otherwise directed by the Commission, shall respectfully decline to disclose the information or produce the documents called for, basing his refusal upon this section. Any such person who is served with such a subpena shall promptly advise the Commission of the service of such subpena, the nature of the information or documents sought, and any circumstances which may bear upon the desirability of making available such information or documents.

Supersedure. This revision of Chapter VII supersedes the notice published at 27 F.R. 4569, concerning the operations and functions of the State Advisory Committees of the Commission, and the notice published at 27 F.R. 4570, concerning meetings of the State Advisory Committees.

Dated: December 15, 1964.

JOHN A. HANNAH,
Chairman,
U.S. Commission on Civil Rights.

[F.R. Doc. 64-13022; Filed, Dec. 17, 1964; 8:50 a.m.]

Title 42—PUBLIC HEALTH

Chapter I—Public Health Service, Department of Health, Education, and Welfare

SUBCHAPTER D—GRANTS

PART 51—GRANTS TO STATES FOR PUBLIC HEALTH SERVICES

Grants for Dental Health Services

Notice of proposed rule making, public rule making procedures, and delay in effective date have been omitted as unnecessary in the issuance of the following amendments to this part which relate solely to grants for programs relating to dental health services. The purpose of these amendments is to add new material providing the basis for grants for dental health services for which funds were made available by the Department of Health, Education, and Welfare Appropriation Act, 1965.

Pursuant to section 314(j) of the Public Health Service Act, as amended (58 Stat. 695; 42 U.S.C. 246(j)), these amendments are made after consultation with, and with the agreement of, a conference of the State health authorities.

Effective date. These amendments shall be effective on the date of publication in the FEDERAL REGISTER.

1. Section 51.1(f) is amended to read as follows:

§ 51.1 Definitions.

* * * * *

(f) "Plans" refers to the information and proposals submitted by the State health authority pursuant to the regulations in this part for activities of the State and political subdivisions thereof for (1) the prevention, treatment and control of venereal disease, (2) the prevention, treatment and control of tuberculosis, (3) establishing and maintaining public health services, (4) the prevention, treatment and control of mental illness, including emotional, psychiatric and neurological disorders, (5) establishing and maintaining organized community programs of heart disease control, (6) the prevention, control and eradication of cancer, (7) services for the chronically ill and the aged, (8) establishing and maintaining radiological health services, or (9) establishing and maintaining dental health services.

* * * * *

2. Section 51.2 is amended by adding thereto a new paragraph (h) which reads as follows:

§ 51.2 Allotments; extent of health problems.

* * * * *

(h) *Dental health.* The extent of the dental health problem shall be determined to be equal to the population of each State.

3. Section 51.3 is amended by adding thereto a new paragraph (i) which reads as follows:

§ 51.3 Basis of allotments.

* * * * *

(i) *Dental health.* Of the amount available for allotment for dental health programs, 100 percent on the basis of population weighted by financial need.

4. Section 51.4(c) is amended to read as follows:

§ 51.4 Allotments; estimates; time of making; duration.

* * * * *

(c) Allotments for each program for the first six months shall be made prior to the beginning of the fiscal year or as soon thereafter as practicable, and shall equal not less than 60 percent nor more than 70 percent of the total sum determined to be available for allotment during that fiscal year. At the end of the second quarter, the amounts of allotments for the first six-month period which have not been certified for payment to the respective States pursuant to § 51.8 shall become available for allotment among the States in the same manner as moneys which had not previously been allotted: *Provided,* That with respect to grants for mental health activities, such amounts of the allotment to any State in any year as are approved in its plan for the development of comprehensive mental health planning shall remain available for expenditure by that State for that purpose during the fiscal year in which the State plan is approved and during such portion of the next succeeding fiscal year as may be approved by the Surgeon General or his designee, and in such cases (1) payments from such amounts shall be made during the period for which such plan has been approved without regard to the six-month allotment limitation in § 51.8(d), and (2) expenditures of public funds of the State or its political subdivision (otherwise allowable for matching payments of mental health grant funds as authorized by § 51.9(a)) which are made during the fiscal year or such longer period for which such plan is approved shall be allowable for matching such payments; and *Provided further,* That with respect to grants from the fiscal year 1965 appropriation for dental health, 100 percent of the funds available for allotment during that year shall be allotted as soon as practicable in the fiscal year, and that such allotments shall remain available for the remainder of the fiscal year.

* * * * *

5. The first sentence in section 51.6(b) is amended to read as follows:

§ 51.6 Plans; contents.

* * * * *

(b) The State health department shall, with respect to its total annual expenditures of Federal and required matching funds for its venereal disease, tuberculosis, heart, cancer, mental health, the chronically ill and the aged, radiological health, and dental health programs, provide in its State plan for the allocation of such expenditures to such programs in accordance with either of the following procedures:

* * * * *

6. Section 51.9(a) is amended to read as follows:

§ 51.9 Required expenditure of State and local funds; funds of cooperating agencies.

(a) Moneys paid to any State or to a cooperating agency pursuant to section 314 of the Act shall be paid upon the condition that there be expended in the State during the fiscal year for which payment is made and for purposes specified in the plan with respect to which payment is made, public funds of the State and its political subdivision (or in the case of payments to a cooperating agency having an approved heart disease control plan, funds of the cooperating agency) in amounts which shall be exclusive of any funds derived from loan or grant from the United States for the same general purpose and which shall equal separately for venereal disease control, tuberculosis, mental health, general health, the chronically ill and the aged, heart disease, radiological health, and dental health, 100 percent of the Federal grant funds expended pursuant to the plan, except that with respect to Federal grant funds appropriated especially for services for the chronically ill and the aged the percentage shall be 50 percent for fiscal years 1962, 1963, and 1964, and $66\frac{2}{3}$ percent for fiscal year 1965.

* * * * *

(Sec. 215, 58 Stat. 690, as amended; 42 U.S.C. 216. Interpret or apply sec. 314, 58 Stat. 693, as amended; 42 U.S.C. 246)

Dated: November 24, 1964.

[SEAL] LUTHER L. TERRY,
Surgeon General.

Approved: December 14, 1964.

ANTHONY J. CELEBREZZE,
Secretary.

[F.R. Doc. 64-12986; Filed, Dec. 17, 1964; 8:49 a.m.]

Title 14—AERONAUTICS AND SPACE

Chapter I—Federal Aviation Agency

[Regulatory Docket No. 4080]

PART 23—AIRWORTHINESS STANDARDS: NORMAL, UTILITY, AND ACROBATIC CATEGORY AIRPLANES [NEW]

This amendment adds Part 23 [New] to the Federal Aviation regulations to replace Part 3 of the Civil Air Regulations and is a part of the Agency recodification program announced in Draft Release 61-25, published in the FEDERAL REGISTER on November 15, 1961 (26 F.R. 10698).

Part 23 [New] was published as a notice of proposed rule making in the FEDERAL REGISTER on April 14, 1964 (29 F.R. 5111), and given further distribution as Notice No. 64-17.

During the life of the recodification project, Chapter I of Title 14 may contain more than one part bearing the same number. To differentiate between the two, the recodified parts, such as this one, will be labeled "[New]". The label will of course be dropped at the completion of the project as all of the regulations will be new.

Many of the comments received recommended specific substantive changes to the regulations. Although many of the recommendations appear to be meritorious, they cannot be adopted as a part of the recodification program. The purpose of the program is simply to streamline and clarify present regulatory language and delete obsolete or redundant provisions. To attempt substantive changes, other than relaxatory ones that are completely noncontroversial, would delay the project and be contrary to the ground rules specified for it in Draft Release 61-25. However, we recognize that an overall substantive review of the Part is long overdue. This review is now being undertaken and all substantive comments received are being carefully studied.

Present CAR Part 3 reflects the various writing styles used by those who have worked on it in the past. The recodification has allowed us to use one style throughout Part 23 [New]. The style changes that have been made do not affect substance. They have been made to ensure consistency in language throughout the new Federal Aviation Regulations, thereby making them easier to understand and apply. Part 23 [New] substitutes the word "must" for "shall". This has been done to reflect the fact that airworthiness standards are simply conditions precedent that are required to be met for the issue of a type certificate. The imperative "shall" would be inappropriate in this case. The failure to meet the standards simply results in a denial of the issue of the type certificate.

The sections in Part 23 [New] have been rearranged and renumbered. This will allow the requirements of this Part to be numbered identically with the comparable requirements in Parts 25 [New], 27 [New], and 29 [New]. In addition, some material has been rearranged in order that the requirements be more logically placed within the Part. An example of this is the regrouping of the requirements in §§ 3.73, 3.73-3, 3.76, 3.84, 3.86, 3.120, 3.123, 3.124, and 3.437 through 3.780, dealing with recording of data and information, into the division of Part 23 [New] dealing with flight manual requirements. A similar rearrangement was the combining of the flutter requirements of §§ 3.159 and 3.311 into § 23.629.

As was stated in the preamble of the notice of proposed rule making of Part 23, those definitions in present Part 3 (and not now in Part 1 or executed in this part) that are necessary, will be recodified with the definitions of other airworthiness parts and added to Part 1 [New].

FAR 23 [New] contains, in addition to the CAM material included in the notice of proposed rule making, CAMs 3.71-1 and 3.311-1, and the second sentence of CAM 3.422-2. CAM 3.71-1 was included as it relaxes the rule by allowing certain tolerances during flight testing. These tolerances are necessary for the proper conduct of flight testing and such tolerances have been safely used in the past. They are now specifically included in the rule on flight testing. The flutter prevention method described in CAM 3.311-1 has been an additional safe acceptable method meeting the flutter requirements of CAR 3.311 and therefore has been included in this part. The second sentence of § 3.422-2, with regard to the amount of deflection necessary to show propeller clearance for airplanes with leaf spring shock struts, has been included in order to eliminate the need for extensive testing ranges for such airplanes. The deflection corresponding to 1.5*g* has been found to be safe and reliable for this purpose and has therefore been included in the rule. That CAM material that has not been incorporated in Part 23 [New] has been determined to be advisory, not regulatory, in nature. This material is being reviewed, and where current and necessary, it will be issued in the Agency's Advisory Circular System.

In the table in present § 3.106, yaw values are given for the "stick" and "wheel" when in fact the yaw values are applicable only to rudder pedal application. The table in this part has been revised accordingly.

The requirement in present CAM 3.294 with regard to approved bolts, pins, screws, and rivets and locking devices for them has been deleted as unnecessary as the Agency does not require specific approval of these items.

Paragraphs A23.7(e) (1) and (3) of Appendix A were reworded, in light of comments received, to make them consistent with the structural load criteria in the basic part.

Other minor changes of a technical clarifying nature have been made. They are not substantive and do not impose any burden on regulated persons.

The definitions, abbreviations, and rules of construction in Part 1 [New] of the Federal Aviation regulations apply to Part 23 [New].

Interested persons have been afforded an opportunity to participate in the making of this regulation and due consideration has been given to all relevant matter presented. The Agency is particularly appreciative of the cooperative spirit in which the public's comments were submitted.

In consideration of the foregoing, Chapter I of Title 14 is amended as follows, effective February 1, 1965:

1. By deleting Part 3.
2. By adding a Part 23 [New] reading as hereinafter set forth.

Issued in Washington, D.C., on September 28, 1964.

N. E. HALABY,
Administrator.

Subpart A—General

Sec.
23.1 Applicability.
23.3 Airplane categories.

Subpart B—Flight

GENERAL

23.21 Proof of compliance.
23.23 Load distribution limits.
23.25 Weight limits.
23.29 Empty weight and corresponding center of gravity.
23.31 Removable ballast.
23.33 Propeller speed and pitch limits.

PERFORMANCE

23.45 General.
23.49 Stalling speed.
23.51 Takeoff.
23.65 Climb: all engines operating.
23.67 Climb: one engine inoperative.
23.75 Landing.
23.77 Balked landing.

FLIGHT CHARACTERISTICS

23.141 General.

CONTROLLABILITY AND MANEUVERABILITY

23.143 General.
23.145 Longitudinal control.
23.147 Directional and lateral control.
23.149 Minimum control speed.
23.151 Acrobatic maneuvers.

TRIM

23.161 Trim.

STABILITY

23.171 General.
23.173 Static longitudinal stability.
23.175 Demonstration of static longitudinal stability.
23.177 Directional and lateral stability.
23.179 Instrumented stick force measurements.
23.181 Dynamic longitudinal stability.

STALLS

23.201 Stall demonstration.
23.203 Stall characteristics.
23.205 Stalls: critical engine inoperative.
23.207 Stall warning.

SPINNING

23.221 Spinning.

GROUND AND WATER HANDLING CHARACTERISTICS

23.231 Longitudinal stability and control.
23.233 Directional stability and control.
23.235 Taxiing condition.
23.239 Spray characteristics.

MISCELLANEOUS FLIGHT REQUIREMENTS

23.251 Vibration and buffeting.

Subpart C—Structure

GENERAL

Sec.
23.301 Loads.
23.303 Factor of safety.
23.305 Strength and deformation.
23.307 Proof of structure.

FLIGHT LOADS

23.321 General.
23.331 Symmetrical flight conditions.
23.333 Flight envelope.
23.335 Design airspeeds.
23.337 Limit maneuvering load factors.
23.341 Gust load factors.
23.345 High lift devices.
23.347 Unsymmetrical flight conditions.
23.349 Rolling conditions.
23.351 Yawing conditions.
23.361 Engine torque.
23.363 Side load on engine mount.
23.365 Pressurized cabin loads.
23.369 Special conditions for rear lift truss.

CONTROL SURFACE AND SYSTEM LOADS

23.391 Control surface loads.
23.395 Control system.
23.397 Control system loads.
23.399 Dual control system.
23.405 Secondary control system.
23.407 Trim tab effects.
23.409 Tabs.
23.415 Ground gust conditions.

HORIZONTAL TAIL SURFACES

23.421 Balancing loads.
23.423 Maneuvering loads.
23.425 Gust loads.
23.427 Unsymmetrical loads.

VERTICAL TAIL SURFACES

23.441 Maneuvering loads.
23.443 Gust loads.
23.445 Outboard fins.

AILERONS, WING FLAPS, AND SPECIAL DEVICES

23.455 Ailerons.
23.457 Wing flaps.
23.459 Special devices.

GROUND LOADS

23.471 General.
23.473 Ground load conditions and assumptions.
23.477 Landing gear arrangement.
23.479 Level landing conditions.
23.481 Tail down landing conditions.
23.483 One-wheel landing conditions.
23.485 Side load conditions.
23.493 Braked roll conditions.
23.497 Supplementary conditions for tail wheels.
23.499 Supplementary conditions for nose wheels.
23.505 Supplementary conditions for skiplanes.

WATER LOADS

Sec.
23.521 Water load conditions.

EMERGENCY LANDING CONDITIONS

23.561 General.

FATIGUE EVALUATION

23.571 Pressurized cabin.

Subpart D—Design and Construction

23.601 General.
23.603 Materials and workmanship.
23.605 Fabrication methods.
23.607 Self-locking nuts.
23.609 Protection of structure.
23.611 Inspection provisions.
23.613 Material strength properties and design values.
23.615 Design properties.
23.617 Interchangeability of seamwelded and seamless steel tubing.
23.619 Special factors.
23.621 Casting factors.
23.623 Bearing factors.
23.625 Fitting factors.
23.627 Fatigue strength.
23.629 Flutter.

WINGS

23.641 Proof of strength.
23.643 Rib tests.

CONTROL SURFACES

23.651 Proof of strength.
23.655 Installation.
23.657 Hinges.
23.659 Mass balance.

CONTROL SYSTEMS

23.671 General.
23.673 Primary flight controls.
23.675 Stops.
23.677 Trim systems.
23.679 Control system locks.
23.681 Limit load static tests.
23.683 Operation tests.
23.685 Control system details.
23.687 Spring devices.
23.689 Cable systems.
23.693 Joints.
23.697 Wing flap controls.
23.699 Wing flap position indicator.
23.701 Flap interconnection.

LANDING GEAR

23.721 General.
23.723 Shock absorption tests.
23.725 Limit drop tests.
23.727 Reserve energy absorption drop test.
23.729 Retracting mechanism.
23.731 Wheels.
23.733 Tires.
23.735 Brakes.
23.737 Skis.

FLOATS AND HULLS

Sec.
23.751 Main float buoyancy.
23.753 Main float design.
23.755 Hulls.
23.757 Auxiliary floats.

PERSONNEL AND CARGO ACCOMMODATIONS

23.771 Pilot compartment.
23.773 Pilot compartment view.
23.775 Windshields and windows.
23.777 Cockpit controls.
23.779 Motion and effect of cockpit controls.
23.781 Cockpit control knob shape.
23.783 Doors.
23.785 Seats and berths.
23.787 Cargo compartments.
23.807 Emergency exits.
23.831 Ventilation.

PRESSURIZATION

23.841 Pressurized cabins.
23.843 Pressurization tests.

FIRE PROTECTION

23.853 Compartment interiors.
23.859 Combustion heater fire protection.

MISCELLANEOUS

23.871 Leveling marks.

Subpart E—Powerplant

GENERAL

23.901 Installation.
23.903 Engines.
23.905 Propellers.
23.907 Propeller vibration.
23.925 Propeller clearance.

FUEL SYSTEM

23.951 General.
23.953 Fuel system independence.
23.955 Fuel flow.
23.957 Flow between interconnected tanks.
23.959 Unusable fuel supply and fuel system operation on low fuel.
23.961 Fuel system hot weather operation.
23.963 Fuel tanks: general.
23.965 Fuel tank tests.
23.967 Fuel tank installation.
23.969 Fuel tank expansion space.
23.971 Fuel tank sump.
23.973 Fuel tank filler connection.
23.975 Fuel tank vents and carburetor vapor vents.
23.977 Fuel tank outlet.

FUEL SYSTEM COMPONENTS

23.991 Fuel pumps.
23.993 Fuel system lines and fittings.
23.995 Fuel valves and controls.
23.997 Fuel strainer or filter.
23.999 Fuel system drains.

AUTHORITY: The provisions of this Part 23 issued under secs. 313(a), 601, 603, Federal Aviation Act of 1958; 49 U.S.C. 1354(a), 1421, 1423.

Subpart A—General

§ 23.1 Applicability.

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

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

§ 23.3 Airplane categories.

(a) The normal category is limited to airplanes intended for nonacrobatic operation. Nonacrobatic operation includes any maneuvers incident to normal flying, stalls (except whip stalls), and turns in which the angle of bank is not more than 60 degrees.

(b) The utility category is limited to airplanes intended for limited acrobatic operation. Limited acrobatic operation includes any maneuvers incident to normal flying, stalls (except whip stalls), spins (if approved for the particular type of airplane), lazy eights, chandelles, and steep turns in which the angle of bank is more than 60 degrees.

