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14 CFR
Aeronautics and Space
CHAPTER I
FEDERAL AVIATION ADMINISTRATION, DEPARTMENT OF TRANSPORTATION

SUBCHAPTER C -- AIRCRAFT

PART 23 -- AIRWORTHINESS STANDARDS: NORMAL, UTILITY, ACROBATIC, AND COMMUTER CATEGORY AIRPLANES

Special Federal Aviation Regulation No. 23

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Special Federal Aviation Regulation No. 23

1. *Applicability.* An applicant is entitled to a type certificate in the normal category for a reciprocating or turbopropeller multiengine powered small airplane that is to be certificated to carry more than 10 occupants and that is intended for use in operations under Part 135 of the Federal Aviation Regulations if he shows compliance with the applicable requirements of Part 23 of the Federal Aviation Regulations, as supplemented or modified by the additional airworthiness requirements of this regulation.

2. *References*. Unless otherwise provided, all references in this regulation to specific sections of Part 23 of the Federal Aviation Regulations are those sections of Part 23 in effect on March 30, 1967.

FLIGHT REQUIREMENTS

3. *General.* Compliance must be shown with the applicable requirements of Subpart B of Part 23 of the Federal Aviation Regulations in effect on March 30, 1967, as supplemented or modified in sections 4 through 10 of this regulation.

PERFORMANCE

4. *General.* (a) Unless otherwise prescribed in this regulation, compliance with each applicable performance requirement in sections 4 through 7 of this regulation must be shown for ambient atmospheric conditions and still air.

(b) The performance must correspond to the propulsive thrust available under the particular ambient atmospheric conditions and the particular flight condition. The available propulsive thrust must correspond to engine power or thrust, not exceeding the approved power or thrust less --

(1) Installation losses; and

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

(c) Unless otherwise prescribed in this regulation, the applicant must select the take-off, en route, and landing configurations for the airplane.

(d) The airplane configuration may vary with weight, altitude, and temperature, to the extent they are compatible with the operating procedures required by paragraph (e) of this section.

(e) Unless otherwise prescribed in this regulation, in determining the critical engine inoperative takeoff performance, the accelerate-stop distance, takeoff distance, changes in the airplane's configuration, speed, power, and thrust, must be made in accordance with procedures established by the applicant for operation in service.

(f) Procedures for the execution of balked landings must be established by the applicant and included in the Airplane Flight Manual.

(g) The procedures established under paragraphs (e) and (f) of this section must --

(1) Be able to be consistently executed in service by a crew of average skill;

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

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

5. *Takeoff* -- (a) *General.* The takeoff speeds described in paragraph (b), the accelerate-stop distance described in paragraph (c), and the takeoff distance described in paragraph (d), must be determined for --

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

(2) The selected configuration for takeoff;

(3) The center of gravity in the most unfavorable position;

(4) The operating engine within approved operating limitation; and

(5) Takeoff data based on smooth, dry, hard-surface runway.

(b) *Takeoff speeds.* (1) The 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 takeoff. The speed *V*1 must be selected by the applicant but may not be less than --

(i) 1.10 *V*s1;

(ii) 1.10 *V*MC;

(iii) A speed that permits acceleration to *V*1 and stop in accordance with paragraph (c) allowing credit for an overrun distance equal to that required to stop the airplane from a ground speed of 35 knots utilizing maximum braking; or

(iv) A speed at which the airplane can be rotated for takeoff and shown to be adequate to safely continue the takeoff, using normal piloting skill, when the critical engine is suddenly made inoperative.

(2) Other essential takeoff speeds necessary for safe operation of the airplane must be determined and shown in the Airplane Flight Manual.

(c) *Accelerate-stop distance.* (1) The accelerate-stop distance is the sum of the distances necessary to --

(i) Accelerate the airplane from a standing start to *V*1; and

(ii) Decelerate the airplane from *V*1 to a speed not greater than 35 knots, assuming that in the case of engine failure, failure of the critical engine is recognized by the pilot at the speed *V*1. The landing gear must remain in the extended position and maximum braking may be utilized during deceleration.

(2) Means other than wheel brakes may be used to determine the accelerate-stop distance if that means is available with the critical engine inoperative and --

(i) Is safe and reliable;

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

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

(d) *All engines operating takeoff distance.* The all engine operating takeoff distance is the horizontal distance required to takeoff and climb to a height of 50 feet above the takeoff surface according to procedures in FAR 23.51(a).

(e) *One-engine-inoperative takeoff.* The maximum weight must be determined for each altitude and temperature within the operational limits established for the airplane, at which the airplane has takeoff capability after failure of the critical engine at or above *V*1 determined in accordance with paragraph (b) of this section. This capability may be established --

(1) By demonstrating a measurably positive rate of climb with the airplane in the takeoff configuration, landing gear extended; or

(2) By demonstrating the capability of maintaining flight after engine failure utilizing procedures prescribed by the applicant.

6. *Climb* -- (a) *Landing climb: All-engines-operating.* The maximum weight must be determined with the airplane in the landing configuration, for each altitude, and ambient temperature within the operational limits established for the airplane and with the most unfavorable center of gravity and out-of-ground effect in free air, at which the steady gradient of climb will not be less than 3.3 percent, with:

(1) The engines at the power that is available 8 seconds after initiation of movement of the power or thrust controls from the mimimum flight idle to the takeoff position.

(2) A climb speed not greater than the approach speed established under section 7 of this regulation and not less than the greater of 1.05 MC or 1.10VS1.

(b) *En route climb, one-engine-inoperative.* (1) the maximum weight must be determined with the airplane in the en route configuration, the critical engine inoperative, the remaining engine at not more than maximum continuous power or thrust, and the most unfavorable center of gravity, at which the gradient at climb will be not less than --

(i) 1.2 percent (or a gradient equivalent to 0.20 *V*so2, if greater) at 5,000 feet and an ambient temperature of 41 °F. or

(ii) 0.6 percent (or a gradient equivalent to 0.01 *V*so2, if greater) at 5,000 feet and ambient temperature of 81 °F.

(2) The minimum climb gradient specified in subdivisions (i) and (ii) of subparagraph (1) of this paragraph must vary linearly between 41 °F. and 81 °F. and must change at the same rate up to the maximum operational temperature approved for the airplane.

7. *Landing.* The landing distance must be determined for standard atmosphere at each weight and altitude in accordance with FAR 23.75(a), except that instead of the gliding approach specified in FAR 23.75(a)(1), the landing may be preceded by a steady approach down to the 50-foot height at a gradient of descent not greater than 5.2 percent (3°) at a calibrated airspeed not less than 1.3 s1.

TRIM

8. *Trim* -- (a) *Lateral and directional trim.* The airplane must maintain lateral and directional trim in level flight at a speed of Vh or VMO/MMO, whichever is lower, with landing gear and wing flaps retracted.

(b) *Longitudinal trim.* The airplane must maintain longitudinal trim during the following conditions, except that it need not maintain trim at a speed greater than VMO/MMO:

(1) In the approach conditions specified in FAR 23.161(c)(3) through (5), except that instead of the speeds specified therein, trim must be maintained with a stick force of not more than 10 pounds down to a speed used in showing compliance with section 7 of this regulation or 1.4 Vs1 whichever is lower.

(2) In level flight at any speed from VH or VMO/MMO, whichever is lower, to either Vx or 1.4 Vs1, with the landing gear and wing flaps retracted.

STABILITY

9. *Static longitudinal stability.* (a) In showing compliance with the provisions of FAR 23.175(b) and with paragraph (b) of this section, the airspeed must return to within ±7 1/2 percent of the trim speed.

(b) *Cruise stability.* The stick force curve must have a stable slope for a speed range of ±50 knots from the trim speed except that the speeds need not exceed VFC/MFC or be less than 1.4 Vs1. This speed range will be considered to begin at the outer extremes of the friction band and the stick force may not exceed 50 pounds with --

(i) Landing gear retracted;

(ii) Wing flaps retracted;

(iii) The maximum cruising power as selected by the applicant as an operating limitation for turbine engines or 75 percent of maximum continuous power for reciprocating engines except that the power need not exceed that required at VMO/MMO:

(iv) Maximum takeoff weight; and

(v) The airplane trimmed for level flight with the power specified in subparagraph (iii) of this paragraph.

VFC/MFC may not be less than a speed midway between VMO/MMO and VDF/MDF, except that, for altitudes where Mach number is the limiting factor, MFC need not exceed the Mach number at which effective speed warning occurs.

(c) *Climb stability. For turbopropeller powered airplanes only.* In showing compliance with FAR 23.175(a), an applicant must in lieu of the power specified in FAR 23.175(a)(4), use the maximum power or thrust selected by the applicant as an operating limitation for use during climb at the best rate of climb speed except that the speed need not be less than 1.4 Vs1.

STALLS

10. *Stall warning.* If artificial stall warning is required to comply with the requirements of FAR 23.207, the warning device must give clearly distinguishable indications under expected conditions of flight. The use of a visual warning device that requires the attention of the crew within the cockpit is not acceptable by itself.

CONTROL SYSTEMS

11. *Electric trim tabs.* The airplane must meet the requirements of FAR 23.677 and in addition it must be shown that the airplane is safely controllable and that a pilot can perform all the maneuvers and operations necessary to effect a safe landing following any probable electric trim tab runaway which might be reasonably expected in service allowing for appropriate time delay after pilot recognition of the runaway. This demonstration must be conducted at the critical airplane weights and center of gravity positions.

INSTRUMENTS: INSTALLATION

12. *Arrangement and visibility.* Each instrument must meet the requirements of FAR 23.1321 and in addition --

(a) Each flight, navigation, and powerplant instrument for use by any pilot must be plainly visible to him from his station with the minimum practicable deviation from his normal position and line of vision when he is looking forward along the flight path.

(b) The flight instruments required by FAR 23.1303 and by the applicable operating rules must be grouped on the instrument panel and centered as nearly as practicable about the vertical plane of each pilot's forward vision. In addition --

(1) The instrument that most effectively indicates the attitude must be on the panel in the top center position;

(2) The instrument that most effectively indicates airspeed must be adjacent to and directly to the left of the instrument in the top center position;

(3) The instrument that most effectively indicates altitude must be adjacent to and directly to the right of the instrument in the top center position; and

(4) The instrument that most effectively indicates direction of flight must be adjacent to and directly below the instrument in the top center position.

13. *Airspeed indicating system.* Each airspeed indicating system must meet the requirements of FAR 23.1323 and in addition --

(a) Airspeed indicating instruments must be of an approved type and must be calibrated to indicate true airspeed at sea level in the standard atmosphere with a mimimum practicable instrument calibration error when the corresponding pilot and static pressures are supplied to the instruments.

(b) The airspeed indicating system must be calibrated to determine the system error, i.e., the relation between IAS and CAS, in flight and during the accelerate takeoff ground run. The ground run calibration must be obtained between 0.8 of the mimimum value of $V1$ and 1.2 times the maximum value of $V1$, considering the approved ranges of altitude and weight. The ground run calibration will be determined assuming an engine failure at the mimimum value of $V1$.

(c) The airspeed error of the installation excluding the instrument calibration error, must not exceed 3 percent or 5 knots whichever is greater, throughout the speed range from VMO to 1.3S1 with flaps retracted and from 1.3 VSO to VFE with flaps in the landing position.

(d) Information showing the relationship between IAS and CAS must be shown in the Airplane Flight Manual.

14. *Static air vent system.* The static air vent system must meet the requirements of FAR 23.1325. The altimeter system calibration must be determined and shown in the Airplane Flight Manual.

OPERATING LIMITATIONS AND INFORMATION

15. *Maximum operating limit speed V*MO/*M*MO. Instead of establishing operating limitations based on VME and VNO, the applicant must establish a maximum operating limit speed VMO/MMO in accordance with the following:

(a) The maximum operating limit speed must not exceed the design cruising speed Vc and must be sufficiently below VD/MD or VDF/MDF to make it highly improbable that the latter speeds will be inadvertently exceeded in flight.

(b) The speed Vmo must not exceed 0.8 VD/MD or 0.8 VDF/MDF unless flight demonstrations involving upsets as specified by the Administrator indicates a lower speed margin will not result in speeds exceeding VD/MD or VDF. Atmospheric variations, horizontal gusts, and equipment errors, and airframe production variations will be taken into account.

16. *Minimum flight crew.* In addition to meeting the requirements of FAR 23.1523, the applicant must establish the minimum number and type of qualified flight crew personnel sufficient for safe operation of the airplane considering --

(a) Each kind of operation for which the applicant desires approval;

(b) The workload on each crewmember considering the following:

(1) Flight path control.

(2) Collision avoidance.

(3) Navigation.

(4) Communications.

(5) Operation and monitoring of all essential aircraft systems.

(6) Command decisions; and

(c) The accessibility and ease of operation of necessary controls by the appropriate crewmember during all normal and emergency operations when at his flight station.

17. *Airspeed indicator.* The airspeed indicator must meet the requirements of FAR 23.1545 except that, the airspeed notations and markings in terms of VNO and VNE must be replaced by the VMO/MMO notations. The airspeed indicator markings must be easily read and understood by the pilot. A placard adjacent to the airspeed indicator is an acceptable means of showing compliance with the requirements of FAR 23.1545(c).

AIRPLANE FLIGHT MANUAL

18. *General.* The Airplane Flight Manual must be prepared in accordance with the requirements of FARs 23.1583 and 23.1587, and in addition the operating limitations and performance information set forth in sections 19 and 20 must be included.

19. *Operating limitations.* The Airplane Flight Manual must include the following limitations --

(a) *Airspeed limitations.* (1) The maximum operating limit speed VMO/MMO and a statement that this speed limit may not be deliberately exceeded in any regime of flight (climb, cruise, or descent) unless a higher speed is authorized for flight test or pilot training;

(2) If an airspeed limitation is based upon compressibility effects, a statement to this effect and information as to any symptoms, the probable behavior of the airplane, and the recommended recovery procedures; and

(3) The airspeed limits, shown in terms of V_{MO}/M_{MO} instead of V_{NO} and V_{NE}.

(b) *Takeoff weight limitations.* The maximum takeoff weight for each airport elevation, ambient temperature, and available takeoff runway length within the range selected by the applicant. This weight may not exceed the weight at which:

(1) The all-engine operating takeoff distance determined in accordance with section 5(d) or the accelerate-stop distance determined in accordance with section 5(c), which ever is greater, is equal to the available runway length;

(2) The airplane complies with the one-engine-inoperative takeoff requirements specified in section 5(e); and

(3) The airplane complies with the one-engine-inoperative en route climb requirements specified in section 6(b), assuming that a standard temperature lapse rate exists from the airport elevation to the altitude of 5,000 feet, except that the weight may not exceed that corresponding to a temperature of 41 °F at 5,000 feet.

20. *Performance information.* The Airplane Flight Manual must contain the performance information determined in accordance with the provisions of the performance requirements of this regulation. The information must include the following:

(a) Sufficient information so that the take-off weight limits specified in section 19(b) can be determined for all temperatures and altitudes within the operation limitations selected by the applicant.

(b) The conditions under which the performance information was obtained, including the airspeed at the 50-foot height used to determine landing distances.

(c) The performance information (determined by extrapolation and computed for the range of weights between the maximum landing and takeoff weights) for --

(1) Climb in the landing configuration; and

(2) Landing distance.

(d) Procedure established under section 4 of this regulation related to the limitations and information required by this section in the form of guidance material including any relevant limitations or information.

(e) An explanation of significant or unusual flight or ground handling characteristics of the airplane.

(f) Airspeeds, as indicated airspeeds, corresponding to those determined for takeoff in accordance with section 5(b).

21. *Maximum operating altitudes.* The maximum operating altitude to which operation is permitted, as limited by flight, structural, powerplant, functional, or equipment characteristics, must be specified in the Airplane Flight Manual.

22. *Stowage provision for Airplane Flight Manual.* Provision must be made for stowing the Airplane Flight Manual in a suitable fixed container which is readily accessible to the pilot.

23. *Operating procedures.* Procedures for restarting turbine engines in flight (including the effects of altitude) must be set forth in the Airplane Flight Manual.

AIRFRAME REQUIREMENTS

FLIGHT LOADS

24. *Engine torque.* (a) Each turbopropeller engine mount and its supporting structure must be designed for the torque effects of --

(1) The conditions set forth in FAR 23.361(a).

(2) The limit engine torque corresponding to takeoff power and propeller speed, multiplied by a factor accounting for propeller control system malfunction, including quick feathering action, simultaneously with 1 *g* level flight loads. In the absence of a rational analysis, a factor of 1.6 must be used.

