel quantity indicator is required for an auxiliary tank that is used only to transfer fuel to other tanks if the relative size of the tank, the rate of fuel transfer and operating instructions are adequate to –

(i) Guard against overflow; and

JAR 23.1337 (b) (continued)

(ii) Give to the flight-crew members a prompt warning if transfer is not proceeding as planned.

(c) *Fuel flowmeter system.* If a fuel flowmeter system is installed, each metering component must have a means to by-pass the fuel supply if malfunctioning of that component severely restricts fuel flow.

(d) *Oil quantity indicator.* There must be a means to indicate the quantity of oil in each tank –

(1) On the ground (such as by a stick gauge); and

(2) In flight, if there is an oil transfer system or a reserve oil supply system.

ELECTRICAL SYSTEMS AND EQUIPMENT

JAR 23.1351 General

[(See ACJ 23.1351 (a) (2) and ACJ 23.1351 (b) (5) (iv))]

(a) *Electrical system capacity.* Each electrical system must be adequate for the intended use. In addition –

(1) Electric power sources, their transmission cables, and their associated control and protective devices, must be able to furnish the required power at the proper voltage to each load circuit essential for safe operation; and

(2) Compliance with sub-paragraph (1) of this paragraph must be shown as follows:

(i) For normal, utility and aerobatic category aeroplanes, by an electrical load analysis, or by electrical measurements, that account for the electrical loads applied to the electrical system in probable combinations and for probable durations; and

(ii) For commuter category aeroplanes, by an electrical load analysis that accounts for the electrical loads applied to the electrical system in probable combinations and for probable durations.

(b) *Functions.* For each electrical system, the following apply:

(1) Each system, when installed, must be –

JAR 23.1351 (b) (continued)

(i) Free from hazards in itself, in its method of operation, and in its effects on other parts of the aeroplane;

(ii) Protected from fuel, oil, water, other detrimental substances and mechanical damage; and

(iii) So designed that the risk of electrical shock to crew, passengers and ground personnel is reduced to a minimum.

(2) Electric power sources must function properly when connected in combination or independently.

(3) No failure or malfunction of any electric power source may impair the ability of any remaining source to supply load circuits essential for safe operation.

(4) Reserved.

(5) In addition, for commuter category aeroplanes, the following apply:

(i) Each system must be designed so that essential load circuits can be supplied in the event of reasonably probable faults or open circuits including faults in heavy current carrying cables;

(ii) A means must be accessible in flight to the flight-crew members for the individual and collective disconnection of the electrical power sources from the system;

(iii) The system must be designed so that voltage and frequency, if applicable, at the terminals of the essential load equipment can be maintained within the limits for which the equipment is designed during any probable operating conditions;

(iv) If two independent sources of electrical power for particular equipment or systems are required, their electrical energy supply must be ensured by means such as duplicate electrical equipment, throwover switching, or multi-channel or loop circuits separately routed; and

(v) For the purpose of complying with sub-paragraph (b) (5) of this paragraph, the distribution system includes the distribution busses, their associated feeders, and each control and protective device.

(c) *Generating system.* There must be at least one generator/alternator if the electrical system supplies power to load circuits essential for safe operation. In addition –

JAR 23.1351 (c) (continued)

(1) Each generator/alternator must be able to deliver its continuous rated power, or such power as is limited by its regulation system;

(2) Generator/alternator voltage control equipment must be able to dependably regulate the generator/alternator output within rated limits;

(3) Automatic means must be provided to prevent either damage to any alternator/generator, or adverse effects on the aeroplane electrical system, due to reverse current. A means must also be provided to disconnect each generator/alternator from the battery and the other generators/alternators.

(4) There must be a means to give immediate warning to the flightcrew of a failure of any generator/alternator; and

(5) Each generator/alternator must have an overvoltage control designed and installed to prevent damage to the electrical system, or to equipment supplied by the electrical system, that could result if that generator/alternator were to develop an overvoltage condition.

(d) *Instruments.* A means must exist to indicate to appropriate flight-crew members the electric power system quantities essential for safe operation.

(1) For normal, utility, and aerobatic category aeroplanes with direct current systems, an ammeter that can be switched into each generator feeder may be used and, if only one generator exists, the ammeter may be in the battery feeder.

(2) For commuter category aeroplanes, the essential electric power system quantities include the voltage and current supplied by each generator.

(e) *Fire resistance.* Electrical equipment must be so designed and installed that in the event of a fire in the engine compartment, during which the surface of the firewall adjacent to the fire is heated to 1 100°C (2 000°F) for 5 minutes or to a lesser temperature substantiated by the applicant, the equipment essential to continued safe operation and located behind the firewall will function satisfactorily and will not create an additional fire hazard.

(f) *External power.* If provisions are made for connecting external power to the aeroplane and that external power can be electrically

JAR 23.1351 (f) (continued)

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, or a reverse phase sequence, can supply power to the aeroplane's electrical system. The location must allow such provisions to be capable of being operated without hazard to the aeroplane or persons.

(g) *Not required for JAR-23.*

[Amdt. 1, 01.02.01]

JAR 23.1353 Storage battery design and installation [(See ACJ 23.1353 (h))]

(a) Each storage battery must be designed and installed as prescribed in this section.

(b) Safe cell temperatures and pressures must be maintained during any probable charging and discharging condition. No uncontrolled increase in cell temperature may result when the battery is recharged (after previous complete discharge) –

(1) At maximum regulated voltage or power;

(2) During a flight of maximum duration; and

(3) Under the most adverse cooling condition likely to occur in service.

(c) Compliance with sub-paragraph (b) of this paragraph must be shown by tests unless experience with similar batteries and installations has shown that maintaining safe cell temperatures and pressures presents no problem.

(d) 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.

(e) No corrosive fluids or gases that may escape from the battery may damage surrounding structures or adjacent essential equipment.

(f) Each nickel cadmium battery installation capable of being used to start an engine or auxiliary power unit must have provisions to prevent any hazardous effect on structure or essential systems that may be caused by the maximum amount of heat the battery can generate during a short circuit of the battery or of its individual cells.

(g) Nickel cadmium battery installations capable of being used to start an engine or auxiliary power unit must have –

JAR 23.1353 (g) (continued)

(1) A system to control the charging rate of the battery automatically so as to prevent battery overheating; or

(2) 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

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

(h) In the event of a complete loss of the primary electrical power generating system, the battery must be capable of providing 30 minutes of electrical power to those loads that are essential *to continued safe flight and landing.* The 30-minute time period includes the time needed for the pilot(s) to recognise the loss of generated power and to take appropriate load shedding action.

[Amdt. 1, 01.02.01]

JAR 23.1357 Circuit protective devices

(a) Protective devices, such as fuses or circuit breakers, must be installed in all electrical circuits other than –

(1) The main circuits of starter motors used during starting only; and

(2) Circuits in which no hazard is presented by their omission.

(b) *A protective device for a circuit essential to flight safety may not be used to protect any* other circuit.

(c) Each resettable circuit protective device ("trip free" device in which the tripping mechanism cannot be over-ridden by the operating control) must be designed so that –

(1) A manual operation is required to restore service after tripping; and

(2) If an overload or circuit fault exists, the device will open the circuit regardless 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 so located and identified that it can be readily reset or replaced in flight.

(e) If fuses are identified as replaceable in flight –

JAR 23.1357 (e) (continued)

(1) There must be one spare of each rating or 50% spare fuses of each rating, whichever is greater; and

(2) The spare fuse(s) must be readily accessible to any required pilot.

JAR 23.1359 Electrical system fire protection

(a) Components of the electrical system must meet the applicable fire protection requirements of JAR 23.1182 and 23.863.

(b) Electrical cables, terminals and equipment in designated fire zones, that are used during emergency procedures, must be fire-resistant.

(c) Insulation on electrical wire and cable installed must be self-extinguishing when tested at an angle of 60° in accordance with the applicable portions of Appendix F of JAR-23 or other approved equivalent methods. The average burn length must not exceed 76 mm (3 in) and the average flame time after removal of the flame source must not exceed 30 seconds. Drippings from the test specimen must not continue to flame for more than an average of 3 seconds after falling.

JAR 23.1361 Master switch arrangement

(a) There must be a master switch arrangement to allow ready disconnection of each electric power source from the power distribution systems, except as provided in sub-paragraph (b) of this paragraph. The point of disconnection must be adjacent to the sources controlled by the switch arrangement. A separate switch may be incorporated into the arrangement for each separate power source provided the switch arrangement can be operated by one hand with a single movement.

(b) Load circuits may be connected so that they remain energised when the master switch is open; if –

(1) The circuits are isolated, or physically shielded, to prevent their igniting flammable fluids or vapours that might be liberated by the leakage or rupture of any flammable fluid systems; and

(2) The circuits are required for continued operation of the engine; or

(3) The circuits are protected by circuit protective devices with a rating of five amperes or less adjacent to the electric power source.

JAR 23.1361 (b) (continued)

In addition, two or more circuits installed in accordance with the requirements of sub-paragraph (b) (2) of this paragraph must not be used to supply a load of more than five amperes.

(c) The master switch or its controls must be so installed that the switch is easily discernible and accessible to a crew member.

JAR 23.1365 Electric cables and equipment

(a) Each electric connecting cable must be of adequate capacity.

(b) Any equipment that is associated with any electrical cable installation and that would overheat in the event of a circuit overload or fault must be flame resistant and must not emit dangerous quantities of toxic fumes.

(c) Means of identification must be provided for electrical cables, connectors and terminals.

(d) 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) Main power cables (including generator cables) must be designed to allow a reasonable degree of deformation and stretching without failure and must –

(1) Be separated from flammable fluid lines; or

(2) Be shrouded by means of electrically insulated flexible conduit or equivalent, which is in addition to the normal cable insulations.

(f) Where a cable cannot be protected by a circuit protection device or other overload protection it must not cause a fire hazard under fault conditions.

JAR 23.1367 Switches

Each switch must be –

(a) Able to carry its rated current;

(b) Constructed with enough distance or insulating material between current carrying parts and the housing so that vibration in flight will not cause shorting;

(c) Accessible to appropriate flight-crew members; and

(d) Labelled as to operation and the circuit controlled.

LIGHTS

JAR 23.1381 Instrument lights

The instrument lights must –

(a) Make each instrument and control easily readable and discernible;

(b) Be installed so that their direct rays, and rays reflected from the windshield or other surface, are shielded from the pilot's eyes; and

(c) Have enough distance or insulating material between current carrying parts and the housing so that vibration in flight will not cause shorting.

A cabin dome light is not an instrument light.

JAR 23.1383 Taxi and landing lights

Each taxi and landing light must be designed and installed so that –

(a) No dangerous glare is visible to the pilot;

(b) The pilot is not seriously affected by halation;

(c) It provides enough light for night operations; and

(d) It must not cause a fire hazard in any configuration.

JAR 23.1385 Position light system installation

(a) *General.* Each part of each position light system must meet the applicable requirements of this section and each system as a whole must meet the requirements of JAR 23.1387 to 23.1397.

(b) *Left and right position lights.* Left and right position lights must consist of a red and a green light spaced laterally as far apart as practicable and installed on the aeroplane such 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.

(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.

(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 23.1387 Position light system dihedral angles

(a) Except as provided in sub-paragraph (e) of this paragraph, each 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 110° 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 110° 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 70° 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 23.1385 (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 30° with a vertical line passing through the rear position light.

JAR 23.1389 Position light distribution and intensities

(a) *General.* The intensities prescribed in this section must be provided by new equipment with each light cover and colour filter 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) *Position lights.* The light distribution and intensities of position lights must be expressed in terms of minimum intensities in the horizontal plane, minimum intensities in any vertical plane and maximum intensities in over-lapping beams, within dihedral angles L, R and A, must meet the following requirements:

JAR 23.1389 (b) (continued)

(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 23.1391.

(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 23.1393, where I is the minimum intensity prescribed in JAR 23.1391 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 in JAR 23.1395, except that higher intensities in overlaps may be used with main beam intensities substantially greater than the minima specified in JAR 23.1391 and 23.1393, if the overlap intensities in relation to the main beam intensities do not adversely affect signal clarity. When the peak intensity of the left and right position lights is more than 100 candelas, the maximum overlap intensities between them may exceed the values in JAR 23.1395 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 more than 2·5% of peak position light intensity.

(c) *Rear position light installation.* A single rear position light may be installed in a position displaced laterally from the plane of symmetry of an aeroplane if –

(1) The axis of the minimum cone of illumination is parallel to the flight path in level flight; and

(2) There is no obstruction aft of the light and between planes 70° to the right and left of the axis of maximum illumination.

JAR 23.1391 Minimum intensities in the horizontal plane of position lights

Each position light intensity must equal or exceed the applicable values in the following table:

JAR 23.1391 (continued)

Dihedral angle (light included)	Angle from right or left of longitudinal axis measured from dead ahead	Intensity (candelas)
L and R	0° to 10°	40
(red and green).	10° to 20°	30
	20° to 110°	5
A (rear white)........	110° to 180°	20

JAR 23.1393 Minimum intensities in any vertical plane of 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
0	1·00 I.
0° to 5°	0·90 I.
5° to 10°	0·80 I.
10° to 15°	0·70 I.
15° to 20°	0·50 I.
20° to 30°	0·30 I.
30° to 40°	0·10 I.
40° to 90°	0·05 I.

JAR 23.1395 Maximum intensities in overlapping beams of position lights

No position light intensity may exceed the applicable values in the following table, except as provided in JAR 23.1389 (b) (3):

Overlaps	Maximum intensity	
	Area A (candelas)	Area B (candelas)
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 10° but less than 20°; and

JAR 23.1395 (continued)

(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 20°.

JAR 23.1397 Colour specifications

Each position light colour must have the applicable International Commission on Illumination chromaticity co-ordinates as follows:

(a) *Aviation red* –

"y" is not greater than 0·335; and

"z" is not greater than 0·002.

(b) *Aviation green* –

"x" is not greater than 0·440–0·320*y*;

"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°–0·010", whichever is the smaller; and

"y" is not greater than "x+0·020" nor "0·636–0·400x";

Where "y°" is the "y" co-ordinate of the Planckian radiator for the value of "x" considered.

JAR 23.1399 Riding light

(a) Each riding (anchor) light required for a seaplane or amphibian, must be installed so that it can –

(1) Show a white light for at least 3·2 km (2 miles) at night under clear atmospheric conditions; and

(2) Show the maximum unbroken light practicable when the aeroplane is moored or drifting on the water.

(b) Externally hung lights may be used.

JAR 23.1401 Anti-collision light system

(a) *General.* The aircraft must have an anti-collision light system that –

(1) Consist of one or more approved anti-collision lights located so that their light will not impair the flight-crew members' vision

JAR 23.1401 (a) (continued)

or detract from the conspicuity of the position lights; and

(2) Meet the requirements of sub-paragraphs (b) to (f) of this paragraph.

(b) *Field of coverage.* The system must consist of enough lights 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 75° above and 75° below the horizontal plane of the aeroplane, except that there may be solid angles of obstructed visibility totalling not more than 0·5 steradians.

(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 sector 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 23.1397.

(e) *Light intensity.* The minimum light intensities in any vertical plane, measured with the 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:

$$Ie = \frac{\int_{t1}^{t2} I(t)\,dt}{0{\cdot}2 + (t2 - t1)}$$

where –

Ie	=	effective intensity (candelas).
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.

JAR 23.1401 (continued)

(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 (candelas)*
0° to 5°	400
5° to 10°	240
10° to 20°	80
20° to 30°	40
30° to 75°	20

SAFETY EQUIPMENT

JAR 23.1411 General

(a) Required safety equipment to be used by the flightcrew in an emergency, such as automatic life-raft releases, must be readily accessible.

(b) Stowage provisions for required safety equipment must be furnished and must –

(1) Be arranged so that the equipment is directly accessible and its location is obvious; and

(2) Protect the safety equipment from damage caused by being subjected to the inertia loads resulting from the ultimate static load factors specified in JAR 23.561 (b) (3).

JAR 23X1413 Safety belts and harnesses

Each safety belt and shoulder harness must be equipped with a metal to metal latching device.

JAR 23.1415 Ditching equipment

(a) Emergency flotation and signalling equipment required by the operating rules must be installed so that it is readily available to the crew and passengers.

(b) Each raft and each life preserver must be approved.

(c) Each raft released automatically or by the pilot must be attached to the aeroplane by a line to keep it alongside the aeroplane. This line must be weak enough to break before submerging the empty raft to which it is attached.

(d) Each signalling device required by the operating rules, must be accessible, function satisfactorily and must be free of any hazard in its operation.

JAR 23.1416 Pneumatic de-icer boot system

If certification with ice protection provisions is desired and a pneumatic de-icer boot system is installed –

(a) The system must meet the requirements specified in JAR 23.1419.

(b) The system and its components must be designed to perform their intended function under any normal system operating temperature or pressure, and

(c) Means to indicate to the flight crew that the pneumatic de-icer boot system is receiving adequate pressure and is functioning normally must be provided.

JAR 23.1419 Ice protection [(See ACJ 23.1419)]

If certification with ice protection provisions is desired, compliance with the following requirements must be shown:

(a) The recommended procedures for the use of the ice protection equipment must be set forth in the Aeroplane Flight Manual or in approved manual material.

(b) An analysis must be performed to establish, on the basis of the aeroplane's operational needs, the adequacy of the ice protection system for the various components of the aeroplane. In addition, tests of the ice protection system must be conducted to demonstrate that the aeroplane is capable of operating safely in continuous maximum and intermittent maximum icing conditions as described in JAR-1.

(c) Compliance with all or portions of the section may be accomplished by reference, where applicable because of similarity of the designs to analysis and tests performed for the type certification of a type certificated aircraft.

(d) When monitoring of the external surfaces of the aeroplane by the flight crew is required for proper operation of the ice protection equipment, external lighting must be provided which is adequate to enable the monitoring to be done at night.

[Amdt. 1, 01.02.01]

MISCELLANEOUS EQUIPMENT

JAR 23.1431 Electronic equipment [(See ACJ 23.1419)]

(a) In showing compliance with JAR 23.1309 (b) (1) and (2) with respect to radio and electronic equipment and their installations, critical environmental conditions must be considered.

(b) Radio and electronic equipment, controls, and wiring must be installed so that operation of any unit or system of units will not adversely affect the simultaneous operation of any other radio or electronic unit, or system of units.

(c) For those aeroplanes required to have more than one flight-crew member, or whose operation will require more than one flight-crew member, the cockpit must be evaluated to determine if, when seated at their duty station, the flight crew members can converse without difficulty. If the aeroplane design includes provisions for the use of communication headsets, the evaluation must also consider conditions where headsets are being used. If the evaluation shows conditions under which it will be difficult to converse, an intercommunication system must be provided.

(d) If communication equipment is installed that incorporates transmit switches, these switches must be such that, when released, they return from the "transmit" to the "off" position .

(e) If provisions for the use of communication headsets are provided, it must be demonstrated that the flight crew members will receive all aural warnings when any headset is being used.

[Amdt. 1, 01.02.01]

JAR 23.1435 Hydraulic systems

(a) *Design.* Each hydraulic system must be designed as follows:

(1) Each hydraulic system and its elements must withstand, without yielding, the structural loads expected in addition to hydraulic loads.

(2) A means to indicate the pressure in each hydraulic system which supplies two or more primary functions must be provided to the flightcrew.