(c) The acrobatic category is limited to airplanes intended for use without restrictions other than those shown to be necessary as a result of required flight tests.

(d) Small airplanes may be certificated in more than one category if the requirements of each requested category are met.

Subpart B—Flight

GENERAL

§ 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.

§ 23.23 Load distribution limits.

Ranges of weights and centers of gravity within which the airplane may be safely operated must be established. If low fuel adversely affects balance or stability, the airplane must be tested under conditions simulating those that would exist when the amount of usable fuel does not exceed one gallon for each 12 maximum continuous horsepower of the engine or engines.

§ 23.25 Weight limits.

(a) *Maximum weight.* The maximum weight (the highest weight at which compliance with each applicable requirement of this part is shown) must be established so that it is—

(1) Not more than—

(i) The highest weight selected by the applicant;

(ii) Except as provided in § 23.473 for multiengine airplanes, the design maximum weight (the highest weight at which compliance with each applicable structural loading condition of this part is shown); or

(iii) The highest weight at which compliance with each applicable flight requirement of this part is shown; and

(2) Assuming a weight of 170 pounds for each occupant of each seat for normal category airplanes and 190 pounds (unless otherwise placarded) for utility and acrobatic category airplanes, not less than the weight with—

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

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

(b) *Minimum weight.* The minimum weight (the lowest weight at which compliance with each applicable requirement of 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);

(3) The weight of the oil at full tank capacity; and

(4) The weight of no more than the quantity of fuel necessary for one-half hour of operation at rated maximum continuous power.

§ 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;

(3) Undrainable oil (the oil remaining in the airplane while in the ground attitude after drainage of all drainable oil in that attitude);

(4) Engine coolant; and

(5) Hydraulic fluid.

(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.

§ 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) The Airplane Flight Manual includes instructions for the proper placement of the removable ballast under each loading condition for which removable ballast is necessary.

§ 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 V_Y, 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 the placarded "never-exceed speed", 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, a means to limit the maximum engine speed to 103 percent of the maximum allowable takeoff r.p.m. with the propeller blades at the lowest possible pitch and with takeoff manifold pressure, the airplane stationary, and no wind.

PERFORMANCE

§ 23.45 General.

Compliance with the performance requirements of this subpart must be shown for still air with a standard atmosphere.

§ 23.49 Stalling speed.

(a) V_{S_0} is the stalling speed, if obtainable, or the minimum steady speed, in miles per hour (CAS), at which the airplane is controllable, with the—

(1) Engines idling, throttles 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) Propellers in the takeoff position;

(3) Landing gear extended;

(4) Wing flaps in the landing position;

(5) Cowl flaps closed;

(6) Center of gravity in the most unfavorable position within the allowable landing range; and

(7) Weight used when V_{S_0} is being used as a factor to determine compliance with a required performance standard.

(b) V_{S_0} at maximum weight may not exceed 70 miles per hour 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(b) with the critical engine inoperative.

(c) V_{S_1} is the calibrated stalling speed, if obtainable, or the minimum steady speed, in miles per hour, at which the airplane is controllable, with the—

(1) Engines idling, throttles 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) Propellers in the takeoff position:

(3) Airplane in the condition existing in the test in which V_{S_1} is being used; and

(4) Weight used when V_{S_1} is being used as a factor to determine compliance with a required performance standard.

(d) V_{S_0} and V_{S_1} must be determined by flight tests, using the procedure specified in § 23.201.

§ 23.51 Takeoff.

(a) For airplanes of more than 6,000 pounds maximum weight (except skiplanes for which landplane takeoff data has been determined under this paragraph and furnished in the Airplane Flight Manual)—

(1) The distance required to take off and climb over a 50-foot obstacle must be determined with—

(i) The engines operating within approved operating limitations; and

(ii) The cowl flaps in the normal takeoff position;

(2) Upon reaching a height of 50 feet above the takeoff surface level, the airplane must have reached a speed of not less than—

(i) 1.3 V_{S_1}; or

(ii) Any lesser speed, not less than V_X plus 5 miles per hour, that is shown to be safe under any condition, including turbulence and complete engine failure;

(3) The starting point for measuring seaplane and amphibian takeoff distance may be the point at which a speed of not more than three miles per hour is reached; and

(4) No takeoff made to determine the data required by this section may require exceptional piloting skill or exceptionally favorable conditions.

(b) For airplanes of 6,000 pounds or less maximum weight—

(1) The takeoff may not require exceptional piloting skill;

(2) With takeoff power, there must be enough elevator control—

(i) For a tail-wheel type airplane, to maintain, at 0.8 V_{S_1}, an attitude that will allow holding the airplane on the runway until a safe takeoff speed is reached; and

(ii) For a nose-wheel type airplane to raise the nose-wheel clear of the takeoff surface at 0.85 V_{S_1}.

§ 23.65 Climb: all engines operating.

(a) For airplanes of more than 6,000 pounds maximum weight—

(1) Each airplane must have a steady rate of climb at sea level of at least 300 feet per minute and a steady angle of climb of at least 1:12 for land planes or 1:15 for seaplanes and amphibians with—

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

(ii) The landing gear retracted;

(iii) The wing flaps in the takeoff position; and

(iv) The cowl flaps in the position used in the cooling tests required by §§ 23.1041 through 23.1047;

(2) Each airplane with engines for which the takeoff and maximum continuous power ratings are identical and that has fixed-pitch, two-position, or similar propellers, may use a lower propeller pitch setting than that allowed by § 23.33 to obtain rated engine r.p.m. at V_X, if—

(i) The airplane shows marginal performance (such as when it can meet the rate of climb requirements of paragraph (a)(1) of this section but has difficulty in meeting the angle of climb requirements of paragraph (a)(1) of this section or of § 23.77); and

(ii) Acceptable engine cooling is shown at the lower speed associated with the best angle of climb.

(b) Each airplane of 6,000 pounds or less maximum weight must have a steady rate of climb at sea level of at least 300 feet per minute, or 10 V_{S_1} (that is, the number of feet per minute is obtained by multiplying the number of miles per hour by 10), whichever is greater, with—

(1) Takeoff power;

(2) The landing gear extended;

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

(4) The cowl flaps in the position used in the cooling tests required by §§ 23.1041 through 23.1047.

§ 23.67 Climb: one engine inoperative.

(a) Each multiengine airplane of more than 6,000 pounds maximum weight must be able to maintain a steady rate of climb of at least 0.02 $V_{S_0}^2$ (that is, the number of feet per minute is obtained by multiplying the square of the number of miles per hour by 0.02) at an altitude of 5,000 feet with the—

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

(2) Remaining engines at not more than maximum continuous power;

(3) Landing gear retracted;

(4) Wing flaps in the most favorable position; and

(5) Cowl flaps in the position used in the cooling tests required by §§ 23.1041 through 23.1047.

(b) For multiengine airplanes of 6,000 pounds or less maximum weight, the following apply:

(1) Each airplane with a V_{S_0} of more than 70 miles per hour must be able to maintain a steady rate of climb of at least 0.02 $V_{S_0}^2$ (that is, the number of feet per minute is obtained by multiplying the square of the number of miles per hour by 0.02), at an altitude of 5,000 feet with the—

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

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

(iii) Landing gear retracted;

(iv) Wing flaps in the most favorable position; and

(v) Cowl flaps in the position used in the cooling tests required by §§ 23.1041 through 23.1047.

(2) For each airplane with a stalling speed of 70 miles per hour or less, the steady rate of climb at 5,000 feet must be determined with the—

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

(ii) Remaining engines at not more than maximum continuous power:

(iii) Landing gear retracted;

(iv) Wing flaps in the most favorable position; and

(v) Cowl flaps in the position used in the cooling tests required by §§ 23.1041 through 23.1047.

§ 23.75 **Landing.**

(a) For airplanes of more than 6,000 pounds maximum weight (except skiplanes for which landplane landing data have been determined under this paragraph and furnished in the Airplane Flight Manual), the horizontal distance required to land and come to a complete stop (or to a speed of approximately three miles per hour for seaplanes and amphibians) from a point 50 feet above the landing surface must be determined as follows:

(1) A steady gliding approach with a calibrated airspeed of at least 1.5 V_{S_1} must be maintained down to the 50 foot height.

(2) The landing may not require exceptional piloting skill or exceptionally favorable conditions.

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

(b) Airplanes of 6,000 pounds or less maximum weight must be able to be landed safely and come to a stop without exceptional piloting skill and without excessive vertical acceleration or tendency to bounce, nose over, ground loop, porpoise, or water loop.

§ 23.77 **Balked landing.**

For balked landings, each airplane with a maximum weight of—

(a) More than 6,000 pounds, must be able to maintain a steady angle of climb at sea level of at least 1: 30 with—

(1) Takeoff power on each engine;

(2) The landing gear extended; and

(3) The wing flaps in 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 or exceptional piloting skill, they may be retracted; and

(b) 6,000 pounds or less, must be able to maintain a steady rate of climb at sea level of at least 200 feet per minute, or 5 V_{S_0} (that is, the number of feet per minute is obtained by multiplying the number of miles per hour by five), whichever is greater, with—

(1) Takeoff power on each engine;

(2) The landing gear extended; and

(3) The wing flaps in the landing position, except that, if rapid retraction is possible with safety, without loss of altitude, and without sudden changes of angle of attack or exceptional piloting skill, they may be retracted.

FLIGHT CHARACTERISTICS

§ 23.141 **General.**

The airplane must meet the requirements of §§ 23.143 through 23.221—

(a) At the normally expected operating altitudes;

(b) Under any critical loading conditions within the center of gravity range; and

(c) Unless otherwise specified, at the highest weight for which certification is requested.

CONTROLLABILITY AND MANEUVERABILITY

§ 23.143 **General.**

(a) The airplane must be safely controllable and maneuverable during—

(1) Takeoff;

(2) Climb;

(3) Level flight;

(4) Dive; and

(5) Landing (power on and power off).

(b) It must be possible to make a smooth transition from one flight condition to another (including turns and slips) without exceptional piloting skill, alertness, or strength, and 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 "strength of pilots" limits must be shown by quantitative tests. In no case may the limits exceed those precribed in the following table:

Values in pounds of force as applied to the control wheel or rudder pedals	Pitch	Roll	Yaw
(a) For temporary application:			
Stick	60	30	
Wheel (applied to rim)	75	60	
Rudder pedal			150
(b) For prolonged application	10	5	20

§ 23.145 **Longitudinal control.**

(a) 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 and the airplane trimmed at V_X;

(2) Power off and the airplane trimmed at 1.5 V_{S_1} or at the minimum trim speed, whichever is higher; and

(3) Wing flaps and landing gear (i) retracted, and (ii) extended.

(b) With the landing gear extended, no change in trim or exertion of more control force than can be readily applied with one hand for a short period of time may be required for the following maneuvers:

(1) With power off, flaps retracted, and the airplane trimmed at 1.5 V_{S_1}, or at the minimum trim speed, whichever is higher, extend the flaps as rapidly as possible while maintaining the airspeed at approximately 40 percent above the instantaneous value of the stalling speed.

(2) Repeat subparagraph (1) of this paragraph except initially extend the flaps and then retract them as rapidly as possible.

(3) Repeat subparagraph (2) of this paragraph except with maximum continuous power.

(4) With power off, flaps retracted, and the airplane trimmed at 1.5 V_{S_1}, or at the minimum trim speed, whichever is higher, apply takeoff power rapidly while maintaining the same airspeed.

(5) Repeat subparagraph (4) of this paragraph, except with the flaps extended.

(6) With power off, flaps extended, and the airplane trimmed at 1.5 V_{S_1}, or at the minimum trim speed, whichever is higher, obtain and maintain airspeeds between 1.1 V_{S_1} and either 1.7 V_{S_1} or V_F, whichever is lower.

(c) It must be possible, without exceptional piloting skill, to maintain approximately level flight when flap retraction from any position is made during steady horizontal flight at 1.1 V_{S_1} with simultaneous application of not more than maximum continuous power.

(d) It must be possible, with a pilot control force of not more than 10 pounds, to maintain a speed of not more than 1.5 V_{S_1} during a power-off glide with landing gear and wing flaps extended, and with—

(1) The most forward center of gravity approved for the maximum weight; and

(2) The most forward center of gravity approved for any weight.

(e) It must be possible, by using the normal flight and power controls except the primary longitudinal control, to control the descent of the airplane to a zero rate of descent and to an attitude suitable for a controlled landing, without exceptional piloting skill, alertness, or strength, and without exceeding the operational and structural limitations of the airplane.

§ 23.147 **Directional and lateral control.**

(a) For each multiengine airplane, it must be possible to make turns with 15 degrees of bank both towards and away from an inoperative engine, from a steady climb at 1.4 V_{S_1} or V_Y with—

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

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

(3) The rearmost allowable center of gravity;

(4) The landing gear (i) retracted, and (ii) extended;

(5) The flaps in the most favorable climb position; and

(6) Maximum weight.

(b) 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 must be shown at 1.4 V_{S_1} or V_Y 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;

(4) Flaps in the most favorable climb position; and

(5) Center of gravity at its rearmost allowable position.

§ 23.149 Minimum control speed.

(a) V_{MC} is the minimum calibrated airspeed at which, when any engine is suddenly made inoperative, it is possible to recover control of the airplane with that engine still inoperative and maintain straight flight, either with zero yaw, or, at the option of the applicant, with an angle of bank of not more than five degrees. V_{MC} may not exceed 1.2 V_{S_1} with—

(1) Takeoff or maximum available power on each engine;

(2) The rearmost allowable center of gravity;

(3) The flaps in the takeoff position; and

(4) The landing gear retracted.

(b) At V_{MC}, the rudder forces required to maintain control may not exceed the limitations set forth in § 23.143, and it may not be necessary to throttle the remaining engines. During recovery, the airplane may not assume any dangerous attitude or require exceptional piloting skill, alertness, or strength to prevent a heading change of more than 20 degrees.

§ 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.

TRIM

§ 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.

(b) *Lateral and directional trim.* The airplane must maintain lateral and directional trim in level flight at 0.9 V_H or V_C, whichever is lower, with the landing gear and wing flaps retracted.

(c) *Longitudinal trim.* The airplane must maintain longitudinal trim during—

(1) A climb with maximum continuous power at a speed between V_X and 1.4 V_{S_1}, with the landing gear and wing flaps retracted;

(2) A climb with maximum continuous power at a speed between V_X and 1.4 V_{S_1}, with the landing gear retracted and the wing flaps in the takeoff position;

(3) A power approach at 1.5 V_{S_1}, with a three degree angle of descent, the landing gear extended, and the wing flaps retracted;

(4) A power approach at 1.5 V_{S_1}, with a three degree angle of descent, the landing gear and wing flaps exended, and the most forward center of gravity approved for the maximum weight;

(5) A power approach at 1.5 V_{S_1}, with a three degree angle of descent, the landing gear and wing flaps extended, and the most forward center of gravity approved for any weight; and

(6) Level flight at any speed from 0.9 V_H to either V_X or 1.4 V_{S_1}, with landing gear and wing flaps retracted.

(d) In addition, each multiengine airplane must maintain longitudinal and directional trim at a speed between V_Y and 1.4 V_{S_1}, with—

(1) The critical engine inoperative;

(2) The remaining engines at maximum continuous power;

(3) The landing gear retracted;

(4) The wing flaps retracted; and

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

STABILITY

§ 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.

§ 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 without excessive control force, except speeds more than the appropriate maximum allowable speed or less than the minimum speed for steady unstalled flight.

(b) The airspeed must return to within plus or minus 10 percent of the original trim speed when the control force is slowly released at any speed within the speed range specified in paragraph (a) of this section.

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

§ 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 1.2 V_{S_1}, and 1.6 V_{S_1}, with—

(1) Flaps retracted;

(2) Landing gear retracted;

(3) Maximum weight;

(4) 75 percent of maximum continuous power; and

(5) The airplane trimmed at 1.4 V_{S_1}.

(b) *Cruise.* The stick force curve must have a stable slope at any speed obtainable with a stick force not more than 40 pounds at speeds between 1.3 V_{S_1} and the maximum allowable speed, with—

(1) Landing gear retracted;

(2) Flaps retracted;

(3) Maximum weight;

(4) 75 percent of maximum continuous power; and

(5) The airplane trimmed for level flight.

Compliance with this paragraph must also be shown with the landing gear extended and without exceeding level flight trim speed.

(c) *Approach.* The stick force curve must have a stable slope and the stick force may not exceed 40 pounds at speeds between 1.1 V_{S_1} and 1.8 V_{S_1}, with—

(1) Flaps in the landing position;

(2) Landing gear extended;

(3) Maximum weight; and

(4) The airplane trimmed at 1.5 V_{S_1} with enough power to maintain a three degree angle of descent.

§ 23.177 Directional and lateral stability.

(a) *Three-control airplanes.* The stability requirements for three-control airplanes are as follows:

(1) The static directional stability, as shown by the tendency to recover from a skid with the rudder free, must be positive for any landing gear and flap position appropriate to the takeoff, climb, cruise, and approach configurations. This must be shown with symmetrical power up to maximum continuous power, and at speeds from 1.2 V_{S_1} up to the maximum allowable speed for the condition being investigated. The angle of skid for these tests must be appropriate to the type of airplane. At larger angles of skid 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 V_{S_1} to V_A, the rudder pedal force must not reverse.

(2) The static lateral stability, as shown by the tendency to raise the low wing in a slip, must be positive for any 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 V_{S_1}, up to the maximum allowable speed for the configuration being investigated. The static lateral stability may not be nega-

tive at 1.2 V_{S_1}. The angle of slip for these tests must be appropriate to the type of airplane, but in no case may the slip angle be less than that obtainable with 10 degrees of bank.

(3) In straight, steady slips at 1.2 V_{S_1} 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 slip is increased up to the maximum appropriate to the type of airplane. At larger slip angles up to the angle at which the full rudder or aileron control is used or a control force limit contained in § 23.143 is obtained, the rudder pedal force may not reverse. Enough bank must accompany slipping to hold a constant heading. Rapid entry into, or recovery from, a maximum slip may not result in uncontrollable flight characteristics.

(4) Any short period oscillation, occurring between stalling speed and the maximum allowable speed, must be heavily damped with the primary controls (i) free and (ii) in a fixed position.

(b) *Two-control (or simplified control) airplanes.* The stability requirements for two-control airplanes are as follows:

(1) The directional stability of the airplane must be shown by showing that, in each configuration, it can be rapidly rolled from a 45 degree bank in one direction to a 45 degree bank in the opposite direction without showing dangerous skid characteristics.

(2) The lateral stability of the airplane must be shown by showing that it will not assume a dangerous attitude or speed when the controls are abandoned for two minutes. This must be done in moderately smooth air with the airplane trimmed for straight level flight at 0.9 V_H or V_C, whichever is lower, with flaps and landing gear retracted, and with a rearward center of gravity.