(b) The limit torque is obtained by multiplying the mean torque by a factor of 1.25.

25. *Turbine engine gyroscopic loads.* Each turbopropeller engine mount and its supporting structure must be designed for the gyroscopic loads that result, with the engines at maximum continuous r.p.m., under either --

(a) The conditions prescribed in FARs 23.351 and 23.423; or

(b) All possible combinations of the following:

(1) A yaw velocity of 2.5 radius per second.

(2) A pitch velocity of 1.0 radians per second.

(3) A normal load factor of 2.5.

(4) Maximum continuous thrust.

26. *Unsymmetrical loads due to engine failure.* (a) Turbopropeller powered airplanes 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 VD, 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 buildup occurring as a result of the prescribed engine failures must be substantiated by test or other data applicable to the particular engine-propeller combination.

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

(b) Pilot corrective action may be assumed to be initiated at the time maximum yawing velocity is reached, but not earlier than two seconds after the engine failure. The magnitude of the corrective action may be based on the control forces specified in FAR 23.397 except that lower forces may be assumed where it is shown by analysis or test that these forces can control the yaw and roll resulting from the prescribed engine failure conditions.

GROUND LOADS

27. *Dual wheel landing gear units.* Each dual wheel landing gear unit and its supporting structure must be shown to comply with the following:

(a) *Pivoting.* The airplane must be assumed to pivot about one side of the main gear with the brakes on that side locked. The limit vertical load factor must be 1.0 and the coefficient of friction 0.8. This condition need apply only to the main gear and its supporting structure.

(b) *Unequal tire inflation.* A 60-40 percent distribution of the loads established in accordance with FAR 23.471 through FAR 23.483 must be applied to the dual wheels.

(c) *Flat tire.* (1) Sixty percent of the loads specified in FAR 23.471 through FAR 23.483 must be applied to either wheel in a unit.

(2) Sixty percent of the limit drag and side loads and 100 percent of the limit vertical load established in accordance with FARs 23.493 and 23.485 must be applied to either wheel in a unit except that the vertical load need not exceed the maximum vertical load in paragraph (c)(1) of this section.

FATIGUE EVALUATION

28. *Fatigue evaluation of wing and associated structure.* Unless it is shown that the structure, operating stress levels, materials, and expected use are comparable from a fatigue standpoint to a similar design which has had substantial satisfactory service experience, the strength, detail design, and the fabrication of those parts of the wing, wing carrythrough, and attaching structure whose failure would be catastrophic must be evaluated under either --

(a) A fatigue strength investigation in which the structure is shown by analysis, tests, or both to be able to withstand the repeated loads of variable magnitude expected in service; or

(b) 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, 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 percent of the critical limit load factor 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.

DESIGN AND CONSTRUCTION

29. *Flutter.* For Multiengine turbopropeller powered airplanes, a dynamic evaluation must be made and must include --

(a) The significant elastic, inertia, and aerodynamic forces associated with the rotations and displacements of the plane of the propeller; and

(b) Engine-propeller-nacelle stiffness and damping variations appropriate to the particular configuration.

LANDING GEAR

30. *Flap operated landing gear warning device.* Airplanes having retractable landing gear and wing flaps must be equipped with a warning device that functions continuously when the wing flaps are extended to a flap position that activates the warning device to give adequate warning before landing, using normal landing procedures, 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 system (including the aural warning device) provided for other landing gear warning devices.

PERSONNEL AND CARGO ACCOMMODATIONS

31. *Cargo and baggage compartments.* Cargo and baggage compartments must be designed to meet the requirements of FAR 23.787 (a) and (b), and in addition means must be provided to protect passengers from injury by the contents of any cargo or baggage compartment when the ultimate forward inertia force is 9*g*.

32. *Doors and exits.* The airplane must meet the requirements of FAR 23.783 and FAR 23.807 (a)(3), (b), and (c), and in addition:

(a) There must be a means to lock and safeguard each external door and exit against opening in flight either inadvertently by persons, or as a result of mechanical failure. Each external door must be operable from both the inside and the outside.

(b) There must be means for direct visual inspection of the locking mechanism by crewmembers to determine whether external doors and exits, for which the initial opening movement is outward, are fully locked. In addition, there must be a visual means to signal to crewmembers when normally used external doors are closed and fully locked.

(c) The passenger entrance door must qualify as a floor level emergency exit. 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:

(1) For a total seating capacity of 15 or less, an emergency exit as defined in FAR 23.807(b) is required on each side of the cabin.

(2) For a total seating capacity of 16 through 23, three emergency exits as defined in 23.807(b) are required with one on the same side as the door and two on the side opposite the door.

(d) An evacuation demonstration must be conducted utilizing the maximum number of occupants for which certification is desired. It must be conducted under simulated night conditions utilizing only the emergency exits on the most critical side of the aircraft. 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.

(e) Each emergency exit must be marked with the word "Exit" by a sign which has white letters 1 inch high on a red background 2 inches high, be self-illuminated or independently internally electrically illuminated, and have a minimum luminescence (brightness) of at least 160 microlamberts. The colors may be reversed if the passenger compartment illumination is essentially the same.

(f) Access to window type emergency exits must not be obstructed by seats or seat backs.

(g) The width of the main passenger aisle at any point between seats must equal or exceed the values in the following table.

Total seating capacity	Minimum main passenger aisle width	
	Less than 25 inches from floor	25 inches and more from floor
10 through 23..................	9 inches..........	15 inches.

MISCELLANEOUS

33. *Lightning strike protection.* Parts that are electrically insulated from the basic airframe must be connected to it through lightning arrestors unless a lightning strike on the insulated part --

(a) Is improbable because of shielding by other parts; or

(b) Is not hazardous.

34. *Ice protection.* 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 Airplane Flight Manual.

(b) An analysis must be performed to establish, on the basis of the airplane's operational needs, the adequacy of the ice protection system for the various components of the airplane. In addition, tests of the ice protection system must be conducted to demonstrate that the airplane is capable of operating safely in continuous maximum and intermittent maximum icing conditions as described in FAR 25, appendix C.

(c) Compliance with all or portions of this section may be accomplished by reference, where applicable because of similarity of the designs, to analysis and tests performed by the applicant for a type certificated model.

35. *Maintenance information.* The applicant must make available to the owner at the time of delivery of the airplane the information he considers essential for the proper maintenance of the airplane. That information must include the following:

(a) Description of systems, including electrical, hydraulic, and fuel controls.

(b) Lubrication instructions setting forth the frequency and the lubricants and fluids which are to be used in the various systems.

(c) Pressures and electrical loads applicable to the various systems.

(d) Tolerances and adjustments necessary for proper functioning.

(e) Methods of leveling, raising, and towing.

(f) Methods of balancing control surfaces.

(g) Identification of primary and secondary structures.

(h) Frequency and extent of inspections necessary to the proper operation of the airplane.

(i) Special repair methods applicable to the airplane.

(j) Special inspection techniques, including those that require X-ray, ultrasonic, and magnetic particle inspection.

(k) List of special tools.

PROPULSION

GENERAL

36. *Vibration characteristics.* For turbopropeller powered airplanes, the engine installation must not result in vibration characteristics of the engine exceeding those established during the type certification of the engine.

37. *In-flight restarting of engine.* If the engine on turbopropeller powered airplanes cannot be restarted at the maximum cruise altitude, a determination must be made of the altitude below which restarts can be consistently accomplished. Restart information must be provided in the Airplane Flight Manual.

38. *Engines* -- (a) *For turbopropeller powered airplanes.* The engine installation must comply with the following requirements:

(1) *Engine isolation.* The powerplants must be arranged and isolated from each other to allow operation, in at least one configuration, so that the failure or malfunction of any engine, or of any system that can affect the engine, will not --

(i) Prevent the continued safe operation of the remaining engines; or

(ii) Require immediate action by any crewmember for continued safe operation.

(2) *Control of engine rotation.* There must be a means to individually stop and restart the rotation of any engine in flight except that engine rotation need not be stopped if continued rotation could not jeopardize the safety of the airplane. Each component of the stopping and restarting system on the engine side of the firewall, and that might be exposed to fire, must be at least fire resistant. If hydraulic propeller feathering systems are used for this purpose, the feathering lines must be at least fire resistant under the operating conditions that may be expected to exist during feathering.

(3) *Engine speed and gas temperature control devices.* The powerplant systems associated with engine control devices, systems, and instrumentation must provide reasonable assurance that those engine operating limitations that adversely affect turbine rotor structural integrity will not be exceeded in service.

(b) *For reciprocating-engine powered airplanes.* To provide engine isolation, the powerplants must be arranged and isolated from each other to allow operation, in at least one configuration, so that the failure or malfunction of any engine, or of any system that can affect that engine, will not --

(1) Prevent the continued safe operation of the remaining engines; or

(2) Require immediate action by any crewmember for continued safe operation.

39. *Turbopropeller reversing systems.* (a) Turbopropeller reversing systems intended for ground operation must be designed so that no single failure 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 the probability of this kind of failure is extremely remote.

(b) Turbopropeller reversing systems 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 reasonably likely combination of failures) of the reversing system, under any anticipated condition of operation of the airplane. Failure of structural elements need not be considered if the probability of this kind of failure is extremely remote.

(c) Compliance with this section may be shown by failure analysis, 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 stop position. The analysis may include or be supported by the analysis made to show compliance with the type certification of the propeller and associated installation components. Credit will be given for pertinent analysis and testing completed by the engine and propeller manufacturers.

40. *Turbopropeller drag-limiting systems.* Turbopropeller 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 airplane was designed. Failure of structural elements of the drag-limiting systems need not be considered if the probability of this kind of failure is extremely remote.

41. *Turbine engine powerplant operating characteristics.* For turbopropeller powered airplanes, the 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 operation within the range of operating limitations of the airplane and of the engine.

42. *Fuel flow.* (a) For turbopropeller powered airplanes --

(1) The fuel system must provide for continuous supply of fuel to the engines for normal operation without interruption due to depletion of fuel in any tank other than the main tank; and

(2) The fuel flow rate for turbopropeller engine fuel pump systems must not be less than 125 percent of the fuel flow required to develop the standard sea level atmospheric conditions takeoff power selected and included as an operating limitation in the Airplane Flight Manual.

(b) For reciprocating engine powered airplanes, it is acceptable for the fuel flow rate for each pump system (main and reserve supply) to be 125 percent of the takeoff fuel consumption of the engine.

FUEL SYSTEM COMPONENTS

43. *Fuel pumps.* For turbopropeller powered airplanes, a reliable and independent power source must be provided for each pump used with turbine engines which do not have provisions for mechanically driving the main pumps. It must be demonstrated that the pump installations provide a reliability and durability equivalent to that provided by FAR 23.991(a).

44. *Fuel strainer or filter.* For turbopropeller powered airplanes, the following apply:

(a) There must be a fuel strainer or filter between the tank outlet and the fuel metering device of the engine. In addition, the fuel strainer or filter must be --

(1) Between the tank outlet and the engine-driven positive displacement pump inlet, if there is an engine-driven positive displacement pump;

(2) Accessible for drainage and cleaning and, for the strainer screen, easily removable; and

(3) 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.

(b) Unless there are means in the fuel system to prevent the accumulation of ice on the filter, there must be means to automatically maintain the fuel flow if ice-clogging of the filter occurs; and

(c) The fuel strainer or filter must be of adequate capacity (with respect to operating limitations established to insure proper service) and of appropriate mesh to insure proper engine operation, with the fuel contaminated to a degree (with respect to particle size and density) that can be reasonably expected in service. The degree of fuel filtering may not be less than that established for the engine type certification.

45. *Lightning strike protection.* Protection must be provided against the ignition of flammable vapors in the fuel vent system due to lightning strikes.

COOLING

46. *Cooling test procedures for turbopropeller powered airplanes.* (a) Turbopropeller powered airplanes must be shown to comply with the requirements of FAR 23.1041 during takeoff, climb en route, and landing stages of flight that correspond to the applicable performance requirements. The cooling test must be conducted with the airplane in the configuration and operating under the conditions that are critical relative to cooling during each stage of flight. For the cooling tests a temperature is "stabilized" when its rate of change is less than 2 °F. per minute.

(b) Temperatures must be stabilized under the conditions from which entry is made into each stage of flight being investigated unless the entry condition is not one during which component and engine fluid temperatures would stabilize, 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 takeoff cooling test must be preceded by a period during which the powerplant component and engine fluid temperatures are stabilized 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 stabilize;

(2) The stage of flight is completed; or

(3) An operating limitation is reached.

INDUCTION SYSTEM

47. *Air induction.* For turbopropeller powered airplanes --

(a) 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 intake system; and

(b) The air inlet ducts must be located or protected so as to minimize the ingestion of foreign matter during takeoff, landing, and taxiing.

48. *Induction system icing protection.* For turbopropeller powered airplanes, each turbine engine must be able to operate throughout its flight power range without adverse effect on engine operation or serious loss of power or thrust, under the icing conditions specified in appendix C of FAR 25. In addition, there must be means to indicate to appropriate flight crewmembers the functioning of the powerplant ice protection system.

49. *Turbine engine bleed air systems.* Turbine engine bleed air systems of turbopropeller powered airplanes must be investigated to determine --

(a) That no hazard to the airplane will result if a duct rupture occurs. This condition must consider that a failure of the duct can occur anywhere between the engine port and the airplane bleed service; and

(b) That if the bleed air system is used for direct cabin pressurization, it is not possible for hazardous contamination of the cabin air system to occur in event of lubrication system failure.

EXHAUST SYSTEM

50. *Exhaust system drains.* Turbopropeller engine exhaust systems having low spots or pockets must incorporate drains at such locations. These drains must discharge clear of the airplane in normal and ground attitudes to prevent the accumulation of fuel after the failure of an attempted engine start.

POWERPLANT CONTROLS AND ACCESSORIES

51. *Engine controls.* If throttles or power levers for turbopropeller powered airplanes are such that any position of these controls will reduce the fuel flow to the engine(s) below that necessary for satisfactory and safe idle operation of the engine while the airplane is in flight, a means must be provided to prevent inadvertent movement of the control into this position. The means provided must incorporate a positive lock or stop at this idle position and must require a separate and distinct operation by the crew to displace the control from the normal engine operating range.

52. *Reverse thrust controls.* For turbopropeller powered airplanes, the propeller reverse thrust controls must have a means to prevent their inadvertent operation. The means must have a positive lock or stop at the idle position and must require a separate and distinct operation by the crew to displace the control from the flight regime.

53. *Engine ignition systems.* Each turbopropeller airplane ignition system must be considered an essential electrical load.

54. *Powerplant accessories.* The powerplant accessories must meet the requirements of FAR 23.1163, and if the continued rotation of any accessory remotely driven by the engine is hazardous when malfunctioning occurs, there must be means to prevent rotation without interfering with the continued operation of the engine.

POWERPLANT FIRE PROTECTION

55. *Fire detector system.* For turbopropeller powered airplanes, the following apply:

(a) There must be a means that ensures prompt detection of fire in the engine compartment. An overtemperature switch in each engine cooling air exit is an acceptable method of meeting this requirement.

(b) Each fire detector must be constructed and installed to withstand the vibration, inertia, and other loads to which it may be subjected in operation.

(c) No fire detector may be affected by any oil, water, other fluids, or fumes that might be present.

(d) There must be means to allow the flight crew to check, in flight, the functioning of each fire detector electric circuit.

(e) Wiring and other components of each fire detector system in a fire zone must be at least fire resistant.

56. *Fire protection, cowling and nacelle skin.* For reciprocating engine powered airplanes, the engine cowling must be designed and constructed so that no fire originating in the engine compartment can enter, either through openings or by burn through, any other region where it would create additional hazards.

57. *Flammable fluid fire protection.* If flammable fluids or vapors might be liberated by the leakage of fluid systems in areas other than engine compartments, there must be means to --

(a) Prevent the ignition of those fluids or vapors by any other equipment; or

(b) Control any fire resulting from that ignition.

EQUIPMENT

58. *Powerplant instruments.* (a) The following are required for turbopropeller airplanes:

(1) The instruments required by FAR 23.1305 (a)(1) through (4), (b)(2) and (4).

(2) A gas temperature indicator for each engine.

(3) Free air temperature indicator.

(4) A fuel flowmeter indicator for each engine.

(5) Oil pressure warning means for each engine.

(6) A torque indicator or adequate means for indicating power output for each engine.

(7) Fire warning indicator for each engine.

(8) A means to indicate when the propeller blade angle is below the low-pitch position corresponding to idle operation in flight.