(3) There must be means to ensure that the pressure, including transient (surge) pressure, in any part of the system will not exceed the safe limit above design operating pressure and to prevent excessive pressure resulting from fluid volumetric changes in all lines which are likely to remain closed long enough for such changes to occur.

(4) The minimum design burst pressure must be 2·5 times the operating pressure.

(b) *Tests.* Each system must be substantiated by proof pressure tests. When proof-tested, no part of any system may fail, malfunction, or experience a permanent set. The proof load of each system must be at least 1·5 times the maximum operating pressure of that system.

(c) *Accumulators.* A hydraulic accumulator or reservoirs may be installed on the engine side of any firewall if –

(1) It is an integral part of an engine or propeller system, or

(2) The reservoir is non-pressurised and the total capacity of all such non-pressurised reservoirs is 0·946 litre 0·208 Imperial gallon/1 US-quart or less.

JAR 23.1437 Accessories for twin-engine aeroplanes

For twin-engine aeroplanes, engine-driven accessories essential to safe operation must be distributed among the two engines so that the failure of any one engine will not impair safe operation through the malfunctioning of these accessories.

JAR 23.1438 Pressurisation and pneumatic systems

(a) Pressurisation system elements must be burst pressure tested to 2·0 times, and proof pressure tested to 1·5 times, the maximum normal operating pressure.

(b) Pneumatic system elements must be burst pressure tested to 3·0 times, and proof pressure tested to 1·5 times, the maximum normal operating pressure.

(c) An analysis, or a combination of analysis and test, may be substituted for any test required by sub-paragraph (a) or (b) of this paragraph if the Authority finds it equivalent to the required test.

JAR 23.1441 Oxygen equipment and supply

(a) If certification with supplemental oxygen equipment is requested, or the aeroplane is approved for operations at or above altitudes where oxygen is required to be used by the operating rules, oxygen equipment must be provided that meets the requirements of this paragraph and JAR 23.1443 to 23.1449. Portable oxygen equipment may be used to meet the requirements of JAR-23 if the portable equipment is shown to comply with the applicable requirements, is identified in aeroplane type design, and its stowage provisions are found to be in compliance with the requirements of JAR 23.561.

(b) The oxygen system must be free from hazards in itself, in its method of operation, and its effect upon other components.

(c) There must be a means to allow the crew to readily determine, during the flight, the quantity of oxygen available in each source of supply.

(d) Each required flight-crew member must be provided with –

(1) Demand flow oxygen equipment if the aeroplane is to be certificated for operation above 25 000 ft.

(2) Pressure demand oxygen equipment if the aeroplane is to be certificated for operation above 40 000 ft.

(e) There must be a means, readily available to the crew in flight, to turn on and shut off the oxygen supply at the high pressure source. This requirement does not apply to chemical oxygen generators.

JAR 23.1443 Minimum mass flow of supplemental oxygen

(a) If continuous flow oxygen equipment is installed, the installation must comply with the requirements of either sub-paragraphs (a) (1) and (a) (2) or sub-paragraph (a) (3) of this paragraph.

(1) For each passenger, the minimum mass flow of supplemental oxygen required at various cabin pressure altitudes may not be less than the flow required to maintain, during inspiration and while using the oxygen equipment (including masks) provided, the following mean tracheal oxygen partial pressures:

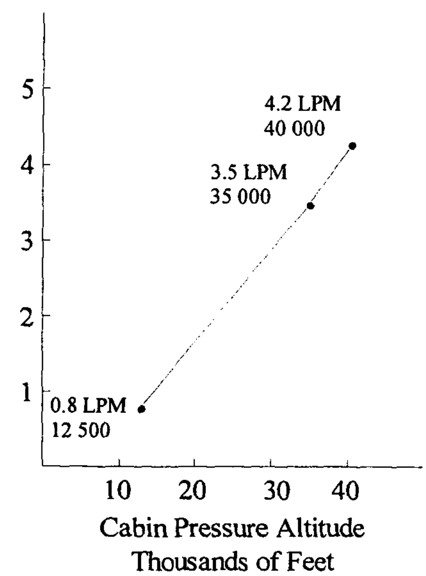
JAR 23.1443 (a) (continued)

(i) At cabin pressure altitudes above 10 000 ft up to and including 18 500 ft, a mean tracheal oxygen partial pressure of 100 mm Hg when breathing 15 litres per minute, Body Temperature, Pressure, Saturated (BTPS) and with a tidal volume of 700 cc with a constant time interval between respirations.

(ii) At cabin pressure altitudes above 18 500 ft up to and including 40 000 ft, a mean tracheal oxygen partial pressure of 83·8 mm Hg when breathing 30 litres per minute BTPS, and with a tidal volume of 1100 cc with a constant time interval between respirations.

(2) For each flight-crew member, the minimum mass flow may not be less than the flow required to maintain, during inspiration, a mean tracheal oxygen partial pressure of 149 mm Hg when breathing 15 litres per minute, BTPS, and with a maximum tidal volume of 700 cc with a constant time interval between respirations.

(3) The minimum mass flow of supplemental oxygen supplied for each user must be at a rate not less than that shown in the following figure for each altitude up to and including the maximum operating altitude of the aeroplane.



(b) If demand equipment is installed for use by flight-crew members, the minimum mass flow of supplemental oxygen required for each crewmember may not be less than the flow required to maintain, during inspiration, a mean tracheal oxygen partial pressure of 122 mm Hg up to and including a cabin pressure altitude of 35 000 ft, and 95% oxygen between cabin

JAR 23.1443 (b) (continued)

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) 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.

(d) As used in this section –

(1) BTPS means Body Temperature, and Pressure, Saturated (which is, 37°C, and the ambient pressure to which the body is exposed, minus 47 mm Hg, which is the tracheal pressure displaced by water vapour pressure when the breathed air becomes saturated with water vapour at 37°C).

(2) STPD means Standard, Temperature, and Pressure, Dry (which is 0°C at 760 mm Hg with no water vapour).

JAR 23.1445 Oxygen distributing system

(a) Except for flexible lines from oxygen outlets to the dispensing units, or where shown to be otherwise suitable to the installation, non-metallic tubing must not be used for any oxygen line that is normally pressurised during flight.

(b) Non-metallic oxygen distribution lines must not be routed where they may be subjected to elevated temperatures, electrical arcing, and released flammable fluids that might result from any probable failure.

JAR 23.1447 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. Each dispensing unit must –

(1) Provide for effective utilisation of the oxygen being delivered to the unit.

(2) Be capable of being readily placed into position on the face of the user.

(3) Be equipped with a suitable means to retain the unit in position on the face.

JAR 23.1447 (a) (continued)

(4) If radio equipment is installed, the flight crew oxygen dispensing units must be designed to allow the use of that equipment and to allow communication with any other required crew member while at their assigned duty station.

(b) If certification for operation up to and including 18 000 ft (MSL) is requested, each oxygen dispensing unit must –

(1) Cover the nose and mouth of the user; or

(2) Be a nasal cannula, in which case one oxygen dispensing unit covering both the nose and mouth of the user must be available. In addition, each nasal cannula or its connecting tubing must have permanently affixed –

(i) A visible warning against smoking while in use;

(ii) An illustration of the correct method of donning; and

(iii) A visible warning against use with nasal obstructions or head colds with resultant nasal congestion.

(c) If certification for operation above 18 000 ft (MSL) is requested, each oxygen dispensing unit must cover the nose and mouth of the user.

(d) For a pressurised aeroplane designed to operate at flight altitudes above 25 000 ft (MSL), the dispensing units must meet the following:

(1) The dispensing units for passengers must be connected to an oxygen supply terminal and be immediately available to each occupant, wherever seated.

(2) The dispensing units for crewmembers must be automatically presented to each crewmember before the cabin pressure altitude exceeds 15 000 ft, or the units must be of the quick-donning type, connected to an oxygen supply terminal that is immediately available to crewmembers at their station.

(e) If certification for operation above 30 000 ft is requested, the dispensing units for passengers must be automatically presented to each occupant before the cabin pressure altitude exceeds 15 000 ft.

(f) If an automatic dispensing unit (hose and mask, or other unit) system is installed, 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.

JAR 23.1449 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.

JAR 23.1450 Chemical oxygen generators

(a) For the purpose of this section, 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

(3) A warning that the replaceable generator element may be hot, unless the element construction is such that the surface temperature cannot exceed 38°C (100°F).

JAR 23.1451 Fire protection for oxygen equipment

Oxygen equipment and lines must –

(a) Not be in any designated fire zone.

(b) Be protected from heat that may be generated in, or escaped from, any designated fire zone.

(c) Be installed so that escaping oxygen cannot cause ignition of grease, fluid, or vapour accumulations that are present in normal operation or that may result from the failure or malfunction of any other system.

JAR 23.1453 Protection of oxygen equipment from rupture

(a) Each element of the oxygen system must have sufficient strength to withstand the maximum pressure and temperature in combination with any externally applied loads arising from consideration of limit structural loads that may be acting on that part of the system.

(b) Oxygen pressure sources and the lines between the source 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 23.1457 Cockpit voice recorders

(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 crewmembers on the flight deck.

(3) Voice communications of flight-crew members on the flight deck, using the aeroplane's interphone system.

(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) (4) (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 crewmembers on the flight deck when directed to those stations. The microphone must be so located and, if necessary, the preamplifiers and filters of the recorder must be so adjusted or supplemented, so 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 play-back of the record may be used in evaluating intelligibility.

JAR 23.1457 (continued)

(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 handheld microphone, headset, or speaker used at the first pilot station.

(2) For the second channel from each boom, mask, or handheld microphone, 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 handheld microphone, headset, or speaker used at the station for the third and fourth crewmembers.

(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 passenger loudspeaker system, if its signals are not picked up by another channel.

(5) And that as far as is practicable all sounds received by the microphone listed in sub-paragraph (c) (1), (2) and (4) of this paragraph must be recorded without interruption irrespective of the position of the interphone-transmitter key switch. 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

JAR 23.1457 (e) (continued)

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 crash 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 operations 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 manner that they are not likely to be separated during crash impact.

JAR 23.1459 Flight recorders [(See ACJ 23.1459 (b))]

(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 23.1323, 23.1325 and 23.1327, as appropriate;

(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 pre-flight checking of the recorder for proper recording of data in the storage medium.

(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

JAR 23.1459 (a) (continued)

erasure feature and prevent each erasure feature from functioning, within 10 minutes after crash impact; and

(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.

(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 360° 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, on or adjacent to the container which is secured in such a manner that they are not likely to be separated during crash impact.

(e) Any novel or unique design or operational characteristics of the aeroplane shall be evaluated to determine if any dedicated parameters must be recorded on flight recorders in addition to or in place of existing requirements.

[Amdt. 1, 01.02.01]

JAR 23.1461 Equipment containing high energy rotors

(a) Equipment containing high energy rotors must meet sub-paragraphs (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

JAR 23.1461 (b) (continued)

(2) Equipment control devices, systems and instrumentation must be 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.

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SUBPART G - OPERATING LIMITATIONS AND INFORMATION

GENERAL

JAR 23.1501 General

(a) Each operating limitation specified in JAR 23.1505 to 23.1527 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 23.1541 to 23.1589.

JAR 23.1505 Airspeed limitations

(a) The never-exceed speed VNE must be established so that it is –

(1) Not less than 0·9 times the minimum value of VD allowed under JAR 23.335; and

(2) Not more than the lesser of –

(i) 0·9 VD established under JAR 23.335; or

(ii) 0·9 times the maximum speed shown under JAR 23.251.

(b) The maximum structural cruising speed VNO must be established so that it is –

(1) Not less than the minimum value of VC allowed under JAR 23.335; and

(2) Not more than the lesser of –

(i) VC established under JAR 23.335; or

(ii) 0·89 VNE established under sub-paragraph (a) of this paragraph.

(c) Sub-paragraphs (a) and (b) of this paragraph do not apply to turbine aeroplanes or to aeroplanes for which a design diving speed VD/MD is established under JAR 23.335 (b) (4). For those aeroplanes, a maximum operating limit speed (VMO/MMO airspeed or Mach number, whichever is critical at a particular altitude) must be established as 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. VMO/MMO must be established so that it is not greater than the design cruising speed VC/MC and so that it is sufficiently below VD/MD and the maximum speed shown under JAR 23.251 to make it highly improbable that the latter speeds

JAR 23.1505 (c) (continued)

will be inadvertently exceeded in operations. The speed margin between VMO/MMO and VD/MD or the maximum speed shown under JAR 23.251 may not be less than the speed margin established between VC/MC and VD/MD under JAR 23.335 (b), or the speed margin found necessary in the flight tests conducted under JAR 23.253.

JAR 23.1507 Manoeuvring speed

The manoeuvring speed VA determined under JAR 23.335, must be established as an operating limitation.

JAR 23.1511 Flap extended speed

(a) The flap extended speed VFE must be established so that it is –

(1) Not less than the minimum value of VF allowed in JAR 23.345 (b); and

(2) Not more than VF established under JAR 23.345 (a), (c) and (d).

(b) Additional combinations of flap setting, airspeed and engine power may be established if the structure has been proven for the corresponding design conditions.

JAR 23.1513 Minimum control speed

The minimum control speed(s) VMC, determined under JAR 23.149 (b), must be established as an operating limitation(s).

JAR 23.1519 Weight and centre of gravity

The weight and centre of gravity ranges, determined under JAR 23.23 must be established as operating limitations.

JAR 23.1521 Powerplant limitations

(a) *General.* The powerplant limitations prescribed in this section must be established so that they do not exceed the corresponding limits for which the engines or propellers are type certificated.

(b) *Take-off operation.* The powerplant take-off operation must be limited by –

(1) The maximum rotational speed (rpm);

JAR 23.1521 (b) (continued)

(2) The maximum allowable manifold pressure (for reciprocating engines);

(3) The maximum allowable gas temperature (for turbine engines);

(4) The time limit for the use of the power or thrust corresponding to the limitations established in sub-paragraphs (1) to (3) of this paragraph; and

(5) The maximum allowable cylinder head (as applicable), liquid coolant and oil temperatures.

(c) *Continuous operation.* The continuous operation must be limited by –

(1) The maximum rotational speed;

(2) The maximum allowable manifold pressure (for reciprocating engines);

(3) The maximum allowable gas temperature (for turbine engines); and

(4) The maximum allowable cylinder head, oil and liquid coolant temperatures.

(d) *Fuel grade or designation.* The minimum fuel grade (for reciprocating engines), or fuel designation (for turbine engines), must be established so that it is not less than that required for the operation of the engines within the limitations in sub-paragraphs (b) and (c) of this paragraph.

(e) *Ambient temperature.* For all aeroplanes except reciprocating engine-powered aeroplanes [of 2 721 kg (6 000 lb) or less maximum weight,] ambient temperature limitations (including limitations for winterisation installations if applicable) must be established as the maximum ambient atmospheric temperature at which compliance with the cooling provisions of JAR 23.1041 to 23.1047 is shown.

JAR 23.1522 Auxiliary power unit limitations

If an auxiliary power unit is installed, the limitations established for the auxiliary power unit must be specified in the operating limitations for the aeroplane.

JAR 23.1523 Minimum flight crew

The minimum flight crew must be established so that it is sufficient for safe operation considering –

(a) The workload on individual crew members and, in addition for commuter category

JAR 23.1523 (a) (continued)

aeroplanes, each crew member workload determination must consider the following:

(1) Flight path control,

(2) Collision avoidance,

(3) Navigation,

(4) Communications,

(5) Operation and monitoring of all essential aeroplane systems,

(6) Command decisions, and

(7) The accessibility and ease of operation of necessary controls by the appropriate crew member during all normal and emergency operations when at the crew member flight station.

(b) The accessibility and ease of operation of necessary controls by the appropriate crew member; and

(c) The kinds of operation authorised under JAR 23.1525.

JAR 23.1524 Maximum passenger seating configuration

The maximum passenger seating configuration must be established.

JAR 23.1525 Kinds of operation

The kinds of operation (such as VFR, IFR, day or night) and the meteorological conditions (such as icing) to which the operation of the aeroplane is limited or from which it is prohibited, must be established appropriate to the installed equipment.

JAR 23.1527 *Maximum operating altitude*

(a) The maximum altitude up to which operation is allowed, as limited by flight, structural, powerplant, functional, or equipment characteristics, must be established.

(b) A maximum operating altitude limitation of not more than 25 000 ft must be established for pressurised aeroplanes, unless compliance with JAR 23.775 (e) is shown.

JAR 23.1529 Instructions for Continued Airworthiness

The applicant must prepare Instructions for Continued Airworthiness in accordance with Appendix G that are acceptable to the Authority.

JAR 23.1529 (continued)

The instructions may be incomplete at type certification if a programme exists to ensure their completion prior to the delivery of the first aeroplane.

MARKINGS AND PLACARDS

JAR 23.1541 General

(a) The aeroplane must contain –

(1) The markings and placards specified in JAR 23.1545 to 23.1567; and

(2) Any additional information, instrument markings and placards required for the safe operation if it has 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.

(c) For aeroplanes which are to be certificated in more than one category –

(1) The applicant must select one category upon which the placards and markings are to be based; and

(2) The placards and marking information for all categories in which the aeroplane is to be certificated must be furnished in the Aeroplane Flight Manual.

JAR 23.1543 Instrument markings: general [(See ACJ 23.1543 (b))]

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 arc and line must be wide enough and located to be clearly visible to the pilot.

(c) All related instruments must be calibrated in compatible units.

[Amdt. 1, 01.02.01]

JAR 23.1545 Airspeed indicator

(a) Each airspeed indicator must be marked as specified in sub-paragraph (b) of this paragraph, with the marks located at the corresponding indicated airspeeds.

(b) The following markings must be made:

(1) For the never-exceed speed V_{NE}, a radial red line.

(2) For the caution range, a yellow arc extending from the red line specified in sub-paragraph (1) of this paragraph to the upper limit of the green arc specified in sub-paragraph (3) of this paragraph.

(3) For the normal operating range, a green arc with the lower limit at V_{S1} with maximum weight and with landing gear and wing flaps retracted, and the upper limit at the maximum structural cruising speed V_{NO} established under JAR 23.1505 (b).

(4) For the flap operating range, a white arc with the lower limit at V_{SO} at the maximum weight and the upper limit at the flaps-extended speed V_{FE} established under JAR 23.1511.

(5) For reciprocating engine-powered [aeroplanes of 2 721 kg (6 000 lb) or less] maximum weight, for the speed at which compliance has been shown with JAR 23.69 (b) relating to rate of climb, at maximum weight and at sea-level, a blue radial line.

(6) For reciprocating engine-powered [aeroplanes of 2 721 kg (6 000 lb) or less] maximum weight, for the maximum value of minimum control speed (one-engine-inoperative) determined under JAR 23.149 (b), V_{MC}, a red radial line.

(c) If V_{NE} or V_{NO} vary with altitude, there must be means to indicate to the pilot the appropriate limitations throughout the operating altitude range.

(d) Sub-paragraphs (b) (1) to (b) (3) and sub-paragraph (c) of this paragraph do not apply to aircraft for which a maximum operating speed V_{MO}/M_{MO} is established under JAR 23.1505 (c). For those aircraft there must either be a maximum allowable airspeed indication showing the variation of V_{MO}/M_{MO} with altitude or compressibility limitations (as appropriate), or a radial red line marking for V_{MO}/M_{MO} must be made at lowest value of V_{MO}/M_{MO} established for any altitude up to the maximum operating altitude for the aeroplane.