(3) Any short period oscillation occurring between the stalling speed and the maximum allowable speed must be heavily damped with the primary controls (i) free and (ii) in a fixed position.

§ 23.179 Instrumented stick force measurements.

Instrumented stick force measurements must be made unless—

(a) Changes in speed are clearly reflected by changes in stick forces; and

(b) The maximum forces obtained under §§ 23.173 and 23.175 are not excessive.

§ 23.181 Dynamic longitudinal stability.

Any short period longitudinal oscillation occurring between the stalling speed and the maximum allowable speed must be heavily damped with the primary controls (a) free and (b) fixed.

STALLS

§ 23.201 Stall demonstration.

(a) Level wing stalls must be shown with—

(1) Power off; and

(2) A power setting not less than that required to show compliance with § 23.65 for an airplane of more than 6,000 lbs. maximum weight, or with 90 percent of maximum continuous power for an airplane of 6,000 lbs. or less maximum weight.

(b) In either condition required by paragraph (a) of this section, it must be possible to comply with the applicable requirements of § 23.203(a) with flaps and landing gear in any position.

(c) The following procedure must be used to show compliance with § 23.203(a):

(1) With the trim controls adjusted for straight flight at 1.5 V_{S_1}, or at the mimimum trim speed, whichever is higher, reduce the speed with the elevator control until the speed is slightly above the stalling speed.

(2) Then pull back the elevator control so that the rate of speed reduction will not exceed one mile per hour per second until a stall is produced, as shown by an uncontrollable downward pitching motion of the airplane, or until the control reaches the stop. Normal use of the elevator control for recovery is allowed after the pitching motion has unmistakably developed.

(d) Except where made inapplicable by the special features of a particular type of airplane, the following procedure must be used to measure loss of altitude during a stall:

(1) The approach to the stall must be made as prescribed in paragraph (b) of this section.

(2) The loss of altitude encountered in the stall (power on or power off) is the change in altitude (as observed on the sensitive altimeter testing installation) between the altitude at which the airplane pitches and the altitude at which horizontal flight is regained.

(3) If required, the power used during stall recovery must be that which would be used under normal operating conditions in this maneuver. However, the power used to regain level flight may not be applied until flying control is regained.

(d) For turning flight stalls, the following maneuver must be used to show compliance with § 23.203(b):

(1) Establish a steady, curvilinear, level, coordinated turn in a 30 degree bank and, while maintaining the 30 degree bank, stall the airplane by steadily and progressively tightening the turn with the elevator control until the airplane is stalled, or until the elevator has reached its stop.

(2) When the stall has fully developed, regain level flight with normal use of the controls.

§ 23.203 Stall characteristics.

(a) For level wing stalls—

(1) For an airplane with independently controlled rolling and directional controls, it must be possible to produce and to correct roll by unreversed use of the rolling control and to produce and correct yaw by unreversed use of the directional control, up to the time the airplane pitches in the maneuver prescribed in § 23.201(b);

(2) For an airplane with interconnected lateral and directional controls (two control), for an airplane with only one of these controls, it must be possible to produce and correct roll by unreversed use of the rolling control without producing excessive yaw, up to the time the airplane pitches in the maneuver prescribed in § 23.201(b); and

(3) During the recovery part of the manuever prescribed in § 23.201(b), it must be possible to prevent more than 15 degrees of roll or yaw by the normal use of the controls.

(b) For turning flight stalls, when stalled during a coordinated turn with 30 degrees of bank, 75 percent maximum continuous power on each engine, and flaps and landing gear retracted, it must be possible to regain normal level flight without excessive loss of altitude or uncontrollable rolling or spinning tendencies.

(c) For limited elevator control stalls, it must be possible, when stalled from an excessive climb attitude, to recover without exceeding airspeed or acceleration limits.

§ 23.205 Stalls: critical engine inoperative.

(a) A multiengine airplane must have stall characteristics that prevent unintentional spin entry. This must be shown by performing the maneuver prescribed in paragraph (b) of this section, at the lowest practical altitude, with—

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

(2) Landing gear extended, with the flaps (i) retracted and (ii) extended; and

(3) The remaining engines at full throttle or maximum continuous power.

(b) The maneuver required by paragraph (a) of this section is as follows: Establish a steady, curvilinear turn and, while maintaining a 15 degree bank (1), toward and (2) away from the inoperative engine, steadily increase the angle of attack with the elevator control until an uncontrollable downward pitching motion occurs. In performing this maneuver it must be possible to—

(1) Produce and correct roll by unreversed use of the lateral control until the airplane stalls; and

(2) Recover immediately to full flight control with wings level, from the stalled condition, by normal use of the controls, reducing power on the operating engines if desired, without exceeding a 60 degree angle of bank.

§ 23.207 Stall warning.

There must be a clear and distinct stall warning with the flaps and the landing gear in any position, both in straight and in turning flight. The stall warning must begin at a speed exceeding the stalling speed by not less than five, and not more than 10, miles per hour, and must continue until the stall occurs.

SPINNING

§ 23.221 Spinning.

(a) *Normal category.* A single-engine, normal category airplane must be able to recover from a one-turn spin in not more than one additional turn, with the controls used in the manner normally used for recovery. In addition—

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

(2) There may be no excessive back pressure during the spin or recovery; and

(3) It must be impossible to obtain uncontrollable spins with any use of the controls.

For the flaps-extended condition, the flaps may be retracted during recovery.

(b) *Utility category.* A utility category airplane must meet the requirements of paragraph (a) of this section or the requirements of paragraph (c) of this section.

(c) *Acrobatic category.* An acrobatic category airplane must be able to spin at least six turns, and must meet the following requirements:

(1) The airplane must recover from any point in a spin, not exceeding six turns with flaps retracted and one turn with flaps extended, in not more than one and one-half additional turns after normal recovery application of the controls.

(2) For both the flaps-retracted and flaps-extended conditions, the applicable airspeed limit and positive limit maneuvering load factor may not be exceeded. For the flaps-extended condition, the flaps may be retracted during recovery, if a placard is installed prohibiting intentional spins with flaps extended.

(3) It must be impossible to obtain uncontrollable spins with any use of the controls.

(d) *Airplanes "characteristically incapable of spinning".* If it is desired to designate an airplane as "characteristically incapable of spinning", this characteristic must be shown with—

(1) A weight five percent more than the highest weight for which approval is requested;

(2) A center of gravity at least three percent aft of the rearmost position for which approval is requested;

(3) An available elevator up-travel four degrees in excess of that to which the elevator travel is to be limited for approval; and

(4) An available rudder travel seven degrees, in both directions, in excess of that to which the rudder travel is to be limited for approval.

GROUND AND WATER HANDLING CHARACTERISTICS

§ 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.

§ 23.233 Directional stability and control.

(a) There may be no uncontrollable ground or water looping tendency in 90 degree cross winds, up to a wind velocity of 0.2 V_{S_0}, at any speed at which the airplane may be expected to be operated on the ground or water.

(b) A landplane must be satisfactorily controllable, without exceptional piloting skill or alertness, in power-off landings at normal landing speed, without using brakes or engine power to maintain a straight path.

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

§ 23.235 Taxiing condition.

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

§ 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

§ 23.251 Vibration and buffeting.

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

Subpart C—Structure

GENERAL

§ 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.

(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 conventional, single-engine airplanes with design weights of 6,000 pounds or less, the design criteria of Appendix A of this part are an approved equivalent of §§ 23.331 through 23.399. If Appendix A is used, the entire Appendix must be substituted for the corresponding sections of this part.

§ 23.303 **Factor of safety.**

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

§ 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. However, when proof of strength is shown by dynamic tests simulating actual load conditions, the three second limit does not apply.

§ 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

§ 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.

§ 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 §§ 23.331 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.

§ 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

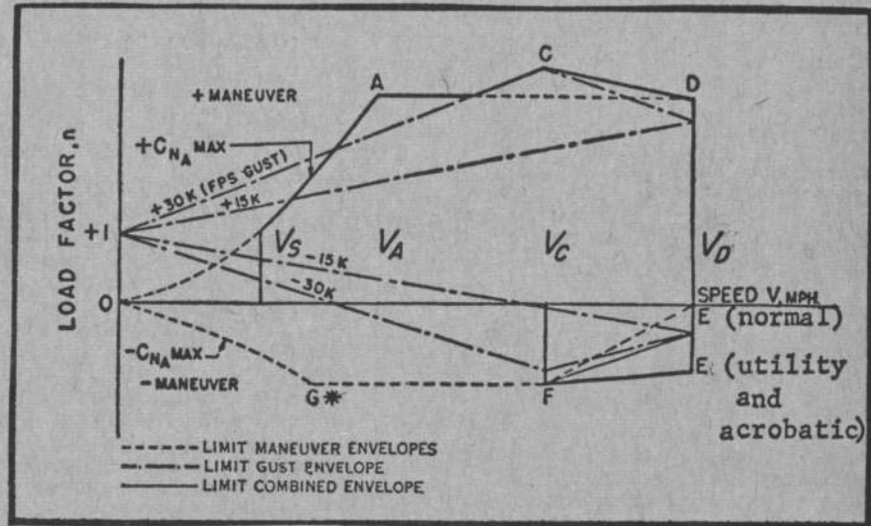
(3) Factors varying linearly with speed from the specified value at V_C to 0.0 at V_D for the normal category, and -1.0 at V_D for the acrobatic and utility categories.

(c) *Gust envelope.* Limit gust loads are the loads that would result when the airplane encounters the following symmetrical vertical gusts (assuming that gust load factors vary linearly between V_C and V_D):

(1) Positive (up) and negative (down) gusts of 30 feet per second nominal intensity at speeds up to V_C.

(2) Positive and negative gusts of 15 feet per second at V_D.

(d) *Flight envelope.*



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

§ 23.335 **Design airspeeds.**

The selected design airspeeds are equivalent airspeeds (EAS).

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

(1) V_C (in miles per hour) may not be less than—

(i) $38\sqrt{W/S}$ (for normal and utility category airplanes); and

(ii) $42\sqrt{W/S}$ (for acrobatic category airplanes).

(2) For values of W/S more than 20, the numerical multiplying factors must be decreased linearly with W/S to a value of 33 where $W/S=100$. The required minimum value need not be more than $0.9\ V_H$ obtained at sea level.

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

(1) With $V_{C\ min}$ the required minimum design cruising speed, V_D (in miles per hour) may not be less than—

(i) $1.40\ V_{C\ min}$ (for normal category airplanes);

(ii) $1.50\ V_{C\ min}$ (for utility category airplanes); and

(iii) $1.55\ V_{C\ min}$ (for acrobatic category airplanes).

(2) For values of W/S more than 20, the numerical multiplying factors must

be decreased linearly with W/S to a value of 1.35 at $W/S=100$.

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

(1) V_A (in miles per hour) may not be less than $V_S\sqrt{n}$ where—

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

§ 23.337 Limit maneuvering load factors.

(a) The positive limit maneuvering load factor n may not be less than—

(1) $2.1+\frac{24{,}000}{W+10{,}000}$ for normal category airplanes, except that n need not be more than 3.8 nor may it be less than 2.5;

(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 and utility 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.

§ 23.341 Gust load factors.

In applying gust load requirements—

(a) The slope of the lift curve may be assumed to be that of the wing alone; and

(b) The gust load factors must be computed as follows:

$$n=1+\frac{KUVm}{575(W/S)}$$

where—

$K=\frac{1}{2}(W/S)^{1/4}$ (for $W/S<16$ p.s.f.);

$K=1.33-\frac{2.67}{(W/S)^{3/4}}$ (for $W/S>16$ p.s.f.);

U = nominal gust velocity, f.p.s. (Note that the "effective sharp-edged gust" equals KU);

V = airplane speed, m.p.h.;

m = slope of lift curve, C_L per radian, corrected for aspect ratio;

W/S = wing loading, p.s.f.

§ 23.345 High lift devices.

(a) If flaps or similar high lift devices to be used for takeoff, approach, or landing are installed, the airplane, with the flaps fully deflected at V_F, is assumed to be subjected to symmetrical maneuvers and gusts resulting in limit load factors within the range determined by—

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

(2) Positive and negative gusts of 15 feet per second acting normal to the flight path in level flight.

(b) V_F must be assumed to be not less than 1.4 V_S or 1.8 V_{SF}, whichever is greater, where—

V_S is the computed stalling speed with flaps retracted at the design weight; and

V_{SF} is the computed stalling speed with flaps fully extended at the design weight.

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

(c) In designing the flaps and supporting structures, slipstream effects must be accounted for, as specified in paragraph (b) of § 23.457.

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

(e) The requirements of §§ 23.175(c), 23.457, and this section, may be complied with separately or in combination.

§ 23.347 Unsymmetrical flight conditions.

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.

§ 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 wing airload acts on one side of the plane of symmetry and 60 percent of this load acts on the other side.

(2) For the normal and utility categories, in condition A, assume that 100 percent of the wing airload acts on one side of the airplane and 70 percent of this load acts on the other side. For airplanes of more than 1,000 pounds design weight, the latter percentage may be increased linearly with weight up to 75 percent at 12,500 pounds.

(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—

Δc_m is the moment coefficient increment; and

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

§ 23.351 Yawing conditions.

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

§ 23.361 Engine torque.

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

(1) The limit torque corresponding to takeoff power and propeller speed acting simultaneously with 75 percent of the limit loads from flight condition A; and

(2) The limit torque corresponding to maximum continuous power and propeller speed, acting simultaneously with the limit loads from flight condition A.

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

(1) 1.33 for engines with five or more cylinders; or

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

(c) Engine torque effects need not be investigated for any other conditions.

§ 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.

§ 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 1.3, 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.

§ 23.369 Special conditions for rear lift truss.

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

$V=10\sqrt{W/S}+10$ (m.p.h.).

(b) Either aerodynamic data for the particular wing section used, or a value of C_L equalling −0.8 with a chordwise distribution that is triangular between a peak at the trailing edge and zero at the leading edge, must be used.

CONTROL SURFACE AND SYSTEM LOADS

§ 23.391 Control surface loads.

(a) 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.

(b) If allowed by the following sections, the values of control surface loading in Appendix B of this part may be used, instead of particular control surface data, to determine the detailed rational requirements of §§ 23.397 through 23.459, unless these values result in unrealistic loads.

§ 23.395 Control system.

(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.

(2) The design must, in any case, provide a rugged system for service use, considering jamming, ground gusts, taxiing downwind, control inertia, and friction.

(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) Acceptable maximum and minimum pilot forces for elevator, aileron, and rudder controls are shown in § 23.397(b). These pilot forces 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.

§ 23.397 Control system loads.

(a) *General.* In the control surface flight loading condition, the airloads on movable sufaces 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 servomechanisms, 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) *Limit pilot forces.* The limit pilot forces are as follows:

Control	Maximum forces for design weight W equal to or less than 5,000 pounds [1]	Minimum forces [2]
Aileron:		
Stick	67 pounds	40 pounds.
Wheel [3]	53 D in-pounds [4]	40 D in-pounds.[4]
Elevator:		
Stick	167 pounds	100 pounds.
Wheel	200 pounds	100 pounds.
Rudder	200 pounds	130 pounds.

[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.

[2] If the design of any individual set of control systems or surfaces makes these specified minimum forces inapplicable, values corresponding to the pertinent hinge moments obtained under § 23.415, but not less than 0.6 of the specified minimum forces, may be used.

[3] The critical parts of the aileron control system must also be designed for a single tangential force with a limit value of 1.25 times the couple force determined from the above criteria.

[4] D=wheel diameter.

§ 23.399 Dual control system.

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

(a) 0.75 times those obtained under § 23.395; or

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

§ 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.

§ 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.

§ 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.

§ 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 subparagraph (2) of this paragraph, but the applicant elects to design a part of the control system for these loads, these loads need only be carried from control surface horns through the nearest stops or gust locks and their supporting structures.

(2) If pilot forces less than the minimums specified in § 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:

$$H=KcSq$$

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 $10\sqrt{W/S}+10$ (m.p.h.) except that the design speed need not exceed 60 m.p.h.; and
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 or lashed in mid-position.
(b) Aileron	±0.50	Ailerons at full throw; + moment on one aileron, − moment on the other.
(c) (d) Elevator	±0.75	(c) Elevator full up (−). (d) Elevator full down (+).
(e) (f) Rudder	±0.75	(e) Rudder in neutral. (f) Rudder at full throw.

HORIZONTAL TAIL SURFACES

§ 23.421 Balancing loads.

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

(b) Horizontal tail 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. The distribution in figure 6 of Appendix B may be used.

§ 23.423 Maneuvering loads.

Each horizontal tail surface must be designed for maneuvering loads imposed by the following conditions:

(a) A sudden deflection of the elevator control, at V_A, to (1) the maximum upward deflection, and (2) the maximum downward deflection, as limited by the control stops, or pilot effort, whichever is critical. The average loading of B23.11 of Appendix B and the distribution in figure 7 of Appendix B may be used.

(b) A sudden upward deflection of the elevator, at speeds above V_A, followed by a downward deflection of the elevator, resulting in the following combinations of normal and angular acceleration:

Condition	Normal acceleration (n)	Angular acceleration (radian/sec.²)
Down load	1.0	$+\frac{45}{V} n_m (n_m-1.5)$
Up load	n_m	$-\frac{45}{V} n_m (n_m-1.5)$

where—
(1) n_m=positive limit maneuvering load factor used in the design of the airplane; and
(2) V=initial speed in miles per hour.

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 avoiding exceeding the limit maneuvering load factor. The total tail load for both down and up load conditions is the sum of the balancing tail 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. The maneuvering load increment in figure 2 of Appendix B and the distributions in figure 7 (for down loads) and in figure 8 (for up loads) of Appendix B may be used.

§ 23.425 Gust loads.

(a) Each horizontal tail surface must be designed for loads resulting from—

(1) Positive and negative gusts of 30 feet per second nominal intensity at V_C, corresponding to the flight condition specified in § 23.333(c), with flaps retracted; and

(2) Positive and negative gusts of 15 feet per second nominal intensity at V_F, corresponding to the flight condition specified in § 23.345(a)(2), with flaps extended and at V_D corresponding with the flight conditions specified in § 23.333(c)(2) with flaps retracted.

(b) The average loadings in figures 3 and 4 of Appendix B and the distribution in figure 8 of Appendix B may be used instead of the requirements of subparagraph (a)(1).

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

(d) The incremental tail load due to the gust may be computed by the formula

$$\Delta t = 0.1KUVS_t a_t \left[1-\frac{36a_w}{R_w}\right]$$

where—
Δt=the limit gust load increment on the tail in pounds;
K=gust coefficient K derived from § 23.341;
U=nominal gust intensity in feet per second;
V=airplane speed in miles per hour;
S_t=tail surface area in square feet;
a_t=slope of lift curve of tail surface, C_L per degree, corrected for aspect ratio;
a_w=slope of lift curve of wing, C_L per degree; and
R_w=aspect ratio of the wing.