(9) A means to indicate the functioning of the ice protection system for each engine.

(b) For turbopropeller powered airplanes, the turbopropeller blade position indicator must begin indicating when the blade has moved below the flight low-pitch position.

(c) The following instruments are required for reciprocating-engine powered airplanes:

(1) The instruments required by FAR 23.1305.

(2) A cylinder head temperature indicator for each engine.

(3) A manifold pressure indicator for each engine.

SYSTEMS AND EQUIPMENTS

GENERAL

59. *Function and installation.* The systems and equipment of the airplane must meet the requirements of FAR 23.1301, and the following:

(a) Each item of additional installed equipment must --

(1) Be of a kind and design appropriate to its intended function;

(2) Be labeled as to its identification, function, or operating limitations, or any applicable combination of these factors, unless misuse or inadvertent actuation cannot create a hazard;

(3) Be installed according to limitations specified for that equipment; and

(4) Function properly when installed.

(b) Systems and installations must be designed to safeguard against hazards to the aircraft in the event of their malfunction or failure.

(c) Where an installation, the functioning of which is necessary in showing compliance with the applicable requirements, requires a power supply, such installation must be considered an essential load on the power supply, and the power sources and the distribution system must be capable of supplying the following power loads in probable operation combinations and for probable durations:

(1) All essential loads after failure of any prime mover, power converter, or energy storage device.

(2) All essential loads after failure of any one engine on two-engine airplanes.

(3) In determining the probable operating combinations and durations of essential loads for the power failure conditions described in subparagraphs (1) and (2) of this paragraph, it is permissible to assume that the power loads are reduced in accordance with a monitoring procedure which is consistent with safety in the types of operations authorized.

60. *Ventilation.* The ventilation system of the airplane must meet the requirements of FAR 23.831, and in addition, for pressurized aircraft the ventilating air in flight crew and passenger compartments must be free of harmful or hazardous concentrations of gases and vapors in normal operation and in the event of reasonably probable failures or malfunctioning of the ventilating, heating, pressurization, 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.

ELECTRICAL SYSTEMS AND EQUIPMENT

61. *General.* The electrical systems and equipment of the airplane must meet the requirements of FAR 23.1351, and the following:

(a) *Electrical system capacity.* The required generating capacity, and number and kinds of power sources must --

(1) Be determined by an electrical load analysis, and

(2) Meet the requirements of FAR 23.1301.

(b) *Generating system.* The generating system includes electrical power sources, main power busses, transmission cables, and associated control, regulation, and protective devices. It must be designed so that --

(1) The system voltage and frequency (as applicable) at the terminals of all essential load equipment can be maintained within the limits for which the equipment is designed, during any probable operating conditions;

(2) System transients due to switching, fault clearing, or other causes do not make essential loads inoperative, and do not cause a smoke or fire hazard;

(3) There are means, accessible in flight to appropriate crewmembers, for the individual and collective disconnection of the electrical power sources from the system; and

(4) There are means to indicate to appropriate crewmembers the generating system quantities essential for the safe operation of the system, including the voltage and current supplied by each generator.

62. *Electrical equipment and installation.* Electrical equipment controls, and wiring must be installed so that operation of any one unit or system of units will not adversely affect the simultaneous operation of to the safe operation.

63. *Distribution system.* (a) For the purpose of complying with this section, the distribution system includes the distribution busses, their associated feeders and each control and protective device.

(b) 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.

(c) If two independent sources of electrical power for particular equipment or systems are required by this regulation, their electrical energy supply must be insured by means such as duplicate electrical equipment, throwover switching, or multichannel or loop circuits separately routed.

64. *Circuit protective devices.* The circuit protective devices for the electrical circuits of the airplane must meet the requirements of FAR 23.1357, and in addition circuits for loads which are essential to safe operation must have individual and exclusive circuit protection.

[Doc. No. 8070, 34 FR 189, Jan. 7, 1969, as amended by SFAR 23-1, 34 FR 20176, Dec. 24, 1969; 35 FR 1102, Jan. 28, 1970]

Subpart A -- General

[TOP]

§23.1 Applicability.

(a) This part prescribes airworthiness standards for the issue of type certificates, and changes to those certificates, for airplanes in the normal, utility, acrobatic, and commuter categories.

(b) Each person who applies under Part 21 for such a certificate or change must show compliance with the applicable requirements of this part.

[Doc. No. 4080, 29 FR 17955, Dec. 18, 1964, as amended by Amdt. 23-34, 52 FR 1825, Jan. 15, 1987]

[TOP]

§23.2 Special retroactive requirements.

(a) Notwithstanding §§21.17 and 21.101 of this chapter and irrespective of the type certification basis, each normal, utility, and acrobatic category airplane having a passenger seating configuration, excluding pilot seats, of nine or less, manufactured after December 12, 1986, or any such foreign airplane for entry into the United States must provide a safety belt and shoulder harness for each forward- or aft-facing seat which will protect the occupant from serious head injury when subjected to the inertia loads resulting from the ultimate static load factors prescribed in §23.561(b)(2) of this part, or which will provide the occupant protection specified in §23.562 of this part when that section is applicable to the airplane. For other seat orientations, the seat/restraint system must be designed to provide a level of occupant protection equivalent to that provided for forward- or aft-facing seats with a safety belt and shoulder harness installed.

(b) Each shoulder harness installed at a flight crewmember station, as required by this section, must allow the crewmember, when seated with the safety belt and shoulder harness fastened, to perform all functions necessary for flight operations.

(c) For the purpose of this section, the date of manufacture is:

(1) The date the inspection acceptance records, or equivalent, reflect that the airplane is complete and meets the FAA approved type design data; or

(2) In the case of a foreign manufactured airplane, the date the foreign civil airworthiness authority certifies the airplane is complete and issues an original standard airworthiness certificate, or the equivalent in that country.

[Amdt. 23-36, 53 FR 30812, Aug. 15, 1988]

[TOP]

§23.3 Airplane categories.

(a) The normal category is limited to airplanes that have a seating configuration, excluding pilot seats, of nine or less, a maximum certificated takeoff weight of 12,500 pounds or less, and intended for nonacrobatic operation. Nonacrobatic operation includes:

(1) Any maneuver incident to normal flying;

(2) Stalls (except whip stalls); and

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

(b) The utility category is limited to airplanes that have a seating configuration, excluding pilot seats, of nine or less, a maximum certificated takeoff weight of 12,500 pounds or less, and intended for limited acrobatic operation. Airplanes certificated in the utility category may be used in any of the operations covered under paragraph (a) of this section and in limited acrobatic operations. Limited acrobatic operation includes:

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

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

(c) The acrobatic category is limited to airplanes that have a seating configuration, excluding pilot seats, of nine or less, a maximum certificated takeoff weight of 12,500 pounds or less, and intended for use without restrictions, other than those shown to be necessary as a result of required flight tests.

(d) The commuter category is limited to propeller-driven, multiengine airplanes that have a seating configuration, excluding pilot seats, of 19 or less, and a maximum certificated takeoff weight of 19,000 pounds or less. The commuter category operation is limited to any maneuver incident to normal flying, stalls (except whip stalls), and steep turns, in which the angle of bank is not more than 60 degrees.

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

[Doc. No. 4080, 29 FR 17955, Dec. 18, 1964, as amended by Amdt. 23-4, 32 FR 5934, Apr. 14, 1967; Amdt. 23-34, 52 FR 1825, Jan. 15, 1987; 52 FR 34745, Sept. 14, 1987; Amdt. 23-50, 61 FR 5183, Feb. 9, 1996]

Subpart B -- Flight

General

[TOP]

§23.21 Proof of compliance.

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

(1) By tests upon an airplane 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 center 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.

[TOP]

§23.23 Load distribution limits.

(a) Ranges of weights and centers of gravity within which the airplane may be safely operated must be established. If a weight and center of gravity combination is allowable only within certain lateral load distribution limits that could be inadvertently exceeded, these limits must be established for the corresponding weight and center of gravity combinations.

(b) The load distribution limits may not exceed any of the following:

(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.

[Doc. No. 26269, 58 FR 42156, Aug. 6, 1993]

[TOP]

§23.25 Weight limits.

(a) *Maximum weight.* The maximum weight is the highest weight at which compliance with each applicable requirement of this part (other than those complied with at the design landing 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 this part (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) Not less than the weight with --

(i) Each seat occupied, assuming a weight of 170 pounds for each occupant for normal and commuter category airplanes, and 190 pounds for utility and acrobatic category airplanes, except that seats other than pilot seats may be placarded for a lesser weight; and

(A) Oil at full capacity, and

(B) At least enough fuel for maximum continuous power operation of at least 30 minutes for day-VFR approved airplanes and at least 45 minutes for night-VFR and IFR approved airplanes; 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 this part is shown) must be established so that it is not more than the sum of --

(1) The empty weight determined under §23.29;

(2) The weight of the required minimum crew (assuming a weight of 170 pounds for each crewmember); and

(3) The weight of --

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

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

[Doc. No. 4080, 29 FR 17955, Dec. 18, 1964, as amended by Amdt. 23-7, 34 FR 13086, Aug. 13, 1969; Amdt. 23-21, 43 FR 2317, Jan. 16, 1978; Amdt. 23-34, 52 FR 1825, Jan. 15, 1987; Amdt. 23-45, 58 FR 42156, Aug. 6, 1993; Amdt. 23-50, 61 FR 5183, Feb. 9, 1996]

[TOP]

§23.29 Empty weight and corresponding center of gravity.

(a) The empty weight and corresponding center of gravity must be determined by weighing the airplane with --

(1) Fixed ballast;

(2) Unusable fuel determined under §23.959; and

(3) Full operating fluids, including --

(i) Oil;

(ii) Hydraulic fluid; and

(iii) Other fluids required for normal operation of airplane systems, except potable water, lavatory precharge water, and water intended for injection in the engines.

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

[Doc. No. 4080, 29 FR 17955, Dec. 18, 1964; 30 FR 258, Jan. 9, 1965, as amended by Amdt. 23-21, 43 FR 2317, Jan. 16, 1978]

[TOP]

§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 §23.1557; and

(b) Instructions are included in the airplane 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.

[Doc. No. 4080, 29 FR 17955, Dec. 18, 1964; 30 FR 258, Jan. 9, 1965, as amended by Amdt. 23-13, 37 FR 20023, Sept. 23, 1972]

[TOP]

§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 takeoff and initial climb at the all engine(s) operating climb speed specified in §23.65, the propeller must limit the engine r.p.m., at full throttle or at maximum allowable takeoff manifold pressure, to a speed not greater than the maximum allowable takeoff r.p.m.; and

(2) During a closed throttle glide, at VNE, the propeller may not cause an engine speed above 110 percent 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 paragraph (b)(1) of this section; and

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

(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 takeoff r.p.m.; and

(2) With the governor inoperative, the propeller blades at the lowest possible pitch, with takeoff power, the airplane stationary, and no wind, either --

(i) A means to limit the maximum engine speed to 103 percent of the maximum allowable takeoff r.p.m., or

(ii) For an engine with an approved overspeed, a means to limit the maximum engine and propeller speed to not more than the maximum approved overspeed.

[Doc. No. 4080, 29 FR 17955, Dec. 18, 1964, as amended by Amdt. 23-45, 58 FR 42156, Aug. 6, 1993; Amdt. 23-50, 61 FR 5183, Feb. 9, 1996]

Performance

[TOP]

§23.45 General.

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

(1) Still air and standard atmosphere; and

(2) Ambient atmospheric conditions, for commuter category airplanes, for reciprocating engine-powered airplanes of more than 6,000 pounds maximum weight, and for turbine engine-powered airplanes.

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

(1) Airport altitudes from sea level to 10,000 feet; and

(2) For reciprocating engine-powered airplanes of 6,000 pounds, or less, maximum weight, temperature from standard to 30 °C above standard; or

(3) For reciprocating engine-powered airplanes of more than 6,000 pounds maximum weight and turbine engine-powered airplanes, temperature from standard to 30 °C above standard, or the maximum ambient atmospheric temperature at which compliance with the cooling provisions of §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 §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 or thrust, must be based on a relative humidity:

(1) Of 80 percent at and below standard temperature; and

(2) From 80 percent, at the standard temperature, varying linearly down to 34 percent at the standard temperature plus 50 °F.

(f) Unless otherwise prescribed, in determining the takeoff and landing distances, changes in the airplane'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) Takeoff distance of §23.53(b);

(2) Accelerate-stop distance of §23.55;

(3) Takeoff distance and takeoff run of §23.59; and

(4) Landing distance of §23.75.

Note: The effect on these distances of operation on other types of surfaces (for example, grass, gravel) when dry, may be determined or derived and these surfaces listed in the Airplane Flight Manual in accordance with §23.1583(p).

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

(1) Unless otherwise prescribed, the applicant must select the takeoff, enroute, approach, and landing configurations for the airplane.

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

(3) Unless otherwise prescribed, in determining the critical-engine-inoperative takeoff performance, takeoff flight path, and accelerate-stop distance, changes in the airplane'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 §23.67(c)(4) and §23.77(c) must be established.

(5) The procedures established under paragraphs (h)(3) and (h)(4) of this section 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 allowance for any reasonably expected time delays in the execution of the procedures.

[Doc. No. 27807, 61 FR 5184, Feb. 9, 1996]

[TOP]

§23.49 Stalling period.

(a) VSO and VS1 are the stalling speeds or the minimum steady flight speeds, in knots (CAS), at which the airplane is controllable with --

(1) For reciprocating engine-powered airplanes, the engine(s) idling, the throttle(s) closed or at not more than the power necessary for zero thrust at a speed not more than 110 percent of the stalling speed;

(2) For turbine engine-powered airplanes, the propulsive thrust not 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) The propeller(s) in the takeoff position;

(4) The airplane in the condition existing in the test, in which VSO and VS1 are being used;

(5) The center of gravity in the position that results in the highest value of VSO and VS1; and

(6) The weight used when VSO and VS1 are being used as a factor to determine compliance with a required performance standard.

(b) VSO and VS1 must be determined by flight tests, using the procedure and meeting the flight characteristics specified in §23.201.

(c) Except as provided in paragraph (d) of this section, VSO and VS1 at maximum weight must not exceed 61 knots for --

(1) Single-engine airplanes; and

(2) Multiengine airplanes of 6,000 pounds or less maximum weight that cannot meet the minimum rate of climb specified in §23.67(a)(1) with the critical engine inoperative.

(d) All single-engine airplanes, and those multiengine airplanes of 6,000 pounds or less maximum weight with a VSO of more than 61 knots that do not meet the requirements of §23.67(a)(1), must comply with §23.562(d).

[Doc. No. 27807, 61 FR 5184, Feb. 9, 1996]

[TOP]

§23.51 Takeoff speeds.

(a) For normal, utility, and acrobatic category airplanes, rotation speed, VR, is the speed at which the pilot makes a control input, with the intention of lifting the airplane out of contact with the runway or water surface.

(1) For multiengine landplanes, VR, must not be less than the greater of 1.05 VMC; or 1.10 VS1;

(2) For single-engine landplanes, VR, must not be less than VS1; and

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

(b) For normal, utility, and acrobatic category airplanes, the speed at 50 feet above the takeoff surface level must not be less than:

(1) or multiengine airplanes, the highest of --

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

(ii) 1.10 VMC; or

(iii) 1.20 VS1.

(2) For single-engine airplanes, 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 VS1.

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

(l) V1 must be established in relation to VEF as follows:

(i) VEF is the calibrated airspeed at which the critical engine is assumed to fail. VEF must be selected by the applicant but must not be less than 1.05 VMC determined under §23.149(b) or, at the option of the applicant, not less than VMCG determined under §23.149(f).

(ii) The takeoff decision speed, V1, 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 takeoff. The takeoff decision speed, V1, must be selected by the applicant but must not be less than VEF 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 recognizes and reacts to the engine failure, as indicated by the pilot's application of the first retarding means during the accelerate-stop determination of §23.55.

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

(i) V1;

(ii) 1.05 VMC determined under §23.149(b);

(iii) 1.10 VS1; or

(iv) The speed that allows attaining the initial climb-out speed, V2, before reaching a height of 35 feet above the takeoff surface in accordance with §23.57(c)(2).

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

(4) The takeoff safety speed, V2, in terms of calibrated airspeed, must be selected by the applicant so as to allow the gradient of climb

required in §23.67 (c)(1) and (c)(2) but mut not be less than 1.10 VMC or less than 1.20 VS1.