[Amdt. 1, 01.02.01]

JAR 23.1547 Magnetic direction indicator

(a) A placard meeting the requirements of this section 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.

(d) Each calibration reading must be in terms of magnetic headings in not more than 30° increments.

(e) If a magnetic non-stabilised direction indicator can have a deviation of more than 10° caused by the operation of electrical equipment, the placard must state which electrical loads, or combination of loads, would cause a deviation of more than 10° when turned on.

JAR 23.1549 Powerplant instruments

For each required powerplant and auxiliary power unit instrument, as appropriate to the type of instruments –

(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, auxiliary power unit or propeller range that is restricted because of excessive vibration stresses must be marked with red arcs or red lines.

JAR 23.1551 Oil quantity indicator

Each oil quantity indicator must be marked in sufficient increments to indicate readily and accurately the quantity of oil.

JAR 23.1553 Fuel quantity indicator

A red radial line must be marked on each indicator at the calibrated zero reading, as specified in JAR 23.1337 (b) (1).

JAR 23.1555 Control markings
[(See ACJ 23.1555 (e) (2))]

(a) Each cockpit control, other than primary flight controls and simple push-button type starter switches, must be plainly marked as to its function and method of operation.

(b) Each secondary control must be suitably marked.

(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 near the selector for those tanks;

(3) The conditions under which the full amount of usable fuel in any restricted usage fuel tank can safely be used must be stated on a placard adjacent to the selector valve for that tank; and

(4) Each valve control for any engine of a twin-engine aeroplane must be marked to indicate the position corresponding to each engine controlled.

(d) Usable fuel capacity must be marked as follows:

(1) For fuel systems having no selector controls, the usable fuel capacity of the system must be indicated at the fuel quantity indicator.

(2) For fuel systems having selector controls, the usable fuel capacity available at each selector control position must be indicated near the selector control.

(e) For accessory, auxiliary and emergency controls –

(1) If retractable landing gear is used, the indicator required by JAR 23.729 must be marked so that the pilot can, at any time, ascertain that the wheels are secured in the extreme positions; and

(2) Each emergency control must be red and must be marked as to method of operation. No control other than an emergency control shall be this colour.

[Amdt. 1, 01.02.01]

JAR 23.1557 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.

(b) *Seats.* If the maximum allowable weight to be carried in a seat is less than 77 kg (170 lb), a placard stating the lesser weight must be permanently attached to the seat structure.

(c) Fuel, oil and coolant filler openings. The following apply:

(1) Fuel filler openings must be marked at or near the filler cover with –

(i) For reciprocating engine-powered aeroplanes –

(A) The word "Avgas"; and

(B) The minimum fuel grade.

(ii) For turbine engine-powered aeroplanes –

(A) The words "Jet Fuel"; and

(B) The permissible fuel designations, or references to the Aeroplane Flight Manual (AFM) for permissible fuel designations.

(iii) 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 –

(i) The word "Oil"; and

(ii) The permissible oil designation, or references to the Aeroplane Flight Manual (AFM) for Permissible oil designations.

(3) Coolant filler openings must be marked at or near the filler cover with the word "Coolant".

(d) *Emergency exit placards.* Each placard and operating control for each emergency exit must be red. A placard must be near each emergency exit control and must clearly indicate the location of that exit and its method of operation.

(e) The system voltage of each direct current installation must be clearly marked adjacent to its external power connection.

JAR 23.1559 Operating limitations placard

(a) There must be a placard in clear view of the pilot stating –

(1) That the aeroplane must be operated in accordance with the Aeroplane Flight Manual; and

(2) The certificated category to which the placards apply.

(b) For aeroplanes certificated in more than one category, there must be a placard in clear view of the pilot, stating that other limitations are contained in the Aeroplane Flight Manual.

(c) There must be a placard in clear view of the pilot that specifies the kind of operations to which the operation of the aeroplane is limited or from which it is prohibited under JAR 23.1525.

JAR 23.1561 Safety equipment

(a) Safety equipment must be plainly marked as to method of operation.

(b) Stowage provisions for required safety equipment must be marked for the benefit of occupants.

JAR 23.1563 Airspeed placards

There must be an airspeed placard in clear view of the pilot and as close as practicable to the airspeed indicator. This placard must list –

(a) The design manoeuvring speed, V_A;

(b) The maximum landing gear operating speed V_{LO}; and

(c) For reciprocating engine-powered [aeroplanes of more than 2 721 kg (6 000 lb)] maximum weight and turbine engine-powered aeroplanes, the maximum value of the minimum control speed (one-engine-inoperative) determined under JAR 23.149 (b), V_{MC}.

[Amdt. 1, 01.02.01]

JAR 23.1567 Flight manoeuvre placard

(a) For normal category aeroplanes, there must be a placard in front of and in clear view of the pilot stating: "No aerobatic manoeuvres including spins, approved".

(b) For utility category aeroplanes, there must be –

(1) A placard in clear view of the pilot stating: "Aerobatic manoeuvres are limited to

JAR 23.1567 (b) (continued)

the following........" (list approved manoeuvres and the recommended entry speed for each); and

(2) For those aeroplanes that do not meet the spin requirements for aerobatic category aeroplanes, an additional placard in clear view of the pilot stating: "Spins Prohibited".

(c) For aerobatic category aeroplanes, there must be a placard in clear view of the pilot listing the approved aerobatic manoeuvres and the recommended entry airspeed for each. If inverted flight manoeuvres are not approved, the placard must bear a notation to this effect.

(d) For aerobatic category aeroplanes and utility category aeroplanes approved for spinning, there must be a placard in clear view of the pilot –

(1) Listing the control actions for recovery from spinning manoeuvres; and

(2) Stating that recovery must be initiated when spiral characteristics appear, or after not more than 6 turns or not more than any greater number of turns for which the aeroplane has been certificated.

AEROPLANE FLIGHT MANUAL

JAR 23.1581 General
[(See ACJ 23.1581 (a) (3))]

(a) An Aeroplane Flight Manual must be submitted to the Authority and it must contain the following:

(1) Information required by JAR 23.1583 to 23.1589.

(2) Other information that is necessary for safe operation because of design, operating or handling characteristics.

(3) Further information necessary to comply with the relevant operating rules.

(b) *Approved information*

(1) Except as provided in sub-paragraph (b) (2) of this paragraph, each part of the Aeroplane Flight Manual containing information prescribed in JAR 23.1583 to 23.1589 must be approved, segregated, identified and clearly distinguished from each unapproved part of that Aeroplane Flight Manual.

(2) The requirements of sub-paragraph (b) (1) of this paragraph do not apply to

JAR 23.1581 (b) (continued)

reciprocating engine-powered aeroplanes of [2 721 kg (6 000 lb) or less maximum weight,] if the following is met:

(i) Each part of the Aeroplane Flight Manual containing information prescribed in JAR 23.1583 must be limited to such information and must be approved, identified and clearly distinguished from each other part of the Aeroplane Flight Manual.

(ii) The information prescribed in JAR 23.1585 to 23.1589 must be determined in accordance with the applicable requirements of JAR-23 and presented in its entirety in a manner acceptable to the Authority.

(3) *Not required for JAR-23.*

(c) The united used in the Aeroplane Flight Manual must be the same as those marked on the appropriate instruments and placards.

(d) All Aeroplane Flight Manual operational airspeeds must, unless otherwise specified, be presented as indicated Airspeeds.

(e) Provisions must be made for stowing the Aeroplane Flight Manual in a suitable fixed container which is readily accessible to the pilot.

(f) *Revisions and/or Amendments.* Each Aeroplane Flight Manual must contain a means for recording the incorporation of revisions and/or amendments.

[Amdt. 1, 01.02.01]

JAR 23.1583 Operating limitations

The Aeroplane Flight Manual must contain operating limitations determined under JAR-23, including the following:

(a) *Airspeed limitations*

(1) Information necessary for the marking of the airspeed limits on the indicator as required in JAR 23.1545, and the significance of each of those limits and of the colour coding used on the indicator.

(2) The speeds VMC, VA, VLE and VLO and their significance.

(3) In addition, for turbine powered commuter category aeroplanes –

(i) The maximum operating limit speed, VMO/MMO and a statement that this speed must not be deliberately exceeded in any regime of flight (climb,

JAR 23.1583 (a) (continued)

cruise or descent) unless a higher speed is authorised for flight test or pilot training;

(ii) 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; and

(iii) The airspeed limits must be shown in terms of VMO/MMO instead of VNO and VNE.

(b) *Powerplant limitations*

(1) Limitations required by JAR 23.1521.

(2) Explanation of the limitations, when appropriate.

(3) Information necessary for marking the instruments required by JAR 23.1549 to 23.1553.

(c) *Weight*

(1) The maximum weight; and

(2) The maximum landing weight, if the design landing weight selected by the applicant is less than the maximum weight.

(3) For normal, utility and aerobatic category reciprocating engine-powered [aeroplanes of more than 2 721 kg (6 000 lb)] maximum weight and for turbine engine-powered aeroplanes in the normal, utility and aerobatic category, performance operating limitations as follows:

(i) The maximum take-off weight for each aerodrome altitude and ambient temperature within the range selected by the applicant at which the aeroplane complies with the climb requirements of JAR 23.63 (c) (1).

(ii) The maximum landing weight for each aerodrome altitude and ambient temperature within the range selected by the applicant at which the aeroplane complies with the climb requirements of JAR 23.63 (c) (2).

(4) For commuter category aeroplanes, the maximum take-off weight for each aerodrome altitude and ambient temperature within the range selected by the applicant at which –

(i) The aeroplane complies with the climb requirements of JAR 23.63 (d) (1); and

JAR 23.1583 (c) (continued)

(ii) The accelerate-stop distance determined under JAR 23.55 is equal to the available runway length plus the length of any stopway, if utilised; and either,

(iii) The take-off distance determined under JAR 23.59 (a) is equal to the available runway length; or

(iv) At the option of the applicant, the take-off distance determined under JAR 23.59 (a) is equal to the available runway length plus the length of any clearway and the take-off run determined under JAR 23.59 (b) is equal to the available runway length.

(5) For commuter category aeroplanes, the maximum landing weight for each aerodrome altitude within the range selected by the applicant at which –

(i) The aeroplane complies with the climb requirements of JAR 23.63 (d) (2) for ambient temperatures within the range selected by the applicant.

(ii) The landing distance determined under JAR 23.75 for standard temperatures is equal to the available runway length; and

(6) The maximum zero wing fuel weight where relevant as established in accordance with JAR 23.343.

(d) *Centre of gravity.* The established centre of gravity limits.

(e) *Manoeuvres.* The following authorised manoeuvres, appropriate airspeed limitations, and unauthorised manoeuvres, as prescribed in this section.

(1) *Normal category aeroplanes.* No aerobatic manoeuvres, including spins, are authorised.

(2) *Utility category aeroplanes.* A list of authorised manoeuvres demonstrated in the type flight tests, together with recommended entry speeds and any other associated limitations. No other manoeuvre is authorised.

(3) *Aerobatic category aeroplanes.* A list of approved flight manoeuvres demonstrated in the type flight tests, together with recommended entry speeds and any other associated limitations.

JAR 23.1583 (e) (continued)

(4) *Aerobatic category aeroplanes and utility category aeroplanes approved for spinning.* Spin recovery procedure established to show compliance with JAR 23.221 (c).

(5) *Commuter category aeroplanes.* Manoeuvres are limited to any manoeuvre incident to normal flying, stalls (except whip stalls) and steep turns in which the angle of bank is not more than 60°.

(f) *Manoeuvre load factor.* The positive limit load factors in g's, and in addition the negative limit load factor for aerobatic category aeroplanes.

(g) *Minimum flight crew.* The number and functions of the minimum flight crew determined under JAR 23.1523.

(h) *Kinds of operation.* A list of the kinds of operation to which the aeroplane is limited or from which it is prohibited under JAR 23.1525, and also a list of installed equipment that affects any operating limitation and identification as to the equipment's required operational status for the kinds of operation for which approval has been granted.

(i) *Maximum operating altitude.* The maximum altitude established under JAR 23.1527.

(j) *Maximum passenger seating configuration.* The maximum passenger seating configuration.

(k) *Allowable lateral fuel loading.* The maximum allowable lateral fuel loading differential, if less than the maximum possible.

(l) *Baggage and cargo loading.* The following information for each baggage and cargo compartment or zone:

(1) The maximum allowable load; and

(2) The maximum intensity of loading.

(m) *Systems.* Any limitations on the use of aeroplane systems and equipment.

(n) *Ambient temperatures.* Where appropriate maximum and minimum ambient air temperatures for operation.

(o) *Smoking.* Any restrictions on smoking in the aeroplane.

(p) *Types of surface.* A statement of the types of surface on which operation may be conducted (see JAR 23.45 (g) and JAR 23.1587 (a) (5)) .

[Amdt. 1, 01.02.01]

JAR 23.1585 Operating procedures

(a) For all aeroplanes, information concerning normal, abnormal (if applicable) and emergency procedures and other pertinent information necessary for safe operation and the achievement of the scheduled performance must be furnished, including –

(1) An explanation of significant or unusual flight or ground handling characteristics;

(2) The maximum demonstrated values of crosswind for take-off and landing and procedures and information pertinent to operations in crosswinds;

(3) A recommended speed for flight in rough air. This speed must be chosen to protect against the occurrence, as a result of gusts, of structural damage to the aeroplane and loss of control (e.g. stalling);

(4) Procedures for restarting any engine in flight, including the effects of altitude;

(5) Procedures, speeds and configuration(s) for making a normal approach and landing in accordance with JAR 23.73 and 23.75 and a transition to the balked landing condition.

(6) *Not required for JAR-23*

(b) In addition to sub-paragraph (a), for all single-engined aeroplanes, the procedures, speeds and configuration(s) for a glide following engine failure in accordance with JAR 23.71 and the subsequent forced landing, must be furnished.

(c) In addition to sub-paragraph (a), for all twin-engined aeroplanes, the following information must be furnished:

(1) Procedures, speeds and configuration(s) for making an approach and landing with one engine inoperative;

(2) Procedures, speeds and configuration(s) for making a go-around with one engine inoperative and the conditions under which a go-around can be performed safely, or a warning against attempting a go-around.

(3) *Not required for JAR-23.*

(4) *Not required for JAR-23.*

(d) In addition to sub-paragraphs (a) and (b) or (c) as appropriate, for all normal, utility and aerobatic category aeroplanes, the following information must be furnished.

JAR 23.1585 (d) (continued)

(1) Procedures, speeds and configuration(s) for making a normal take-off in accordance with JAR 23.51 (a) and (b) and JAR 23.53 (a) and (b) and the subsequent climb in accordance with JAR 23.65 and 23.69 (a);

(2) Procedures for abandoning a take-off due to engine failure or other cause.

(e) In addition to sub-paragraphs (a), (c) and (d) for all normal, utility and aerobatic category twin-engined aeroplanes, the information must include –

(1) Procedures and speeds for continuing a take-off following engine failure and the conditions under which take-off can safely be continued, or a warning against attempting to continue the take-off;

(2) Procedures, speeds and configurations for continuing a climb following engine failure, after take-off, in accordance with JAR 23.67, or en-route, in accordance with JAR 23.69 (b).

(f) In addition to sub-paragraphs (a) and (c), for commuter category aeroplanes, the information must include –

(1) Procedures, speeds and configuration(s) for making a normal take-off;

(2) Procedures and speeds for carrying out an accelerate-stop in accordance with JAR 23.55;

(3) Procedures and speeds for continuing a take-off following engine failure in accordance with JAR 23.59 (a) (1) and for following the flight path determined in accordance with JAR 23.57 and 23.61 (a).

(g) For twin-engine aeroplanes, information identifying each operating condition in which the fuel system independence prescribed in JAR 23.953 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.

(h) For each aeroplane showing compliance with JAR 23.1353 (g) (2) or (g) (3), the operating procedures for disconnecting the battery from its charging source must be furnished.

(i) Information on the total quantity of usable fuel for each fuel tank and the effect on the usable fuel quantity as a result of a failure of any pump, must be furnished.

(j) Procedures for the safe operation of the aeroplane's systems and equipment, both in

JAR 23.1585 (j) (continued)

normal use and in the event of malfunction, must be furnished.

JAR 23.1587 Performance information

Unless otherwise presented, performance information must be provided over the altitude and temperature ranges required by JAR 23.45 (b).

(a) For all aeroplanes, the following information must be furnished:

(1) The stalling speeds V_{SO}, and V_{S1} with the landing gear and wing flaps retracted, determined at maximum weight under JAR 23.49 and the effect on these stalling speeds of angles of bank up to 60°;

(2) The steady rate and gradient of climb with all engines operating, determined under JAR 23.69 (a);

(3) The landing distance, determined under JAR 23.75 for each aerodrome altitude and standard temperature and the type of surface for which it is valid;

(4) The effect on landing distance of operation on other than smooth hard surfaces, when dry, determined under JAR 23.45 (g); and

(5) The effect on landing distance of runway slope and 50% of the headwind component and 150% of the tailwind component.

(b) In addition to sub-paragraph (a), for all normal, utility and aerobatic category reciprocating engine-powered aeroplanes of [2 721 kg (6 000 lb) or less maximum weight, the] steady angle of climb/descent determined under JAR 23.77 (a) must be furnished.

(c) In addition to sub-paragraph (a) and paragraph (b) if appropriate, for normal, utility and aerobatic category aeroplanes, the following information must be furnished:

(1) The take-off distance, determined under JAR 23.53 and the type of surface for which it is valid;

(2) The effect on take-off distance of operation on other than smooth hard surfaces, when dry, determined under JAR 23.45 (g);

(3) The effect on take-off distance of runway slope and 50% of the headwind component and 150% of the tailwind component;

JAR 23.1587 (c) (continued)

(4) For twin reciprocating engine-[powered aeroplanes of more than 2 721 kg] (6 000 lb) maximum weight and twin turbine-engined aeroplanes, the one-engine-inoperative take-off climb/descent gradient, determined under JAR 23.66;

(5) For twin-engined aeroplanes, the en-route rate and gradient of climb/descent with one engine inoperative, determined under JAR 23.69 (b); and

(6) For single-engine aeroplanes, the glide performance determined under JAR 23.71.

(d) In addition to paragraph (a), for commuter category aeroplanes, the following information must be furnished:

(1) The accelerate-stop distance determined under JAR 23.55;

(2) The take-off distance determined under JAR 23.59 (a);

(3) At the option of the applicant, the take-off run determined under JAR 23.59 (b);

(4) The effect on accelerate-stop distance, take-off distance and, if determined, take-off run, of operation on other than smooth hard surfaces, when dry, determined under JAR 23.45 (g);

(5) The effect on accelerate-stop distance, take-off distance and, if determined, take-off run, of runway slope and 50% of the headwind component and 150% of the tailwind component;

(6) The net take-off flight path determined under JAR 23.61 (b);

(7) The en-route gradient of climb/descent with one engine inoperative, determined under JAR 23.69 (b);

(8) The effect, on the net take-off flight path and on the en-route gradient of climb/descent with one engine inoperative, of 50% of the headwind component and 150% of the tailwind component;

(9) Overweight landing performance information (determined by extrapolation and computed for the range of weights between the maximum landing and maximum take-off weights) as follows:

(i) The maximum weight for each aerodrome altitude and ambient temperature at which the aeroplane complies with the climb requirements of JAR 23.63 (d) (2); and

JAR 23.1587 (d) (continued)

(ii) The landing distance determined under JAR 23.75 for each aerodrome altitude and standard temperature.