§ 23.427 Unsymmetrical loads.

The maximum horizontal tail surface loading (load per unit area), as determined under §§ 23.421 through 23.425, must be applied to the horizontal surfaces on one side of the plane of symmetry and the following percentage of that loading must be applied to the opposite side:

$\%=100-10(n-1)$ where n is the specified positive maneuvering local factor

This value may not be more than 80 percent.

VERTICAL TAIL SURFACES

§ 23.441 Maneuvering loads.

(a) At speeds up to V_A, the vertical tail surfaces must be designed to withstand—

(1) A sudden displacement of the rudder control (with the airplane in unaccelerated flight with zero yaw) to the maximum deflection allowed by the control stops or by pilot strength, whichever is critical;

(2) A yaw angle of 15 degrees with the rudder fully deflected (except as limited by pilot strength) in the direction tending to increase the slip; and

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

(b) The average loading of B23.11 and figure 1 of Appendix B and the distribution in figures 7, 6, and 8 of Appendix B may be used instead of the requirements of subparagraphs (a)(1), (a)(2), and (a)(3), respectively.

(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.

§ 23.443 Gust loads.

(a) Vertical tail surfaces must be designed to withstand, in unaccelerated flight at V_C, a gust of 30 feet per second nominal intensity normal to the plane of symmetry.

(b) The gust loading for that part of a vertical tail surface with a well defined leading edge must be computed by the formula

$$\bar{w}=\frac{KUVm}{575}$$

where—
$\bar{w}$=average limit unit pressure in pounds per square foot;
$K=1.33-\frac{4.5}{(W/S_v)^{3/4}}$, except that K may not be less than 1.0.
U=nominal gust intensity in feet per second;
V=airplane speed in miles per hour;
m=slope of lift curve of vertical surface, C_L per radian, corrected for aspect ratio;
W=design weight in pounds; and
S_v=vertical surface area in square feet.

A value of K obtained by rational determination may be used.

(c) The average loading in figure 5 and the distribution in figure 8 of Appendix B may be used.

§ 23.445 Outboard fins.

(a) If outboard fins are on the horizontal tail surface, the tail surfaces must be designed for the maximum horizontal surface load in combination with the corresponding loads induced on the vertical surfaces by endplate effects. These induced effects need not be combined with other vertical surface loads.

(b) If outboard fins 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.

AILERONS, WING FLAPS, AND SPECIAL DEVICES

§ 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 subparagraph (2)(i).

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

(b) The average loading in B23.11 and figure 1 of Appendix B and the distribution in figure 9 of Appendix B may be used.

§ 23.457 Wing flaps.

(a) The wing flaps, their operating mechanisms, and their supporting structures must be designed for critical loads occurring in the flaps-extended flight conditions with the flaps in any position. However, if an automatic flap load limiting device is used, these components may be designed for the critical combinations of airspeed and flap position allowed by that device.

(b) The effects of propeller slipstream, corresponding to takeoff power, must be taken into account at not less than 1.4 V_S, where V_S is the computed stalling speed with flaps fully retracted at the design weight. For the investigation of slipstream effects, the load factor may be assumed to be 1.0.

§ 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

§ 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.

§ 23.473 Ground load conditions and assumptions.

(a) The design landing weight (the maximum weight for landing conditions at the maximum descent velocity) may be used for structural design purposes only. Except as provided in paragraphs (b) and (c) of this section, this weight may not be less than the maximum weight.

(b) The design landing weight may be as low as 95 percent of the maximum weight if—

(1) The structural limit load values at the maximum weight are not exceeded at speeds up to takeoff speed over terrain as rough as that expected in service;

(2) The minimum fuel capacity is enough for at least one-half hour of operation at maximum continuous power plus the capacity equal to a fuel weight equal to the difference between the maximum weight and the design landing weight; and

(3) The operating limitations limit the takeoff weight to ensure that landing weights in normal operation do not exceed the design landing weight.

(c) The design landing weight of a multiengine airplane may be less than 95 percent of the maximum weight if—

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

(2) Instead of the corresponding requirements of this part, compliance is shown with the following requirements of Part 25 [New]:

(i) The ground load requirements of §§ 25.471 and 25.473.

(ii) The landing gear requirements of §§ 25.721 through 25.733.

(iii) The fuel jettisoning system requirements of § 25.1001.

(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) Energy absorption tests (to determine the limit load factor corresponding to the required limit descent velocities) must be made under § 23.725.

(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, 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.

§ 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.

§ 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 subdivision (i) of this subparagraph may be used in the analysis required under subdivision (ii) of this subparagraph.

(b) When investigating landing conditions, the drag components simulating the forces required to accelerate the tires and wheels up to the landing speed must be properly combined with the corresponding instantaneous vertical ground reactions, 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 determining the wheel spin-up loads for landing conditions, the method set forth in Appendix D or the arbitrary drag components in Appendix C must be used. However, if Appendix D is used, the 25 percent value for the minimum drag component must be used.

§ 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 wheeels up to speed before the maximum vertical load is attained.

§ 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.

§ 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.

§ 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.

§ 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.

§ 23.499 Supplementary conditions for nose wheels.

In determining the ground loads on nose wheels and affected supporting structures, and assuming that the shock absorbers and 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.

§ 23.505 **Supplementary conditions for skiplanes.**

In determining ground loads on skiplanes, and assuming that the airplane is resting on the ground with one main ski frozen at rest and the other main ski and the tail ski free to slide, a limit side force equal to $P/3$ must be applied at the most convenient point near the tail assembly, with—

(a) P being the static ground reaction on the tail ski; and

(b) A factor of safety of 1.0.

WATER LOADS

§ 23.521 **Water load conditions.**

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

(b) Unless the applicant makes a rational analysis of the water loads, or uses the standards in ANC-3, §§ 25.523 through 25.537 of this chapter apply.

(c) Floats certificated under Part 4a of this chapter before November 9, 1945, may be installed on airplanes that are designed under this part.

EMERGENCY LANDING CONDITIONS

§ 23.561 **General.**

(a) The airplane, although it may be damaged in emergency landing conditions, must be designed as prescribed in this section to protect each occupant under those conditions.

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

(1) Proper use is made of belts or harnesses provided for in the design; and

(2) The occupant experiences the ultimate inertia forces shown in the following table:

ULTIMATE INERTIA FORCES

	Normal and utility categories	Acrobatic category
Upward	3.0g	4.5g
Forward	9.0g	9.0g
Sideward	1.5g	1.5g

(c) Each airplane with retractable landing gear must be designed to protect each occupant in a landing—

(1) With the wheels retracted;

(2) With moderate descent velocity; and

(3) Assuming—

(i) An upward ultimate inertia force of 3g; and

(ii) A coefficient of friction of 0.5 at the ground.

(d) If a turnover is reasonably probable, the structure must be designed to protect the occupants in a complete turnover, assuming—

(1) An upward ultimate inertia force of 3g; and

(2) A coefficient of friction of 0.5 at the ground.

(e) Except as provided in § 23.787 the supporting structure must be designed to restrain, under loads up to those specified in paragraph (b) (2) of this section, each item of mass that could injure an occupant if it came loose in a minor crash landing.

FATIGUE EVALUATION

§ 23.571 **Pressurized cabin.**

The strength, detail design, and fabrication of the pressure cabin structure must be evaluated under either of the following:

(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.

(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 failure, or obvious partial failure, of a principal structural element, and that the remaining structures are able to withstand a static ultimate load factor of 75 percent of the limit load factor at V_C, considering the combined effects of normal operating pressures, expected external aerodynamic pressures, and flight loads. These loads must be multiplied by a factor of 1.15 unless the dynamic effects of failure under static load are otherwise considered.

Subpart D—Design and Construction

§ 23.601 General.

The suitability of each questionable design detail and part having an important bearing on safety in operations, must be established by tests.

§ 23.603 Materials and workmanship.

(a) The suitability and durability of materials used in the structure must be—

(1) Established by experience or tests; and

(2) Meet approved specifications that ensure their having the strength and other properties assumed in the design data.

(b) Workmanship must be of a high standard.

§ 23.605 Fabrication methods.

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

§ 23.607 Self-locking nuts.

No self-locking nut may be used on any bolt subject to rotation in operation.

§ 23.609 Protection of structure.

Each part of the structure must—

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

(1) Weathering;

(2) Corrosion; and

(3) Abrasion; and

(b) Have adequate provisions for ventilation and drainage.

§ 23.611 Inspection provisions.

There must be means to allow close examination of each part requiring recurring inspection, adjustments for proper alignment and function, or lubrication.

§ 23.613 Material strength properties and design values.

(a) Material strength properties must be based on enough tests of material meeting specifications to establish design values on a statistical basis.

(b) The design values must be chosen so that the probability of any structure being understrength because of material variations is extremely remote.

(c) Unless they are inapplicable in a particular case, the design values must be those contained in the following publications (obtainable from the Superintendent of Documents, Government Printing Office, Washington, D.C., 20402):

MIL-HDBK-5, "Metallic Materials and Elements for Flight Vehicle Structure";
MIL-HDBK-17, "Plastics for Flight Vehicles";
ANC-18, "Design of Wood Aircraft Structures"; and
MIL-HDBK-23, "Composite Construction for Flight Vehicles".

§ 23.615 Design properties.

(a) Design properties outlined in MIL-HDBK-5 may be used subject to the following conditions:

(1) Where applied loads are eventually distributed through a single member within an assembly, the failure of which would result in the loss of the structural integrity of the component involved, the guaranteed minimum design mechanical properties ("A" values) listed in MIL-HDBK-5 must be met. Examples of these items include—

(i) Wing lift struts;

(ii) Wing spars;

(iii) Sparcaps in regions such as wing cutouts and wing center sections where loads are transmitted through caps only; and

(iv) Primary attachment fittings dependent on single bolts for load transfer.

(2) Redundant structures in which the partial failure of individual elements would result in applied loads being safely distributed to other load carrying members may be designed on the basis of the "90 percent probability" ("B" values) listed in MIL-HDBK-5. Examples of these items are sheet-stiffener combinations and multirivet or multiple bolt connections.

(b) Design values greater than the guaranteed minimums required by paragraph (a) of this section may be used if a "premium selection" of the material is made in which a specimen of each individual item is tested before use to determine that the actual strength properties of that particular item will equal or exceed those used in design.

(c) Material correction factors for structural items such as sheets, sheet-stringer combinations, and riveted joints, may be omitted if sufficient test data are obtained to allow a probability analysis showing that 90 percent or more of the elements will equal or exceed allowable selected design values.

§ 23.617 Interchangeability of seam-welded and seamless steel tubing.

Seam-welded and seamless steel tubing may be interchanged as follows:

(a) SAE 4130 welded tubing meeting Specification MIL-T-6731 and SAE 4130 seamless tubing meeting Specification MIL-T-6736.

(b) SAE 1025 welded tubing and SAE 1025 seamless tubing meeting Specification MIL-T-5066.

(c) SAE 8630 welded tubing meeting Specification MIL-T-6734 and SAE 8630 seamless tubing meeting Specification MIL-T-6732.

§ 23.619 Special factors.

(a) If there is uncertainty concerning the actual strength of a part of the structure, or if the strength is likely to deteriorate in service before normal replacement, increased factors of safety must be used to ensure that the reliability of that part is not less than that of the rest of the structure, as specified in paragraph (b) of this section and in §§ 23.619 through 23.625.

(b) For parts whose strength is subject to appreciable variability due to uncertainties in manufacturing processes and inspection methods, the factor of safety must be increased so that the probability of any part being understrength from these causes is extremely remote.

(c) Minimum variability factors are in §§ 23.621 through 23.625. Only the highest pertinent variability factor need be considered.

§ 23.621 Casting factors.

(a) *General.* The factors, tests, and inspections specified in paragraphs (b) through (d) of this section must be applied in addition to those necessary to establish foundry quality control. The inspections must meet approved specifications. Paragraphs (c) and (d) of this section apply to any structural castings except castings that are pressure tested as parts of hydraulic or other fluid systems and do not support structural loads.

(b) *Bearing stresses and surfaces.* The casting factors specified in paragraphs (c) and (d) of this section—

(1) Need not exceed 1.25 with respect to bearing stresses regardless of the method of inspection used; and

(2) Need not be used with respect to the bearing surfaces of a part whose bearing factor is larger than the applicable casting factor.

(c) *Critical castings.* For each casting whose failure would preclude continued safe flight and landing of the airplane or result in serious injury to occupants, the following apply:

(1) Each critical casting must—

(i) Have a casting factor of not less than 1.25; and

(ii) Receive 100 percent inspection by visual, radiographic, and magnetic particle or penetrant inspection methods or approved equivalent nondestructive inspection methods.

(2) For each critical casting with a casting factor less than 1.50, three sample castings must be static tested and shown to meet—

(i) The strength requirements of § 23.305 at an ultimate load corresponding to a casting factor of 1.25; and

(ii) The deformation requirements of § 23.305 at a load of 1.15 times the limit load.

(3) Examples of these castings are structural attachment fittings, parts of flight control systems, control surface hinges and balance weight attachments, seat, berth, safety belt, and fuel and oil tank supports and attachments, and cabin pressure valves.

(d) *Noncritical castings.* For each casting other than those specified in paragraph (c) of this section, the following apply:

(1) Except as provided in subparagraphs (2) and (3) of this paragraph, the casting factors and corresponding inspections must meet the following table:

Casting factor	*Inspection*
2.0 or more	100 per cent visual.
Less than 2.0 but more than 1.5.	100 percent visual, and magnetic particle or penetrant or equivalent nondestructive inspection methods.
1.25 through 1.50.	100 percent visual, magnetic particle or penetrant, and radiographic, or approved equivalent nondestructive inspection methods.

(2) The percentage of castings inspected by nonvisual methods may be reduced below that specified in subparagraph (1) of this paragraph when an approved quality control procedure is established.

(3) For castings procured to a specification that guarantees the mechanical properties of the material in the casting and provides for demonstration of these properties by test of coupons cut from the castings on a sampling basis—

(i) A casting factor of 1.0 may be used; and

(ii) The castings must be inspected as provided in subparagraph (1) of this paragraph for casting factors of "1.25 through 1.50" and tested under paragraph (c)(2) of this section.

§ 23.623 Bearing factors.

(a) Except as provided in paragraph (b), the factor of safety in bearings at bolted or pinned joints must be increased to provide for—

(1) Relative motion in operation; and

(2) Joints, with clearance (free fit), subject to pounding or vibration.

(b) No bearing factor need be applied if other special factors apply.

§ 23.625 Fitting factors.

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

(a) For each fitting whose strength is not proven by limit and ultimate load tests in which actual stress conditions are simulated in the fitting and surrounding structures, a fitting factor of at least 1.15 must be applied to each part of—

(1) The fitting;

(2) The means of attachment; and

(3) The bearing on the joined members.

(b) No fitting factor need be used for joint designs based on comprehensive test data (such as continuous joints in metal plating, welded joints, and scarf joints in wood).

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

§ 23.627 Fatigue strength.

The structure must be designed, as far as practicable, to avoid points of stress concentration where variable stresses above the fatigue limit are likely to occur in normal service.

§ 23.629 Flutter.

(a) Each part of the airplane must be free from flutter under each appropriate speed and power condition up to at least the minimum value of V_D allowed in § 23.335. In addition—

(1) The wings, tail, and control surfaces must be free from flutter, airfoil divergence, and control reversal from lack of rigidity for any condition of operation within the limit V-n envelope;

(2) Adequate wing torsional rigidity must be shown by tests or other approved methods;

(3) The mass balance of surfaces must be designed to prevent flutter; and

(4) The natural frequencies of main structural components must be determined by vibration tests or other approved methods.

(b) Flight flutter tests are acceptable as proof of freedom from flutter if it is shown by these tests that proper and adequate attempts to induce flutter have been made within the speed range up to V_D, and that the vibratory response of the structure during the test indicates freedom from flutter.

(c) Compliance with the rigidity and mass balance criteria (pages 4–12) in Air Frame and Equipment Engineering Report No. 45 (as corrected) "Simplified Flutter Prevention Criteria" (published by the Federal Aviation Agency) is acceptable as proof of freedom from flutter if—

(1) The wing and aileron flutter prevention criteria, as represented by the wing torsional stiffness and aileron balance criteria, are limited to airplanes without large mass concentrations (such as engines, floats, or fuel tanks in outer wing panels) along the wing span; and

(2) The elevator and rudder balance criteria are used only for tail surface configurations that have fixed-fin and fixed-stabilizer surfaces.

WINGS

§ 23.641 Proof of strength.

The strength of stressed-skin wings must be proven by load tests or by combined structural analysis and load tests.

§ 23.643 Rib tests.

(a) Rib tests must simulate the conditions in the airplane with respect to—

(1) Torsional rigidity of spars;

(2) Fixity conditions;

(3) Lateral supports; and

(4) Attachment to spars.

(b) The effects of ailerons and high lift devices must be accounted for.

CONTROL SURFACES

§ 23.651 Proof of strength.

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

(b) In structural analyses, rigging loads due to wire bracing must be accounted for in a rational or conservative manner.

§ 23.655 Installation.

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

(b) If an adjustable stabilizer is used, it must have stops that will limit its ranged travel to that allowing safe flight and landing.

§ 23.657 Hinges.

(a) Control surface hinges, except ball and roller bearing hinges, must have a factor of safety of not less than 6.67 with respect to the ultimate bearing strength of the softest material used as a bearing.

(b) For ball or roller bearing hinges, the approved rating of the bearing may not be exceeded.

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

§ 23.659 Mass balance.

The supporting structure and the attachment of concentrated mass balance weights used on control surfaces must be designed for—

(a) 24g normal to the plane of the control surface;

(b) 12g fore and aft; and

(c) 12g parallel to the hinge line.

CONTROL SYSTEMS

§ 23.671 General.

(a) Each control must operate easily, smoothly, and positively enough to allow proper performance of its functions.

(b) Controls must be arranged and identified to provide for convenience in operation and to prevent the possibility of confusion and subsequent inadvertent operation.

§ 23.673 Primary flight controls.

(a) Primary flight controls are those used by the pilot for the immediate control of pitch, roll, and yaw.

(b) The design of two-control airplanes must minimize the likelihood of complete loss of lateral or directional control in the event of failure of any connecting or transmitting element in the control system.

§ 23.675 Stops.

(a) Each control system must have stops that positively limit the range of motion of the pilot's controls.

(b) Each stop must be so located in the system that the range of travel of its control is not appreciably affected by—

(1) Wear;

(2) Slackness; or

(3) Takeup adjustments.

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

§ 23.677 Trim systems.