(5) The one-engine-inoperative takeoff distance, using a normal rotation rate at a speed 5 knots less than VR, established in accordance with paragraph (c)(2) of this section, must be shown not to exceed the corresponding one-engine-inoperative takeoff distance, determined in accordance with §23.57 and §23.59(a)(1), using the established VR. The takeoff, otherwise performed in accordance with §23.57, must be continued safely from the point at which the airplane is 35 feet above the takeoff surface and at a speed not less than the established V2 minus 5 knots.

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

[Doc. No. 27807, 61 FR 5184, Feb. 9, 1996]

[TOP]

§23.53 Takeoff performance.

(a) For normal, utility, and acrobatic category airplanes, the takeoff distance must be determined in accordance with paragraph (b) of this section, using speeds determined in accordance with §23.51 (a) and (b).

(b) For normal, utility, and acrobatic category airplanes, the distance required to takeoff and climb to a height of 50 feet above the takeoff surface must be determined for each weight, altitude, and temperature within the operational limits established for takeoff with --

(1) Takeoff power on each engine;

(2) Wing flaps in the takeoff position(s); and

(3) Landing gear extended.

(c) For commuter category airplanes, takeoff performance, as required by §§23.55 through 23.59, must be determined with the operating engine(s) within approved operating limitations.

[Doc. No. 27807, 61 FR 5185, Feb. 9, 1996]

[TOP]

§23.55 Accelerate-stop distance.

For each commuter category airplane, 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 airplane from a standing start to VEF with all engines operating;

(2) Accelerate the airplane from VEF to V1, assuming the critical engine fails at VEF; and

(3) Come to a full stop from the point at which V1 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;

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

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

[Amdt. 23-34, 52 FR 1826, Jan. 15, 1987, as amended by Amdt. 23-50, 61 FR 5185, Feb. 9, 1996]

[TOP]

§23.57 Takeoff path.

For each commuter category airplane, the takeoff path is as follows:

(a) The takeoff path extends from a standing start to a point in the takeoff at which the airplane is 1500 feet above the takeoff surface at or below which height the transition from the takeoff to the enroute configuration must be completed; and

(1) The takeoff path must be based on the procedures prescribed in §23.45;

(2) The airplane must be accelerated on the ground to VEF at which point the critical engine must be made inoperative and remain inoperative for the rest of the takeoff; and

(3) After reaching VEF, the airplane must be accelerated to V2.

(b) During the acceleration to speed V2, the nose gear may be raised off the ground at a speed not less than VR. However, landing gear retraction must not be initiated until the airplane is airborne.

(c) During the takeoff path determination, in accordance with paragraphs (a) and (b) of this section --

(1) The slope of the airborne part of the takeoff path must not be negative at any point;

(2) The airplane must reach V2 before it is 35 feet above the takeoff surface, and must continue at a speed as close as practical to, but not less than V2, until it is 400 feet above the takeoff surface;

(3) At each point along the takeoff path, starting at the point at which the airplane reaches 400 feet above the takeoff surface, the available gradient of climb must not be less than --

(i) 1.2 percent for two-engine airplanes;

(ii) 1.5 percent for three-engine airplanes;

(iii) 1.7 percent for four-engine airplanes; and

(4) Except for gear retraction and automatic propeller feathering, the airplane configuration must not be changed, and no change in power that requires action by the pilot may be made, until the airplane is 400 feet above the takeoff surface.

(d) The takeoff path to 35 feet above the takeoff surface must be determined by a continuous demonstrated takeoff.

(e) The takeoff path to 35 feet above the takeoff 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, and speed;

(2) The weight of the airplane, 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 takeoff flight path must be based on the airplane's performance without utilizing ground effect.

[Amdt. 23-34, 52 FR 1827, Jan. 15, 1987, as amended by Amdt. 23-50, 61 FR 5185, Feb. 9, 1996]

[TOP]

§23.59 Takeoff distance and takeoff run.

For each commuter category airplane, the takeoff distance and, at the option of the applicant, the takeoff run, must be determined.

(a) Takeoff distance is the greater of --

(1) The horizontal distance along the takeoff path from the start of the takeoff to the point at which the airplane is 35 feet above the takeoff surface as determined under §23.57; or

(2) With all engines operating, 115 percent of the horizontal distance from the start of the takeoff to the point at which the airplane is 35 feet above the takeoff surface, determined by a procedure consistent with §23.57.

(b) If the takeoff distance includes a clearway, the takeoff run is the greater of --

(1) The horizontal distance along the takeoff path from the start of the takeoff to a point equidistant between the liftoff point and the point at which the airplane is 35 feet above the takeoff surface as determined under §23.57; or

(2) With all engines operating, 115 percent of the horizontal distance from the start of the takeoff to a point equidistant between the liftoff point and the point at which the airplane is 35 feet above the takeoff surface, determined by a procedure consistent with §23.57.

[Amdt. 23-34, 52 FR 1827, Jan. 15, 1987, as amended by Amdt. 23-50, 61 FR 5185, Feb. 9, 1996]

[TOP]

§23.61 Takeoff flight path.

For each commuter category airplane, the takeoff flight path must be determined as follows:

(a) The takeoff flight path begins 35 feet above the takeoff surface at the end of the takeoff distance determined in accordance with §23.59.

(b) The net takeoff flight path data must be determined so that they represent the actual takeoff flight paths, as determined in accordance with §23.57 and with paragraph (a) of this section, reduced at each point by a gradient of climb equal to --

(1) 0.8 percent for two-engine airplanes;

(2) 0.9 percent for three-engine airplanes; and

(3) 1.0 percent for four-engine airplanes.

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

[Amdt. 23-34, 52 FR 1827, Jan. 15, 1987]

[TOP]

§23.63 Climb: General.

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

(1) Out of ground effect; and

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

(3) Unless otherwise specified, with one engine inoperative, at a bank angle not exceeding 5 degrees.

(b) For normal, utility, and acrobatic category reciprocating engine-powered airplanes of 6,000 pounds or less maximum weight, compliance must be shown with §23.65(a), §23.67(a), where appropriate, and §23.77(a) at maximum takeoff or landing weight, as appropriate, in a standard atmosphere.

(c) For normal, utility, and acrobatic category reciprocating engine-powered airplanes of more than 6,000 pounds maximum weight, and turbine engine-powered airplanes in the normal, utility, and acrobatic category, compliance must be shown at weights as a function of airport altitude and ambient temperature, within the operational limits established for takeoff and landing, respectively, with --

(1) Sections 23.65(b) and 23.67(b) (1) and (2), where appropriate, for takeoff, and

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

(d) For commuter category airplanes, compliance must be shown at weights as a function of airport altitude and ambient temperature within the operational limits established for takeoff and landing, respectively, with --

(1) Sections 23.67(c)(1), 23.67(c)(2), and 23.67(c)(3) for takeoff; and

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

[Doc. No. 27807, 61 FR 5186, Feb. 9, 1996]

[TOP]

§23.65 Climb: All engines operating.

(a) Each normal, utility, and acrobatic category reciprocating engine-powered airplane of 6,000 pounds or less maximum weight must have a steady climb gradient at sea level of at least 8.3 percent for landplanes or 6.7 percet 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 takeoff position(s); and

(4) A climb speed not less than the greater of 1.1 VMC and 1.2 VS1 for multiengine airplanes and not less than 1.2 VS1 for single --engine airplanes.

(b) Each normal, utility, and acrobatic category reciprocating engine-powered airplane of more than 6,000 pounds maximum weight and turbine engine-powered airplanes in the normal, utility, and acrobatic category must have a steady gradient of climb after takeoff of at least 4 percent 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 sven seconds, the test may be conducted with the gear retracted;

(3) The wing flaps in the takeoff position(s); and

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

[Doc. No. 27807, 61 FR 5186, Feb. 9, 1996]

[TOP]

§23.66 Takeoff climb: One-engine inoperative.

For normal, utility, and acrobatic category reciprocating engine-powered airplanes of more than 6,000 pounds maximum weight, and turbine engine-powered airplanes in the normal, utility, and acrobatic 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 --

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

(b) The remaining engine(s) at takeoff power;

(c) The landing gear extended, except that if the landing gear can be retracted in not more than seven seconds, the test may be conducted with the gear retracted;

(d) The wing flaps in the takeoff position(s):

(e) The wings level; and

(f) A climb speed equal to that achieved at 50 feet in the demonstration of §23.53.

[Doc. No. 27807, 61 FR 5186, Feb. 9, 1996]

[TOP]

§23.67 Climb: One engine inoperative.

(a) For normal, utility, and acrobatic category reciprocating engine-powered airplanes of 6,000 pounds or less maximum weight, the following apply:

(1) Except for those airplanes that meet the requirements prescribed in §23.562(d), each airplane with a VSO of more than 61 knots must be able to maintain a steady climb gradient of at least 1.5 percent at a pressure altitude of 5,000 feet with the --

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

(ii) Remaining engine(s) at not more than maximum continuous power;

(iii) Landing gear retracted;

(iv) Wing flaps retracted; and

(v) Climb speed not less than 1.2 VS1.

(2) For each airplane that meets the requirements prescribed in §23.562(d), or that has a VSO of 61 knots or less, the steady gradient of climb or descent at a pressure altitude of 5,000 feet must be determined with the --

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

(ii) Remaining engine(s) at not more than maximum continuous power;

(iii) Landing gear retracted;

(iv) Wing flaps retracted; and

(v) Climb speed not less than 1.2VS1.

(b) For normal, utility, and acrobatic category reciprocating engine-powered airplanes of more than 6,000 pounds maximum weight, and turbine engine-powered airplanes in the normal, utility, and acrobatic category --

(1) The steady gradient of climb at an altitude of 400 feet above the takeoff must be measurably positive with the --

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

(ii) Remaining engine(s) at takeoff power;

(iii) Landing gear retracted;

(iv) Wing flaps in the takeoff position(s); and

(v) Climb speed equal to that achieved at 50 feet in the demonstration of §23.53.

(2) The steady gradient of climb must not be less than 0.75 percent at an altitude of 1,500 feet above the takeoff surface, or landing surface, as appropriate, with the --

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

(ii) Remaining engine(s) at not more than maximum continuous power;

(iii) Landing gear retracted;

(iv) Wing flaps retracted; and

(v) Climb speed not less than 1.2 VS1.

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

(1) *Takeoff; landing gear extended.* The steady gradient of climb at the altitude of the takeoff surface must be measurably positive for two-engine airplanes, not less than 0.3 percent for three-engine airplanes, or 0.5 percent for four-engine airplanes with --

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

(ii) The remaining engine(s) at takeoff power;

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

(iv) The wing flaps in the takeoff position(s);

(v) The wings level; and

(vi) A climb speed equal to V2.

(2) *Takeoff; landing gear retracted.* The steady gradient of climb at an altitude of 400 feet above the takeoff surface must be not less than 2.0 percent of two-engine airplanes, 2.3 percent for three-engine airplanes, and 2.6 percent for four-engine airplanes with --

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

(ii) The remaining engine(s) at takeoff power;

(iii) The landing gear retracted;

(iv) The wing flaps in the takeoff position(s);

(v) A climb speed equal to V2.

(3) *Enroute.* The steady gradient of climb at an altitude of 1,500 feet above the takeoff or landing surface, as appropriate, must be not less than 1.2 percent for two-engine airplanes, 1.5 percent for three-engine airplanes, and 1.7 percent for four-engine airplanes with --

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

(ii) The remaining engine(s) 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 VS1.

(4) *Discontinued approach.* The steady gradient of climb at an altitude of 400 feet above the landing surface must be not less than 2.1 percent for two-engine airplanes, 2.4 percent for three-engine airplanes, and 2.7 percent for four-engine airplanes, with --

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

(ii) The remaining engine(s) at takeoff power;

(iii) Landing gear retracted;

(iv) Wing flaps in the approach position(s) in which VS1 for these position(s) does not exceed 110 percent of the VS1 for the related all-engines-operated landing position(s); and

(v) A climb speed established in connection with normal landing procedures but not exceeding 1.5 VS1.

[Doc. No. 27807, 61 FR 5186, Feb. 9, 1996]

[TOP]

§23.69 Enroute 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 VS1.

(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 --

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

(2) The remaining engine(s) 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 VS1.

[Doc. No. 27807, 61 FR 5187, Feb. 9, 1996]

[TOP]

§23.71 Glide: Single-engine airplanes.

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

[Doc. No. 27807, 61 FR 5187, Feb. 9, 1996]

[TOP]

§23.73 Reference landing approach speed.

(a) For normal, utility, and acrobatic category reciprocating engine-powered airplanes of 6,000 pounds or less maximum weight, the reference landing approach speed, VREF, must not be less than the greater of VMC, determined in §23.149(b) with the wing flaps in the most extended takeoff position, and 1.3 VSO.

(b) For normal, utility, and acrobatic category reciprocating engine-powered airplanes of more than 6,000 pounds maximum weight, and turbine engine-powered airplanes in the normal, utility, and acrobatic category, the reference landing approach speed, VREF, must not be less than the greater of VMC, determined in §23.149(c), and 1.3 VSO.

(c) For commuter category airplanes, the reference landing approach speed, VREF, must not be less than the greater of 1.05 VMC, determined in §23.149(c), and 1.3 VSO.

[Doc. No. 27807, 61 FR 5187, Feb. 9, 1996]

[TOP]

§23.75 Landing distance.

The horizontal distance necessary to land and come to a complete stop from a point 50 feet 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 VREF, determined in accordance with §23.73 (a), (b), or (c), as appropriate, must be maintained down to the 50 foot height and --

(1) The steady approach must be at a gradient of descent not greater than 5.2 percent (3 degrees) 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 percent, 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 maneuver.

(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 §23.77 can be made from the conditions that exist at the 50 foot height, at maximum landing weight, or at the maximum landing weight for altitude and temperature of §23.63 (c)(2) or (d)(2), as appropriate.

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

(f) Retardation means other than wheel brakes may be used if that means --

(1) Is safe and reliable; and

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

(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.

[Amdt. 23-21, 43 FR 2318, Jan. 16, 1978, as amended by Amdt. 23-34, 52 FR 1828, Jan. 15, 1987; Amdt. 23-42, 56 FR 351, Jan. 3, 1991; Amdt. 23-50, 61 FR 5187, Feb. 9, 1996]

[TOP]

§23.77 Balked landing.

(a) Each normal, utility, and acrobatic category reciprocating engine-powered airplane at 6,000 pounds or less maximum weight must be able to maintain a steady gradient of climb at sea level of at least 3.3 percent with --

(1) Takeoff power on each engine;

(2) The landing gear extended;

(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 §23.73(a).

(b) Each normal, utility, and acrobatic category reciprocating engine-powered airplane of more than 6,000 pounds maximum weight and each normal, utility, and acrobatic category turbine engine-powered airplane must be able to maintain a steady gradient of climb of at least 2.5 percent with --

(1) Not more than the power that is available on each engine eight seconds after initiation of movement of the power controls from 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 §23.73(b).

(c) Each commuter category airplane must be able to maintain a steady gradient of climb of at least 3.2 percent with --

(1) Not more than the power that is available on each engine eight 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 §23.73(c).

[Doc. No. 27807, 61 FR 5187, Feb. 9, 1996]

Flight Characteristics

[TOP]
§23.141 General.

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

[Doc. No. 26269, 58 FR 42156, Aug. 6, 1993]

Controllability and Maneuverability

[TOP]
§23.143 General.

(a) The airplane must be safely controllable and maneuverable during all flight phases including --

(1) Takeoff;

(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 multiengine airplanes, 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 necessary must be determined by quantitative tests. In no case may the control forces under the conditions specified in paragraphs (a) and (b) of this section exceed those prescribed in the following table:

Values in pounds force applied to the relevant control	Pitch	Roll	Yaw
(a) For temporary application:			
Stick	60	30	....
Wheel (Two hands on rim)	75	50	....
Wheel (One hand on rim)	50	25	....
Rudder Pedal	....	....	150
(b) For prolonged application	10	5	20

[Doc. No, 4080, 29 FR 17955, Dec. 18, 1964, as amended by Amdt. 23-14, 38 FR 31819, Nov. 19, 1973; Amdt. 23-17, 41 FR 55464, Dec. 20, 1976; Amdt. 23-45, 58 FR 42156, Aug. 6, 1993; Amdt. 23-50, 61 FR 5188, Feb. 9, 1996]

[TOP]
§23.145 Longitudinal control.

(a) With the airplane as nearly as possible in trim at 1.3 VS1, 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

(3) Wing flap and landing gear --

(i) retracted, and

(ii) extended.