(10) The relationship between IAS and CAS determined in accordance with JAR 23.1323 (b) and (c); and

(11) The altimeter system calibration required by JAR 23.1325 (e).

[Amdt. 1, 01.02.01]

JAR 23.1589 Loading information

The following loading information must be furnished:

(a) The weight and location of each item of equipment that can easily be removed, relocated, or replaced and that is installed when the aeroplane was weighed under JAR 23.25.

(b) Appropriate loading instructions for each possible loading condition between the maximum and minimum weights established under JAR 23.25, to facilitate the centre of gravity remaining within the limits established under JAR 23.23.

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APPENDICES

Appendix A – Simplified Design Load Criteria for Conventional, Single-Engine Airplanes of 6 000 Pounds or Less Maximum Weight

A23.1 General
[(See ACJ A23.1)]

(a) The design load criteria in this Appendix are an approved equivalent of those in JAR 23.321 to 23.459 for the certification of single-reciprocating engine aeroplanes of 2 721 kg (6 000 lb) or less maximum weight with the following configuration:

An aeroplane designed with a forward wing and a rearward empennage mounted to the fuselage, whose lifting surfaces are either untapered or have essentially continuous taper with not more than 15° fore or aft sweep at the quarter chord line and are equipped with trailing edge controls. Trailing edge flaps may be fitted.

The aspect ratio of the wing must not exceed the value of 7.

The aspect ratio of the horizontal tail is limited to 4 and the tail volume coefficient must not be smaller than 0·5.

The aspect ratio of the vertical tail must not exceed the value of 2 with a surface area of not more than 10% of the wing area.

For the horizontal and the vertical tail, only symmetrical profiles may be used.

Configurations for which the use of Appendix A is prohibited include:

(1) Canard, tandem-wing, close-coupled or tailless arrangements of the lifting surfaces;

(2) Cantilever biplanes or multiplanes;

(3) T-tail, V-tail or cruciform (+) - tail arrangements;

(4) Highly swept (more than 15° at quarter chord), delta or slatted lifting surfaces;

(5) Winglets or other tip devices, including outboard fins.

(b) Unless otherwise stated, the nomenclature and symbols in this Appendix are the same as the corresponding nomenclature and symbols in JAR-23.

[Amdt. 1, 01.10.00]

A23.3 Special symbols

n_1 = Aeroplane Positive Manoeuvring Limit Load Factor.

n_2 = Aeroplane Negative Manoeuvring Limit Load Factor.

n_3 = Aeroplane Positive Gust Limit Load Factor at Vc.

n_4 = Aeroplane Negative Gust Limit Load Factor at Vc.

n_{flap} = Aeroplane Positive Limit Load Factor With Flaps Fully Extended at V_F.

* $V_{F\,min}$ = Minimum Design Flap Speed $= 11{\cdot}0\sqrt{n_1 W/S}$ kts.

* $V_{A\,min}$ = Minimum Design Manoeuvring Speed $= 15{\cdot}0\sqrt{n_1 W/S}$ kts.

* $V_{C\,min}$ = Minimum Design Cruising Speed $= 17{\cdot}0\sqrt{n_1 W/S}$ kts.

* $V_{D\,min}$ = Minimum Design Dive Speed $= 24{\cdot}0\sqrt{n_1 W/S}$ kts.

* Also see sub-paragraph A23.7 (e) (2) of this Appendix.

A23.5 Certification in more than one category

The criteria in this Appendix may be used for certification in the normal, utility, and aerobatic categories, or in any combination of these categories. If certification in more than one category is desired, the design category weights must be selected to make the term "n_1W" constant for all categories or greater for one desired category than for others. The wings and control surfaces (including wing flaps and tabs) need only be investigated for the maximum value of "n_1W", or for the category corresponding to the maximum design weight, where "n_1W" is constant. If the aerobatic category is selected, a special unsymmetrical flight load investigation in accordance with sub-paragraphs A23.9 (c) (2) and A23.11 (c) (2) of this Appendix must be completed. The wing, wing carry-through, and the horizontal tail structures must be checked for this condition. The basic fuselage structure need only be investigated for the highest load factor design category selected. The local supporting structure for dead weight items need only be designed for the highest load factor imposed when the particular items are installed in the aeroplane. The engine mount, however, must be designed for a higher sideload factor, if certification in the aerobatic category is desired, than that required for certification in the normal and utility categories. When designing for landing loads, the landing gear and the aeroplane as a whole need only be investigated for the category corresponding to the maximum design weight. These simplifications apply to single-engine aircraft of conventional types for which experience is available, and the Authority may require additional investigations for aircraft with unusual design features.

A23.7 Flight loads

(a) Each flight load may be considered independent of altitude and, except for the local supporting structure for dead weight items, only the maximum design weight conditions must be investigated.

(b) Table 1 and figures 3 and 4 of this Appendix must be used to determine values of n_1, n_2, n_3 and n_4, corresponding to the maximum design weights in the desired categories.

(c) Figures 1 and 2 of this Appendix must be used to determine values of n_3 and n_4 corresponding to the minimum flying weights in the desired categories, and, if these load factors are greater than the load factors at the design weight, the supporting structure for dead weight items must be substantiated for the resulting higher load factors.

(d) Each specified wing and tail loading is independent of the centre of gravity range. The applicant, however, must select a c.g. range, and the basic fuselage structure must be investigated for the most adverse dead weight loading conditions for the c.g. range selected.

(e) The following loads and loading conditions are the minimum's for which strength must be provided in the structure:

(1) *Aeroplane equilibrium.* The aerodynamic wing loads may be considered to act normal to the relative wind, and to have a magnitude of 1·05 times the aeroplane normal loads (as determined from sub-paragraphs A23.9 (b) and (c) of this Appendix) for the positive flight conditions and a magnitude equal to the aeroplane normal loads for the negative conditions. Each chordwise and normal component of this wing load must be considered.

(2) *Minimum design airspeeds.* The minimum design airspeed may be chosen by the applicant except that they may not be less than the minimum speeds found by using figure 3 of this Appendix. In addition, $V_{C\,min}$ need not exceed values of 0·9 V_H actually obtained at sea-level for the lowest design weight category for which certification is desired. In computing these minimum design airspeeds, n_1 may not be less than 3·8.

(3) *Flight load factor.* The limit flight load factors specified in Table 1 of this Appendix 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 flight load factor is an aerodynamic force acting upwards, with respect to the aeroplane.

A23.9 Flight conditions

(a) *General.* Each design condition in sub-paragraph (b) and (c) of this paragraph must be used to assure sufficient strength for each condition of speed and load factor on or within the boundary of a V-n diagram for the aeroplane similar to the diagram in figure 4 of this Appendix. This diagram must also be used to determine the aeroplane structural operating limitations as specified in JAR 23.1501 (c) to 23.1513 and 23.1519.

(b) *Symmetrical flight conditions.* The aeroplane must be designed for symmetrical flight conditions as follows:

(1) The aeroplane must be designed for at least the four basic flight conditions, "A", "D", "E", and "G" as noted on the flight envelope of figure 4 of this Appendix. In addition, the following requirements apply:

(i) The design limit flight load factors corresponding to conditions "D" and "E" of figure 4 must be at least as great as those specified in Table 1 and figure 4 of this Appendix, and the design speed for these conditions must be at least equal to the value of V_D found from figure 3 of this Appendix.

Appendix A (continued)

(ii) For conditions "A" and "G" of figure 4, the load factors must correspond to those specified in Table 1 of this Appendix, and the design speeds must be computed using these load factors with [the maximum static lift coefficient C_{NA}] determined by the applicant. However, in the absence of more precise computations, these latter conditions may be based on a value of $C_{NA} = \pm 1{\cdot}35$ and the design speed for condition "A" may be less than $V_{A\,min}$.

(iii) Conditions "C" and "F" of figure 4 need only be investigated when n_3 W/S or n_4 W/S are greater than n_1 W/S or n_2 W/S of this Appendix, respectively.

(2) If flaps or other high lift devices intended for use at the relatively low airspeed of approach, landing, and take-off, are installed, the aeroplane must be designed for the two flight conditions corresponding to the values of limit flap-down factors specified in Table 1 of this Appendix with the flaps fully extended at not less than the design flap speed $V_{F\,min}$ from figure 3 of this Appendix.

(c) *Unsymmetrical flight conditions.* Each affected structure must be designed for unsymmetrical loads as follows:

(1) The aft fuselage-to-wing attachment must be designed for the critical vertical surface load determined in accordance with sub-paragraph A23.11 (c) (1) and (2) of this Appendix.

(2) The wing and wing carry-through structures must be designed for 100% of condition "A" loading on one side of the plane of symmetry and 70% on the opposite side for certification in the normal and utility categories, or 60% on the opposite side for certification in the aerobatic category.

(3) The wing and wing carry-through structures must be designed for the loads resulting from a combination of 75% of the positive manoeuvring wing loading on both sides of the plane of symmetry and the maximum wing torsion resulting from aileron displacement. The effect of aileron displacement on wing torsion at V_C or V_A using the basic airfoil moment coefficient modified over the aileron portion of the span, must be computed as follows:

(i) $C_m = C_m + 0.01\delta_u$ (up aileron side) wing basic airfoil.

(ii) $C_m = C_m - 0.01\delta_d$ (down aileron side) wing basic airfoil, where δ_u is the up aileron deflection and δ_d is the down aileron deflection.

(4) Δ critical, which is the sum of $\delta_u + \delta_d$, must be computed as follows:

(i) Compute Δ_a and Δ_b from the formulae:

$$\Delta_a = \frac{V_A}{V_C} \times \Delta_p \quad \text{and}$$

$$\Delta_b = 0{\cdot}5\frac{V_A}{V_D} \times \Delta_p$$

where Δ_p = the maximum total deflection (sum of both aileron deflections) at V_A with V_A, V_C, and V_D described in sub-paragraph (2) of A 23.7 (e) of this Appendix

(ii) Compute K from the formula:

$$K = \frac{(C_m - 0{\cdot}01\delta_b)V_D^2}{(C_m - 0{\cdot}01\delta_a)V_C^2}$$

where δ_a is the down aileron deflection corresponding to Δ_a and δ_b is the down aileron deflection corresponding to Δ_b as computed in step (i).

(iii) If K is less than 1·0, Δ_a is Δ critical and must be used to determine δ_u and δ_d. In this case, V_C is the critical speed which must be used in computing the wing torsion loads over the aileron span.

(iv) If K is equal to or greater than 1·0, Δ_b is Δ critical and must be used to determined δ_u and δ_d. In this case, V_D is the critical speed which must be used in computing the wing torsion loads over the aileron span.

(d) *Supplementary conditions; rear lift truss; engine torque; side load on engine mount.* Each of the following supplementary conditions must be investigated:

(1) In designing the rear lift truss, the special condition specified in JAR 23.369 may be investigated instead on condition "G" of figure 4 of this Appendix. If this is done, and if certification in more than one category is desired, the value of W/S used in the formula appearing in JAR 23.369 must be that for the category corresponding to the maximum gross weight.

Appendix A (continued)

(2) Each engine mount and its supporting structures must be designed for the maximum limit torque corresponding to METO power and propeller speed acting simultaneously with the limit loads resulting from the maximum positive manoeuvring flight load factor n_1. The limit torque must be obtained by multiplying the mean torque by a factor of 1·33 for engines with five or more cylinders. For 4, 3, and 2 cylinder engines, the factor must be 2, 3, and 4, respectively.

(3) Each engine mount and its supporting structure must be designed for the loads resulting from a lateral limit load factor of not less than 1·47 for the normal and utility categories, or 2·0 for the aerobatic category.

[Amdt. 1, 01.10.00]

A23.11 Control surface loads

(a) *General.* Each control surface load must be determined using the criteria of sub-paragraph (b) of this paragraph and must lie within the simplified loadings of sub-paragraph (c) of this paragraph.

(b) *Limit pilot forces.* In each control surface loading condition described in sub-paragraphs (c) to (e) of this paragraph, the airloads on the movable surfaces and the corresponding deflections need not exceed those which could be obtained in flight by employing the maximum limit pilot forces specified in the table in JAR 23.397 (b). If the surface loads are limited by these maximum limit pilot forces, the tabs must either be considered to be deflected to their maximum travel in the direction which would assist the pilot or the deflection must correspond to the maximum degree of "out of trim" expected at the speed for the condition under consideration. The tab load, however, need not exceed the value specified in Table 2 of this Appendix.

(c) *Surface loading conditions.* Each surface loading condition must be investigated as follows:

(1) Simplified limit surface loadings for the horizontal tail, vertical tail, aileron, wing flaps and trim tabs are specified in figures (A)5 and (A)6 of this Appendix.

(i) The distribution of load along the span of the surface, irrespective of the chordwise load distribution, must be assumed proportional to the total chord, except on horn balanced surfaces.

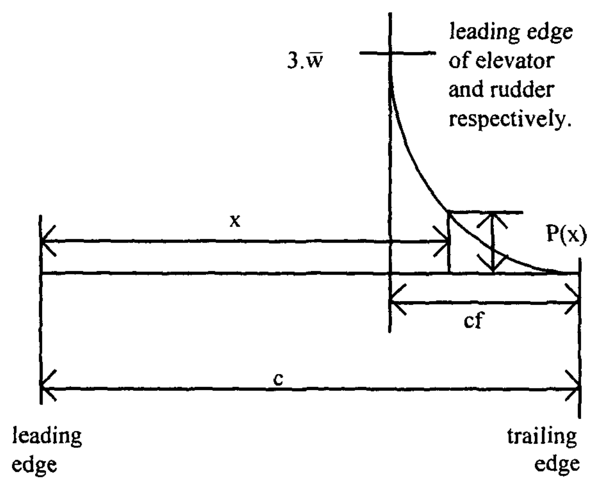
(ii) The load on the stabiliser and elevator, and the load on fin and rudder, must be distributed chordwise as shown in Figure A7 of this Appendix.

(iii) In order to ensure adequate torsional strength and also to cover manoeuvres and gusts, the most severe loads must be considered in association with every centre of pressure position between leading edge and the half chord of the mean chord of the surface (stabiliser and elevator, or fin and rudder).

(iv) To ensure adequate strength under high leading edge loads, the most severe stabiliser and fin loads must be further considered as being increased by 50% over the leading 10% of the chord with the loads aft of this appropriately decreased to retain the same total load.

(v) The most severe elevator and rudder loads should be further considered as being distributed parabolically from three times the mean loading of the surface (stabiliser and elevator, or fin and rudder) at the leading edge at the elevator and rudder respectively to zero at the trailing edge according to the equation –

$$P(x)=3.\bar{w}\left(\frac{c-x}{cf}\right)^2$$



Where –

P(x)	=	local pressure at the chordwise stations x
c	=	chord length of the tail surface,
cf	=	chord length of the elevator and rudder respectively, and

Appendix A (continued)

$\overline{w}$ = average surface loading as specified in Figure A5

(vi) The chordwise loading distribution for ailerons, wing flaps and trim tabs are specified in Table 2 of this Appendix.

(2) If certification in the acrobatic category is desired, the horizontal tail must be investigated for an unsymmetrical load of 100% $\overline{w}$ on one side of the aeroplane centreline and 50% on the other side of the aeroplane centreline.

(d) *Outboard fins.* Outboard fins must meet the requirements of JAR 23.455.

(e) *Special devices.* Special devices must meet the requirements of JAR 23.459.

A23.13 Control system loads

(a) *Primary flight controls and systems.* Each primary flight control and system must be designed as follows:

(1) The flight control system and its supporting structure must be designed for loads corresponding to 125% of the computed hinge moments of the movable control surface in the conditions prescribed in A23.11 of this Appendix. In addition –

(i) The system limit loads need not exceed those that could be produced by the pilot and automatic devices operating the controls; and

(ii) The design must provide a rugged system for service use, including jamming, ground gusts, taxying downwind, control inertia, and friction.

(2) Acceptable maximum and minimum limit pilot forces for elevator, aileron, and rudder controls are shown in the table in JAR 23.397 (b). These pilots loads must be assumed to act at the appropriate control grips or pads as they would under flight conditions, and to be reacted at the attachments of the control system to the control surface horn.

(b) *Dual control.* If there are dual controls, the systems must be designed for pilots operating in opposition, using individual pilot loads equal to 75% of those obtained in accordance with sub-paragraph (a) of this paragraph, except that individual pilot loads may not be less than the minimum limit pilot forces shown in the table in JAR 23.397 (b).

(c) *Ground gust conditions.* Ground gust conditions must meet the requirements of JAR 23.415.

(d) *Secondary controls and systems.* Secondary controls and systems must meet the requirements of JAR 23.405.

TABLE 1-Limit flight load factors

LIMIT FLIGHT LOAD FACTORS					
			Normal category	Utility category	Aerobatic category
FLIGHT Load Factors	Flaps Up	n_1	3·8	4·4	6·0
		n_2	$-0{\cdot}5n_1$		
		n_3	Find n_3 from Fig. 1		
		n_4	Find n_4 from Fig. 2		
	Flaps Down	n_{flap}	$0{\cdot}5n_1$		
		n_{flap}	Zero*		

* Vertical wing load may be assumed equal to zero and only the flap part of the wing need be checked for this condition.

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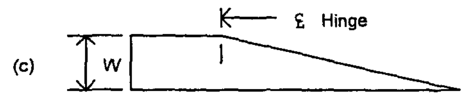
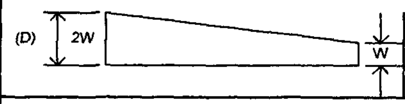
Appendix A (continued)

TABLE 2 Average limit control surface loading

AVERAGE LIMIT CONTROL SURFACE LOADING			
SURFACE	DIRECTION OF LOADING	MAGNITUDE OF LOADING	CHORDWISE DISTRIBUTION
HORIZONTAL TAIL 1	(a) Up and Down	Figure A5 Curve (2)	See figure A7
	(b) Unsymmetrical loading (Up and Down)	100% $\bar{w}$ on one side aeroplane ℄, 65% $\bar{w}$ on other side aeroplane ℄ for normal and utility categories. For aerobatic category see A3.11(C)	
VERTICAL TAIL II	Right and Left	Figure A5 Curve (1)	Same as above
AILERON III	(a) Up and Down	Figure A6 Curve (5)	
WING FLAP IV	(a) Up	Figure A6 Curve (4)	
	(b) Down	·25 x Up Load (a)	
TRIM TAB V	(a) Up and Down	Figure A6 Curve (3)	Same as (D) above

NOTE: The surface loading I, II, III, and V above are based on speeds V_A min and V_C min. The loading of IV is based on V_F min. If values of speed greater than these minimum's are selected for design, the appropriate surface loadings must be multiplied by the ratio $\left[\frac{V \text{ selected}}{V \text{ minimum}}\right]^2$. For conditions I, II, III, and V the multiplying factor used must be the higher of $\left[\frac{V_A \text{ sel.}}{V_A \text{ min.}}\right]^2$ or $\left[\frac{V_C \text{ sel.}}{V_C \text{ min.}}\right]^2$.