(a) Proper precautions must be taken to prevent inadvertent, improper, or abrupt trim tab operation. There must be means near the trim control to indicate to the pilot the direction of trim control movement relative to airplane motion. In addition, there must be means to indicate to the pilot the position of the trim device with respect to the range of adjustment. This means must be visible to the pilot and must be located and designed to prevent confusion.

(b) Trimming devices must be designed so that, when any one connecting or transmitting element in the primary flight control system fails, normal trimming operation may be continued with—

(1) For single-engine airplanes, the longitudinal trimming devices; or

(2) For multiengine airplanes, the longitudinal and directional trimming devices.

(c) Tab controls must be irreversible unless the tab is properly balanced and has no unsafe flutter characteristics. Irreversible tab systems must have adequate rigidity and reliability in the portion of the system from the tab to the attachment of the irreversible unit to the airplane structure.

§ 23.679 Control system locks.

If there is a device to lock the control system on the ground or water, there must be means to—

(a) Give unmistakable warning to the pilot when the lock is engaged; and

(b) Prevent the lock from engaging in flight.

§ 23.681 Limit load static tests.

(a) Compliance with the limit load requirements of this part must be shown by tests in which—

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

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

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

§ 23.683 Operation tests.

(a) It must be shown by operation tests that, when the controls are operated from the pilot compartment with the system loaded as prescribed in paragraph (b) of this section, the system is free from—

(1) Jamming;

(2) Excessive friction; and

(3) Excessive deflection.

(b) The prescribed test loads are—

(1) For the entire system, loads corresponding to the limit airloads on the appropriate surface; and

(2) For secondary controls, loads not less than those corresponding to the maximum pilot effort established under § 23.405.

§ 23.685 Control system details.

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

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

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

(d) Each element of the flight control system must have design features, or must be distinctively and permanently marked, to minimize the possibility of incorrect assembly that could result in malfunctioning of the control system.

§ 23.687 Spring devices.

The reliability of any spring device used in the control system must be established by tests simulating service conditions unless failure of the spring will not cause flutter or unsafe flight characteristics.

§ 23.689 Cable systems.

(a) Each cable, cable fitting, turnbuckle, splice, and pulley used must meet approved specifications. In addition—

(1) No cable smaller than ⅛ inch diameter may be used in primary control systems;

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

(3) There must be means for visual inspection at each fairlead, pulley, terminal, and turnbuckle.

(b) Each kind and size of pulley must correspond to the cable with which it is used, as specified in the pulley specification. Each pulley must have closely fitted guards to prevent the cables from being misplaced or fouled, even when slack. Each pulley must lie in the plane passing through the cable so that the cable does not rub against the pulley flange.

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

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

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

(f) Tab control cables are not part of the primary control system and may be less than ⅛ inch diameter in airplanes that are safely controllable with the tabs in the most adverse positions.

§ 23.693 Joints.

Control system joints (in push-pull systems) that are subject to angular motion, except those in ball and roller bearing systems, must have a special factor of safety of not less than 3.33 with respect to the ultimate bearing strength of the softest material used as a bearing. This factor may be reduced to 2.0 for joints in cable control systems. For ball or roller bearings, the approved ratings may not be exceeded.

§ 23.697 Wing flap controls.

(a) Each wing flap control must be designed so that, when the flap has been placed in any position upon which compliance with the performance requirements of this part is based, the flap will not move from that position unless the control is adjusted or is moved by the automatic operation of a flap load limiting device.

(b) The rate of movement of the flaps in response to the operation of the pilot's control or automatic device must give satisfactory flight and performance characteristics under steady or changing conditions of airspeed, engine power, and attitude.

§ 23.699 Wing flap position indicator.

There must be a wing flap position indicator for—

(a) Flap installations with only the retracted and fully extended position, unless—

(1) A direct operating mechanism provides a sense of "feel" and position (such as when a mechanical linkage is employed); or

(2) The flap position is readily determined without seriously detracting from other piloting duties under any flight condition, day or night; and

(b) Flap installation with intermediate flap positions if—

(1) Any flap position other than retracted or fully extended is used to show compliance with the performance requirements of this part; and

(2) The flap installation does not meet the requirements of paragraph (a)(1) of this section.

§ 23.701 Flap interconnection.

(a) The motion of flaps on opposite sides of the plane of symmetry must be synchronized by a mechanical interconnection unless the airplane has safe flight characteristics with the flaps retracted on one side and extended on the other.

(b) If an interconnection is used in multiengine airplanes, it must be designed to account for the unsymmetrical loads resulting from flight with the engines on one side of the plane of symmetry inoperative and the remaining engines at takeoff power. For single-engine airplanes, it may be assumed that 100 percent of the critical air load acts on one side and 70 percent on the other.

LANDING GEAR

§ 23.721 General.

(a) The shock absorbing elements in main, nose, and tail wheel units must be substantiated by the tests specified in § 23.723.

(b) The shock absorbing ability of the landing gear during taxiing must be shown in the operational tests required by § 23.235.

§ 23.723 Shock absorption tests.

(a) It must be shown by energy absorption tests that the limit load factors selected for design under § 23.473 will not be exceeded in landings with the limit descent velocity specified in that section.

(b) The landing gear may not fail, but may yield, in a test showing its reserved energy absorption capacity, simulating a descent velocity of 1.2 times the limit descent velocity, assuming wing lift equal to the weight of the airplane.

§ 23.725 Limit drop tests.

(a) If compliance with § 23.723(a) is shown by free drop tests, these tests must be made on the complete airplane, or on units consisting of wheel, tire, and shock absorber, in their proper relation, from free drop heights not less than those determined by the following formula:

$$h \text{ (inches)} = 3.6\,(W/S)^{1/2}$$

However, the free drop height may not be less than 9.2 inches and need not be more than 18.7 inches.

(b) If wing lift is simulated in free drop tests, the landing gear must be dropped with an effective weight equal to

$$W_e = W\left[\frac{h+(1-L)d}{h+d}\right]$$

where—

W_e=the effective weight to be used in the drop test (lbs.);

h=specified free drop height (inches);

d=deflection under impact of the tire (at the approved inflation pressure) plus the vertical component of the axle travel relative to the drop mass (inches);

$W=W_M$ for main gear units (lbs.), equal to the static weight on that unit with the airplane in the level attitude (with the nose wheel clear in the case of nose wheel type airplanes);

$W=W_T$ for tail gear units (lbs.), equal to the static weight on the tail unit with the airplane in the tail-down attitude;

$W=W_N$ for nose wheel units (lbs.), equal to the vertical component of the static reaction that would exist at the nose wheel, assuming that the mass of the airplane acts at the center of gravity and exerts a force of 1.0g downward and 0.33g forward; and

L=the ratio of the assumed wing lift to the airplane weight, but not more than 0.667.

(c) The attitude in which a landing gear unit is drop tested must simulate the critical landing conditions for the unit.

(d) The value of d used in the computation of W_e in paragraph (b) of this section may not exceed the value actually obtained in the drop test.

(e) The limit inertia load factor must be determined from the drop test in paragraph (b) of this section according to the following formula:

$$n = n_j \frac{W_e}{W} + L$$

where—

n_j=the load factor developed in the drop test (that is, the acceleration (dv/dt) in g's recorded in the drop test) plus 1.0; and

W_e, W, and L are the same as in the drop test computation.

(f) The value of n determined in accordance with paragraph (e) may not be more than the limit inertia load factor used in the landing conditions in § 23.473.

§ 23.727 Reserve energy absorption drop test.

(a) If compliance with the reserve energy absorption requirement in § 23.723 (b) is shown by free drop tests, the drop height may not be less than 1.44 times that specified in § 23.725.

(b) If wing lift equal to the airplane weight is simulated, the units must be dropped with an effective mass equal to $W_e = W\left(\frac{h}{h+d}\right)$ where the symbols and other details are the same as in § 23.725.

§ 23.729 Retracting mechanism.

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

(1) Each landing gear retracting mechanism and its supporting structure must be designed for maximum flight load factors with the gear retracted and must be designed for the combination of friction, inertia, brake torque, and air loads, occurring during retraction at any airspeed up to 1.6 V_{S_1} with flaps retracted, and for any load factor up to those specified in § 23.345 for the flaps-extended condition.

(2) The landing gear and retracting mechanism, including the wheel well doors, must withstand flight loads with the landing gear extended at any speed up to at least 1.6 V_{S_1} with flaps retracted.

(b) *Landing gear lock.* There must be positive means (other than the use of hydraulic pressure) to keep the landing gear extended.

(c) *Emergency operation.* A landplane without manually operated landing gear must have an auxiliary means of extending the gear.

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

(e) *Position indicator and warning device.* There must be means to indicate to the pilot when the wheels are secured in the extreme positions. In addition, landplanes must have an aural or equally effective warning device that functions continuously, when one or more throttles are closed, until the gear is down and locked. A throttle stop is not an acceptable alternative to an aural landing gear warning device.

§ 23.731 Wheels.

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

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

(1) Design maximum weight; and

(2) Critical center of gravity.

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

§ 23.733 Tires.

(a) Each landing gear wheel must have a tire—

(1) That is a proper fit on the rim of the wheel; and

(2) Whose tire rating (assigned by the Tire and Rim Association or the Administrator) is not exceeded—

(i) By a load on each main wheel tire equal to the corresponding static ground reaction under the design maximum weight and critical center of gravity; and

(ii) By a load on nose wheel tires (to be compared with the dynamic rating established for such tires) equal to the reaction obtained at the nose wheel, assuming the mass of the airplane to be concentrated at the most critical center of gravity and exerting a force of 1.0W downward and 0.31W forward (where W is the design maximum weight), with the reactions distributed to the nose and main wheels by the principles of statics, and with the drag reaction at the ground applied only at wheels with brakes.

(b) If specially constructed tires are used, the wheels must be plainly and conspicuously marked to that effect. The markings must include the make, size, number of plies, and identification marking of the proper tire.

§ 23.735 Brakes.

There must be brakes that are adequate to—

(a) Prevent the airplane from rolling on a paved runway with takeoff power on the critical engine; and

(b) Provide adequate speed control during taxiing without excessive pilot loads.

§ 23.737 Skis.

Each ski must be approved. The maximum limit load rating of each ski must equal or exceed the maximum limit load determined under the applicable ground load requirements of this part.

FLOATS AND HULLS

§ 23.751 Main float buoyancy.

(a) Each main float must have—

(1) A buoyancy of 80 percent in excess of that required to support the maximum weight of the seaplane or amphibian in fresh water; and

(2) Enough watertight compartments to provide reasonable assurance that the seaplane or amphibian will stay afloat if any two compartments of the main floats are flooded.

(b) Each main float must contain at least four watertight compartments approximately equal in volume.

§ 23.753 Main float design.

Each seaplane main float must be approved and must meet the requirements of § 23.521.

§ 23.755 Hulls.

(a) The hull of a hull seaplane or amphibian of 1,500 pounds or more maximum weight must have watertight compartments designed and arranged so that the hull, auxiliary floats, and tires (if used), will keep the airplane afloat in fresh water when—

(1) For airplanes of 5,000 pounds or more maximum weight, any two adjacent compartments are flooded; and

(2) For airplanes of 1,500 pounds up to, but not including, 5,000 pounds maximum weight, any single compartment is flooded.

(b) The hulls of hull seaplanes or amphibians of less than 1,500 pounds maximum weight need not be compartmented.

(c) Bulkheads with watertight doors may be used for communication between compartments.

§ 23.757 Auxiliary floats.

Auxiliary floats must be arranged so that, when completely submerged in fresh water, they provide a righting moment of at least 1.5 times the upsetting moment caused by the seaplane or amphibian being tilted.

PERSONNEL AND CARGO ACCOMMODATIONS

§ 23.771 Pilot compartment.

For each pilot compartment—

(a) The compartment and its equipment must allow each pilot to perform his duties without unreasonable concentration or fatigue; and

(b) The aerodynamic controls listed in § 23.779, excluding cables and control rods, must be located with respect to the propellers so that no part of the pilot or the controls lies in the region between the plane of rotation of any inboard propeller and the suface generated by a line passing through the center of the propeller hub making an angle of 5 degrees forward or aft of the plane of rotation of the propeller.

§ 23.773 Pilot compartment view.

(a) Each pilot compartment must be free from glare and reflections that could interfere with the pilot's vision, and designed so that—

(1) The pilot's view is sufficiently extensive, clear, and undistorted, for safe operation; and

(2) Each pilot is protected from the elements so that moderate rain conditions do not unduly impair his view of the flight path in normal flight and while landing.

(b) If certification for night operation is requested, compliance with paragraph (a) of this section must be shown in night flight tests.

§ 23.775 Windshields and windows.

(a) Nonsplintering safety glass must be used in internal glass panes.

(b) The design of windshields, windows, and canopies in pressurized airplanes must be based on factors peculiar to high altitude operation, including—

(1) The effects of continuous and cyclic pressurization loadings;

(2) The inherent characteristics of the material used; and

(3) The effects of temperatures and temperature gradients.

(c) On pressurized airplanes, an inclosure canopy including a representative part of the installation must be subjected to special tests to account for the combined effects of continuous and cyclic pressurization loadings and flight loads.

(d) The windshield and side windows forward of the pilot's back when he is seated in the normal flight position must have a luminous transmittance value of not less than 70 percent.

§ 23.777 Cockpit controls.

(a) Each cockpit control must be located and (except where its function is obvious) identified to provide convenient operation and to prevent confusion and inadvertent operation.

(b) The controls must be located and arranged so that the pilot, when seated, has full and unrestricted movement of each control without interference from either his clothing or the cockpit structure.

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

(d) Wing flap and auxiliary lift device controls must be located—

(1) Centrally, or to the right of the pedestal or powerplant throttle control centerline; and

(2) Far enough away from the landing gear control to avoid confusion.

(e) The landing gear control must be located to the left of the throttle centerline or pedestal centerline.

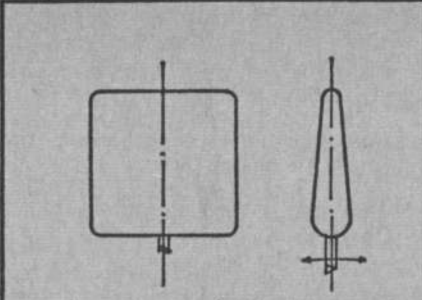
§ 23.779 Motion and effect of cockpit controls.

Cockpit controls must be designed so that they operate as follows:

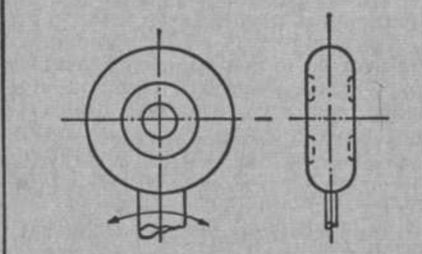
Controls	*Motion and effect*
Aerodynamic:	
Aileron	Right (clockwise) for right wing down.
Elevator	Rearward for nose up.
Rudder	Right pedal forward for nose right.
Powerplant:	
Throttle	Forward to open.

§ 23.781 Cockpit control knob shape.

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



FLAP CONTROL KNOB



LANDING GEAR CONTROL KNOB

§ 23.783 Doors.

(a) Each closed cabin with passenger accommodations must have at least one adequate and easily accessible external door.

(b) No passenger door may be located with respect to any propeller disc so as to endanger persons using that door.

§ 23.785 Seats and berths.

(a) Each seat, berth, and its supporting structure, must be designed for occupants weighing at least 170 pounds (or 190 pounds with parachute for seats in utility and acrobatic category airplanes), and for the maximum load factors corresponding to the specified flight and ground load conditions, including the emergency landing conditions prescribed in § 23.561.

(b) Each seat and berth must be approved.

(c) Each pilot seat must be designed for the reactions resulting from the application of pilot forces to the primary flight controls, as prescribed in § 23.395.

(d) Unless otherwise placarded, each seat in utility and acrobatic category airplanes must be designed to accommodate passengers wearing parachutes.

(e) Each berth installed parallel to the longitudinal axis of an airplane must be designed so that the forward part has a padded end-board, canvas diaphragm, or equivalent means that can withstand the static load reaction of the occupant when the occupant is subjected to the forward inertia forces prescribed in § 23.561. In addition—

(1) The berth must have an approved safety belt and may not have corners or other parts likely to cause serious injury to a person occupying it during emergency conditions; and

(2) Safety belt attachments for the berth must be designed to withstand the critical loads resulting from relevant flight and ground load conditions and from the emergency landing conditions prescribed in § 23.561, with the exception of the forward load.

(f) Proof of compliance with the strength and deformation requirements of this section for seats and berths approved as part of the type design and for seat and berth installations may be shown by—

(1) Structural analysis, if the structure conforms to conventional airplane types for which existing methods of analysis are known to be reliable;

(2) A combination of structural analysis and static load tests to limit loads; or

(3) Static load tests to ultimate loads.

The inertia forces prescribed in § 23.561 must be multiplied by a factor of 1.33 (rather than by the fitting factor prescribed in § 23.625) in determining the strength of the atachment of each seat or berth to the structure.

§ 23.787 Cargo compartments.

(a) Each cargo compartment must be designed for its placarded maximum weight of contents and for the critical load distributions at the appropriate maximum load factors corresponding to the flight and ground load conditions of this part.

(b) There must be means to prevent the contents of any cargo compartment from becoming a hazard by shifting.

(c) There must be means to protect the passengers from injury by the contents of any cargo compartment when the ultimate forward inertia force is 4.5*g*.

§ 23.807 Emergency exits.

(a) *Number and location.* Emergency exits must be located to allow escape without crowding in any probable crash attitude. The airplane must have at least the following emergency exits:

(1) For an airplane with a seating capacity of more than five occupants, but less than 16, at least one emergency exit on the opposite side of the cabin from the main door specified in § 23.783.

(2) For an airplane with a seating capacity of more than 15 occupants, the emergency exit specified in subparagraph (1) of this paragraph, and an emergency exit in the top or side of the cabin for each seven occupants, or fraction thereof, above 15. However, no more than four exits are required if their arrangement and size allow quick evacuation of each occupant.

(3) If the pilot compartment is separated from the cabin by a door that is likely to block the pilot's escape in a minor crash, there must be an exit in the pilot's compartment. The number of exits required by subparagraphs (1) and (2) of this paragraph must then be separately determined for the passenger compartment, using the seating capacity of that compartment.

(b) *Type and operation.* Emergency exits must be movable windows, panels, or external doors, that provide a clear and unobstructed opening large enough to admit a 19-by-26-inch ellipse. In addition, each emergency exit must—

(1) Be readily accessible, requiring no exceptional agility to be used in emergencies;

(2) Have a method of opening that is simple and obvious;

(3) Be arranged and marked for easy location and operation, even in darkness;

(4) Have reasonable provisions against jamming by fuselage deformation; and

(5) In the case of acrobatic category airplanes, allow each occupant to bail out quickly with parachutes at any speed between V_{S_0} and V_D.