(b) Unless otherwise required, it must be possible to carry out the following maneuvers without requiring the application of single-handed control forces exceeding those specified in §23.143(c). The trimming controls must not be adjusted during the maneuvers:

(1) With the landing gear extended, the flaps retracted, and the airplanes as nearly as possible in trim at 1.4 VS1, extend the flaps as rapidly as possible and allow the airspeed to transition from 1.4VS1 to 1.4 VSO:

(i) With power off; and

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

(2) With landing gear and flaps extended, power off, and the airplane as nearly as possible in trim at 1.3 VSO, quickly apply takeoff power and retract the flaps as rapidly as possible to the recommended go around setting and allow the airspeed to transition from 1.3 VSO to 1.3 VS1. Retract the gear when a positive rate of climb is established.

(3) With landing gear and flaps extended, in level flight, power necessary to attain level flight at 1.1 VSO, and the airplane 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 flat positions are provided, the flap retraction may be demonstrated in stages with power and trim reset for level flight at 1.1 VS1, 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 airplane as nearly as possible in trim at 1.4 VS1, apply takeoff power rapidly while maintaining the same airspeed.

(5) With power off, landing gear and flaps extended, and the airplane as nearly as 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 §23.143(c).

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

(c) At speeds above VMO/MMO, and up to the maximum speed shown under §23.251, a maneuvering capability of 1.5 g 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 10 pounds, to maintain a speed of not more than VREF during a power-off glide with landing gear and wing flaps extended, for any weight of the airplane, up to and including the maximum weight.

(e) By using normal flight and power controls, except as otherwise noted in paragraphs (e)(1) and (e)(2) of this section, 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 airplane, as follows:

(1) For single-engine and multiengine airplanes, without the use of the primary longitudinal control system.

(2) For multiengine airplanes --

(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.

[Doc. No. 26269, 58 FR 42157, Aug. 6, 1993; Amdt. 23-45, 58 FR 51970, Oct. 5, 1993, as amended by Amdt. 23-50, 61 FR 5188, Feb. 9, 1996]

[TOP]

§23.147 Directional and lateral control.

(a) For each multiengine airplane, it must be possible, while holding the wings level within five degrees, to make sudden changes in heading safely in both directions. This ability must be shown at 1.4 VS1 with heading changes up to 15 degrees, except that the heading change at which the rudder force corresponds to the limits specified in §23.143 need not be exceeded, with the --

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

(2) Remaining engines at maximum continuous power;

(3) Landing gear --

(i) Retracted; and

(ii) Extended; and

(4) Flaps retracted.

(b) For each multiengine airplane, it must be possible to regain full control of the airplane without exceeding a bank angle of 45 degrees, 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 two seconds in the initiation of recovery action appropriate to the situation, with the airplane initially in trim, in the following condition:

(1) Maximum continuous power on each engine;

(2) The wing flaps retracted;

(3) The landing gear retracted;

(4) A speed equal to that at which compliance with §23.69(a) has been shown; and

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

(c) For all airplanes, it must be shown that the airplane is safely controllable without the use of the primary lateral control system in any all-engine configuration(s) and at any speed or altitude within the approved operating envelope. It must also be shown that the airplane'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 airplane. 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), compliance with the above requirement must be shown with those additional systems also assumed to be inoperative.

[Doc. No. 27807, 61 FR 5188, Feb. 9, 1996]

[TOP]

§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 airplane with that engine still inoperative, and thereafter maintain straight flight at the same speed with an angle of bank of not more than 5 degrees. The method used to simulate critical engine failure must represent the most critical mode of powerplant failure expected in service with respect to controllability.

(b) VMC for takeoff must not exceed 1.2 VS1, where VS1 is determined at the maximum takeoff weight. VMC must be determined with the most unfavorable weight and center of gravity position and with the airplane airborne and the ground effect negligible, for the takeoff configuration(s) with --

(1) Maximum available takeoff power initially on each engine;

(2) The airplane trimmed for takeoff;

(3) Flaps in the takeoff position(s);

(4) Landing gear retracted; and

(5) All propeller controls in the recommended takeoff position throughout.

(c) For all airplanes except reciprocating engine-powered airplanes of 6,000 pounds or less maximum weight, the conditions of paragraph (a) of this section must also be met for the landing configuration with --

(1) Maximum available takeoff power initially on each engine;

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

(3) Flaps in the landing position;

(4) Landing gear extended; and

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

(d) A minimum speed to intentionally render the critical engine inoperative must be established and designated as the safe, intentional, one-engine-inoperative speed, VSSE.

(e) At VMC, the rudder pedal force required to maintain control must not exceed 150 pounds and it must not be necessary to reduce power of the operative engine(s). During the maneuver, the airplane must not assume any dangerous attitude and it must be possible to prevent a heading change of more than 20 degrees.

(f) At the option of the applicant, to comply with the requirements of §23.51(c)(1), VMCG may be determined. VMCG is the minimum control speed on the ground, and is the calibrated airspeed during the takeoff run at which, when the critical engine is suddenly made inoperative, it is possible to maintain control of the airplane using the rudder control alone (without the use of nosewheel steering), as limited by 150 pounds of force, and using the lateral control to the extent of keeping the wings level to enable the takeoff to be safely continued. In the determination of VMCG, assuming that the path of the airplane accelerating with all engines operating is along the centerline of the runway, its path from the point at which the critical engine is made inoperative to the point at which recovery to a direction parallel to the centerline is completed may not deviate more than 30 feet laterally from the centerline at any point. VMCG must be established with --

(1) The airplane in each takeoff configuration or, at the option of the applicant, in the most critical takeoff configuration;

(2) Maximum available takeoff power on the operating engines;

(3) The most unfavorable center of gravity;

(4) The airplane trimmed for takeoff; and

(5) The most unfavorable weight in the range of takeoff weights.

[Doc. No. 27807, 61 FR 5189, Feb. 9, 1996]

[TOP]

§23.151 Acrobatic maneuvers.

Each acrobatic and utility category airplane must be able to perform safely the acrobatic maneuvers for which certification is requested. Safe entry speeds for these maneuvers must be determined.

[TOP]

§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 §23.143(c) following an approach to land --

(a) At a speed of VREF minus 5 knots;

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

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

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

[Doc. No. 27807, 61 FR 5189, Feb. 9, 1996]

[TOP]

§23.155 Elevator control force in maneuvers.

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

(1) For wheel controls, W/100 (where W is the maximum weight) or 20 pounds, whichever is greater, except that it need not be greater than 50 pounds; or

(2) For stick controls, W/140 (where W is the maximum weight) or 15 pounds, whichever is greater, except that it need not be greater than 35 pounds.

(b) The requirement of paragraph (a) of this section must be met at 75 percent of maximum continuous power for reciprocating engines, or the maximum continuous power for turbine engines, and with the wing flaps and landing gear retracted --

(1) In a turn, with the trim setting used for wings level flight at VO; and

(2) In a turn with the trim setting used for the maximum wings level flight speed, except that the speed may not exceed VNE or VMO/MMO, whichever is appropriate.

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

[Amdt. 23-14, 38 FR 31819, Nov. 19, 1973; 38 FR 32784, Nov. 28, 1973, as amended by Amdt. 23-45, 58 FR 42158, Aug. 6, 1993; Amdt. 23-50, 61 FR 5189 Feb. 9, 1996]

[TOP]

§23.157 Rate of roll.

(a) *Takeoff*. It must be possible, using a favorable combination of controls, to roll the airplane from a steady 30-degree banked turn through an angle of 60 degrees, so as to reverse the direction of the turn within:

(1) For an airplane of 6,000 pounds or less maximum weight, 5 seconds from initiation of roll; and

(2) For an airplane of over 6,000 pounds maximum weight,

$$(W+500)/1,300$$

seconds, but not more than 10 seconds, where W is the weight in pounds.

(b) The requirement of paragraph (a) of this section must be met when rolling the airplane in each direction with --

(1) Flaps in the takeoff position;

(2) Landing gear retracted;

(3) For a single-engine airplane, at maximum takeoff power; and for a multiengine airplane with the critical engine inoperative and the propeller in the minimum drag position, and the other engines at maximum takeoff power; and

(4) The airplane trimmed at a speed equal to the greater of 1.2 VS1 or 1.1 VMC, or as nearly as possible in trim for straight flight.

(c) *Approach*. It must be possible, using a favorable combination of controls, to roll the airplane from a steady 30-degree banked turn through an angle of 60 degrees, so as to reverse the direction of the turn within:

(1) For an airplane of 6,000 pounds or less maximum weight, 4 seconds from initiation of roll; and

(2) For an airplane of over 6,000 pounds maximum weight, " "

"(W+2,800)/2,200 " ""

""seconds, but not more than 7 seconds, where W is the weight in pounds. ""

""(d) The requirement of paragraph (c) of this section must be met when rolling the airplane 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 degree approach; and ""

""(4) The airplane trimmed at VREF. ""

""[Amdt. 23-14, 38 FR 31819, Nov. 19, 1973, as amended by Amdt. 23-45, 58 FR 42158, Aug. 6, 1993; Amdt. 23-50, 61 FR 5189, Feb. 9, 1996]

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""Trim ""

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[TOP]
§23.161 Trim.
""

""(a) *General*. Each airplane 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 §23.143(c). This applies in normal operation of the airplane 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 airplane must maintain lateral and directional trim in level flight with the landing gear and wing flaps retracted as follows: ""

""(1) For normal, utility, and acrobatic category airplanes, at a speed of 0.9 VH, VC, or VMO/MO, whichever is lowest; and ""

""(2) For commuter category airplanes, at all speeds from 1.4 VS1 to the lesser of VH or VMO/MMO. ""

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

""(1) A climb with -- ""

""(i) Takeoff power, landing gear retracted, wing flaps in the takeoff position(s), at the speeds used in determining the climb performance required by §23.65; and ""

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

""(2) Level flight at all speeds from the lesser of VH and either VNO or VMO/MMO (as appropriate), to 1.4 VS1, with the landing gear and flaps retracted. ""

""(3) A descent at VNO or VMO/MMO, 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 degree angle of descent, with flaps retracted and at a speed of 1.4 VS1; ""

""(ii) A 3 degree angle of descent, flaps in the landing position(s) at VREF; and ""

""(iii) An approach gradient equal to the steepest used in the landing distance demonstrations of §23.75, flaps in the landing position(s) at VREF. ""

""(d) In addition, each multiple airplane must maintain longitudinal and directional trim, and the lateral control force must not exceed 5 pounds at the speed used in complying with §23.67(a), (b)(2), or (c)(3), as appropriate, with -- ""

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

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

""(3) The landing gear retracted; ""

""(4) Wing flaps retracted; and ""

""(5) An angle of bank of not more than five degrees. ""

""(e) In addition, each commuter category airplane for which, in the determination of the takeoff path in accordance with §23.57, the climb in the takeoff configuration at V2 extends beyond 400 feet above the takeoff surface, it must be possible to reduce the longitudinal and lateral control forces to 10 pounds and 5 pounds, respectively, and the directional control force must not exceed 50 pounds at V2 with -- ""

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

""(2) The remaining engine(s) at takeoff power; ""

""(3) Landing gear retracted; ""

""(4) Wing flaps in the takeoff position(s); and ""

""(5) An angle of bank not exceeding 5 degrees. ""

""[Doc. No. 4080, 29 FR 17955, Dec. 18, 1964, as amended by Amdt. 23-21, 43 FR 2318, Jan. 16, 1978; Amdt. 23-34, 52 FR 1828, Jan. 15, 1987; Amdt. 23-42, 56 FR 351, Jan. 3, 1991; 56 FR 5455, Feb. 11, 1991; Amdt. 23-50, 61 FR 5189, Feb. 9, 1996]

""

""Stability ""

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""

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[TOP]
§23.171 General.
""

""The airplane must be longitudinally, directionally, and laterally stable under §§23.173 through 23.181. In addition, the airplane 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. ""

""
[TOP]
§23.173 Static longitudinal stability.
""

""Under the conditions specified in §23.175 and with the airplane 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 40 pounds 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 for applicable categories of airplanes when the control force is slowly released at any speed within the speed range specified in paragraph (a) of this section. The applicable tolerances are -- ""

""(1) The airspeed must return to within plus or minus 10 percent of the original trim airspeed; and ""

""(2) For commuter category airplanes, the airspeed must return to within plus or minus 7.5 percent of the original trim airspeed for the cruising condition specified in §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. ""

""[Doc. No. 4080, 29 FR 17955, Dec. 18, 1964, as amended by Amdt. 23-14, 38 FR 31820 Nov. 19, 1973; Amdt. 23-34, 52 FR 1828, Jan. 15, 1987]

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[TOP]

§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 percent of the trim speed, with -- ""

""(1) Flaps retracted; ""

""(2) Landing gear retracted; ""

""(3) Maximum continuous power; and ""

""(4) The airplane trimmed at the speed used in determining the climb performance required by §23.69(a). ""

""(b) *Cruise.* With flaps and landing gear retracted and the airplane 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 acrobatic category airplanes, the stick force curve must have a stable slope at all speeds within a range that is the greater of 15 percent 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 VS1; or ""

""(ii) For airplanes with VNE established under §23.1505(a), at speeds greater than VNE; or ""

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

""(2) For commuter category airplanes, 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 VS1; or ""

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

""(iii) At speeds that require a stick force greater than 50 pounds. ""

""(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; ""

""(2) Landing gear extended; and ""

""(3) The airplane trimmed at -- ""

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

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

""[Doc. No. 27807, 61 FR 5190, Feb. 9, 1996]

""

""
[TOP]
§23.177 Static directional and lateral stability.
""

""(a) The static directional stability, as shown by the tendency to recover from a wings level sideslip with the rudder free, must be positive for any landing gear and flap position appropriate to the takeoff, 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 the maximum allowable speed for the condition being investigated. The angel of sideslip for these tests must be appropriate to the type of airplane. At larger angles of sideslip, up to that at which full rudder is used or a control force limit in §23.143 is reached, whichever occurs first, and at speeds from 1.2 VS1 to VO, 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 percent 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 takeoff, climb, cruise, and approach configurations. For the landing configuration, the power must be that necessary to maintain a 3 degree angle of descent in coordinated flight. The static lateral stability must not be negative at 1.2 VS1 in the takeoff configuration, or at 1.3 VS1 in other configurations. The angle of sideslip for these tests must be appropriate to the type of airplane, but in no case may the constant heading sideslip angle be less than that obtainable with a 10 degree bank, or if less, the maximum bank angle obtainable with full rudder deflection or 150 pound rudder force. ""

""(c) Paragraph (b) of this section does not apply to acrobatic category airplanes certificated for inverted flight. ""

""(d) In straight, steady slips at 1.2 VS1 for any landing gear and flap positions, and for any symmetrical power conditions up to 50 percent of 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 airplane. At larger slip angles, up to the angle at which full rudder or aileron control is used or a control force limit contained in §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, and recovery from, a maximum sideslip considered appropriate for the airplane must not result in uncontrollable flight characteristics. ""

""[Doc. No. 27807, 61 FR 5190, Feb. 9, 1996]

""

""
[TOP]
§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 airplane must be heavily damped with the primary controls -- ""

""(1) Free; and ""

""(2) In a fixed position. ""

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

""(1) Free; and ""

""(2) In a fixed position. ""

""(c) If it is determined that the function of a stability augmentation system, reference §23.672, is needed to meet the flight characteristic requirements of this part, the primary control requirements of paragraphs (a)(2) and (b)(2) of this section are not applicable to the tests needed to verify the acceptability of that system. ""

""(d) During the conditions as specified in §23.175, when the longitudinal control force required to maintain speeds differing from the trim speed by at least plus and minus 15 percent is suddenly released, the response of the airplane must not exhibit any dangerous characteristics nor be excessive in relation to the magnitude of the control force released. Any long-period oscillation of flight path, phugoid oscillation, that results must not be so unstable as to increase the pilot's workload or otherwise endanger the airplane. ""

""[Amdt. 23-21, 43 FR 2318, Jan. 16, 1978, as amended by Amdt. 23-45, 58 FR 42158, Aug. 6, 1993]

""

""Stalls ""

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""

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[TOP]

§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 airplane 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 airplane; ""

""(2) A downward pitching motion of the airplane that results from the activation of a stall avoidance device (for example, 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 paragraphs (b)(1) or (b)(2) of this section has unmistakably been produced, or after the control has been held against the stop for not less than the longer of two seconds or the time employed in the minimum steady slight speed determination of §23.49. ""

""(d) During the entry into and the recovery from the maneuver, it must be possible to prevent more than 15 degrees 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 percent of maximum continuous power. However, if the power-to-weight ratio at 75 percent of maximum continuous power result 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 VSO, except that the power may not be less than 50 percent of maximum continuous power. ""