APPENDIX A

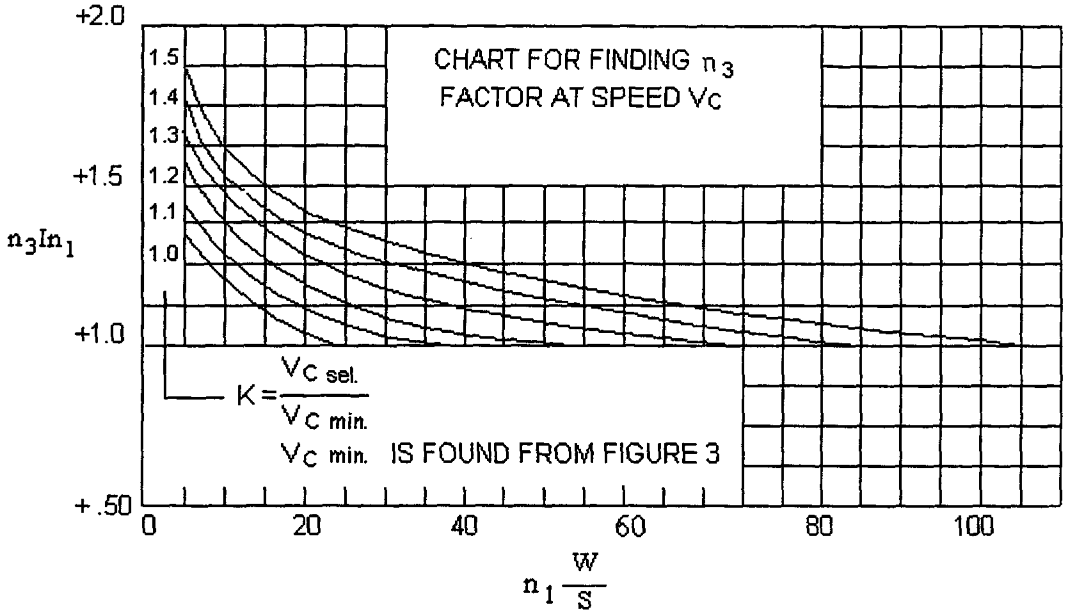


FIGURE A1 - Chart for finding n_3 factor at speed Vc

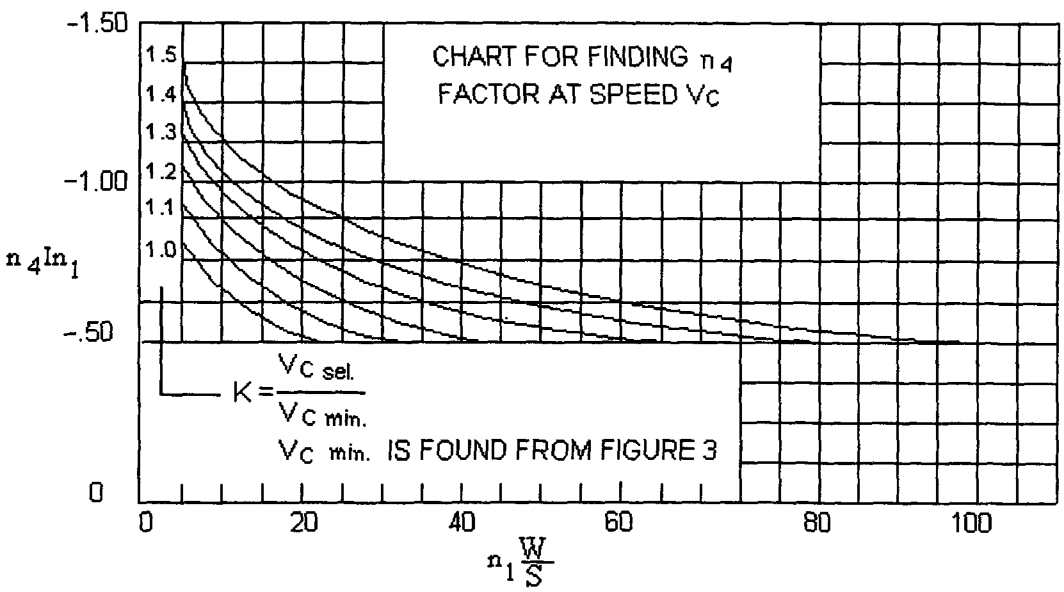


FIGURE A2 - Chart for finding n_4 factor at speed Vc.

Appendix A (continued)

$$V_{D\,min} = 24{\cdot}0\sqrt{n_1\frac{W}{S}} \text{ but not exceed } 1{\cdot}4\sqrt{\frac{n_1}{3{\cdot}8}}\, V_{C\,min}$$

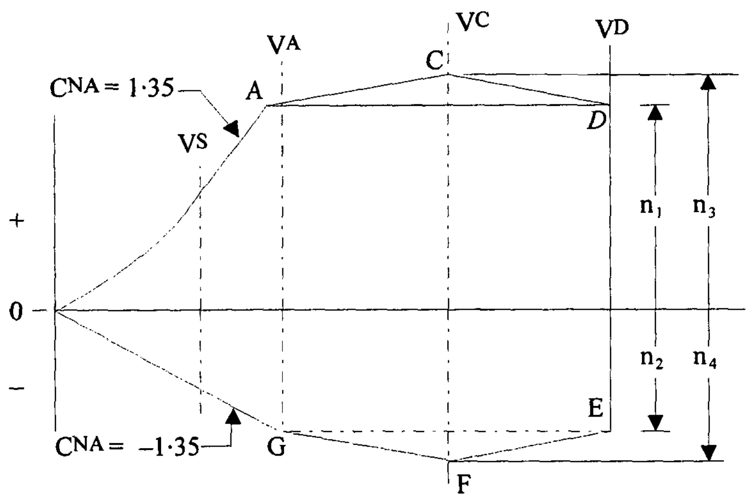
$$V_{C\,min} = 17{\cdot}0\sqrt{n_1\frac{W}{S}} \text{ but not exceed } 0{\cdot}9\, V_H$$

$$V_{A\,min} = 15{\cdot}0\sqrt{n_1\frac{W}{S}} \text{ but not exceed } V_C \text{ used in design}$$

$$V_{F\,min} = 11{\cdot}0\sqrt{n_1\frac{W}{S}}$$

FIGURE A3 - Determination of minimum design speeds - equations.

(Speeds are in knots.)



1. Conditions "C" or "F" need only be investigated when $n_3\frac{W}{S}$ or $n_4\frac{W}{S}$ is greater than $n_1\frac{W}{S}$ or $n_2\frac{W}{S}$, respectively.

2. Condition "G" need not be investigated when the supplementary condition specified in JAR 23.369 is investigated.

FIGURE A4 - Flight envelope.

Appendix A (continued)

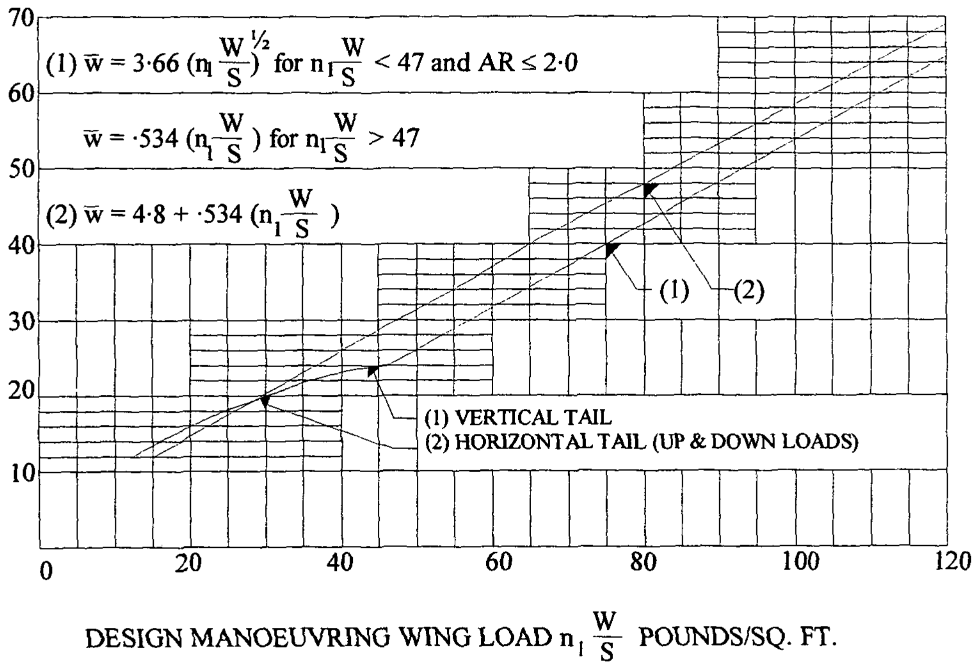


FIGURE A5 - Average limit control surface loading.

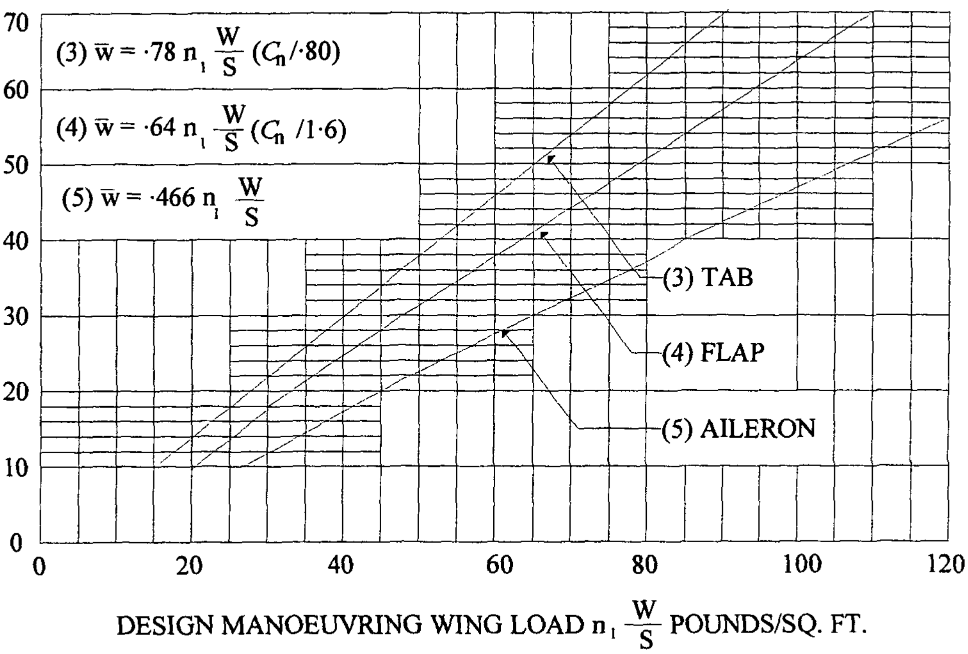
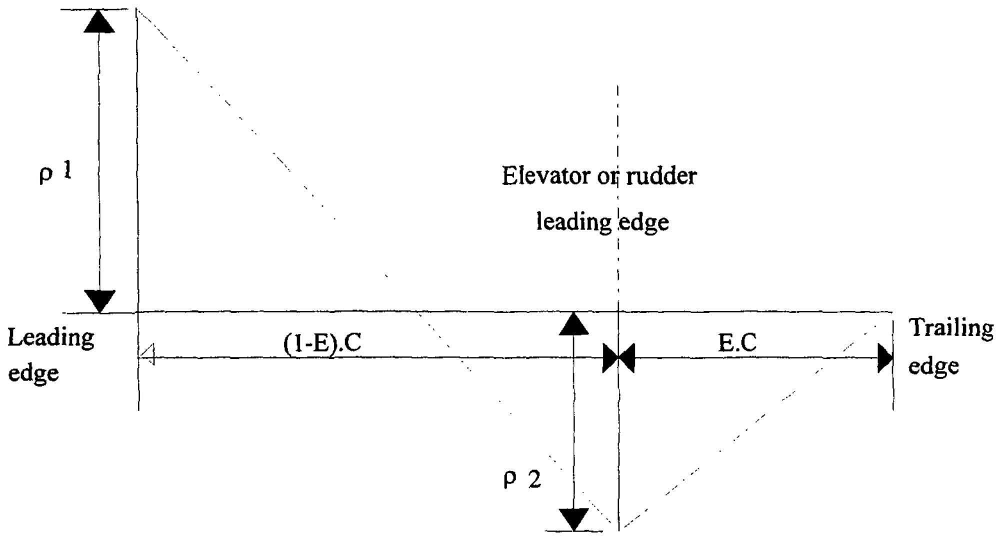


FIGURE A6 - Average limit control surface loading.

Appendix A (continued)



$$\rho 1 = 2 \cdot \overline{w} \cdot \left(\frac{2 - E - 3d'}{1 - E} \right)$$

$$\rho 2 = 2 \cdot \overline{w} \cdot (3d' + E - 1)$$

where: $\overline{w}$ = average surface loading (as specified in figure A.5).

E = ratio of elevator (or rudder) chord to total stabiliser and elevator (or fin and rudder) chord.

d' = ratio of distance of centre of pressure of a unit spanwise length of combined stabiliser and elevator (or fin and rudder) measured from stabiliser (or fin) leading edge to the local chord.

c = local chord.

Note: Positive value of $\overline{w}$, ρ1 and ρ2 are all measured in the same direction

Figure A7 Chordwise load distribution for stabiliser and elevator or fin and rudder.

Appendix B

Not required for JAR-23.

Appendix B (continued)

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Appendix C

Basic Landing Conditions

C23.1 Basic landing conditions

Condition	Tail wheel type		Nose wheel type		
	Level landing	Tail-down landing	Level landing with inclined reactions	Level landing with nose wheel just clear of ground	Tail-down landing
Reference section	23.479(a)(1)	23.481(a)(1)	23.479(a)(2)(i)	23.479(a)(2)(ii)	23.481(a)(2) and (b)
Vertical component at c.g.	nW	nW	nW	nW	nW
Fore and aft component at c.g.	KnW	0	KnW	KnW	0
Lateral component in either direction at c.g.	0	0	0	0	0
Shock absorber extension (hydraulic shock absorber)	Note (2)	Note (2)	Note (2)	Note (2)	Note (2)
Shock absorber deflection (rubber or spring shock absorber)	100%	100%	100%	100%	100%
Tyre deflection	Static	Static	Static	Static	Static
Main wheel loads (both wheels) Vr	(n-L)W	(n-L)Wb/d	(n-L)Wa'/d'	(n-L)W	(n-L)W
Main wheel loads (both wheels) Dr	KnW	0	KnWa'/d'	KnW	0
Tail (nose) wheel loads Vf	0	(n-L)Wa/d	(n-L)Wb'/d'	0	0
Tail (nose) wheel loads Df	0	0	KnWb'/d'	0	0
Notes	(1), (3), and (4)	(4)	(1)	(1), (3), and (4)	(3) and (4)

NOTE (1) K may be determined as follows: K=0.25 for W=3,000 pounds or less; K=0.33 for W=6,000 pounds or greater, with linear variation of K between these weights.

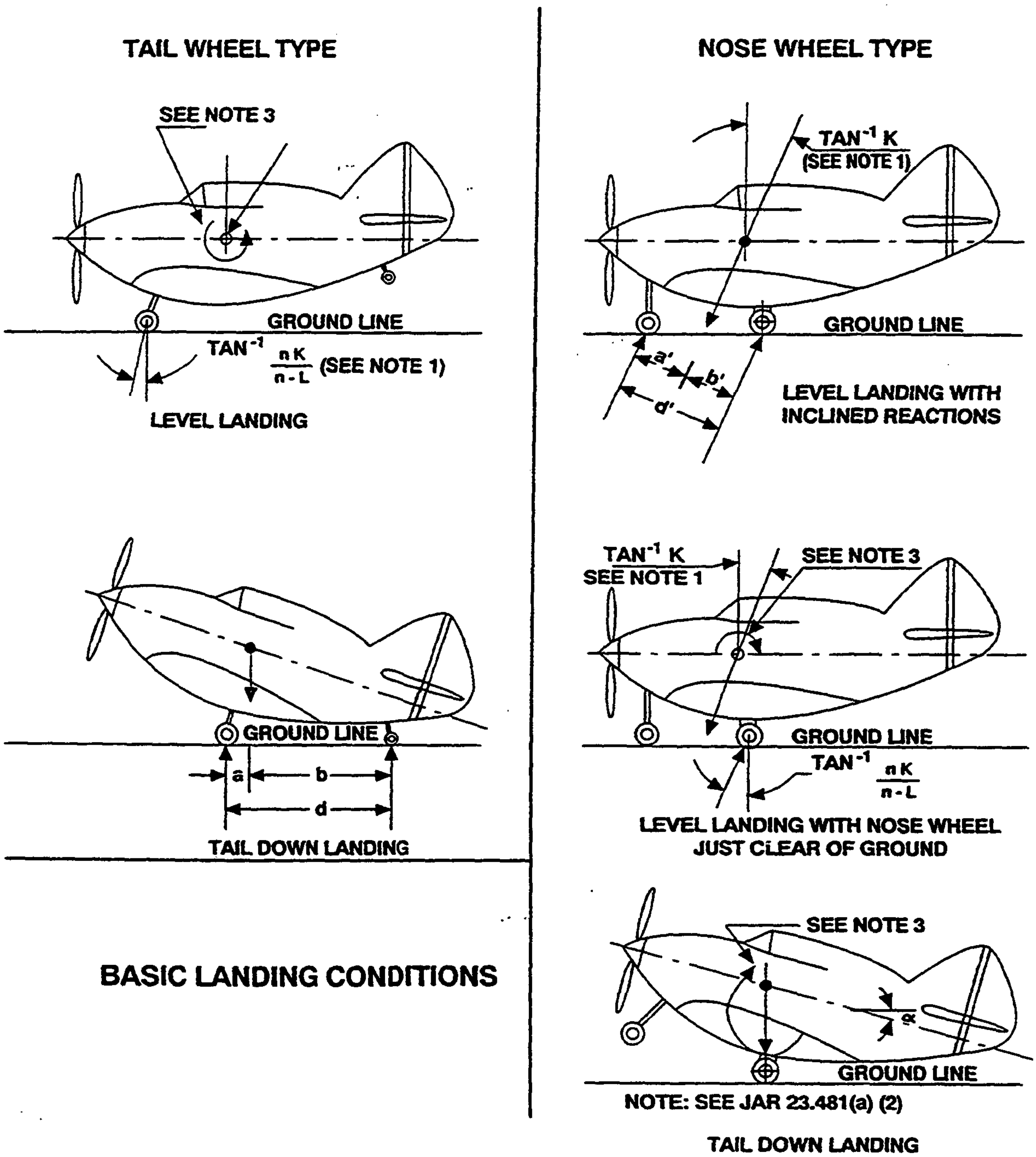
NOTE (2) For the purpose of design, the maximum load factor is assumed to occur throughout the shock absorber stroke from 25% deflection to 100% deflection unless otherwise shown and the load factor must be used with whatever shock absorber extension is most critical for each element of the landing gear.

NOTE (3) Unbalanced moments must be balanced by a rational conservative method.

NOTE (4) L is defined in JAR 23.725(b).