(e) *Tests.* The proper functioning of each emergency exit must be shown by tests.

§ 23.831 Ventilation.

Each passenger and crew compartment must be suitably ventilated. Carbon monoxide concentration may not exceed one part in 20,000 parts of air.

PRESSURIZATION

§ 23.841 Pressurized cabins.

Pressurized cabins must have at least the following valves, controls, and indicators, for controlling cabin pressure:

(a) Two pressure relief valves (at least one of which is the normal regulating valve) to automatically limit the positive pressure differential to a predetermined value at the maximum rate of flow delivered by the pressure source. The combined capacity of the relief valves must be large enough so that the failure of any one valve would not cause an appreciable rise in the pressure differential. The pressure differential is positive when the internal pressure is greater than the external.

(b) Two reverse pressure differential relief valves (or their equivalents) to automatically prevent a negative pressure differential that would damage the structure. However, one valve is enough if it is of a design that reasonably precludes its malfunctioning.

(c) A means by which the pressure differential can be rapidly equalized.

(d) An automatic or manual regulator for controlling the intake or exhaust airflow, or both, for maintaining the required internal pressures and airflow rates.

(e) Instruments to indicate to the pilot the pressure differential, the absolute pressure in the cabin, and the rate of change of the absolute pressure.

(f) A warning device to indicate to the pilot when the safe or preset pressure differential and absolute cabin pressure limits are exceeded.

(g) A warning placard for the pilot if the structure is not designed for pressure differentials up to the maximum relief valve setting in combination with landing loads.

(h) A means to stop rotation of the compressor or to divert airflow from the cabin if continued rotation of an engine-driven cabin compressor or continued flow of any compressor bleed air will create a hazard if a malfunction occurs.

§ 23.843 Pressurization tests.

(a) *Strength test.* The complete pressurized cabin, including doors, windows, canopy, and valves, must be tested as a pressure vessel for the pressure differential specified in § 23.365(d).

(b) *Functional tests.* The following functional tests must be performed:

(1) Tests of the functioning and capacity of the positive and negative pressure differential valves, and of the emergency release valve, to simulate the effects of closed regulator valves.

(2) Tests of the pressurization system to show proper functioning under each possible condition of pressure, temperature, and moisture, up to the maximum altitude for which certification is requested.

(3) Flight tests, to show the performance of the pressure supply, pressure and flow regulators, indicators, and warning signals, in steady and stepped climbs and descents at rates corresponding to the maximum attainable within the operating limitations of the airplane, up to the maximum altitude for which certification is requested.

(4) Tests of each door and emergency exit, to show that they operate properly after being subjected to the flight tests prescribed in subparagraph (3) of this paragraph.

FIRE PROTECTION

§ 23.853 Compartment interiors.

For each compartment to be used by the crew or passengers—

(a) The materials must be at least flash-resistant;

(b) If smoking is to be allowed—

(1) The wall and ceiling linings, and the covering of upholstery, floors, and furnishings must be at least flame resistant; and

(2) There must be an adequate number of self-contained ash trays; and

(c) If smoking is to be prohibited, there must be a placard so stating.

§ 23.859 Combustion heater fire protection.

Each gasoline-operated combustion heater must be approved and installed to meet the applicable powerplant installation requirements covering fire hazards and precautions. In addition—

(a) Each applicable requirement concerning fuel tanks, lines, and exhaust systems must be met; and

(b) Means independent of the components provided for the normal continuous control of air temperature, airflow, and fuel flow must be provided, for each heater, to automatically shut off and hold off the ignition and fuel supply of that heater at a point remote from that heater, when—

(1) The heat exchanger temperature or ventilating air temperature exceeds safe limits; or

(2) Either the combustion airflow or the ventilating airflow becomes inadequate for safe operation.

MISCELLANEOUS

§ 23.871 Leveling marks.

There must be reference marks for leveling the airplane on the ground.

Subpart E—Powerplant

GENERAL

§ 23.901 Installation.

(a) For the purpose of this part, the airplane powerplant installation includes each component that—

(1) Is necessary for propulsion; and

(2) Affects the safety of the major propulsive units.

(b) Each powerplant must be constructed, arranged, and installed to—

(1) Ensure safe operation; and

(2) Be accessible for necessary inspections and maintenance.

§ 23.903 Engines.

Each engine must be type certificated under Part 33 [New].

§ 23.905 Propellers.

(a) Each propeller must be type certificated under Part 35 [New] of this chapter.

(b) Engine power and propeller shaft rotational speed may not exceed the limits for which the propeller is certificated.

(c) Each featherable propeller must have a means to unfeather it in flight.

§ 23.907 Propeller vibration.

(a) Each propeller with metal blades or highly stressed metal components must be shown to have vibration stresses, in normal operating conditions, that do not exceed values that have been shown by the propeller manufacturer to be safe for continuous operation. This must be shown by—

(1) Measurement of stresses through direct testing of the propeller;

(2) Comparison with similar installations for which these measurements have been made; or

(3) Any other acceptable test method or service experience that proves the safety of the installation.

(b) Proof of safe vibration characteristics for any type of propeller, except for conventional, fixed-pitch, wood propellers must be shown where necessary.

§ 23.925 Propeller clearance.

Unless smaller clearances are substantiated, propeller clearances with the airplane at maximum weight, with the most adverse center of gravity, and with the propeller in the most adverse pitch position, may not be less than the following:

(a) *Ground clearance.* There must be a clearance of at least seven inches (for each airplane with nose wheel landing gear) or nine inches (for each airplane with tail wheel landing gear) between each propeller and the ground with the landing gear statically deflected and in the level, normal takeoff, or taxiing attitude, whichever is most critical. In addition, for each airplane with conventional landing gear struts using fluid or mechanical means for absorbing landing shocks, there must be positive clearance between the propeller and the ground in the level takeoff attitude with the critical tire completely deflated and the corresponding landing gear strut bottomed. Positive clearance for airplanes using leaf spring struts is shown with a deflection corresponding to 1.5*g*.

(b) *Water clearance.* There must be a clearance of at least 18 inches between each propeller and the water, unless compliance with § 23.237 can be shown with a lesser clearance.

(c) *Structural clearance.* There must be—

(1) At least one inch radial clearance between the blade tips and the airplane structure, plus any additional radial clearance necessary to prevent harmful vibration;

(2) At least one-half inch longitudinal clearance between the propeller blades or cuffs and stationary parts of the airplane; and

(3) Positive clearance between other rotating parts of the propeller or spinner and stationary parts of the airplane.

FUEL SYSTEM

§ 23.951 General.

(a) Each fuel system must be constructed and arranged to ensure a flow of fuel at a rate and pressure established for proper engine functioning under any normal operating condition.

(b) Each fuel system must be arranged to allow a fuel pump to draw fuel from one tank at a time. No gravity feed system may supply fuel to an engine from more than one tank at a time, unless the tank air spaces are interconnected so that interconnected tanks will feed equally.

§ 23.953 Fuel system independence.

(a) Each fuel system for a multiengine airplane must be arranged so that, in at least one system configuration, the failure of any one component (other than a fuel tank) will not result in the loss of power of more than one engine or require immediate action by the pilot to prevent the loss of power of more than one engine.

(b) If a single fuel tank (or series of fuel tanks interconnected to function as a single fuel tank) is used on a multiengine airplane, the following must be provided:

(1) Independent tank outlets for each engine, each incorporating a shutoff valve at the tank. This shutoff valve may also serve as the firewall shutoff valve required by § 23.995 if the line between the valve and the engine compartment does not contain a hazardous amount of fuel that can drain into the engine compartment.

(2) At least two vents arranged to minimize the probability of both vents becoming obstructed simultaneously.

(3) Filler caps designed to minimize the probability of incorrect installation or inflight loss.

(4) A fuel system in which those parts of the system from each tank outlet to any engine are independent of each part of the system supplying fuel to any other engine.

§ 23.955 Fuel flow.

(a) *General.* The ability of the fuel system to provide fuel at the rates specified in this section and at a pressure sufficient for proper carburetor operation must be shown in the attitude that is most critical with respect to fuel feed and quantity of unusable fuel. These conditions may be simulated in a suitable mockup. In addition—

(1) The quantity of fuel in the tank may not exceed the amount established as the unusable fuel supply for that tank under § 23.959 plus that necessary to show compliance with this section; and

(2) If there is a fuel flowmeter, it must be blocked during the flow test and the fuel must flow through the meter bypass.

(b) *Gravity systems.* The fuel flow rate for gravity systems (main and reserve supply) must be 150 percent of the takeoff fuel consumption of the engine.

(c) *Pump systems.* The fuel flow rate for each pump system (main and reserve supply) must be 0.9 pound per hour for each takeoff horsepower or 125 percent of the takeoff fuel consumption of the engine, whichever is more. In addition—

(1) This flow rate is required for each primary engine-driven pump and each emergency pump, and must be available when the pump is running as it would during takeoff; and

(2) For each hand-operated pump, this rate must occur at not more than 60 complete cycles (120 single strokes) per minute.

(d) *Auxiliary fuel systems and fuel transfer systems.* Paragraphs (b) and (c) of this section apply to each auxiliary and transfer system, except that—

(1) The required fuel flow rate must be established upon the basis of maximum continuous power and engine rotational speed, instead of takeoff power and fuel consumption; and

(2) A lesser flow rate may be used for a small auxiliary tank feeding into a large main tank, if there is a suitable placard stating that the auxiliary tank is not to be opened to the main tank unless a predetermined amount of fuel remains in the main tank.

§ 23.957 Flow between interconnected tanks.

It must be impossible, in a gravity feed system with interconnected tank outlets, for enough fuel to flow between the tanks to cause an overflow of fuel from any tank vent under the conditions in § 23.959, except that full tanks must be used.

§ 23.959 Unusable fuel supply and fuel system operation on low fuel.

(a) The unusable fuel supply for each tank must be established as not less than the quantity at which the first evidence of malfunctioning occurs under the conditions specified in this section. If more than one fuel tank is involved—

(1) Each tank not needed to feed the engine under the conditions specified in this section need only be investigated for the flight conditions in which it is to be used; and

(2) The unusable fuel supply for that tank is based on the most critical applicable conditions.

(b) For test purposes, the quantity of fuel to be used to show compliance with this section must be chosen by the applicant. In addition, when establishing the unusable fuel supply, the following flight conditions must be arranged in order, from the most to the least critical:

(1) Level flight at maximum continuous power, or at the power required for level flight at V_C, whichever is lower.

(2) Climb at maximum continuous power at the calculated best angle of climb at minimum weight.

(3) Rapid application of power and subsequent transition to best rate of climb from a power-off glide at 1.3 V_{S_0}.

(4) Slips and skids in level flight, climb, and glide, under the applicable conditions specified in subparagraphs (1), (2), and (3) of this paragraph, of the greatest severity likely to be encountered in normal service or turbulent air.

(c) For each acrobatic and utility category airplane, there may be no evidence of malfunctioning during any maneuver in the Airplane Flight Manual. During this test the amount of fuel in each tank may not exceed the unusable fuel supply established under paragraph (b) of this section, plus 0.03 gallon for each maximum continuous horsepower for which certification is requested.

(d) There may be no evidence of malfunctioning during takeoff and one minute of climb at the calculated best angle of climb at takeoff power and minimum weight where the takeoff is begun with the amount of fuel in each tank specified in paragraph (c) of this section.

(e) If an engine can be supplied with fuel from more than one tank, it must be possible, in level flight, to regain full power and fuel pressure to that engine in not more than 10 seconds (for single-engine airplanes) or 20 seconds (for multiengine airplanes) after switching to any full tank after engine malfunctioning due to fuel depletion becomes apparent while the engine is being supplied from any other tank.

§ 23.961 Fuel system hot weather operation.

Each fuel system conducive to vapor formation must be free from vapor lock when using fuel at a temperature of 110° F. under critical operating conditions.

§ 23.963 Fuel tanks: general.

(a) Each fuel tank must be able to withstand, without failure, the vibration, inertia, fluid, and structural loads that it may be subjected to in operation.

(b) Each flexible fuel tank liner must be of an acceptable kind.

(c) Each integral fuel tank must have adequate facilities for interior inspection and repair.

(d) The total usable capacity of the fuel tanks must be enough for at least one-half hour of operation at maximum continuous power.

(e) Each fuel quantity indicator must be adjusted, as specified in § 23.1337(b), to account for the unusable fuel supply determined under § 23.959.

§ 23.965 Fuel tank tests.

(a) Each fuel tank must be able to withstand the following pressures without failure or leakage:

(1) For each conventional metal tank and nonmetallic tank with walls not supported by the airplane structure, a pressure of 3.5 p.s.i., or that pressure developed during maximum ultimate acceleration with a full tank, whichever is greater.

(2) For each integral tank, the pressure developed during the maximum limit acceleration of the airplane with a full tank, with simultaneous application of the critical limit structural loads.

(3) For each nonmetallic tank with walls supported by the airplane structure and constructed in an acceptable manner using acceptable basic tank material, and with actual or simulated support conditions, a pressure of 2 p.s.i. for the first tank of a specific design. The supporting structure must be designed for the critical loads occurring in the flight or landing strength conditions combined with the fuel pressure loads resulting from the corresponding accelerations.

(b) Each fuel tank with large, unsupported, or unstiffened flat areas must be able to withstand the following test without leakage or failure:

(1) Each complete tank assembly and its supports must be vibration tested while mounted to simulate the actual installation.

(2) Except as specified in subparagraph (4) of this paragraph, the tank assembly must be vibrated for 25 hours at an amplitude of not less than 1/32 of an inch (unless another amplitude is substantiated) while 2/3 filled with water or other suitable test fluid.

(3) The test frequency of vibration must be as follows:

(i) If no frequency of vibration resulting from any r.p.m. within the normal operating range of engine speeds is critical, the test frequency of vibration, in number of cycles per minute, must be the number obtained by multiplying the maximum continuous engine speed (r.p.m.) by 0.9.

(ii) If only one frequency of vibration resulting from any r.p.m. within the normal operating range of engine speeds is critical, that frequency of vibration must be the test frequency.

(iii) If more than one frequency of vibration resulting from any r.p.m. within the normal operating range of engine speeds is critical, the most critical of these frequencies must be the test frequency.

(4) Under subparagraph (3) (ii) and (iii) of this paragraph, the time of test must be adjusted to accomplish the same number of vibration cycles that would be accomplished in 25 hours at the frequency specified in subparagraph (3) (i) of this paragraph.

(5) During the test, the tank assembly must be rocked at a rate of 16 to 20 complete cycles per minute, through an angle of 15 degrees on either side of the horizontal (30 degrees total), about an axis parallel to the axis of the fuselage, for 25 hours.

(c) Each integral tank using methods of construction and sealing not previously proven to be adequate by test data or service experience must be able to withstand the vibration test specified in subparagraphs (1) through (4) of paragraph (b).

(d) Each tank with a nonmetallic liner must be subjected to the sloshing test outlined in subparagraph (5) of paragraph (b) of this section, with the fuel at room temperature. In addition, a specimen liner of the same basic construction as that to be used in the airplane must, when installed in a suitable test tank, withstand the sloshing test with fuel at a temperature of 110° F.

§ 23.967 Fuel tank installation.

(a) Each fuel tank must be supported so that tank loads are not concentrated. In addition—

(1) There must be pads, if necessary, to prevent chafing between each tank and its supports;

(2) Padding must be nonabsorbent or treated to prevent the absorption of fuel;

(3) If a flexible tank liner is used, it must be supported so that it is not required to withstand fluid loads;

(4) Interior surfaces adjacent to the liner must be smooth and free from projections that could cause wear, unless—

(i) Provisions are made for protection of the liner at those points; or

(ii) The construction of the liner itself provides such protection; and

(5) A positive pressure must be maintained within the vapor space of each bladder cell under any condition of operation, including the critical conditions of low air-speed and rate of descent likely to be encountered.

(b) Each tank compartment must be ventilated and drained to prevent the accumulation of flammable fluids or vapors. Each compartment adjacent to a tank that is an integral part of the airplane structure must also be ventilated and drained.

(c) No fuel tank may be on the engine side of the firewall. There must be at least one-half inch of clearance between the fuel tank and the firewall. No part of the engine nacelle skin that lies immediately behind a major air opening from the engine compartment may act as the wall of an integral tank.

(d) No fuel tank may be in the personnel compartment of a multiengine airplane. If a fuel tank is in the personnel compartment of a single engine airplane, it must—

(1) If no larger than 25 gallons total capacity, be properly drained and ventilated; and

(2) If larger than 25 gallons total capacity—

(i) (For a conventional fuel tank) be isolated from the personnel compartment by fume and fuel proof enclosures; or

(ii) (For a bladder type fuel cell) have a retaining shell that is at least equivalent to a metal fuel tank in structural integrity and in fume and fuel tightness, and that is drained to the exterior of the airplane.

§ 23.969 Fuel tank expansion space.

Each fuel tank must have an expansion space of not less than two percent of the tank capacity, unless the tank vent discharges clear of the airplane (in which case no expansion space is required). It must be impossible to fill the expansion space inadvertently with the airplane in the normal ground attitude.

§ 23.971 Fuel tank sump.

Each fuel tank must have a drainable sump with an effective capacity, in the normal ground and flight attitudes, of 0.25 percent of the tank capacity, or $1/16$ gallon, whichever is greater, unless—

(a) The fuel system has a sediment bowl or chamber that is accessible for drainage and has a capacity of 1 ounce for every 20 gallons of fuel tank capacity; and

(b) Each fuel tank outlet is located so that, in the normal ground attitude, water will drain from all parts of the tank to the sediment bowl or chamber.

§ 23.973 Fuel tank filler connection.

(a) Each fuel tank filler connection must be marked as prescribed in § 23.1557(c).

(b) Spilled fuel must be prevented from entering the fuel tank compartment or any part of the airplane other than the tank itself.

(c) Each filler cap must provide a fuel-tight seal for the main filler opening. However, there may be small openings in the fuel tank cap for venting purposes or for the purpose of allowing passage of a fuel gauge through the cap.

§ 23.975 Fuel tank vents and carburetor vapor vents.

(a) Each fuel tank must be vented from the top part of the expansion space. In addition—

(1) Each vent outlet must be located and constructed in a manner that minimizes the possibility of its being obstructed by ice or other foreign matter;

(2) Each vent must be constructed to prevent siphoning of fuel during normal operation;

(3) The venting capacity must allow the rapid relief of excessive differences of pressure between the interior and exterior of the tank;

(4) Airspaces of tanks with interconnected outlets must be interconnected;

(5) There may be no undrainable points in any vent line where moisture can accumulate with the airplane in either the ground or level flight attitudes; and

(6) No vent may terminate at a point where the discharge of fuel from the vent outlet will constitute a fire hazard or from which fumes may enter personnel compartments.