""(5) *Trim.* The airplane trimmed at a speed as near 1.5 VS1 as practicable. ""

""(6) *Propeller.* Full increase r.p.m. position for the power off condition. ""

""[Doc. No. 27807, 61 FR 5191, Feb. 9, 1996]

""

""

[TOP]

§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 coordinated turn in a 30 degree bank. Reduce speed by steadily and progressively tightening the turn with the elevator until the airplane is stalled, as defined in §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 airplane has stalled, as defined in §23.201(b), it must be possible to regain wings level flight by normal use of the flight controls, but without increasing power and without -- ""

""(1) Excessive loss of altitude; ""

""(2) Undue pitchup; ""

""(3) Uncontrollable tendency to spin; ""

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

""(5) Exceeding a bank angle of 90 degrees in the original direction of the turn or 60 degrees 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; ""

""(2) *Landing gear:* Retracted and extended; ""

""(3) *Cowl flaps:* Appropriate to configuration; ""

""(4) *Power:* ""

""(i) Power off; and ""

""(ii) 75 percent of maximum continuous power. However, if the power-to-weight ratio at 75 percent 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 VSO, except that the power may not be less than 50 percent of maximum continuous power. ""

""(5) *Trim:* The airplane trimmed at a speed as near 1.5 VS1 as practicable. ""

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

""[Amdt. 23-14, 38 FR 31820, Nov. 19, 1973, as amended by Amdt. 23-45, 58 FR 42159, Aug. 6, 1993; Amdt. 23-50, 61 FR 5191, Feb. 9, 1996]

""

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[TOP]

§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 airplane or by a device that will give clearly distinguishable indications under expected conditions of flight. However, a visual stall warning device that requires the attention of the crew within the cockpit is not acceptable by itself. ""

""(c) During the stall tests required by §23.201(b) and §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 procedures furnished in accordance with §23.1585, the stall warning must not occur during a takeoff with all engines operating, a takeoff continued with one engine inoperative, or during an approach to landing. ""

""(e) During the stall tests required by §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 acrobatic category airplanes, an artificial stall warning may be mutable, provided that it is armed automatically during takeoff and rearmed automatically in the approach configuration. ""

""[Amdt. 23-7, 34 FR 13087, Aug. 13, 1969, as amended by Amdt. 23-45, 58 FR 42159, Aug. 6, 1993; Amdt. 23-50, 61 FR 5191, Feb. 9, 1996]

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""**Spinning** ""

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[TOP]
§23.221 Spinning.
""

""(a) *Normal category airplanes.* A single-engine, normal category airplane 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, or demonstrate compliance with the optional spin resistant requirements of this section. ""

""(1) The following apply to one turn or three second spins: ""

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

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

""(iii) 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 ""

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

""(2) At the applicant's option, the airplane may be demonstrated to be spin resistant by the following: ""

""(i) During the stall maneuver contained in §23.201, the pitch control must be pulled back and held against the stop. Then, using ailerons and rudders in the proper direction, it must be possible to maintain wings-level flight within 15 degrees of bank and to roll the airplane from a 30 degree bank in one direction to a 30 degree bank in the other direction; ""

""(ii) Reduce the airplane speed using pitch control at a rate of approximately one knot per second until the pitch control reaches the stop; then, with the pitch control pulled back and held against the stop, apply full rudder control in a manner to promote spin entry for a period of seven seconds or through a 360 degree heading change, whichever occurs first. If the 360 degree heading change is reached first, it must have taken no fewer than four seconds. This maneuver must be performed first with the ailerons in the neutral position, and then with the ailerons deflected opposite the direction of turn in the most adverse manner. Power and airplane configuration must be set in accordance with §23.201(e) without change during the maneuver. At the end of seven seconds or a 360 degree heading change, the airplane must respond immediately and normally to primary flight controls applied to regain coordinated, unstalled flight without reversal of control effect and without exceeding the temporary control forces specified by §23.143(c); and ""

""(iii) Compliance with §§23.201 and 23.203 must be demonstrated with the airplane in uncoordinated flight, corresponding to one ball width displacement on a slip-skid indicator, unless one ball width displacement cannot be obtained with full rudder, in which case the demonstration must be with full rudder applied. ""

""(b) *Utility category airplanes.* A utility category airplane must meet the requirements of paragraph (a) of this section. In addition, the requirements of paragraph (c) of this section and §23.807(b)(7) must be met if approval for spinning is requested. ""

""(c) *Acrobatic category airplanes.* An acrobatic category airplane must meet the spin requirements of paragraph (a) of this section and §23.807(b)(6). In addition, the following requirements must be met in each configuration for which approval for spinning is requested: ""

""(1) The airplane 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 maneuvering load factors must not be exceeded. For flaps-extended configurations 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. ""

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

""[Doc. No. 27807, 61 FR 5191, Feb. 9, 1996]

""

""Ground and Water Handling Characteristics ""

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[TOP]

§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 takeoff. 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 porpoising characteristics at any normal operating speed on the water. ""

""
[TOP]

§23.233 Directional stability and control.

""

""(a) A 90 degree cross-component of wind velocity, demonstrated to be safe for taxiing, takeoff, and landing must be established and must be not less than 0.2 VSO. ""

""(b) The airplane 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 at least 50 percent of the speed at touchdown. ""

""(c) The airplane must have adequate directional control during taxiing. ""

""(d) Seaplanes must demonstrate satisfactory directional stability and control for water operations up to the maximum wind velocity specified in paragraph (a) of this section. ""

""[Doc. No. 4080, 29 FR 17955, Dec. 18, 1964, as amended by Amdt. 23-45, 58 FR 42159, Aug. 6, 1993; Amdt. 23-50, 61 FR 5192, Feb. 9, 1996]

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[TOP]

§23.235 Operation on unpaved surfaces.

""

""The airplane must be demonstrated to have satisfactory characteristics and the shock-absorbing mechanism must not damage the structure of the airplane when the airplane is taxied on the roughest ground that may reasonably be expected in normal operation and when takeoffs and landings are performed on unpaved runways having the roughest surface that may reasonably be expected in normal operation. ""

""[Doc. No. 27807, 61 FR 5192, Feb. 9, 1996]

""

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[TOP]
§23.237 Operation on water.
""

""A wave height, demonstrated to be safe for operation, and any necessary water handling procedures for seaplanes and amphibians must be established. ""

""[Doc. No. 27807, 61 FR 5192, Feb. 9, 1996]

""

""
[TOP]
§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 taxiing, takeoff, and landing.
""

""Miscellaneous Flight Requirements ""

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""

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[TOP]
§23.251 Vibration and buffeting.
""

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

""[Doc. No. 26269, 58 FR 42159, Aug. 6, 1993]

""

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[TOP]
§23.253 High speed characteristics.
""

""If a maximum operating speed VMO/MMO is established under §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 airplane trimmed at any likely speed up to VMO/MMO. These conditions and characteristics include gust upsets, inadvertent control movements, low stick force gradients in relation to control friction, passenger movement, leveling off from climb, and descent from Mach to airspeed limit altitude. ""

""(b) Allowing for pilot reaction time after occurrence of the effective inherent or artificial speed warning specified in §23.1303, it must be shown that the airplane can be recovered to a normal attitude and its speed reduced to VMO/MMO, without -- ""

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

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

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

""[Amdt. 23-7, 34 FR 13087, Aug. 13, 1969; as amended by Amdt. 23-26, 45 FR 60170, Sept. 11, 1980; Amdt. 23-45, 58 FR 42160, Aug. 6, 1993; Amdt. 23-50, 61 FR 5192, Feb. 9, 1996]

""

""Subpart C -- Structure ""

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""

""General ""

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[TOP]

§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 airplane. 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 §§23.331 through 23.521. For airplane configurations described in appendix A, §23.1, the design criteria of appendix A of this part are an approved equivalent of §§23.321 through 23.459. If appendix A of this part is used, the entire appendix must be substituted for the corresponding sections of this part. ""

""[Doc. No. 4080, 29 FR 17955, Dec. 18, 1964; 30 FR 258, Jan. 9, 1965, as amended by Amdt. 23-28, 47 FR 13315, Mar. 29, 1982; Amdt. 23-42, 56 FR 352, Jan. 3, 1991; Amdt. 23-48, 61 FR 5143, Feb. 9, 1996]

""

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[TOP]

§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 this part applicable to a wing; and ""

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

""[Amdt. 23-42, 56 FR 352, Jan. 3, 1991]

""

""

[TOP]

§23.303 Factor of safety.

""

""Unless otherwise provided, a factor of safety of 1.5 must be used. ""

""
[TOP]
§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. ""

""[Doc. No. 4080, 29 FR 17955, Dec. 18, 1964, as amended by Amdt. 23-45, 58 FR 42160, Aug. 6, 1993]

""

""
[TOP]
§23.307 Proof of structure.
""

""(a) Compliance with the strength and deformation requirements of §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 this part.
""

""Flight Loads ""

""
""

""
[TOP]
§23.321 General.
""

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

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

""(1) At each critical altitude within the range in which the airplane 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 §§23.1583 through 23.1589. ""

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

""[Doc. No. 4080, 29 FR 17955, Dec. 18, 1964, as amended by Amdt. 23-45, 58 FR 42160, Aug. 6, 1993]

""

""
[TOP]
§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 §§23.333 through 23.341. ""

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

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

""[Doc. No. 4080, 29 FR 17955, Dec. 18, 1964; 30 FR 258, Jan. 9, 1965, as amended by Amdt. 23-42, 56 FR 352, Jan. 3, 1991]

""

""

[TOP]

§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 paragraph (d) of this section) that represents the envelope of the flight loading conditions specified by the maneuvering and gust criteria of paragraphs (b) and (c) of this section respectively. ""

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

""(1) The positive maneuvering load factor specified in §23.337 at speeds up to *V*D; ""

""(2) The negative maneuvering load factor specified in §23.337 at *V*C; and ""

""(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 acrobatic and utility categories. ""

""(c) *Gust envelope.* (1) The airplane 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 f.p.s. at *V*C must be considered at altitudes between sea level and 20,000 feet. The gust velocity may be reduced linearly from 50 f.p.s. at 20,000 feet to 25 f.p.s. at 50,000 feet. ""

""(ii) Positive and negative gusts of 25 f.p.s. at *V*D must be considered at altitudes between sea level and 20,000 feet. The gust velocity may be reduced linearly from 25 f.p.s. at 20,000 feet to 12.5 f.p.s. at 50,000 feet. ""

""(iii) In addition, for commuter category airplanes, positive (up) and negative (down) rough air gusts of 66 f.p.s. at V&Bgr; must be considered at altitudes between sea level and 20,000 feet. The gust velocity may be reduced linearly from 66 f.p.s. at 20,000 feet to 38 f.p.s. at 50,000 feet. ""

""(2) The following assumptions must be made: ""

""(i) The shape of the gust is -- ""

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

"" ""

""Where -- " """

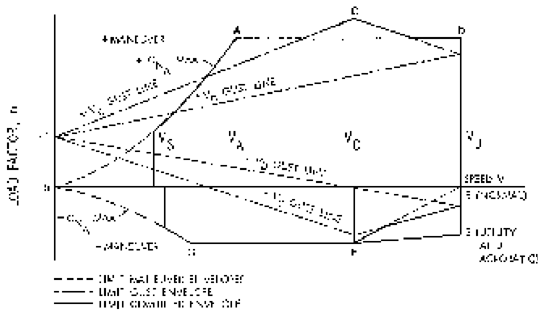
"""*s*=Distance penetrated into gust (ft.); """

"""*C*=Mean geometric chord of wing (ft.); and """

"""*Ude*=Derived gust velocity referred to in subparagraph (1) of this section.
" "" """"

""""(ii) Gust load factors vary linearly with speed between *V*C and *V*D . """"

""""(d) *Flight envelope.* """"



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""""[Doc. No. 4080, 29 FR 17955, Dec. 18, 1964, as amended by Amdt. 23-7, 34 FR 13087, Aug. 13, 1969; Amdt. 23-34, 52 FR 1829, Jan. 15, 1987]

""""""

""""""

[TOP]

§23.335 Design airspeeds.

""""""

""""Except as provided in paragraph (a)(4) of this section, the selected design airspeeds are equivalent airspeeds (EAS). """"

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

""""(1) Where W/S'=wing loading at the design maximum takeoff weight, Vc (in knots) may not be less than -- """"

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

""""(ii) 36 $\sqrt{(W/S)}$ (for acrobatic category airplanes). """"

""""(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/MD may not be less than 1.25 V_C/MC; 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 airplanes); """"

""""(ii) 1.50 V_C min (for utility category airplanes); and """"

""""(iii) 1.55 V_C min (for acrobatic category airplanes). """"

""""(3) For values of *W/S* more than 20, the multiplying factors in paragraph (b)(2) of this section may be decreased linearly with *W/S* to a value of 1.35 where *W/S*=100. """"

""""(4) Compliance with paragraphs (b)(1) and (2) of this section 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 stabilized flight at V_C/M_C, the airplane 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 percent 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 the pullup is initiated, at which point power reduction and pilot-controlled drag devices may be used; and either -- """"

""""(ii) Mach 0.05 for normal, utility, and acrobatic category airplanes (at altitudes where MD is established); or """"

""""(iii) Mach 0.07 for commuter category airplanes (at altitudes where MD 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 maneuvering speed V*A. For *V*A, the following applies: """"

""""(1) *V*A may not be less than *V*S√ *n* where -- """"

""""(i) *V*S is a computed stalling speed with flaps retracted at the design weight, normally based on the maximum airplane normal force coefficients, *C*NA*;* and """"

""""(ii) *n* is the limit maneuvering 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 VB, the following apply: """"

""""(1) VB may not be less than the speed determined by the intersection of the line representing the maximum positive lift, CNMAX, and the line representing the rough air gust velocity on the gust V-n diagram, or VS1√ ng, whichever is less, where: """"

""""(i) ng the positive airplane gust load factor due to gust, at speed VC (in accordance with §23.341), and at the particular weight under consideration; and """"

""""(ii) VS1 is the stalling speed with the flaps retracted at the particular weight under consideration. """"

""""(2) VB need not be greater than VC. """"

""""[Doc. No. 4080, 29 FR 17955, Dec. 18, 1964, as amended by Amdt. 23-7, 34 FR 13088, Aug. 13, 1969; Amdt. 23-16, 40 FR 2577, Jan. 14, 1975; Amdt. 23-34, 52 FR 1829, Jan. 15, 1987; Amdt. 23-24, 52 FR 34745, Sept. 14, 1987; Amdt. 23-48, 61 FR 5143, Feb. 9, 1996]

""""""

""""""

[TOP]

§23.337 Limit maneuvering load factors.

""""""

""""(a) The positive limit maneuvering load factor *n* may not be less than -- """"

""""(1) 2.1+(24,000÷(W+10,000)) for normal and commuter category airplanes, where W=design maximum takeoff weight, except that n need not be more than 3.8; """"

""""(2) 4.4 for utility category airplanes; or """"

""""(3) 6.0 for acrobatic category airplanes. """"

""""(b) The negative limit maneuvering 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 acrobatic category. """"

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

""""[Doc. No. 4080, 29 FR 17955, Dec. 18, 1964, as amended by Amdt. 23-7, 34 FR 13088, Aug. 13, 1969; Amdt. 23-34, 52 FR 1829, Jan. 15, 1987; Amdt. 23-48, 61 FR 5144, Feb. 9, 1996]

""""""

""""""
[TOP]

§23.341 Gust loads factors.

""""""

"""""(a) Each airplane must be designed to withstand loads on each lifting surface resulting from gusts specified in §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 paragraph (c) of this section, provided that the resulting net loads are shown to be conservative with respect to the gust criteria of §23.333(c). """""

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

"""""" $$n = 1 + \frac{K_g U_{de} V a}{498\,(W/S)}$$ """"""

"""""" """"""

""""""Where -- " """"""

""""""K_g=0.88μg/5.3+μg=gust alleviation factor; """"""

""""""μg=2(W/S)/ρ Cag=airplane mass ratio; """"""

""""""U_{de}=Derived gust velocities referred to in §23.333(c) (f.p.s.); """"""

""""""ρ=Density of air (slugs/cu.ft.); """"""

""""""*W/S*=Wing loading (p.s.f.) due to the applicable weight of the airplane in the particular load case. """"""

""""""*W/S*=Wing loading (p.s.f.); """"""

""""""*C*=Mean geometric chord (ft.); """"""

""""""*g*=Acceleration due to gravity (ft./sec. ^{2}) """"""

""""""*V*=Airplane equivalent speed (knots); and """"""

""""""*a*=Slope of the airplane 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. 23-7, 34 FR 13088, Aug. 13, 1969, as amended by Amdt. 23-42, 56 FR 352, Jan. 3, 1991; Amdt. 23-48, 61 FR 5144, Feb. 9, 1996]

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"""""""
[TOP]

§23.343 Design fuel loads.