NOTE (5) n is the limit inertia load factor, at the c.g. of the aeroplane, selected under JAR 23.475 (d), (f), and (g).

Appendix C (continued)



BASIC LANDING CONDITIONS

Appendix D

Wheel Spin-Up Loads

D23.1 Wheel spin-up loads

(a) The following method for determining wheel spin-up loads for landing conditions is based on NACA T.N. 863. However, the drag component used for design may not be less than the drag load prescribed in JAR 23.479 (b).

$$F_{H\,max} = \frac{1}{r_e}\sqrt{\frac{2I_w\,(V_H - V_C)\,n\,F_{V\,max}}{t_z}}$$

where –

$F_{H\,max}$ = maximum rearward horizontal force acting on the wheel (in pounds);

r_e = effective rolling radius of wheel under impact based on recommended operating tyre pressure (which may be assumed to be equal to the rolling radius under a static load of n_jW_e) in feet;

I_w = rotation mass moment of inertia of rolling assembly (in slug feet);

V_H = linear velocity of aeroplane parallel to ground at instant of contact (assumed to be 1·2 V_{SO}, in feet per second);

V_C = peripheral speed of tyre, if pre-rotation is used (in feet per second) (there must be a positive means of pre-rotation before pre-rotation may be considered);

n = effective coefficient of friction (0·80 may be used);

$F_{V\,max}$ = maximum vertical force on wheel (pounds = n_jW_e, where W_e and n_j) are defined in JAR 23.725;

t_z = time interval between ground contact and attainment of maximum vertical force on wheel (seconds). However, if the value of $F_{H\,max}$, from the above equation exceeds 0·8 $F_{V\,max}$, the latter value must be used for $F_{H\,max}$.

(b) This equation assumes a linear variation of load factor with time until the peak load is reached and under this assumption, the equation determines the drag force at the time that the wheel peripheral velocity at radius r_e equals the aeroplane velocity. Most shock absorbers do not exactly follow a linear variation of load factor with time. Therefore, rational or conservative allowances must be made to compensate for these variations. On most landing gears, the time for wheel spin-up will be less than the time required to develop maximum vertical load factor for the specified rate of descent and forward velocity. For exceptionally large wheels, a wheel peripheral velocity equal to the ground speed may not have been attained at the time of maximum vertical gear load. However, as stated above, the drag spin-up load need not exceed 0·8 of the maximum vertical loads.

(c) *Not required for JAR-23.*

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Appendix D (continued)

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Appendix E

Not required for JAR-23.

Appendix E (continued)

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Appendix F

An Acceptable Test Procedure for Self-Extinguishing Materials for Showing Compliance with JAR 23.853, 23.855 and 23.1359

(a) *Conditioning*. Specimens must be conditioned to 21° ± 2°C (70° ± 5°F), and at 50% ± 5% relative humidity until moisture equilibrium is reached or for 24 hours. Only one specimen at a time may be removed from the conditioning environment immediately before subjecting it to the flame.

(b) *Specimen configuration*. Except as provided for materials used in electrical wire and cable insulation and in small parts, 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. The specimen thickness must be not thicker than the minimum thickness to be qualified for use in the aeroplane, except that: (1) thick foam parts, such as seat cushions, must be tested in 12·7 mm (½-in) thickness; (2) when showing compliance with JAR 23.853 (d) (3) (v) for materials used in small parts that must be tested, the materials must be tested in no more than 3 mm (⅛ in) thickness; (3) when showing compliance with JAR 23.1359 (c) for materials used in electrical wire and cable insulation, the 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. When performing the tests prescribed in sub-paragraphs (d) and (e) of this Appendix, the specimen must be mounted in a metal frame so that; (1) in the vertical tests of sub-paragraph (d), the two long edges and the upper edge are held securely; (2) in the horizontal test of sub-paragraph (e), the two long edges and the edge away from the flame are held securely; (3) the exposed area of the specimen is at least 50·8 mm (2 in) wide and 305 mm (12 in) long, unless the actual size used in the aeroplane is smaller; and (4) 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 installed in the aeroplane. When performing the test prescribed in sub-paragraph (f) of this Appendix, 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 203·2 mm by 203·2 mm (8 in by 8 in).

(c) *Apparatus*. Except as provided in sub-paragraph (e) of this Appendix, tests must be conducted in a draft-free cabinet in accordance with Federal Test Method Standard 191 Method 5903 (revised Method 5902) which is available from the General Services Administration, Business Service Centre, Region 3, Seventh and D Streets SW. Washington, D.C. 20407, or with some other approved equivalent method. Specimens which are too large for the cabinet must be tested in similar draft-free conditions.

(d) *Vertical test*. A minimum of three specimens must be tested and the 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 Tirrill burner with a nominal 9·525 mm (⅜-in) I.D. tube adjusted to give a flame of 38·1 mm (1½ in) in height. The minimum flame temperature measured by a calibrated thermo-couple pyrometer in the centre of the flame must be 843·33°C (1550°F). The lower edge of the specimen must be 19·05 mm (¾ in) 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 JAR 23.853 (d) (3) (i) and 23.853 (f), the flame must be applied for 60 seconds and then removed. For materials covered by JAR 23.853 (d) (3) (ii), the flame must be applied for 12 seconds and then removed. Flame time, burn length, and flaming time of drippings, if any, must be recorded. The burn length determined in accordance with sub-paragraph (h) of this Appendix must be measured to the nearest 2·54 mm (1/10 in).

(e) *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 aeroplane must be face down for the test. The specimen must be exposed to a Bunsen burner or Tirrill burner with a nominal 9·525 mm (⅜ in) I.D. tube adjusted to give a flame of 38·1 mm (1½ in) in height. The minimum flame temperature measured by a calibrated thermocouple pyrometer in the centre of the flame must be 843·33°C (1550°F). The specimen must be positioned so that the edge being tested is 19·05 mm (¾ in) above the top of, and on the centre line of, the burner. The flame must be applied for 15 seconds and then removed. A minimum of 254 mm (10 in) of the specimen must be used for timing purposes, approximately 38·1 mm (1½ in) must burn before the burning front reaches the timing zone, and the average burn rate must be recorded.

(f) *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 9·525 mm (⅜ in) I.D. tube adjusted to give a flame of 38·1mm (1½ in) in height. The minimum flame temperature measured by a calibrated thermocouple pyrometer in the centre of the flame must be 843·33°C (1550°F). Suitable precautions must be taken to avoid drafts. 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.

(g) *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 (c) of this appendix with the cabinet door open during the test or placed within a chamber approximately 609·6 mm (2 ft) high by 304·8 mm by 304·8 mm (1 ft by 1 ft), open at the top and at one vertical side (front), that allows sufficient flow of air for complete combustion but is free from drafts. The specimen must be parallel to and approximately 152·4 mm (6 in) 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 609·6mm (24 in) and must be marked 203·2 mm (8 in) from the lower end to indicate the centre 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 9·525 mm (⅜ in), and must be adjusted to provide a 76·2 mm (3 in) 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 954·44°C (1750°F). The burner must be positioned so that the hottest portion of the 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 (h) of this appendix must be measured to the nearest 2·54 mm (⅒ in). Breaking of the wire specimen is not considered a failure.

(h) *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 G

Instructions For Continued Airworthiness

G23.1 General

(a) This appendix specifies requirements for the preparation of Instructions for Continued Airworthiness as required by JAR 23.1529.

(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 JAR-23, 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.

G23.2 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.

G23.3 Content

The contents of the manual or manuals must be prepared in the English language. 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 reference 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) Trouble-shooting 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.

(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.

Appendix G (continued)

(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.

(h) In addition, for commuter category aeroplanes, the following information must be furnished:

(1) Electrical loads applicable to the various systems;

(2) Methods of balancing control surfaces;

(3) Identification of primary and secondary structures; and

(4) Special repair methods applicable to the aeroplane.

G23.4 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 required for type certification. 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..

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Appendix H

Installation of an Automatic Power Reserve (APR) System

Not required for JAR-23.

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Appendix I

Seaplane Loads

Appendix I to JAR-23 - Seaplane Loads.

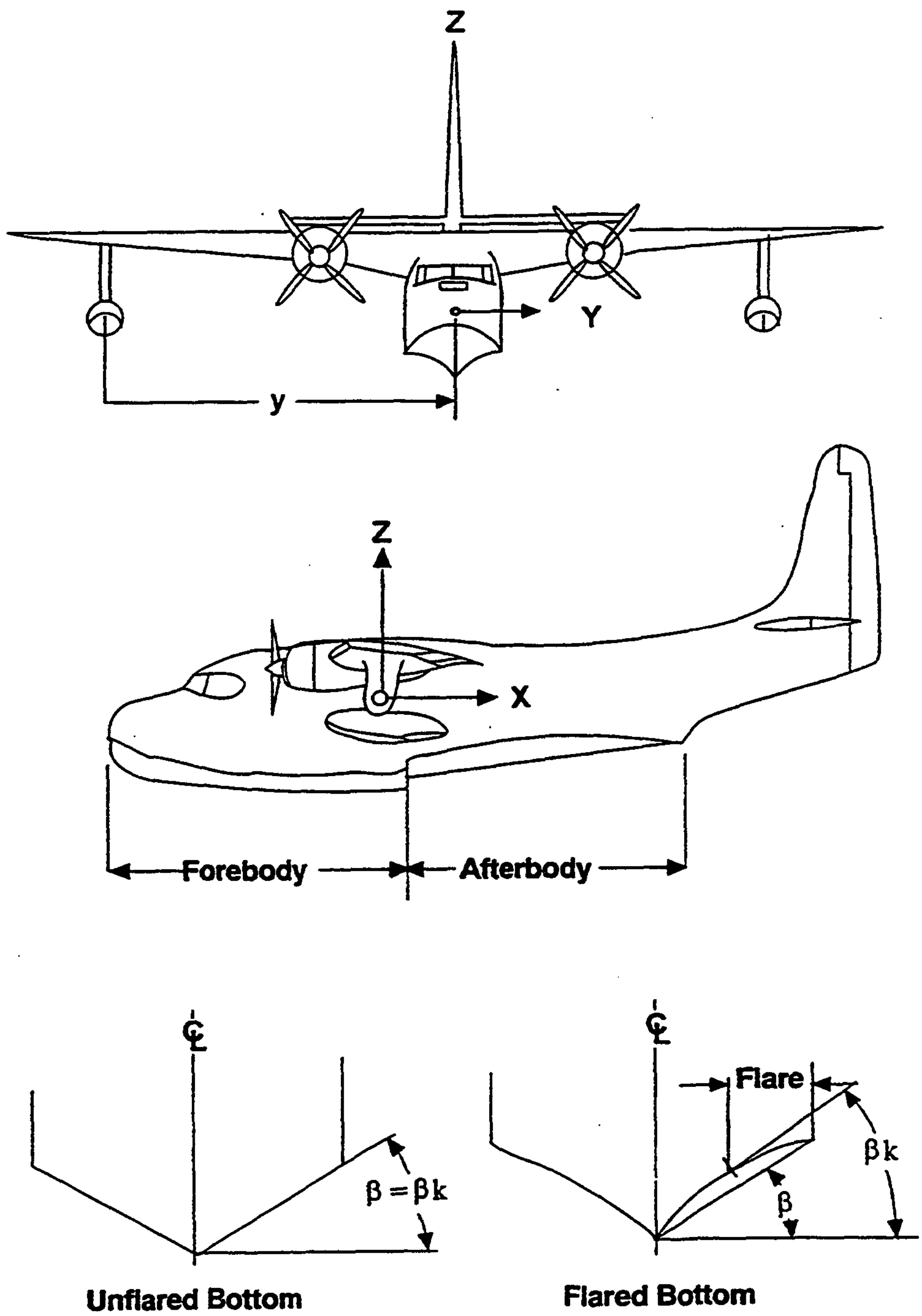


FIGURE 1 . Pictorial definition of angles, dimensions and directions on a seaplane.

Appendix I (continued)

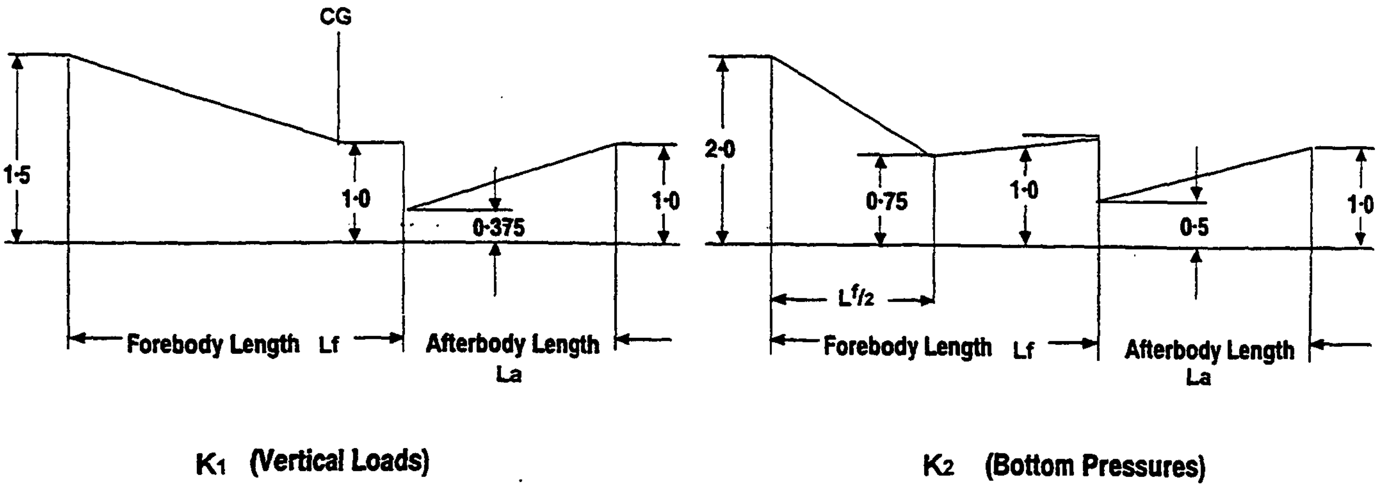


FIGURE 2. Hull station weight factor

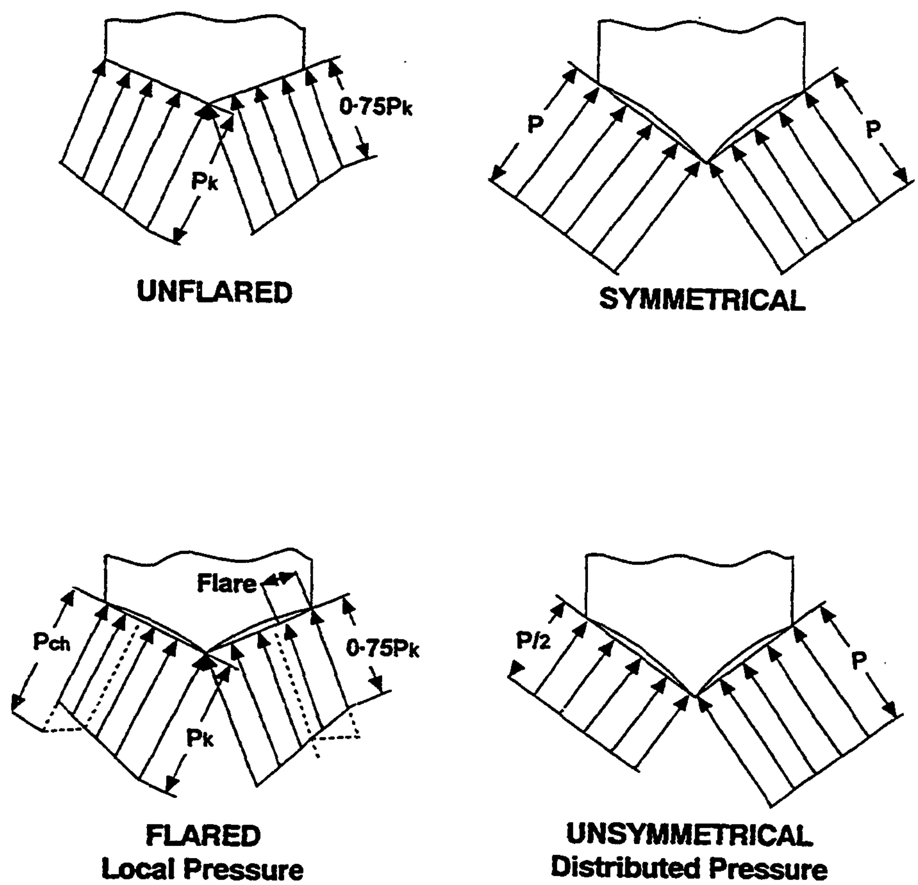


FIGURE 3. Transverse pressure distribution.

Appendix J

Anthropomorphic Test Dummies for showing compliance with 23.562

SUBPART A-GENERAL

J23.1 Scope

This Appendix describes the anthropomorphic test dummies that are to be used for compliance testing of aeroplane and aeroplane equipment with aeroplane safety standards.

J23.2 Purpose

The design and performance criteria specified in this Appendix are intended to describe measuring tools with sufficient precision to give repetitive and correlative results under similar test conditions and to reflect adequately the protective performance of an aeroplane or item of aeroplane equipment with respect to human occupants.

J23.3 Application

This Appendix does not in itself impose duties or liabilities on any person. It is a description of tools that measure the performance of occupant protection systems required by the safety standards that incorporate it. It is designed to be referenced by, and become a part of, the test procedures.

J23.4 Terminology

(a) The term "dummy", when used in this Subpart A, refers to any test device described by this part. The term "dummy", when used in any other subpart of this part, refers to the particular dummy described in that part.

(b) Terms describing parts of the dummy, such as "head", are the same as names for corresponding parts of the human body.

(c) *Not required for JAR-23.*

SUBPART B-50TH PERCENTILE MALE

J23.5 General description.

(a) The dummy consists of the component assemblies specified in Figure 1, which are described in their entirety by means of approximately 250 drawings and specifications that are grouped by component assemblies under the following nine headings:

SA 150 M070-Right arm assembly

SA 150 M071-Left arm assembly

SA 150 M050-Lumber spine assembly

SA 150 M060-Pelvis and abdomen assembly

SA 150 M080-Right leg assembly

SA 150 M081-Left leg assembly

SA 150 M010-Head assembly

SA 150 M020-Neck assembly

SA 150 M030-Shoulder-thorax assembly.

(b) The drawings and specifications referred to in this Appendix that are not set forth in full are incorporated by reference.

(c) *Not required for JAR-23.*

(d) Adjacent segments are joined in a manner such that throughout the range of motion and also under crash impact conditions there is no contact between metallic elements except for contacts that exist under static conditions.

(e) The structural properties of the dummy are such that the dummy conforms to this Appendix in every respect both before and after being used in aeroplane tests.

(f) *Not required for JAR-23.*

J23.6 Head

(a) The head consists of the assembly shown as number SA 150 M010 in Figure 1 and conforms to each of the drawings subtended by number SA 150 M010.

(b) When the head is dropped from a height of 10 inches in accordance with paragraph (c) of this section, the peak resultant accelerations at the location of the acceleraometers mounted in the head

Appendix J (continued)

form in accordance with J23.11(b) of this Appendix shall be not less than 210g, and not more than 260g. The acceleration/time curve for the test shall be unimodal and shall lie at or above the 100g level for an interval not less than 0·9 milliseconds and not more than 1·5 milliseconds. The lateral acceleration vector shall not exceed 10g.