(b) Each carburetor with vapor elimination connections must have a vent line to lead vapors back to one of the fuel tanks. If there is more than one fuel tank, and if it is necessary to use these tanks in a definite sequence for any reason, the vapor vent return line must lead back to the fuel tank to be used first, unless the relative capacities of the tanks are such that return to another tank is preferable.

(c) For acrobatic category airplanes, excessive loss of fuel during acrobatic maneuvers, including short periods of inverted flight, must be prevented. It must be impossible for fuel to siphon from the vent when normal flight has been resumed after any acrobatic maneuver for which certification is requested.

§ 23.977 Fuel tank outlet.

(a) There must be a fuel strainer, with 8 to 16 meshes per inch, for the fuel tank outlet. The diameter of the strainer must be at least equal to that of the fuel tank outlet.

(b) If a finger strainer is used—

(1) The length of the strainer must be at least four times the diameter of the outlet; and

(2) Each strainer must be accessible for inspection and cleaning.

FUEL SYSTEM COMPONENTS

§ 23.991 Fuel pumps.

(a) *Main pumps.* If there are fuel pumps to maintain a supply of fuel to the engine, at least one pump for each engine must be directly driven by the engine. The fuel pumps must be adequate to meet the flow requirements of applicable § 23.955.

(b) *Emergency pumps.* There must be emergency pumps to feed the engines after the failure of any engine-driven fuel pump other than a fuel injection pump (a pump that supplies proper flow and pressure for fuel injection when the injection is not accomplished in a carburetor) approved as part of an engine.

(c) *Warning means.* If both the normal pump and emergency pump operate continuously, there must be a means to indicate to the appropriate flight crewmembers a malfunction of either pump.

§ 23.993 Fuel system lines and fittings.

(a) Each fuel line must be installed and supported to prevent excessive vibration and to withstand loads due to fuel pressure and accelerated flight conditions.

(b) Each fuel line connected to components of the airplane between which relative motion could exist must have provisions for flexibility.

(c) Each flexible connection in fuel lines that may be under pressure and subjected to axial loading must use flexible hose assemblies.

(d) Each flexible hose must be approved or must be shown to be suitable for the particular application.

(e) No flexible hose that might be adversely affected by exposure to high temperatures may be used where excessive temperatures will exist during operation or after engine shutdown.

§ 23.995 Fuel valves and controls.

(a) There must be a means to allow appropriate flight crew members to rapidly shut off, in flight, the fuel to each engine individually.

(b) No shutoff valve may be on the engine side of any firewall. In addition, there must be means to—

(1) Guard against inadvertent operation of each shutoff valve; and

(2) Allow appropriate flight crew members to reopen each valve rapidly after it has been closed.

(c) Each valve and fuel system control must—

(1) Have either positive stops or "feel" in the "on" and "off" positions; and

(2) Be supported so that loads resulting from its operation or from accelerated flight conditions are not transmitted to the lines connected to the valve.

(d) Each valve or fuel system control must be installed so that the effect of gravity and vibration will tend to turn its handle to the open or "on" position, not to the closed or "off" position.

(e) Each fuel valve handle and its connections to the valve mechanism must have design features that minimize the possibility of incorrect installation.

§ 23.997 Fuel strainer or filter.

(a) There must be a fuel strainer or filter between the fuel tank outlet and the carburetor inlet (or engine driven fuel pump, if there is one).

(b) Each strainer or filter must be accessible for drainage and cleaning.

(c) Each strainer screen must be removable.

§ 23.999 Fuel system drains.

(a) There must be at least one drain to allow safe drainage of the entire fuel system with the airplane in its normal ground attitude.

(b) Each drain must have a means to lock it closed.

OIL SYSTEM

§ 23.1011 General.

(a) Each engine must have an independent oil system that can supply it with an appropriate quantity of oil at a temperature not above that safe for continuous operation.

(b) The usable oil tank capacity may not be less than the product of the endurance of the airplane under critical operating conditions and the maximum oil consumption of the engine under the same conditions, plus a suitable margin to ensure adequate circulation and cooling.

(c) For an oil system without an oil transfer system, only the usable oil tank capacity may be considered. The amount of oil in the engine oil lines, the oil radiator, and the feathering reserve, may not be considered.

(d) If an oil transfer system is used, and the transfer pump can pump some of the oil in the transfer lines into the main engine oil tanks, the amount of oil in these lines that can be pumped by the transfer pump may be included in the oil capacity.

§ 23.1013 Oil tanks.

(a) *Installation.* Each oil tank must be installed to—

(1) Meet the requirements of § 23.967 (a) and (b); and

(2) Withstand any vibration, inertia, and fluid loads expected in operation.

(b) *Expansion space.* Oil tank expansion space must be provided so that—

(1) Each oil tank has an expansion space of not less than the greater of—

(i) 10 percent of the tank capacity; or

(ii) 0.5 gallon; and

(2) It is impossible to fill the expansion space inadvertently with the airplane in the normal ground attitude.

(c) *Filler connection.* Each oil tank filler connection must be marked under § 23.1557(c).

(d) *Vent.* Oil tanks must be vented as follows:

(1) Each oil tank must be vented to the engine crankcase from the top part of the expansion space so that the vent connection is not covered by oil under any normal flight condition.

(2) Oil tank vents must be arranged so that condensed water vapor that might freeze and obstruct the line cannot accumulate at any point.

(3) For acrobatic category airplanes, there must be means to prevent hazardous loss of oil during acrobatic maneuvers, including short periods of inverted flight.

(e) *Outlet.* No oil tank outlet may be enclosed or covered by any screen or guard that might reduce the flow of oil. No oil tank outlet diameter may be less than the diameter of the engine oil pump inlet.

(f) *Flexible liners.* Each flexible oil tank liner must be of an acceptable kind.

§ 23.1015 Oil tank tests.

Each oil tank must be tested under § 23.965, except that—

(a) The applied pressure must be five p.s.i. for the tank construction instead of the pressures specified in § 23.965(a); and

(b) For a tank with a nonmetallic liner the test fluid must be oil rather than fuel as specified in § 23.965(d), and the slosh test on a specimen liner must be conducted with the oil at 250° F.

§ 23.1017 Oil lines and fittings.

(a) *General.* Each oil line must meet the requirements of § 23.993, except that the inside diameter of the engine oil inlet and outlet lines may not be less than the diameter of the corresponding engine oil pump inlet and outlet.

(b) *Breather lines.* Breather lines must be arranged so that—

(1) Condensed water vapor that might freeze and obstruct the line cannot accumulate at any point;

(2) The breather discharge will not constitute a fire hazard if foaming occurs, or cause emitted oil to strike the pilot's windshield;

(3) The breather does not discharge into the engine air induction system; and

(4) For acrobatic category airplanes, there is no excessive loss of oil from the breather during acrobatic maneuvers, including short periods of inverted flight.

§ 23.1019 Oil strainer or filter.

Each oil strainer or filter in the powerplant installation must be constructed and installed so that oil will flow at the normal rate through the rest of the system with the strainer or filter element completely blocked.

§ 23.1021 Oil system drains.

There must be at least one accessible drain that—

(a) Allows safe drainage of the entire oil system; and

(b) Has manual or automatic means for positive locking in the closed position.

§ 23.1023 Oil radiators.

Each oil radiator and its supporting structures must be able to withstand the vibration, inertia, and oil pressure loads to which it would be subjected in operation.

§ 23.1027 Propeller feathering system.

(a) If the propeller feathering system depends on engine oil, there must be means to trap an amount of oil in the tank if the supply becomes depleted due to failure of any part of the lubricating system, other than the tank itself.

(b) The amount of trapped oil must be enough to accomplish feathering and must be available only to the feathering pump.

(c) The ability of the system to accomplish feathering with the trapped oil must be shown.

COOLING

§ 23.1041 General.

The powerplant cooling provisions must be able to maintain the temperatures of powerplant components and fluids within the limits established during ground and flight operation.

§ 23.1043 Cooling tests.

(a) *General.* Compliance with § 23.1041 must be shown under critical ground, water, and flight operating conditions. For these tests, the following apply:

(1) If the tests are conducted under conditions deviating from the maximum anticipated air temperatures specified in paragraph (b) of this section, the recorded powerplant temperatures must be corrected under paragraphs (c) and (d) of this section, unless a more rational correction method is applicable.

(2) No corrected temperature determined under subparagraph (1) of this paragraph may exceed established limits.

(3) The fuel used during the cooling tests must be of the minimum grade approved for the engines, and the mixture settings must be those used in normal operation.

(4) The test procedures must be as prescribed in §§ 23.1045 and 23.1047.

(5) Water taxiing tests must be conducted on each hull seaplane that may reasonably be expected to be taxied for extended periods.

(b) *Maximum anticipated air temperature.* For cooling tests, the maximum anticipated temperature (hot-day condition) is 100 degrees F. at sea level, decreasing from this value at the rate of 3.6 degrees F. per thousand feet of altitude above sea level up to the altitude at which a temperature of −69.7 degrees F. is reached, above which altitude the temperature is constant at −69.7 degrees F. However, cooling test results for winterization installations may be corrected to any desired temperature.

(c) *Correction factor for cylinder head, oil inlet, carburetor air, and engine and transmission coolant outlet temperatures.* The cylinder head, oil inlet, carburetor air, and engine coolant outlet temperatures must be corrected by adding to them the difference between the maximum anticipated air temperature and the temperature of the ambient air at the time of the first occurrence of the maximum head, oil, air, or coolant temperatures recorded during the cooling test.

(d) *Correction factor for cylinder barrel temperatures.* Cylinder barrel temperatures must be corrected by adding to them 0.7 times the difference between the maximum anticipated air temperature and the temperature of the ambient air at the time of the first occurrence of the maximum cylinder barrel temperature recorded during the cooling test.

§ 23.1045 Cooling test procedures for single-engine airplanes.

(a) For each single-engine airplane, engine cooling tests must be conducted as follows:

(1) Engine temperatures must be stabilized in flight with the engines at not less than 75 percent of maximum continuous power.

(2) After temperatures have stabilized, a climb must be begun at the lowest practicable altitude and continued for one minute with the engine at takeoff power.

(3) At the end of one minute, the climb must be continued at maximum continuous power for at least five minutes after the occurrence of the highest temperature recorded.

(b) The climb required in paragraph (a) of this section must be conducted at a speed not more than the best rate-of-climb speed with maximum continuous power unless—

(1) The slope of the flight path at the speed chosen for the cooling test is equal to or greater than the minimum required angle of climb determined under § 23.65(a)(1); and

(2) The airplane has a cylinder head temperature indicator as specified in § 23.1337(e).

(c) The stabilizing and climb parts of the test must be conducted with cowl flap settings selected by the applicant.

§ 23.1047 Cooling test procedures for multiengine airplanes.

(a) For each multiengine airplane that meets the minimum one-engine-inoperative climb performance specified in § 23.67(a) or § 23.67(b)(1), engine cooling tests must be conducted as follows:

(1) The airplane must be in the configuration specified in § 23.67(a) or § 23.67(b)(1), except that, when above the critical altitude, the operating engines must be at maximum continuous power or at full throttle.

(2) The stabilizing and climb parts of the test must be conducted with cowl flap settings selected by the applicant.

(3) The temperatures of the operating engines must be stabilized in flight, with the engines at not less than 75 percent of the maximum continuous power.

(4) After engine temperatures have stabilized, a climb must be—

(i) Begun from 1,000 feet below the critical altitude (or, if this is impracticable, at the lowest altitude that the terrain will allow) or 1,000 feet below the altitude at which the single-engine-inoperative rate of climb is 0.02 $V_{S_0}^2$, whichever is lower; and

(ii) Continued for at least five minutes after the highest temperature has been recorded.

(5) The climb must be conducted at a speed not more than the highest speed at which compliance with the climb requirement of § 23.67(a) or § 23.67(b)(1) can be shown. If the speed used exceeds the speed for best rate of climb with one engine inoperative, the airplane must have a cylinder head temperature indicator as specified in § 23.1337(e).

(b) For each multiengine airplane that cannot meet the minimum one-engine-inoperative climb performance specified in § 23.67(a) or § 23.67(b)(1), engine cooling tests must be conducted as prescribed in paragraph (a) of this section, except that, after stabilizing temperatures in flight, the climb (or descent, for airplanes with zero or negative one-engine-inoperative rates of climb) must be—

(1) Begun as close to sea level as is practicable; and

(2) Conducted at the best rate-of-climb speed (or the speed of minimum rate of descent, for airplanes with zero or negative one-engine-inoperative rates of climb).

LIQUID COOLING

§ 23.1061 Installation.

(a) *General.* Each liquid-cooled engine must have an independent cooling system (including coolant tank) installed so that—

(1) Each coolant tank is supported so that tank loads are distributed over a large part of the tank surface;

(2) There are pads between the tank and its supports to prevent chafing; and

(3) No air or vapor can be trapped in any part of the system, except the expansion tank, during filling or during operation.

Padding must be nonabsorbent or must be treated to prevent the absorption of flammable fluids.

(b) *Coolant tank.* The tank capacity must be at least one gallon, plus 10 percent of the cooling system capacity. In addition—

(1) Each coolant tank must be able to withstand the vibration, inertia, and fluid loads to which it may be subjected in operation;

(2) Each coolant tank must have an expansion space of at least 10 percent of the total cooling system capacity; and

(3) It must be impossible to fill the expansion space inadvertently with the airplane in the normal ground attitude.

(c) *Filler connection.* Each coolant tank filler connection must be marked as specified in § 23.1557(c). In addition—

(1) Spilled coolant must be prevented from entering the coolant tank compartment or any part of the airplane other than the tank itself; and

(2) Each recessed coolant filler connection must have a drain that discharges clear of the entire airplane.

(d) *Lines and fittings.* Each coolant system line and fitting must meet the requirements of § 23.993, except that the inside diameter of the engine coolant inlet and outlet lines may not be less than the diameter of the corresponding engine inlet and outlet connections.

(e) *Radiators.* Each coolant radiator must be able to withstand any vibration, inertia, and coolant pressure load to which it may normally be subjected. In addition—

(1) Each radiator must be supported to allow expansion due to operating temperatures and prevent the transmittal of harmful vibration to the radiator; and

(2) If flammable coolant is used, the air intake duct to the coolant radiator must be located so that (in case of fire) flames from the nacelle cannot strike the radiator.

(f) *Drains.* There must be an accessible drain that—

(1) Drains the entire cooling system (including the coolant tank, radiator, and the engine) when the airplane is in the normal ground attitude;

(2) Discharges clear of the entire airplane; and

(3) Has means to positively lock it closed.

§ 23.1063 Coolant tank tests.

Each coolant tank must be tested under § 23.965, except that—

(a) The test required by § 23.965(a)(1) must be replaced with a similar test using the sum of the pressure developed during the maximum ultimate acceleration with a full tank or a pressure of 3.5 pounds per square inch, whichever is greater, plus the maximum working pressure of the system; and

(b) For a tank with a nonmetallic liner the test fluid must be coolant rather than fuel as specified in § 23.965(d), and the slosh test on a specimen liner must be conducted with the coolant at operating temperature.

INDUCTION SYSTEM

§ 23.1091 Air induction.

(a) The air induction system for each engine must supply the air required by that engine under the operating conditions for which certification is requested.

(b) Each engine must have at least two separate air intake sources, except that an engine with a fuel injection pump need have only one air intake source if the air intake, opening, or passage, is not obstructed by a screen, filter, or other part on which ice might form and restrict the airflow so as to adversely affect engine operation.

(c) Primary air intakes may open within the cowling if that part of the cowling is isolated from the engine accessory section by a fire-resistant diaphragm or if there are means to prevent the emergence of backfire flames.

(d) Each alternate air intake must be located in a sheltered position and may not open within the cowling if the emergence of backfire flames will result in a hazard.

(e) The supplying of air to the engine through the alternate air intake system of the carburetor air preheater may not result in a loss of excessive power in addition to the power loss due to the rise in air temperature.

§ 23.1093 Induction system icing protection.

Each engine air induction system must have means to prevent and eliminate icing. Unless this is done by other means, it must be shown that, in air free of visible moisture at a temperature of 30 degrees F.—

(a) Each airplane with sea level engines using conventional venturi carburetors has a preheater that can provide a heat rise of 90° F. with the engines at 75 percent of maximum continuous power;

(b) Each airplane with altitude engines using conventional venturi carburetors has a preheater that can provide a heat rise of 120° F. with the engines at 75 percent of maximum continuous power;

(c) Each airplane with altitude engines using carburetors tending to prevent icing has a preheater that, with the engines at 60 percent of maximum continuous power, can provide a heat rise of—

(1) 100° F.; or

(2) 40° F., if a fluid deicing system meeting the requirements of §§ 23.1095 through 23.1099 is installed;

(d) Each single-engine airplane with a sea level engine using a carburetor tending to prevent icing has a sheltered alternate source of air with a preheat of not less than that provided by the engine cooling air down-stream of the cylinders; and

(e) Each multiengine airplane with sea level engines using a carburetor tending to prevent icing has a preheater that can provide a heat rise of 90° F. with the engines at 75 percent of maximum continuous power.

§ 23.1095 Carburetor deicing fluid flow rate.

(a) If a carburetor deicing fluid system is used, it must be able to simultaneously supply each engine with a rate of fluid flow, expressed in pounds per hour, of not less than 2.5 times the square root of the maximum continuous power of the engine.

(b) The fluid must be introduced into the air induction system—

(1) Close to, and upstream of, the carburetor; and

(2) So that it is equally distributed over the entire cross section of the induction system air passages.

§ 23.1097 **Carburetor deicing fluid system capacity.**

(a) The capacity of each carburetor deicing fluid system—

(1) May not be less than the greater of—

(i) That required to provide fluid at the rate specified in § 23.1095 for a time equal to three percent of the maximum endurance of the airplane; or

(ii) 20 minutes at that flow rate; and

(2) Need not exceed that required for two hours of operation.

(b) If the available preheat exceeds 50° F. but is less than 100° F., the capacity of the system may be decreased in proportion to the heat rise available in excess of 50° F.

§ 23.1099 **Carburetor deicing fluid system detail design.**

Each carburetor deicing fluid system must meet the applicable requirements for the design of a fuel system, except as specified in §§ 23.1095 and 23.1097.

§ 23.1101 **Carburetor air preheater design.**

Each carburetor air preheater must be designed and constructed to—

(a) Ensure ventilation of the preheater when the engine is operated in cold air;

(b) Allow inspection of the exhaust manifold parts that it surrounds; and

(c) Allow inspection of critical parts of the preheater itself.

§ 23.1103 **Induction system ducts.**

(a) Each induction system duct must have a drain to prevent the accumulation of fuel or moisture in the normal ground and flight attitudes. No open drain may be on the pressure side of turbosupercharger installations. No drain may discharge where it will cause a fire hazard.