"""""""

""""""(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 airplane 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) For commuter category airplanes, a structural reserve fuel condition, not exceeding fuel necessary for 45 minutes of operation at maximum continuous power, may be selected. If a structural reserve fuel condition is selected, it must be used as the minimum fuel weight condition for showing compliance with the flight load requirements prescribed in this part and -- """"""

""""""(1) The structure must be designed to withstand a condition of zero fuel in the wing at limit loads corresponding to: """"""

""""""(i) Ninety percent of the maneuvering load factors defined in §23.337, and """""" """"(ii) Gust velocities equal to 85 percent of the values prescribed in §23.333(c). """"

""""(2) The fatigue evaluation of the structure must account for any increase in operating stresses resulting from the design condition of paragraph (c)(1) of this section. """"

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

""""[Doc. No. 27805, 61 FR 5144, Feb. 9, 1996]

""""

""""
[TOP]
§23.345 High lift devices.
""""

""""(a) If flaps or similar high lift devices are to be used for takeoff, approach or landing, the airplane, with the flaps fully extended at VF, is assumed to be subjected to symmetrical maneuvers and gusts within the range determined by -- """"

""""(1) Maneuvering, to a positive limit load factor of 2.0; and """"

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

""""(b) VF must be assumed to be not less than 1.4 VS or 1.8 VSF, whichever is greater, where -- """"

""""(1) VS is the computed stalling speed with flaps retracted at the design weight; and """"

""""(2) VSF is the computed stalling speed with flaps fully extended at the design weight. """"

""""(3) If an automatic flap load limiting device is used, the airplane may be designed for the critical combinations of airspeed and flap position allowed by that device. """"

""""(c) In determining external loads on the airplane as a whole, thrust, slipstream, and pitching acceleration may be assumed to be zero. """"

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

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

""""(2) The effects of propeller slipstream corresponding to maximum takeoff power. """"

""""[Doc. No. 27805, 61 FR 5144, Feb. 9, 1996]

""""

""""
[TOP]
§23.347 Unsymmetrical flight conditions.
""""

""""(a) The airplane is assumed to be subjected to the unsymmetrical flight conditions of §§23.349 and 23.351. Unbalanced aerodynamic moments about the center of gravity must be reacted in a rational or conservative manner, considering the principal masses furnishing the reacting inertia forces. """"

""""(b) Acrobatic category airplanes certified for flick maneuvers (snap roll) must be designed for additional asymmetric loads acting on the wing and the horizontal tail. """"

""""[Doc. No. 4080, 29 FR 17955, Dec. 18, 1964, as amended by Amdt. 23-48, 61 FR 5144, Feb. 9, 1996]

""""

""""""
[TOP]
§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 §23.333(d) as follows: """"""

""""""(1) For the acrobatic category, in conditions A and F, assume that 100 percent of the semispan wing airload acts on one side of the plane of symmetry and 60 percent of this load acts on the other side. """"""

""""""(2) For normal, utility, and commuter categories, in Condition A, assume that 100 percent of the semispan wing airload acts on one side of the airplane and 75 percent of this load acts on the other side. """"""

""""""(b) The loads resulting from the aileron deflections and speeds specified in §23.455, in combination with an airplane load factor of at least two thirds of the positive maneuvering 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 §23.333(d): " """""""

"""""""$\Delta c m = -0.01\delta$ " """"""""

""""""""where -- " """"""""""

""""""""""$\Delta c m$ is the moment coefficient increment; and """"""""""

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

""""""""""[Doc. No. 4080, 29 FR 17955, Dec. 18, 1964, as amended by Amdt. 23-7, 34 FR 13088, Aug. 13, 1969; Amdt. 23-34, 52 FR 1829, Jan. 15, 1987; Amdt. 23-48, 61 FR 5144, Feb. 9, 1996]

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""""""""""""
[TOP]
§23.351 Yawing conditions.
""""""""""""

""""""""""""The airplane must be designed for yawing loads on the vertical surfaces resulting from the loads specified in §§23.441 through 23.445. """"""""""""

""""""""""""[Doc. No. 4080, 29 FR 17955, Dec. 18, 1964; 30 FR 258, Jan. 9, 1965, as amended by Amdt. 23-42, 56 FR 352, Jan. 3, 1991]

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""""""""""""
[TOP]
§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 takeoff power and propeller speed acting simultaneously with 75 percent of the limit loads from flight condition A of §23.333(d); """"""""""""

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

""""""""""""(3) For turbopropeller installations, in addition to the conditions specified in paragraphs (a)(1) and (a)(2) of this section, a limit engine torque corresponding to takeoff power and propeller speed, multiplied by a factor accounting for propeller control system malfunction, including quick feathering, acting simultaneously with lg 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). """"""""""

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

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

""""""""""(1) 1.25 for turbopropeller 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. """"""""""

""""""""""[Amdt. 23-26, 45 FR 60171, Sept. 11, 1980, as amended by Amdt. 23-45, 58 FR 42160, Aug. 6, 1993]

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""""""""""
[TOP]
§23.363 Side load 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 side load 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 side load prescribed in paragraph (a) of this section may be assumed to be independent of other flight conditions. """"""""""

""""""""""
[TOP]
§23.365 Pressurized cabin loads.
""""""""""

""""""""""For each pressurized compartment, the following apply: """"""""""

""""""""""(a) The airplane 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 pressurized, landing loads must be combined with pressure differential loads from zero up to the maximum allowed during landing. """"""""""

""""""""""(d) The airplane 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 pressurized 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. """"""""""

""""""""""
[TOP]
§23.367 Unsymmetrical loads due to engine failure.
""""""""""

""""""""""(a) Turbopropeller airplanes 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 VMC and VD, the loads resulting from power failure because of fuel flow interruption are considered to be limit loads. """"""""""

""""""""""(2) At speeds between VMC and VC, 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 buildup occurring as a result of the prescribed engine failures must be substantiated by test or other data applicable to the particular engine-propeller combination. """"""""""

""""""""""(4) The timing and magnitude of the probable pilot corrective action must be conservatively estimated, considering the characteristics of the particular engine-propeller-airplane 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 §23.397 except that lower forces may be assumed where it is shown by analysis or test that these forces can control the yaw and roll resulting from the prescribed engine failure conditions. """"""""""

""""""""""[Amdt. 23-7, 34 FR 13089, Aug. 13, 1969]

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""""""""""

[TOP]

§23.369 Rear lift truss.

""""""""""

""""""""""(a) If a rear lift truss is used, it must be designed to withstand conditions of reversed airflow at a design speed of -- """"""""""

""""""""""V=8.7 √(W/S) + 8.7 (knots), where W/S=wing loading at design maximum takeoff weight. """"""""""

""""""""""(b) Either aerodynamic data for the particular wing section used, or a value of CL 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. """"""""""

""""""""""[Doc. No. 4080, 29 FR 17955, Dec. 18, 1964, as amended by Amdt. 23-7, 34 FR 13089, Aug. 13, 1969; 34 FR 17509, Oct. 30, 1969; Amdt. 23-45, 58 FR 42160, Aug. 6, 1993; Amdt. 23-48, 61 FR 5145, Feb. 9, 1996]

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""""""""""

[TOP]

§23.371 Gyroscopic and aerodynamic loads.

""""""""""

""""""""""(a) Each engine mount and its supporting structure must be designed for the gyroscopic, inertial, and aerodynamic loads that result, with the engine(s) and propeller(s), if applicable, at maximum continuous r.p.m., under either: """"""""""

""""""""""(1) The conditions prescribed in §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; """"""""""

""""""""""(iii) A normal load factor of 2.5; and """"""""""

""""""""""(iv) Maximum continuous thrust. """"""""""

""""""""""(b) For airplanes approved for aerobatic maneuvers, each engine mount and its supporting structure must meet the requirements of paragraph (a) of this section and be designed to withstand the load factors expected during combined maximum yaw and pitch velocities. """"""""""

""""""""""(c) For airplanes certificated in the commuter category, each engine mount and its supporting structure must meet the requirements of paragraph (a) of this section and the gust conditions specified in §23.341 of this part. """"""""""

""""""""""[Doc. No. 27805, 61 FR 5145, Feb. 9, 1996]

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""""""""""

[TOP]

§23.373 Speed control devices.

""""""""""

""""""""""If speed control devices (such as spoilers and drag flaps) are incorporated for use in enroute conditions -- """"""""""

""""""""""(a) The airplane must be designed for the symmetrical maneuvers and gusts prescribed in §§23.333, 23.337, and 23.341, and the yawing maneuvers and lateral gusts in §§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 airplane must be designed for the maneuver and gust conditions prescribed in paragraph (a) of this section at the speeds and corresponding device positions that the mechanism allows. """"""""""

""""""""""[Amdt. 23-7, 34 FR 13089, Aug. 13, 1969]

""""""""""

""""""""""Control Surface and System Loads """"""""""

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[TOP]

§23.391 Control surface loads.

""""""""""

""""""""""The control surface loads specified in §§23.397 through 23.459 are assumed to occur in the conditions described in §§23.331 through 23.351. """"""""""

""""""""""[Doc. No. 4080, 29 FR 17955, Dec. 18, 1964, as amended by Amdt. 23-48, 61 FR 5145, Feb. 9, 1996]

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""""""""""

[TOP]

§23.393 Loads parallel to hinge line.

""""""""""

""""""""""(a) Control surfaces and supporting hinge brackets must be designed to withstand inertial loads acting parallel to the hinge line. """"""""""

""""""""""(b) In the absence of more rational data, the inertial 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. """"""""""

""""""""""[Doc. No. 27805, 61 FR 5145, Feb. 9, 1996]

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""""""""""""

[TOP]

§23.395 Control system loads.

""""""""""""

""""""""""(a) Each flight control system and its supporting structure must be designed for loads corresponding to at least 125 percent of the computed hinge moments of the movable control surface in the conditions prescribed in §§23.391 through 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 §23.397(b). """"""""""

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

""""""""""(b) A 125 percent factor on computed hinge moments 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. """"""""""

""""""""""[Doc. No. 4080, 29 FR 17955, Dec. 18, 1964, as amended by Amdt. 23-7, 34 FR 13089, Aug. 13, 1969]

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""""""""""""

[TOP]

§23.397 Limit control forces and torques.

""""""""""""

""""""""""(a) In the control surface flight loading condition, the airloads 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 paragraph (b) of this section. 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 5,000 pounds \1\	Minimum forces or torques \2\
Aileron:		
Stick	67 lbs.	40 lbs.
Wheel \3\	50 D in.-lbs \4\	40 D in.-lbs.\4\
Elevator:		
Stick	167 lbs.	100 lbs.
Wheel (symmetrical)	200 lbs.	100 lbs.
Wheel (unsymmetrical) \5\	....	100 lbs.
Rudder	200 lbs.	150 lbs.

\1\ For design weight (W) more than 5,000 pounds, the specified maximum values must be increased linearly with weight to 1.18 times the specified values at a design weight of 12,500 pounds and for commuter category airplanes, the specified values must be increased linearly with weight to 1.35 times the specified values at a design weight of 19,000 pounds.

\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 moments obtained under § 23.415, but not less than 0.6 of the specified minimum forces or torques, may be used.

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\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 (inches).
\5\ The unsymmetrical force must be applied at one of the normal
  handgrip points on the control wheel.
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""""""""""[Doc. No. 4080, 29 FR 17955, Dec. 18, 1964, as amended by Amdt. 23-7, 34 FR 13089, Aug. 13, 1969; Amdt. 23-17, 41 FR 55464, Dec. 20, 1976; Amdt. 23-34, 52 FR 1829, Jan. 15, 1987; Amdt. 23-45, 58 FR 42160, Aug. 6, 1993]

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[TOP]

§23.399 Dual control system.

""""""""""""

""""""""""(a) Each dual control system must be designed to withstand the force of the pilots operating in opposition, using individual pilot forces not less than the greater of -- """"""""""

""""""""""(1) 0.75 times those obtained under §23.395; or """"""""""

""""""""""(2) The minimum forces specified in §23.397(b). """"""""""

""""""""""(b) Each dual control system must be designed to withstand the force of the pilots applied together, in the same direction, using individual pilot forces not less than 0.75 times those obtained under §23.395. """"""""""

""""""""""[Doc. No. 27805, 61 FR 5145, Feb. 9, 1996]

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""""""""""""

[TOP]

§23.405 Secondary control system.

""""""""""""

""""""""""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. """"""""""

""""""""""""

[TOP]

§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.
""""""""""""

""""""""""""

[TOP]

§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. """"""""""

""""""""""""

[TOP]

§23.415 Ground gust conditions.

""""""""""""

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

""""""""""

""""""""""(1) If an investigation of the control system for ground gust loads is not required by paragraph (a)(2) of this section, but the applicant elects to design a part of the control system of 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 §23.397(b) are used for design, the effects of surface loads due to ground gusts and taxiing 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 (p.s.f.) based on a design speed not less than 14.6 $\sqrt{(W/S)}$ + 14.6 (f.p.s.) where W/S=wing loading at design maximum weight, except that the design speed need not exceed 88 (f.p.s.); """"""""""""""

""""""""""""""K=limit hinge moment factor for ground gusts derived in paragraph (b) of this section. (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: """"""""""""""

""""""""""""

Surface	K	Position of controls
(a) Aileron....................	0.75	Control column locked lashed in mid-position.
(b) Aileron....................	±0 .50	Ailerons at full throw; + moment on one aileron, - moment on the other.
(c) Elevator...................	±0 .75	(c) Elevator full up (-).
(d) Elevator...................	....	(d) Elevator full down (+).
(e) Rudder.....................	±0 .75	(e) Rudder in neutral.
(f) Rudder.....................	....	(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 to withstand the limit load conditions that exist when the airplane is tied down and that result from wind speeds of up to 65 knots horizontally from any direction. """"""""""""""

""""""""""""""[Doc. No. 4080, 29 FR 17955, Dec. 18, 1964, as amended by Amdt. 23-7, 34 FR 13089, Aug. 13, 1969; Amdt. 23-45, 58 FR 42160, Aug. 6, 1993; Amdt. 23-48, 61 FR 5145, Feb. 9, 1996]

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""""""""""""""**Horizontal Stabilizing and Balancing Surfaces** """"""""""""""

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[TOP]

§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 maneuvering envelope and in the flap conditions specified in §23.345. """"""""""""""

""""""""""""""[Doc. No. 4080, 29 FR 17955, Dec. 18, 1964, as amended by Amdt. 23-7, 34 FR 13089, Aug. 13, 1969; Amdt. 23-42, 56 FR 352, Jan. 3, 1991]

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[TOP]

§23.423 Maneuvering loads.