(c) Test procedure:

(1) Suspend the head as shown in Figure 2, so that the lowest point on the forehead is 0·5 inches below the lowest point on the dummy's nose when the midsagittal plane is vertical.

(2) Drop the head from the specified height by means that ensure instant release onto a rigidly supported flat horizontal steel plate, 2 inches thick and 2 feet square, which has a clean, dry surface and any microfinish of not less than 8 microinches (rms) and not more than 80 microinches (rms).

(3) Allow a time period of at least 2 hours between successive tests on the same head.

J23.7 Neck

(a) The neck consists of the assembly shown as number SA 150 M020 in Figure 1 and conforms to each of the drawings subtended by number SA 150 M020.

(b) When the neck is tested with the head in accordance with paragraph (c) of this section, the head shall rotate in reference to the pendulum's longitudinal centreline a total of 68° ± 5° about its centre of gravity, rotating to the extent specified in the following table at each indicated point in time, measured from impact, with a chordal displacement measured at its centre of gravity that is within the limits specified. The chordal displacement at time T is defined as the straight line distance between (1) the position relative to the pendulum arm of the head centre of gravity at time zero, and (2) the position relative to the pendulum arm of the head centre of gravity at time T as illustrated by Figure 3. The peck resultant acceleration recorded at the location of the accelerometers mounted in the head form in accordance with J23.11(b) of this Appendix shall not exceed 26g. The pendulum shall not reverse direction until the head's centre of gravity returns to the original zero time position relative to the pendulum arm.

Rotation (degrees)	Time (ms)± (2+-08T)	Chordal Displacement (inches ±0·5)
0	0	0·0
30	30	2·6
60	46	4·8
Maximum	60	5·5
60	75	4·8
30	95	2·6
0	112	0·0

(c) Test procedure:

(1) Mount the head and neck on a rigid pendulum as specified in Figure 4, so that the head's midsagittal plane is vertical and coincides with the plane of motion of the pendulum's longitudinal centreline. Mount the neck directly to the pendulum as shown in Figure 4.

(2) Release the pendulum and allow it to fall freely from a height such that the velocity at impact is 23·5 ± 2·0 feet per second (fps), measured at the centre of the accelerometer specified in Figure 4.

(3) Decelerate the pendulum to a stop with an acceleration-time pulse described as follows:

(i) Establish 5g and 20g levels on the a-t curve.

(ii) Establish t_1 at the point where the rising a-t curve first crosses the 5g level, t_2 at the point where the rising a-t curve first crosses the 20g level, t_2 at the point where the decaying a-t curve last crosses the 20g level, and t_4 at the point where the decaying a-t curve first crosses the 5g level.

(iii) t_2-t_1 shall be not more than 3 milliseconds.

(iv) t_3-t_2 shall be not less than 25 milliseconds and not more than 30 milliseconds.

(v) t_4-t_3 shall be not more than 10 milliseconds.

(vi) The average decelera-tion between t_2 and t_3 shall be not less than 20g and not more than 24g.

(4) Allow the neck to flex without impact of the head or neck with any object other than the pendulum arm.

Appendix J (continued)

J23.8 Thorax

(a) The thorax consists of the assembly shown as number SA 150 M030 in Figure 1, and conforms to each of the drawings subtended by number SA 150 M030.

(b) The thorax contains enough unobstructed interior space behind the rib cage to permit the midpoint of the sternum to be depressed 2 inches without contact between the rib cage and other parts of the dummy or its instrumentation, except for instruments specified in paragraph (d) (7) of this section.

(c) When impacted by a test probe conforming to J23.11(a) of this Appendix at 14 fps and at 22 fps in accordance with paragraph (d) of this section, the thorax shall resist with forces measured by the test probe of not more than 1450 pounds and 2250 pounds, respectively, and shall deflect by amounts not greater than 1·1 inches and 1·7 inches, respectively. The internal hysteresis in each impact shall not be less than 50% and not more than 70%.

(d) Test procedure:

(1) With the dummy seated without back support on a surface as specified in J23.11(i) of this Appendix and in the orientation specified in J23.11(i) of this Appendix, adjust the dummy arms and legs until they are extended horizontally forward parallel to the midsagittal plane.

(2) Place the longitudinal centre line of the test probe so that it is 17·7 ± 0·1 inches above the seating surface at impact.

(3) Align the test probe specified in J23.11(a) of this Appendix so that at impact its longitudinal centreline coincides within 2° of a horizontal line in the dummy's midsagittal plane.

(4) Adjust the dummy so that the surface area on the thorax immediately adjacent to the projected longitudinal centre line of the test probe is vertical. Limb support, as needed to achieve and maintain this orientation, may be provided by placement of a steel rod of any diameter not less than one-quarter of an inch and not more than three-eights of an inch, with hemispherical ends, vertically under the limb at its projected geometric centre.

(5) Impact the thorax with the test probe so that its longitudinal centreline falls within 2° of a horizontal line in the dummy's midsagittal plane at the moment of impact.

(6) Guide the probe during impact so that it moves with no significant lateral, vertical, or rotational movement.

(7) Measure the horizontal deflection of the sternum relative to the thoracic spine along the line established by the longitudinal centreline of the probe at the moment of impact, using a potentiometer mounted inside the sternum.

(8) Measure hysteresis by determining the ratio of the area between the loading and unloading portions of the force deflection curve to the area under the loading portion of the curve.

J23.9 Lumber spine, abdomen, and pelvis

(a) The lumber spine, abdomen and pelvis consist of the assemblies designated as numbers SA 150 M050 and SA 150 M060 in Figure 1 and conform to the drawings subtended by these numbers.

(b) When subjected to continuously applied force in accordance with paragraph (c) of this section, the lumber spine assembly shall flex by an amount that permits the rigid thoracic spine to rotate from its initial position in accordance with Figure 11 by the number of degrees shown below at each specified force level, and straighten upon removal of the force to within 12° of its initial position in accordance with Figure 11.

Flexion (degrees)	Force (± 6 pounds)
0	0
20	28
30	40
40	52

(c) Test procedure:

(1) Assemble the thorax, lumber spine, pelvic, and upper leg assemblies (above the femur force transducers), ensuring that all component surfaces are clean, dry, and untreated unless otherwise specified, and attach them to the horizontal fixture shown in Figure 5 at the two link rod pins and with the mounting brackets for the lumber test fixtures illustrated in Figures 6 to 9.

(2) Attach the rear mounting of the pelvis to the pelvic instrument cavity rear face at the four ¼ in cap screw holes and attach the front mounting at the femur axial rotation joint. Tighten the mountings so that the pelvic-lumber adapter is horizontal and adjust the femur friction plungers at each hip socket joint to 240 inch-pounds torque.

(3) Flex the thorax forward 50° and then

rearward as necessary to return it to its initial position in accordance with Figure 11 unsupported by external means.

(4) Apply a forward force perpendicular to the thorax instrument cavity rear face in the midsagittal plane 15 inches above the top surface of the pelvic-lumber adapter. Apply the force at any torso deflection rate between ·5 and 1·5° per second up to 40° of flexion but no further, continue to apply for 10 seconds that force necessary to maintain 40° of flexion, and record the force with an instrument mounted to the thorax as shown in Figure 5. Release all force as rapidly as possible and measure the return angle 3 minutes after the release.

(d) When the abdomen is subjected to continuously applied force in accordance with paragraph (e) of this section, the abdominal force-deflection curve shall be within the two curves plotted in Figure 10.

(e) Test procedure:

(1) Place the assembled thorax, lumber spine and pelvic assemblies in a supine position on a flat, rigid, smooth, dry, clean horizontal surface, ensuring that all component surfaces are clean, dry, and untreated unless otherwise specified.

(2) Place a rigid cylinder 6 inches in diameter and 18 inches long transversely across the abdomen, so that the cylinder is symmetrical about the midsagittal plane, with its longitudinal centreline horizontal and perpendicular to the midsagittal plane at a point 9·2 inches above the bottom line of the buttocks, measured with the dummy positioned in accordance with Figure 11.

(3) Establish the zero deflection point as the point at which a force of 10 pounds has been reached.

(4) Apply a vertical downward force through the cylinder at any rate between 0·25 and 0·35 inches per second.

(5) Guide the cylinder so that it moves without significant lateral or rotational movement.

J23.10 Limbs

(a) The limbs consist of the assemblies shown as numbers SA 150 M070, SA 150 M071, SA 150 M080, and SA 150 M081 in Figure 1 and conform to the drawings subtended by these numbers.

(b) When each knee is impacted at 6·9 ft/sec. in accordance with paragraph (c) of this section, the maximum force on the femur shall be not more than 2500 pounds and not less than 1850 pounds, with a duration above 1000 pounds of not less than 1·7 milliseconds.

(c) Test procedure:

(1) Seat the dummy without back support on a surface as specified in J23.11(i) of this Appendix that is 17·3 ± 0·2 inches above a horizontal surface, oriented as specified in J23.11(i) of this Appendix, and with the hip joint adjustment at any setting between 1g and 2g. Place the dummy legs in planes parallel to its midsagittal plane (knee pivot centreline perpendicular to the midsagittal plane) and with the feet flat on the horizontal surface. Adjust the feet and lower legs until the lines between the midpoints of the knee pivots and the ankle pivots are at any angle not less than 2° and not more than 4° rear of the vertical, measured at the centreline of the knee pivots.

(2) Reposition the dummy if necessary so that the rearmost point of the lower legs at the level one inch below the seating surface remains at any distance not less than 5 inches and not more than 6 inches forward of the forward edge of the seat.

(3) Align the test probe specified in J23.11(a) of this Appendix so that at impact its longitudinal centreline coincides within ± 2° with the longitudinal certreline of the femur.

(4) Impact the knee with the test probe moving horizontally and parallel to the midsagittal plane at the specified velocity.

(5) Guide the probe during impact so that it moves with no significant lateral, vertical, or rotational movement.

J23.11 Test conditions and instrumention

(a) The test probe used for thoracic and knee impact tests is a cylinder 6 inches in diameter that weighs 51·5 pounds including instrumentation. Its impacting end has a flat right face that is rigid and that has an edge radius of 0·5 inches.

(b) Accelerometers are mounted in the head on the horizontal transverse bulkhead shown in the drawings sub-referenced under assembly No. SA 150 M010 in Figure 1, so that their sensitive axes intersect at a point in the midsagittal plane 0·5 inches above the horizontal bulkhead and 1·9 inches ventral of the vertical mating surface of the skull with the skull cover. One accelerometer is aligned

Appendix J (continued)

with its sensitive axis perpendicular to the horizontal bulkhead in the midsagittal plane and with its seismic mass centre at any distance up to 0·3 inches superior to the axial intersection point. Another accelerometer is aligned with its sensitive axis parallel to the horizontal bulkhead and perpendicular to the midsagittal plane, and with its seismic mass centre at any distance up to 1·3 inches to the left of the axial intersection point (left side of dummy is the same as that of man). A third accelerometer is aligned with its sensitive axis parallel to the horizontal bulkhead in the midsagittal plane, and with its seismic mass centre at any distance up to 1·3 inches dorsal to the axial intersection point.

(c) Accelerometers are mounted in the thorax by means of a bracket attached to the rear vertical surface (hereafter "attachment surface") of the thoracic spine so that their sensitive axes intersect at a point in the midsagittal plane 0·8 inches below the upper surface of the plate to which the neck mounting bracket is attached and 3·2 inches perpendicularly forward of the surface to which the accelerometer bracket is attached. One accelerometer has its sensitive axis oriented parallel to the attachment surface in the midsagittal plane, with its seismic mass centre at any distance up to 1·3 inches inferior to the intersection of the sensitive axes specified above. Another accelerometer has its sensitive axis oriented parallel to the attachment surface and perpendicular to the midsagittal plane, with its seismic mass centre at any distance up to 0·2 inches to the right of the intersection of the sensitive axes specified above. A third accelerometer has its sensitive axis oriented perpendicular to the attachment surface in the midsagittal plane, with its seismic mass centre at any distance up to 1·3 inches dorsal to the intersection of the sensitive axes specified above. Accelerometers are oriented with the dummy in the position specified in J23.11(i) of this Appendix.

(d) A force-sensing device is mounted axially in each femur shaft so that the transverse centreline of the sensing element is 4·25 inches from the knee's centre of rotation.

(e) The outputs of acceleration and force-sensing devices installed in the dummy and in the test apparatus specified by this Part are recorded in individual data channels, with channel classes as follows:

(1) Head acceleration - Class 1000.

(2) Pendulum acceleration - Class 60.

(3) Thorax acceleration - Class 180.

(4) Thorax compression - Class 180.

(5) Femur force - Class 600.

(f) The mountings for sensing devices have no resonance frequency within a range of 3 times the frequency range of the applicable channel class.

(g) Limb joints are set at 1g, barely restraining the weight of the limb when it is extended horizontally. The force required to move a limb segment does not exceed 2g throughout the range of limb motion.

(h) Performance tests are conducted at any temperature from 66°F to 78°F and at any relative humidity from 10% to 70% after exposure of the dummy to these conditions for a period of not less than 4 hours.

(i) For the performance tests specified in J23.8, J23.9 and J23.10 of this Appendix, the dummy is positioned in accordance with Figure 11 as follows:

(1) The dummy is placed on a flat, rigid, smooth, clean, dry, horizontal, steel test surface whose length and width dimensions are not less than 16 inches, so that the dummy's midsagittal plane is vertical and centred on the test surface and the rearmost points on its lower legs at the level of the test surface are at any distance not less the 5 inches and not more than 6 inches forward of the forward edge of the test surface.

(2) The pelvis is adjusted so that the upper surface of the lumbar-pelvic adapter is horizontal.

(3) The shoulder yokes are adjusted so that they are at the midpoint of their anteroir-posterior travel with their upper surfaces horizontal.

(4) The dummy is adjusted so that the rear surfaces of the shoulders and buttocks are tangent to a transverse vertical plane.

(5) The upper legs are positioned symmetrically about the midsagittal plane so that the distance between the knee pivot bolt heads is 11·6 inches.

(6) The lower legs are positioned in planes parallel to the midsagittal plane so that the lines between the midpoint of the knee pivots and the ankle pivots are vertical.

(j) The dummy's dimensions, as specified in drawing number SA 150 M002, are determined as follows:

(1) With the dummy seated as specified in paragraph (i) of this section, the head is adjusted and secured so that its occiput is 1·7 inches forward of the transverse vertical plane with the vertical mating surface of the skull with its cover parallel to the transverse vertical plane.

(2) The thorax is adjusted and secured so

that the rear surface of the chest accelerometer mounting cavity is inclined 3° forward of vertical.

(3) Chest and waist circumference and chest depth measurements are taken with the dummy positioned in accordance with paragraph (j)(1) and (2) of this section.

(4) The chest skin and abdominal sac are removed and all following measurements are made without them.

(5) Seated height is measured from the seating surface to the uppermost point on the head-skin surface.

(6) Shoulder pivot height is measured from the seating surface to the centre of the arm elevation pivot.

(7) H-point locations are measured from the seating surface to the centre of the holes in the pelvis flesh covering in line with the hip motion ball.

(8) Knee pivot distance from the backline is measured to the centre of the knee pivot bolt head.

(9) Knee pivot distance from floor is measured from the centre of the knee pivot bolt head to the bottom of the heel when the foot is horizontal and pointing forward.

(10) Shoulder width measurement is taken at arm elevation pivot centre height with the centreline between the elbow pivots and the shoulder pivots vertical.

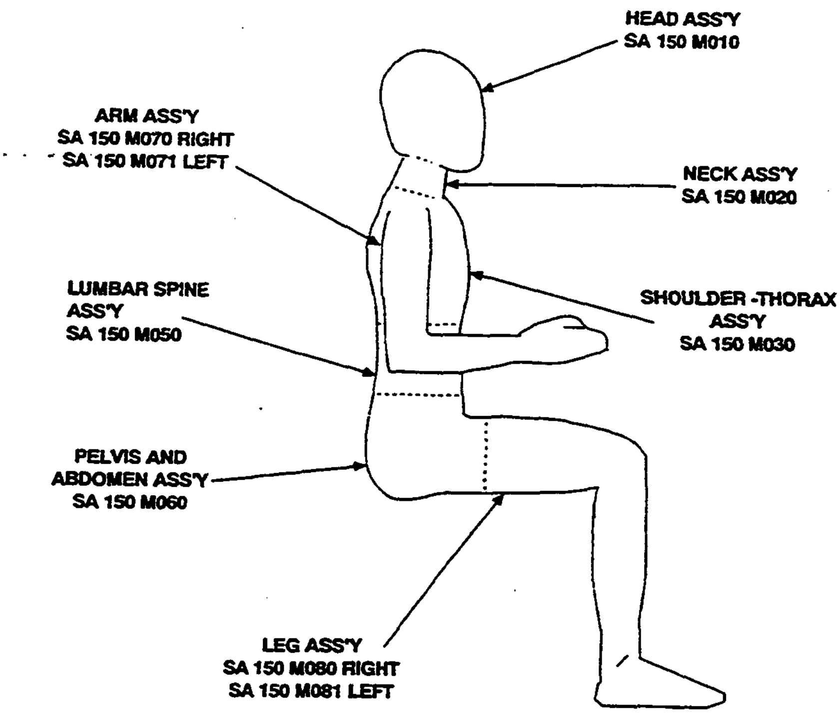
(11) Hip width measurement is taken at widest point of pelvic section.

(k) Performance tests of the same components, segment, assembly, or fully assembled dummy are separated in time by a period of not less than 30 minutes unless otherwise noted.

(1) Surfaces of dummy components are not painted except as specified in this part or in drawings subtended by this part.

Appendix J (continued)

FIGURE No. 1



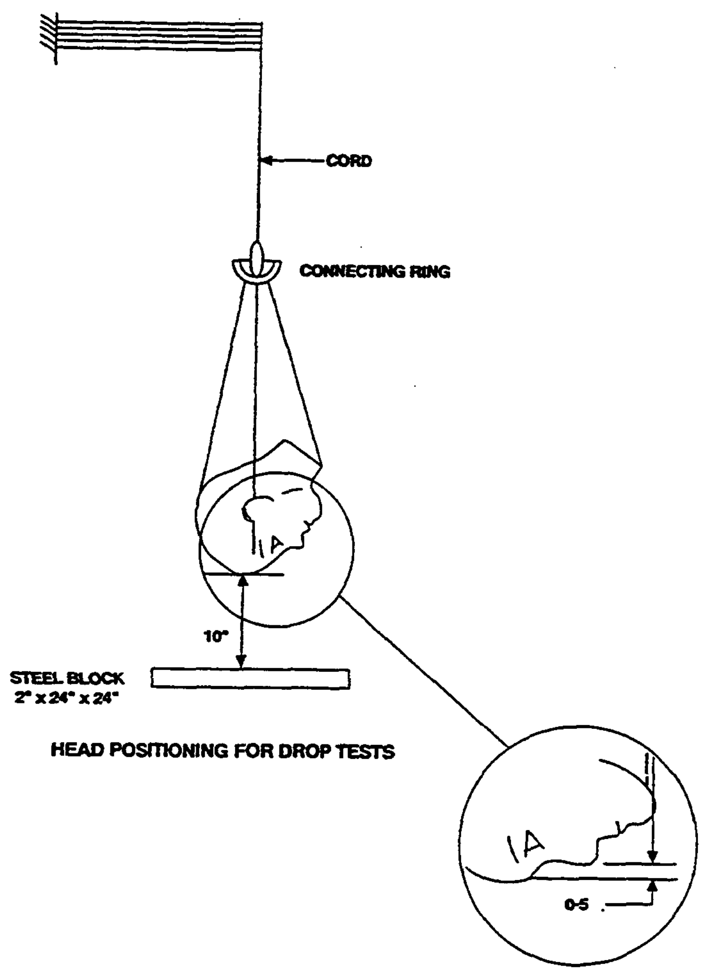


FIGURE No. 2

Appendix J (continued)

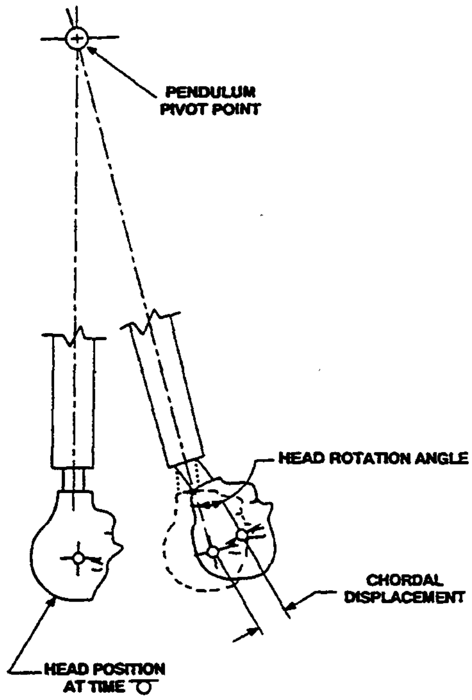
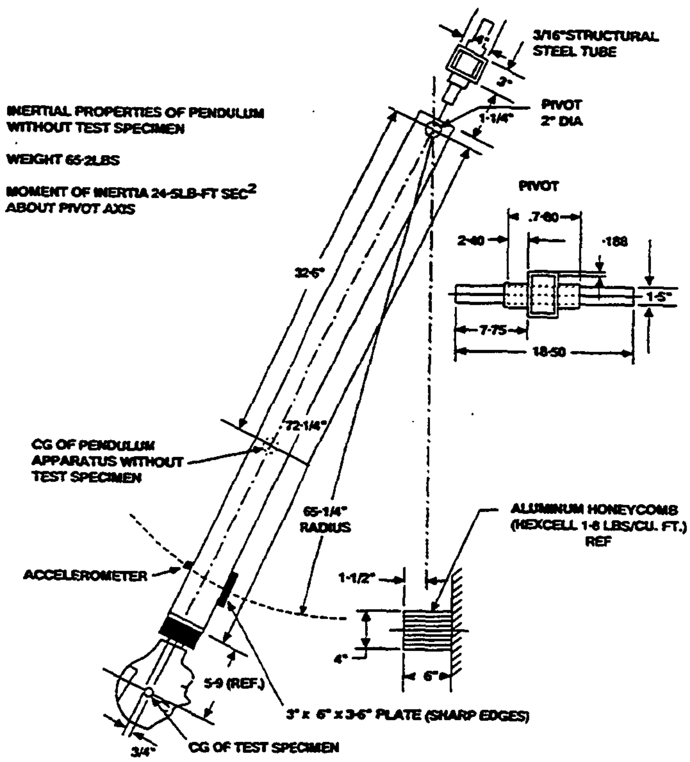


FIGURE No. 3
NECK COMPONENT TEST

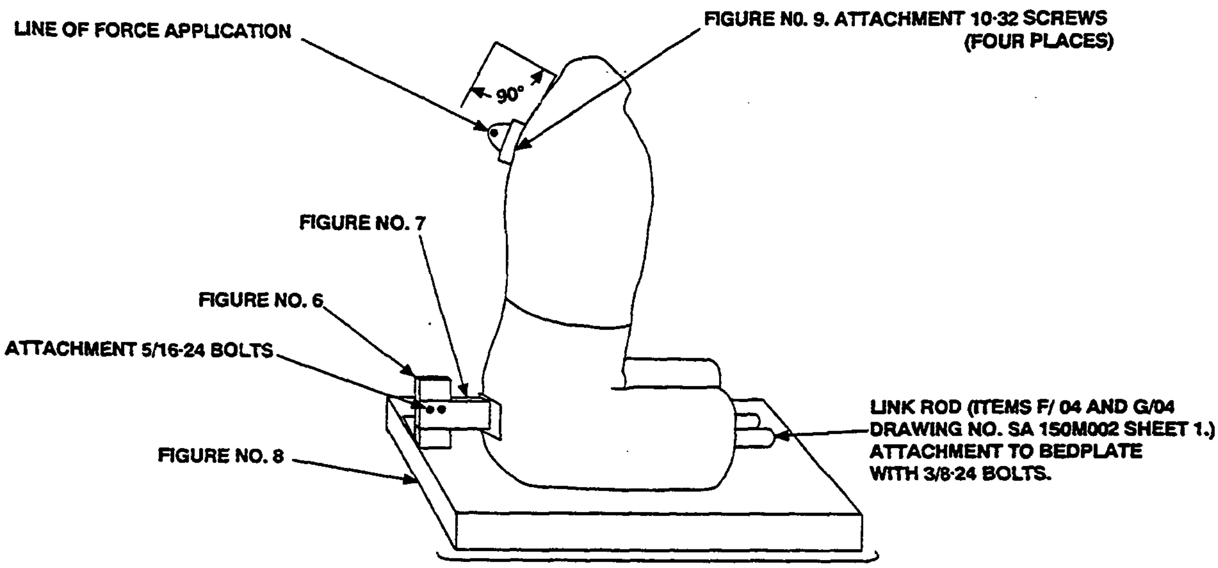


NOTE: Leading edge of neck must be aligned with the leading edge of the pendulum.

FIGURE No. 4
NECK COMPONENT TEST

Appendix J (continued)

FIGURE No. 5
LUMBER FLEXION TEST



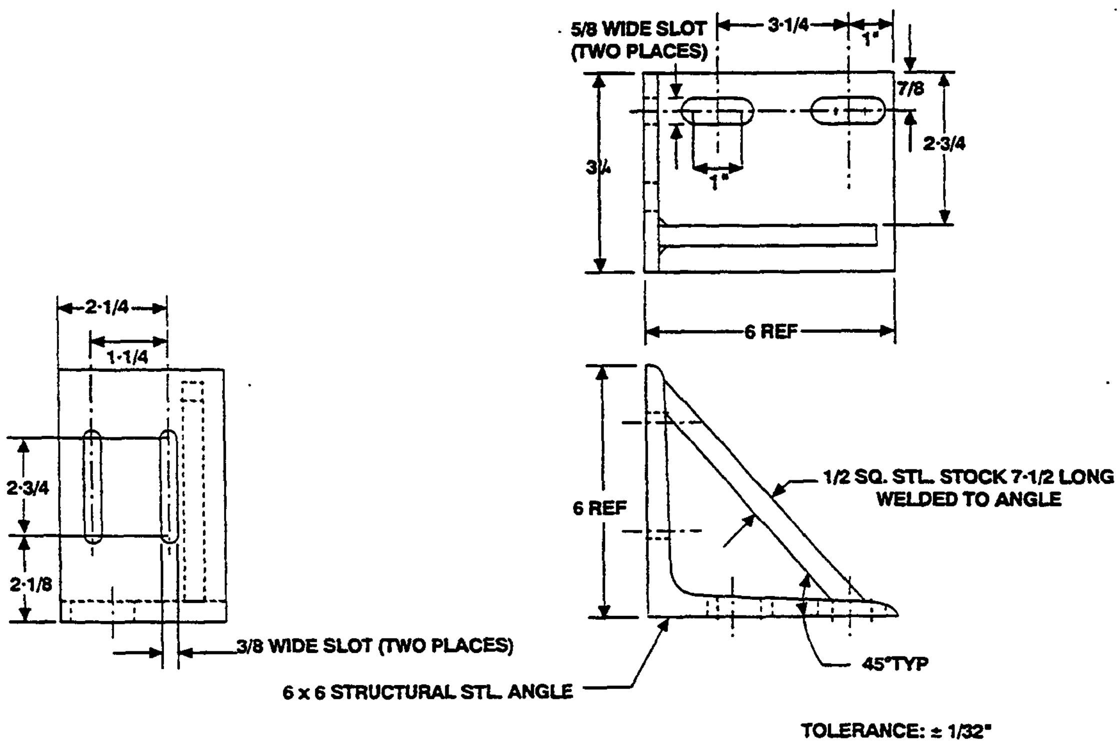


FIGURE No. 6
SUPPORT BRACKET
LUMBER TEST FIXTURE

Appendix J (continued)

FIGURE No. 7
MOUNTING BRACKET - LUMBER TEST FIXTURE

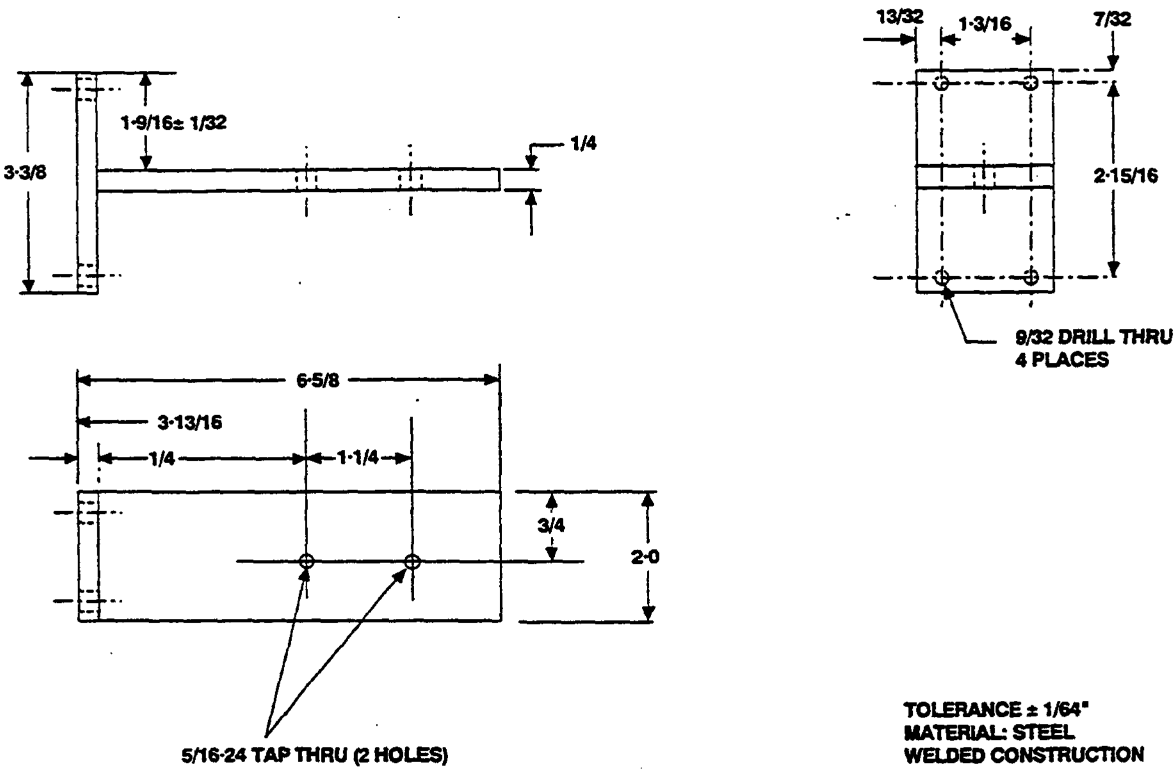
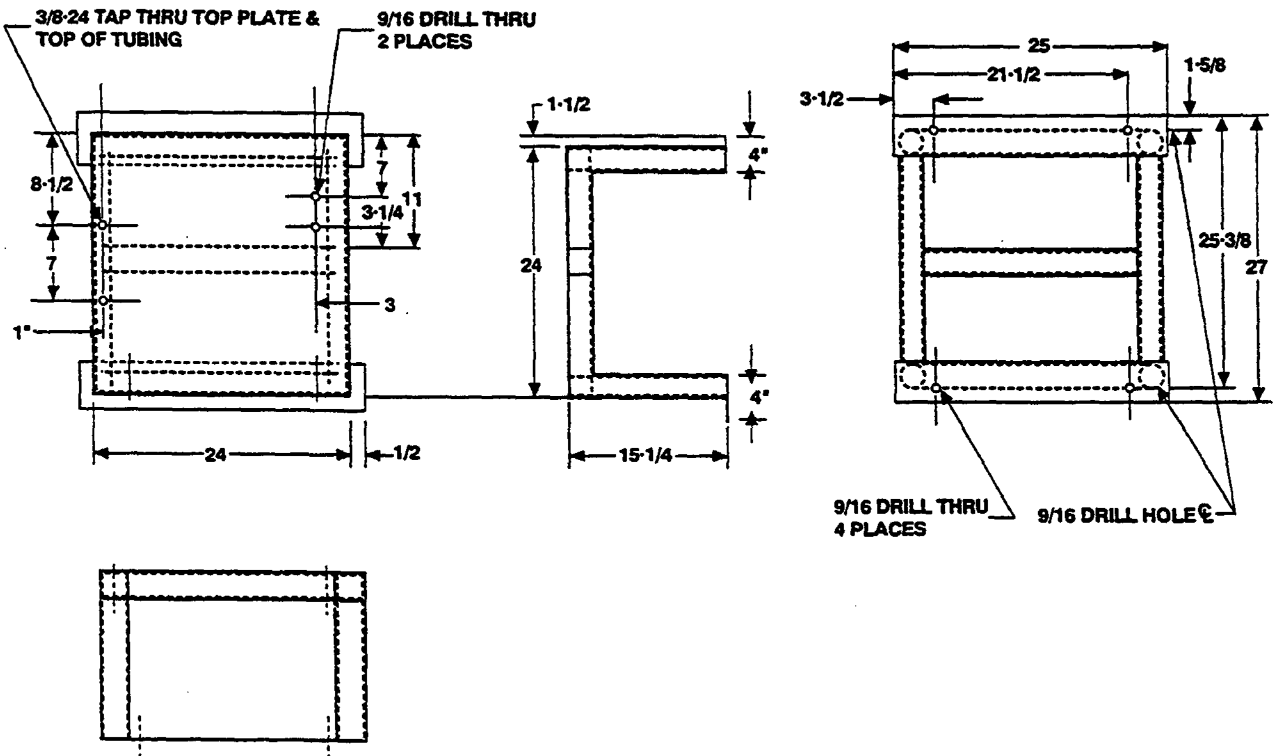


FIGURE No. 8
BEDPLATE - LUMBAR TEST FIXTURE



MATL: STEEL - 1/4 THICK PLATE & 2 x 2-1/4 WALL SQ. TUBING
WELDED CONSTRUCTION

TOLERANCE ± 1/32"

Appendix J (continued)

FIGURE No. 9
LOADING PLATE - LUMBAR TEST FIXTURE

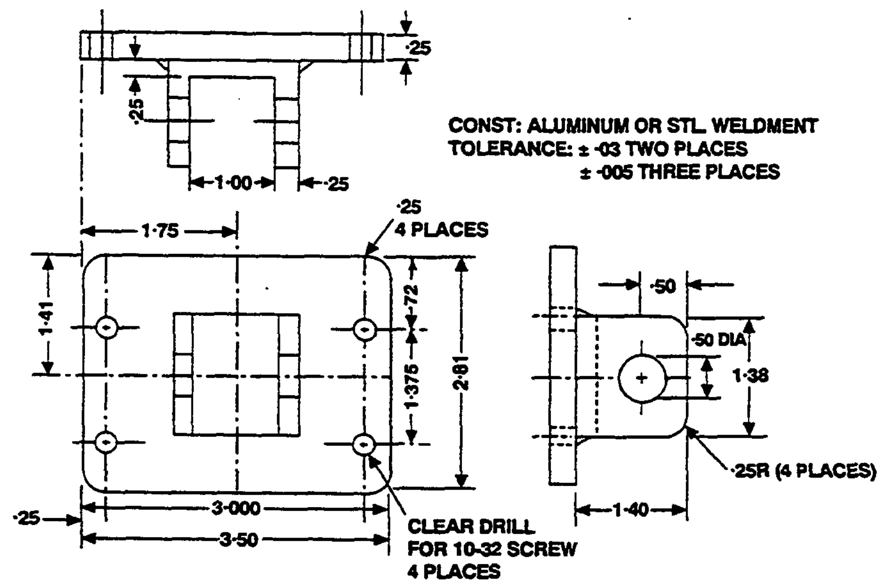
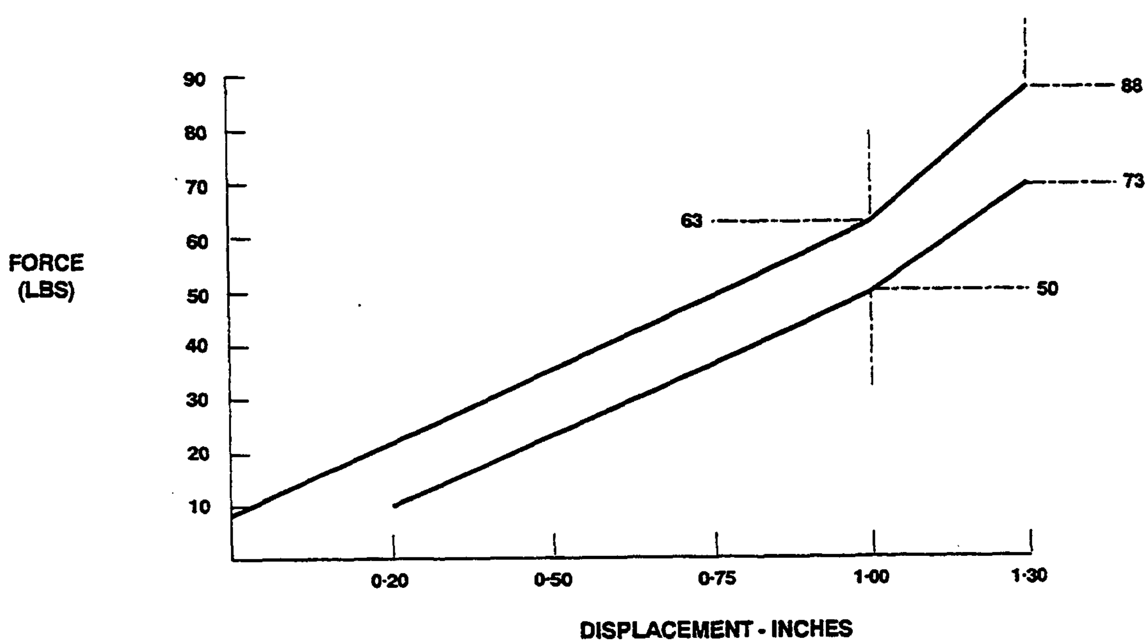


FIGURE No. 10
ABDOMEN COMPONENT TEST



Appendix J (continued)

FIGURE No 11
UPRIGHT SEATED POSITION FOR LINEAR MEASUREMENTS