""""""""""""""

""""""""""""""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 the maneuvering loads imposed by the following conditions: """"""""""""""

""""""""""""""(a) A sudden movement of the pitching control, at the speed VA, 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 VA, followed by a forward movement of the pitching control resulting in the following combinations of normal and angular acceleration: """"""""""""""

""""""""""""

Condition	Normal acceleration (n)	Angular acceleration (radian/sec[INF]2[/INF])
Nose-up pitching..............	1.0	+39n[INF]m[/INF]÷Vx(n[INF]m[/INF]-1.5)
Nose-down ptiching............	n[INF]m[/INF]	-39n[INF]m[/INF]÷Vx(n[INF]m[/INF]-1.5)

""""""""""""

""""""""""""""where -- """"""""""""""

""""""""""""""(1) nm=positive limit maneuvering load factor used in the design of the airplane; and """"""""""""""

""""""""""""""(2) V=initial speed in knots. """"""""""""""

""""""""""""""The conditions in this paragraph involve loads corresponding to the loads that may occur in a "checked maneuver" (a maneuver 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 maneuver" must avoid exceeding the limit maneuvering 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 maneuvering load increment due to the specified value of the angular acceleration. """"""""""""""

""""""""""""""[Amdt. 23-42, 56 FR 353, Jan. 3, 1991; 56 FR 5455, Feb. 11, 1991]

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[TOP]

§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 §23.333(c) with flaps retracted; and """"""""""""""

""""""""""""""(2) Positive and negative gusts of 25 f.p.s. nominal intensity at *V*F corresponding to the flight conditions specified in §23.345(a)(2). """"""""""""""

""""""""""""""(b) [Reserved] """""""""""""" """"""""""""""(c) When determining the total load on the horizontal surfaces for the conditions specified in paragraph (a) of this section, the initial balancing loads for steady unaccelerated flight at the pertinent design speeds VF, VC, and VD must first be determined. The incremental load resulting from the gusts must be added to the initial balancing load to obtain the total load. """"""""""""""

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

"""""""""""""""" [illegible] """"""""""""""""

"""""""""""""""" """"""""""""""""

""""""""""""""""where -- " """"""""""""""""

""""""""""""""""ΔLht=Incremental horizontal tailload (lbs.); """"""""""""""""

""""""""""""""""Kg=Gust alleviation factor defined in §23.341; """"""""""""""""

""""""""""""""""Ude=Derived gust velocity (f.p.s.); """"""""""""""""

""""""""""""""""V=Airplane equivalent speed (knots); """"""""""""""""

""""""""""""""""aht=Slope of aft horizontal lift curve (per radian) """"""""""""""""

""""""""""""""""Sht=Area of aft horizontal lift surface (ft ^{2}); and
" """"""""""""""""

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

""""""""""""""""""[Doc. No. 4080, 29 FR 17955, Dec. 18, 1964, as amended by Amdt. 23-7, 34 FR 13089 Aug. 13, 1969; Amdt. 23-42, 56 FR 353, Jan. 3, 1991]

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""""""""""""""""""
[TOP]

§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 §§23.421 through 23.425. """"""""""""""""""

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

""""""""""""""""""(1) 100 percent 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: " """"""""""""""""""

""""""""""""""""""""Percent=100−10 (n−1), where n is the specified positive maneuvering load factor, but this value may not be more than 80 percent.
" """"""""""""""""""""

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

""""""""""""""""""""[Amdt. 23-14, 38 FR 31820, Nov. 19, 1973, as amended by Amdt. 23-42, 56 FR 353, Jan. 3, 1991]

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""""""""""""""""""""**Vertical Surfaces** """"""""""""""""""""

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""""""""""""""""""
[TOP]
§23.441 Maneuvering loads.
""""""""""""""""""

""""""""""""""""""(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 airplane 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 paragraph (a)(1) of this section, it is assumed that the airplane yaws to the overswing sideslip angle. In lieu of a rational analysis, an overswing angle equal to 1.5 times the static sideslip angle of paragraph (a)(3) of this section may be assumed. """"""""""""""""""

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

""""""""""""""""""(b) For commuter category airplanes, the loads imposed by the following additional maneuver must be substantiated at speeds from VA to VD/MD. When computing the tail loads -- """"""""""""""""""

""""""""""""""""""(1) The airplane must be yawed to the largest attainable steady state sideslip angle, with the rudder at maximum deflection caused by any one of the following: """"""""""""""""""

""""""""""""""""""(i) Control surface stops; """"""""""""""""""

""""""""""""""""""(ii) Maximum available booster effort; """"""""""""""""""

""""""""""""""""""(iii) Maximum pilot rudder force as shown below: """"""""""""""""""

"""""""""""""""""" """"""""""""""""""

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""""""""""""""""""(2) The rudder must be suddenly displaced from the maximum deflection to the neutral position. """"""""""""""""""

""""""""""""""""""(c) The yaw angles specified in paragraph (a)(3) of this section 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 """"""""""""""""""

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

""""""""""""""""""[Doc. No. 4080, 29 FR 17955, Dec. 18, 1964, as amended by Amdt. 23-7, 34 FR 13090, Aug. 13, 1969; Amdt. 23-14, 38 FR 31821, Nov. 19, 1973; Amdt. 23-28, 47 FR 13315, Mar. 29, 1982; Amdt. 23-42, 56 FR 353, Jan. 3, 1991; Amdt. 23-48, 61 FR 5145, Feb. 9, 1996]

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""""""""""""""""""
[TOP]
§23.443 Gust loads.
""""""""""""""""""

""""""""""""""""""(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 §23.333(c). """"""""""""""""""

""""""""""""""""(b) In addition, for commuter category airplanes, the airplane is assumed to encounter derived gusts normal to the plane of symmetry while in unaccelerated flight at VB, VC, VD, and VF. The derived gusts and airplane speeds corresponding to these conditions, as determined by §§23.341 and 23.345, must be investigated. The shape of the gust must be as specified in §23.333(c)(2)(i). """"""""""""""""""

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

""""""""""""""""""$$L_{vt}=\frac{K_{gt}U_{de}V a_{vt}S_{vt}}{498}$$""""""""""""""""""

"""""""""""""""""" """"""""""""""""""

""""""""""""""""""Where -- " """"""""""""""""""

""""""""""""""""""Lvt=Vertical surface loads (lbs.);
" """"""""""""""""""

"""""""""""""""""""" """"""""""""""""""""

"""""""""""""""""""" """"""""""""""""""""

"""""""""""""""""""" """"""""""""""""""""

""""""""""""""""""""Ude=Derived gust velocity (f.p.s.); """"""""""""""""""

""""""""""""""""""""ρ=Air density (slugs/cu.ft.); """"""""""""""""""

""""""""""""""""""""W=the applicable weight of the airplane in the particular load case (lbs.); """"""""""""""""""

""""""""""""""""""""Svt=Area of vertical surface (ft. ^{2}); """"""""""""""""""

""""""""""""""""""""c t=Mean geometric chord of vertical surface (ft.); """"""""""""""""""

""""""""""""""""""""avt=Lift curve slope of vertical surface (per radian); """"""""""""""""""

""""""""""""""""""""K=Radius of gyration in yaw (ft.); """"""""""""""""""

""""""""""""""""""""lvt=Distance from airplane c.g. to lift center of vertical surface (ft.); """"""""""""""""""

""""""""""""""""""""g=Acceleration due to gravity (ft./sec. ^{2}); and """"""""""""""""""

""""""""""""""""""""V=Equivalent airspeed (knots).
""""""""""""""""""""

""""""""""""""""""""[Amdt. 23-7, 34 FR 13090, Aug. 13, 1969, as amended by Amdt. 23-34, 52 FR 1830, Jan. 15, 1987; 52 FR 7262, Mar. 9, 1987; Amdt. 23-24, 52 FR 34745, Sept. 14, 1987; Amdt. 23-42, 56 FR 353, Jan. 3, 1991; Amdt. 23-48, 61 FR 5147, Feb. 9, 1996]

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""""""""""""""""""""
[TOP]

§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 moments or forces exerted on the 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 §§23.441 and 23.443) must be applied to -- """"""""""""""""""

""""""""""""""""""""(1) The part of the vertical surfaces above the horizontal surface with 80 percent 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 percent of that loading applied to the part above the horizontal surface. """"""""""""""""""

""""""""""""""""""(c) The end plate effects of outboard fins or winglets must be taken into account in applying the yawing conditions of §§23.441 and 23.443 to the vertical surfaces in paragraph (b) of this section. """"""""""""""""""

""""""""""""""""""(d) When rational methods are used for computing loads, the maneuvering loads of §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. """"""""""""""""""

""""""""""""""""""[Doc. No. 4080, 29 FR 17955, Dec. 18, 1964, as amended by Amdt. 23-14, 38 FR 31821, Nov. 19, 1973; Amdt. 23-42, 56 FR 353, Jan. 3, 1991]

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""""""""""""""""""Ailerons and Special Devices """"""""""""""""""

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""""""""""""""""""
[TOP]
§23.455 Ailerons.
""""""""""""""""""

""""""""""""""""""(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. """"""""""""""""""

""""""""""""""""""(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 paragraph (a)(2)(i) of this section. """"""""""""""""""

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

""""""""""""""""""(b) [Reserved] """"""""""""""""""

""""""""""""""""""[Doc. No. 4080, 29 FR 17955, Dec. 18, 1964, as amended by Amdt. 23-7, 34 FR 13090, Aug. 13, 1969; Amdt. 23-42, 56 FR 353, Jan. 3, 1991]

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""""""""""""""""""
[TOP]
§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 """"""""""""""""""

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""""""""""""""""""
[TOP]
§23.471 General.
""""""""""""""""""

""""""""""""""""""The limit ground loads specified in this subpart are considered to be external loads and inertia forces that act upon an airplane 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. """"""""""""""""""

""""""""""""""""""

[TOP]

§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 §§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 paragraphs (b) and (c) of this section. """"""""""""""""""

""""""""""""""""""(b) The design landing weight may be as low as -- """"""""""""""""""

""""""""""""""""""(1) 95 percent 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 percent of the total fuel capacity. """"""""""""""""""

""""""""""""""""""(c) The design landing weight of a multiengine airplane may be less than that allowed under paragraph (b) of this section if -- """"""""""""""""""

""""""""""""""""""(1) The airplane meets the one-engine-inoperative climb requirements of §23.67(b)(1) or (c); and """"""""""""""""""

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

""""""""""""""""""(d) The selected limit vertical inertia load factor at the center of gravity of the airplane for the ground load conditions prescribed in this subpart may not be less than that which would be obtained when landing with a descent velocity (*V*), in feet per second, equal to 4.4 (W/S) 1/4, except that this velocity need not be more than 10 feet per second and may not be less than seven feet per second. """"""""""""""""""

""""""""""""""""""(e) Wing lift not exceeding two-thirds of the weight of the airplane may be assumed to exist throughout the landing impact and to act through the center 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 airplane 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 §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 taxiing at speeds up to takeoff speed over terrain as rough as that expected in service. """"""""""""""""""

""""""""""""""""""[Doc. No. 4080, 29 FR 17955, Dec. 18, 1964, as amended by Amdt. 23-7, 34 FR 13090, Aug. 13, 1969; Amdt. 23-28, 47 FR 13315, Mar. 29, 1982; Amdt. 23-45, 58 FR 42160, Aug. 6, 1993; Amdt. 23-48, 61 FR 5147, Feb. 9, 1996]

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[TOP]

§23.477 Landing gear arrangement.

""""""""""""""""""

""""""""""""""""""Sections 23.479 through 23.483, or the conditions in appendix C, apply to airplanes with conventional arrangements of main and nose gear, or main and tail gear. """"""""""""""""""

""""""""""""""""""

[TOP]

§23.479 Level landing conditions.

""""""""""""""""""

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

""""""""""""""""""(1) For airplanes with tail wheels, a normal level flight attitude. """"""""""""""""""

""""""""""""""""""(2) For airplanes with nose wheels, attitudes in which -- """"""""""""""""""

""""""""""""""""""(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 paragraph (a)(2)(i) of this section may be used in the analysis required under paragraph (a)(2)(ii) of this section. """"""""""""""""""

""""""""""""""""""(b) When investigating landing conditions, the drag components simulating the forces required to accelerate the tires 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 tire-sliding coefficient of friction of 0.8. However, the drag loads may not be less than 25 percent of the maximum vertical ground reactions (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 of this part must be used. If appendix D of this part is used, the drag components used for design must not be less than those given by appendix C of this part. """"""""""""""""""

""""""""""""""""""(d) For airplanes 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 paragraph (a)(1) or (a)(2)(ii) of this section. In evaluating the effects of dynamic response, an airplane lift equal to the weight of the airplane may be assumed. """"""""""""""""""

""""""""""""""""""[Doc. No. 4080, 29 FR 17955, Dec. 18, 1964, as amended by Amdt. 23-17, 41 FR 55464, Dec. 20, 1976; Amdt. 23-45, 58 FR 42160, Aug. 6, 1993]

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""""""""""""""""""""""

[TOP]

§23.481 Tail down landing conditions.

""""""""""""""""""""""

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

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

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

""""""""""""""""""(b) For airplanes 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. """"""""""""""""""

""""""""""""""""""""""

[TOP]

§23.483 One-wheel landing conditions.

""""""""""""""""""""""

""""""""""""""""""For the one-wheel landing condition, the airplane 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 §23.479. """"""""""""""""""""""

""""""""""""""""""""""

[TOP]

§23.485 Side load conditions.

""""""""""""""""""""""

""""""""""""""""""(a) For the side load condition, the airplane is assumed to be in a level attitude with only the main wheels contacting the ground and with the shock absorbers and tires 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 paragraph (c) of this section are assumed to be applied at the ground contact point and the drag loads may be assumed to be zero.

[Doc. No. 4080, 29 FR 17955, Dec. 18, 1964, as amended by Amdt. 23-45, 58 FR 42160, Aug. 6, 1993]

[TOP]

§23.493 Braked roll conditions.

Under braked roll conditions, with the shock absorbers and tires 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 §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.

[TOP]

§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 degrees. The shock absorber and tire may be assumed to be in their static positions.

(b) For the side load, 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 swiveled 90 degrees to the airplane 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 side load acting at the ground contact point; and

(3) The shock absorber and tire 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 §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 paragraph (c)(1) of this section.

[Doc. No. 4080, 29 FR 17955, Dec. 18, 1964, as amended by Amdt. 23-48, 61 FR 5147, Feb. 9, 1996]

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[TOP]

§23.499 Supplementary conditions for nose wheels.

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""""""""""""""""""In determining the ground loads on nose wheels and affected supporting structures, and assuming that the shock absorbers and tires 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 """"""""""""""""""

""""""""""""""""""(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 side loads, 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 airplanes with a steerable nose wheel that is controlled by hydraulic or other power, at design takeoff 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 airplanes with a steerable nose wheel that has a direct mechanical connection to the rudder pedals, the mechanism must be designed to withstand the steering torque for the maximum pilot forces specified in §23.397(b). """"""""""""""""""

""""""""""""""""""[Doc. No. 4080, 29 FR 17955, Dec. 18, 1964, as amended by Amdt. 23-48, 61 FR 5147, Feb. 9, 1996]

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[TOP]

§23.505 Supplementary conditions for skiplanes.

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""""""""""""""""""In determining ground loads for skiplanes, and assuming that the airplane 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. """"""""""""""""""

""""""""""""""""""[Amdt. 23-7, 34 FR 13090, Aug. 13, 1969]

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[TOP]

§23.507 Jacking loads.

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""""""""""""""""""(a) The airplane 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. """"""""""""""""""

""""""""""""""""""(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. """"""""""""""""""

""""""""""""""""""[Amdt. 23-14, 38 FR 31821, Nov. 19, 1973]

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[TOP]

§23.509 Towing loads.

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""""""""""""""""""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 paragraph (d) of this section 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 center of gravity; and """"""""""""""""""

""""""""""""""""""(2) The shock struts and tires must be in there static positions. """"""""""""""""""

""""""""""""""""""(b) For towing points not on the landing gear but near the plane of symmetry of the airplane, 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 paragraph (d) of this section 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 airplane inertia to achieve equilibrium must be applied. """"""""""""""""""

""""""""""""""""""(ii) The loads must be reacted by airplane inertia. """"""""""""""""""

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

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Tow point	Position	Load		
		Magnitude	No.	Direction
Main gear		0.225W	1 2 3 4	Forward, parallel to drag axis. Forward, at 30° to drag axis. Aft, parallel to drag axis. Aft, at 30° to drag axis.
Auxiliary gear	Swiveled forward	0.3W	5 6	Forward. Aft.
	Swiveled aft	0.3W	7 8	Forward. Aft.
	Swiveled 45° from forward.	0.15W	9 10	Forward, in plane of wheel. Aft, in plane of wheel.
	Swiveled 45° from aft.	0.15W	11 12	Forward, in plane of wheel. Aft, in plane of wheel.

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""""""""""""""""""[Amdt. 23-14, 38 FR 31821, Nov. 19, 1973]

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[TOP]

§23.511 Ground load; unsymmetrical loads on multiple-wheel units.

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""""""""""""""""""(a) *Pivoting loads.* The airplane is assumed to pivot about on 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. """"""""""""""""""

""""""""""""""""""(b) *Unequal tire loads.* The loads established under §§23.471 through 23.483 must be applied in turn, in a 60/40 percent distribution, to the dual wheels and tires in each dual wheel landing gear unit. """"""""""""""""""

""""""""""""""""""(c) *Deflated tire loads.* For the deflated tire condition -- """"""""""""""""""

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

""""""""""""""""""(2) 60 percent of the limit drag and side loads, and 100 percent of the limit vertical load established under §§23.485 and 23.493 or lesser vertical load obtained under paragraph (c)(1) of this section, must be applied in turn to each wheel in the dual wheel landing gear unit. """"""""""""""""""

""""""""""""""""""[Amdt. 23-7, 34 FR 13090, Aug. 13, 1969]

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""""""""""""""""""Water Loads""""""""""""""""""

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