(b) Each duct connected to components between which relative motion could exist must have means for flexibility.

§ 23.1105 **Induction system screens.**

If induction system screens are used—

(a) Each screen must be upstream of the carburetor;

(b) No screen may be in any part of the induction system that is the only passage through which air can reach the engine, unless—

(1) The available preheat is at least 100° F.; and

(2) The screen can be deiced by heated air;

(c) No screen may be deiced by alcohol alone; and

(d) It must be impossible for fuel to strike any screen.

EXHAUST SYSTEM

§ 23.1121 **General.**

(a) Each exhaust system must ensure safe disposal of exhaust gases without fire hazard or carbon monoxide contamination in any personnel compartment.

(b) Unless suitable precautions are taken, no exhaust system part may be dangerously close to any system carrying flammable fluids or vapors, or under any such system that may leak.

(c) Each exhaust system component must be separated by fireproof shields from adjacent flammable parts of the airplane that are outside the engine compartment.

(d) No exhaust gases may discharge dangerously near any fuel or oil system drain.

(e) No exhaust gases may be discharged where they will cause a glare seriously affecting pilot vision at night.

(f) Each exhaust system component must be ventilated to prevent points of excessively high temperature.

§ 23.1123 **Exhaust manifold.**

(a) Each exhaust manifold must be fireproof and corrosion-resistant, and must have means to prevent failure due to expansion by operating temperatures.

(b) Each exhaust manifold must be supported to withstand the vibration and inertia loads to which it may be subjected in operation.

(c) Parts of the manifold connected to components between which relative motion could exist must have means for flexibility.

§ 23.1125 **Exhaust heat exchangers.**

(a) Each exhaust heat exchanger must be constructed and installed to withstand the vibration, inertia, and other loads that it may be subjected to in normal operation. In addition—

(1) Each exchanger must be suitable for continued operation at high temperatures and resistant to corrosion from exhaust gases;

(2) There must be means for inspection of critical parts of each exchanger; and

(3) Each exchanger must be ventilated where it is subject to contact with exhaust gases.

(b) Each heat exchanger used for heating ventilating air must be constructed so that exhaust gases may not enter the ventilating air.

POWERPLANT CONTROLS AND ACCESSORIES

§ 23.1141 **Powerplant controls: general.**

(a) Powerplant controls must be located and arranged under § 23.777 and marked under § 23.1555(a).

(b) Each flexible control must be of an acceptable kind.

(c) Each control must be able to maintain any necessary position without—

(1) Constant attention by flight crew members; or

(2) Tendency to creep due to control loads or vibration.

(d) Each control must be able to withstand operating loads without failure or excessive deflection.

§ 23.1143 **Throttle controls.**

(a) There must be a separate throttle control for each engine.

(b) Throttle controls must be arranged to allow—

(1) Separate control of each engine; and

(2) Simultaneous control of all engines.

(c) Each throttle control must give a positive and immediately responsive means of controlling its engine.

§ 23.1145 **Ignition switches.**

(a) Ignition switches must control each ignition circuit on each engine.

(b) There must be means to quickly shut off all ignition on multiengine airplanes by the grouping of switches or by a master ignition control.

(c) Each master ignition control must have means to prevent its inadvertent operation.

§ 23.1147 **Mixture controls.**

If there are mixture controls, each engine must have a separate control. The controls must be grouped and arranged to allow—

(a) Separate control of each engine; and

(b) Simultaneous control of all engines.

§ 23.1149 **Propeller speed and pitch controls.**

(a) If there are propeller speed or pitch controls, they must be grouped and arranged to allow—

(1) Separate control of each propeller; and

(2) Simultaneous control of all propellers.

(b) The controls must allow ready synchronization of all propellers on multiengine airplanes.

§ 23.1153 **Propeller feathering controls.**

If there are propeller feathering controls, each propeller must have a separate control. Each control must have means to prevent inadvertent operation.

§ 23.1157 **Carburetor air temperature controls.**

There must be a separate carburetor air temperature control for each engine.

§ 23.1163 **Powerplant accessories.**

(a) Each engine-driven accessory must—

(1) Be satisfactory for mounting on the engine concerned; and

(2) Use the provisions on the engine for mounting.

(b) Electrical equipment subject to arcing or sparking must be installed to minimize the probability of contact with any flammable fluids or vapors that might be present in a free state.

§ 23.1165 **Engine ignition systems.**

(a) Each battery ignition system must be supplemented by a generator that is automatically available as an alternate source of electrical energy to allow continued engine operation if any battery becomes depleted.

(b) The capacity of batteries and generators must be large enough to meet the simultaneous demands of the engine ignition system and the greatest demands of any electrical system components that draw from the same source.

(c) The design of the engine ignition system must account for—

(1) The condition of an inoperative generator;

(2) The condition of a completely depleted battery with the generator running at its normal operating speed; and

(3) The condition of a completely depleted battery with the generator operating at idling speed, if there is only one battery.

(d) There must be means to warn appropriate crewmembers if malfunctioning of any part of the electrical system is causing the continuous discharge of any battery used for engine ignition.

POWERPLANT FIRE PROTECTION

§ 23.1183 Lines and fittings.

(a) Except as provided in paragraph (b) of this section, each line and fitting carrying flammable fluids in any area subject to engine fire conditions must meet the following requirements:

(1) The line and fitting must be at least fire resistant.

(2) Flexible hose assemblies (hose and end fittings) must be approved.

(b) Paragraph (a) of this section does not apply to—

(1) Lines and fittings forming an integral part of an engine; and

(2) Vent and drain lines, and their fittings, whose failure will not result in, or add to, a fire hazard.

§ 23.1189 Shutoff means.

For each multiengine airplane subject to §§ 23.67(a) or 23.67(b)(1), the following apply:

(a) Each engine must have means to shut off or otherwise prevent hazardous quantities of fuel, oil, deicing fluid, and other flammable fluids from flowing into, within, or through any engine compartment, except in lines forming an integral part of an engine.

(b) The closing of the fuel shutoff valve for any engine may not make any fuel unavailable to the remaining engines.

(c) Operation of any shutoff means may not interfere with the later emergency operation of other equipment such as propeller feathering devices.

(d) Each shutoff must be outside of the engine compartment unless an equal degree of safety is provided with the shutoff inside the compartment.

(e) No hazardous amount of flammable fluid may drain into the engine compartment after shutoff.

(f) There must be means to guard against inadvertent operation of each shutoff means, and to make it possible for the crew to reopen the shutoff means in flight after it has been closed.

§ 23.1191 Firewalls.

(a) Each engine, auxiliary power unit, fuel burning heater, and other combustion equipment intended for operation in flight, must be isolated from the rest of the airplane by firewalls, shrouds, or equivalent means.

(b) Each firewall or shroud must be constructed so that no hazardous quantity of liquid, gas, or flame can pass from the engine compartment to other parts of the airplane.

(c) Each opening in the firewall or shroud must be sealed with close fitting, fireproof grommets, bushings, or firewall fittings.

(d) Fire-resistant seals may be used on single-engine airplanes and multiengine airplane not subject to § 23.67(a) or (b)(1), if—

(1) Each engine has a volumetric displacement of 1,000 cubic inches or less; and

(2) No opening in the firewall or shroud will allow the passage of a hazardous amount of flame without seals.

(e) Each firewall and shroud must be fireproof and protected against corrosion.

(f) Compliance with the criteria for fireproof materials or components must be shown as follows:

(1) The flame to which the materials or components are subjected must be $2{,}000 \pm 50°$ F.

(2) Sheet materials approximately 10 inches square must be subjected to the flame from a suitable burner.

(3) The flame must be large enough to maintain the required test temperature over an area approximately five inches square.

(g) Firewall materials and fittings must resist flame penetration for at least 15 minutes.

(h) The following materials may be used in firewalls or shrouds without being tested as required by this section:

(1) Stainless steel sheet, 0.015 inch thick.

(2) Mild steel sheet (coated with aluminum or otherwise protected against corrosion) 0.018 inch thick.

(3) Terne plate, 0.018 inch thick.

(4) Monel metal, 0.018 inch thick.

(5) Steel or copper base alloy firewall fittings.

§ 23.1193 Cowling.

(a) Each cowling must be constructed and supported so that it can resist any vibration, inertia, and air loads to which it may be subjected in operation.

(b) There must be means for rapid and complete drainage of each part of the cowling in the normal ground and flight attitudes. No drain may discharge where it will cause a fire hazard.

(c) Cowling must be at least fire resistant.

(d) Each part behind an opening in the engine compartment cowling must be at least fire resistant for a distance of at least 24 inches aft of the opening.

(e) Each part of the cowling subjected to high temperatures due to its nearness to exhaust system ports or exhaust gas impingement, must be fire proof.

Subpart F—Equipment

GENERAL

§ 23.1301 Function and installation.

(a) Each item of equipment essential for safe operation, including radio communication and navigation equipment, must—

(1) Adequately perform its intended function;

(2) In the case of equipment other than radio communications and navigation equipment, function properly when installed;

(3) In the case of radio communications and navigation equipment, be installed as prescribed in § 23.1431; and

(4) Where appropriate, be adequately labeled as to its identification, function, and operating limitations.

(b) Whenever necessary, additional equipment that is installed as prescribed in the operating rules of this chapter, must meet the requirements of this section.

§ 23.1303 Flight and navigation instruments.

The following are required flight and navigational instruments:

(a) An airspeed indicator.

(b) An altimeter.

(c) A magnetic direction indicator.

§ 23.1305 Powerplant instruments.

(a) The following are required powerplant instruments for each engine or tank:

(1) A fuel quantity indicator.

(2) An oil pressure indicator.

(3) An oil temperature indicator.

(4) A tachometer.

(b) The following powerplant instruments, for each engine or tank, are required as prescribed in this subpart:

(1) A cylinder head temperature indicator.

(2) A fuel pressure indicator for pump fed engines.

(3) A manifold pressure indicator for altitude engines.

(4) An oil quantity indicator.

§ 23.1307 Miscellaneous equipment.

(a) There must be an approved safety belt for each occupant.

(b) The following miscellaneous equipment is required as prescribed in this subpart:

(1) A master switch arrangement.

(2) An adequate source of electrical energy.

(3) Electrical protective devices.

INSTRUMENTS: INSTALLATION

§ 23.1321 Arrangement and visibility.

(a) Each flight, navigation, and powerplant instrument for use by any pilot must be easily visible to him.

(b) For each multiengine airplane, identical powerplant instruments must be located so as to prevent confusion as to which engine each instrument relates.

(c) Instrument panel vibration may not damage, or impair the accuracy of, any instrument.

§ 23.1323 Airspeed indicating system.

(a) Except for an allowable installational error of plus or minus three percent of the calibrated airspeed, or five miles per hour, whichever is greater, each airspeed indicating system must indicate true airspeed at sea level with a standard atmosphere—

(1) At speeds from V_C to 1.3 V_{S_1}, with flaps up; and

(2) At 1.3 V_{S_1}, with flaps extended.

(b) Calibration must be made in flight.

§ 23.1325 Static air vent system.

Each instrument with static air case connections must be vented so that the influence of speed, the opening and closing of windows, airflow variation, and moisture or other foreign matter does not seriously affect its accuracy.

§ 23.1327 Magnetic direction indicator.

(a) Each magnetic direction indicator must be installed so that its accuracy is not excessively affected by the airplane's vibration or magnetic fields.

(b) The compensated installation may not have a deviation, in level flight, greater than ten degrees on any heading.

§ 23.1329 Automatic pilot system.

If an automatic pilot system is installed, it must meet the following:

(a) Each system must be designed so that the automatic pilot can—

(1) Be quickly and positively disengaged by the pilots to prevent it from interfering with their control of the airplane; or

(2) Be sufficiently overpowered by one pilot to let him control the airplane.

(b) Unless there is automatic synchronization, each system must have a means to readily indicate to the pilot the alignment of the actuating device in relation to the control system it operates.

(c) Each manually operated control for the system operation must be readily accessible to the pilot. Each control must operate in the same plane and sense of motion as specified in § 23.779 for cockpit controls. The direction of motion must be plainly indicated on or near each control.

(d) Each system must be designed and adjusted so that, within the range of adjustment available to the pilot, it cannot produce hazardous loads on the airplane or create hazardous deviations in the flight path, under any flight condition appropriate to its use, either during normal operation or in the event of a malfunction, assuming that corrective action begins within a reasonable period of time.

(e) Each system must be designed so that a single malfunction will not produce a hardover signal in more than one control axis. If the automatic pilot integrates signals from auxiliary controls or furnishes signals for operation of other equipment, positive interlocks and sequencing of engagement to prevent improper operation are required.

(f) There must be protection against adverse interaction of integrated components, resulting from a malfunction.

§ 23.1331 Instruments using a power supply.

(a) For each airplane—

(1) Each gyroscopic instrument must derive its energy from power sources adequate to maintain its required accuracy at any speed above the best rate-of-climb speed;

(2) Each gyroscopic instrument must be installed so as to prevent malfunction due to rain, oil, and other detrimental elements; and

(3) There must be a means to indicate the adequacy of the power being supplied to the instruments.

(b) For each multiengine airplane—

(1) There must be at least two independent sources of power (not driven by the same engine), a manual or an automatic means to select each power source, and a means to indicate the adequacy of the power being supplied by each source; and

(2) The installation and power supply systems must be designed so that—

(i) The failure of one instrument will not interfere with the proper supply of energy to the remaining instruments; and

(ii) The failure of the energy supply from one source will not interfere with the proper supply of energy from any other source.

§ 23.1335 Flight director instrument.

(a) The flight director instrument, if installed, may not affect the performance and accuracy of the required instruments.

(b) There must be a means to disconnect the flight director instrument from the required instruments or their installations.

§ 23.1337 Powerplant instruments.

(a) *Instrument lines.* Each powerplant instrument line must meet the requirements of § 23.993. Each line carrying inflammable fluids or gases under pressure must have restricting orifices or other safety devices at the source of pressure to prevent escape of excessive fluid or gas if the line fails.

(b) *Fuel quantity indicator.* There must be a means to indicate to the flight crewmembers the quantity of fuel in each tank during flight. An indicator, calibrated in either gallons or pounds, and clearly marked to indicate which scale is being used, may be used. In addition—

(1) Each fuel quantity indicator must be calibrated to read "zero" during level flight when the quantity of fuel remaining in the tank is equal to the unusable fuel supply determined under § 23.959;

(2) Each exposed sight gauge used as a fuel quantity indicator must be protected against damage;

(3) Each sight gauge that forms a trap in which water can collect and freeze must have means to allow drainage on the ground;

(4) Tanks with interconnected outlets and airspaces may be considered as one tank and need not have separate indicators; and

(5) No fuel quantity indicator is required for a small auxiliary tank that is

used only to transfer fuel to other tanks if the relative size of the tank, the rate of fuel transfer, and operating instructions are adequate to—

(i) Guard against overflow; and

(ii) Give the flight crewmembers prompt warning if transfer is not proceeding as planned.

(c) *Fuel flowmeter system.* If a fuel flowmeter system is installed, each metering component must have a means to by-pass the fuel supply if malfunctioning of that component severely restricts fuel flow.

(d) *Oil quantity indicator.* There must be a means to indicate the quantity of oil in each tank—

(1) On the ground (such as by a stick gauge); and

(2) In flight, to the flight crew members, if there is an oil transfer system or a reserve oil supply system.

(e) *Cylinder head temperature indicator.* There must be a cylinder head temperature indicator for—

(1) Each air cooled engine with cowl flaps; and

(2) Each airplane for which compliance with § 23.1041 is shown at a speed higher than V_Y.

ELECTRICAL SYSTEMS AND EQUIPMENT

§ 23.1351 General.

(a) *Electrical system capacity.* Each electrical system must be adequate for the intended use. In addition—

(1) Electric power sources, their transmission cables, and their associated control and protective devices, must be able to furnish the required power at the proper voltage to each load circuit essential for safe operation; and

(2) Compliance with subparagraph (1) of this paragraph must be shown by an electrical load analysis, or by electrical measurements, that account for the electrical loads applied to the electrical system in probable combinations and for probable durations.

(b) *Function.* For each electrical system, the following apply:

(1) Each system, when installed, must be—

(i) Free from hazards in itself, in its method of operation, and in its effects on other parts of the airplane; and

(ii) Protected from fuel, oil, water, other detrimental substances, and mechanical damage.

(2) Electric power sources must function properly when connected in combination or independently.

(3) No failure or malfunction of any electric power source may impair the ability of any remaining source to supply load circuits essential for safe operation.

(4) Each electric power source control must allow the independent operation of each source.

(c) *Generating system.* There must be at least one generator if the electrical system supplies power to load circuits essential for safe operation. In addition—

(1) Each generator must be able to deliver its continuous rated power;

(2) Generator voltage control equipment must be able to dependably regulate the generator output within rated limits; and

(3) Each generator must have a reverse current cutout designed to disconnect the generator from the battery and from the other generators when enough reverse current exists to damage that generator.

(d) *Instruments.* There must be a means to indicate to appropriate flight crewmembers the electric power system quantities essential for safe operation. For direct current systems, an ammeter that can be switched into each generator feeder may be used and if there is only one generator, the ammeter may be in the battery feeder.

§ 23.1353 Storage battery design and installation.

(a) Each storage battery must be designed and installed as prescribed in this section.

(b) Safe cell temperatures and pressures must be maintained during any probable charging and discharging condition. No uncontrolled increase in cell temperature may result when the battery is recharged (after previous complete discharge)—

(1) At maximum regulated voltage;

(2) During a flight of maximum duration; and

(3) Under the most adverse cooling condition likely to occur in service.

(c) Compliance with paragraph (b) of this section must be shown by tests unless experience with similar batteries and installations has shown that maintaining safe cell temperatures and pressures presents no problem.

(d) No explosive or toxic gases emitted by any battery in normal operation, or as the result of any probable malfunction in the charging system or battery installation, may accumulate in hazardous quantities within the airplane.

(e) No corrosive fluids or gases that may escape from the battery may damage surrounding structures or adjacent essential equipment.

§ 23.1357 Circuit protective devices.

(a) Protective devices, such as fuses or circuit breakers, must be installed in all electrical circuits other than—

(1) The main circuits of starter motors; and

(2) Circuits in which no hazard is presented by their omission.

(b) No protective device may protect more than one circuit essential to flight safety.

(c) Each resettable circuit protective device ("trip free" device in which the tripping mechanism cannot be overridden by the operating control) must be designed so that—

(1) A manual operation is required to restore service after tripping; and

(2) If an overload or circuit fault exists, the device will open the circuit regardless of the position of the operating control.

(d) If the ability to reset a circuit breaker or replace a fuse is essential to safety in flight, that circuit breaker or fuse must be so located and identified that it can be readily reset or replaced in flight.

(e) If fuses are used, there must be one spare of each rating, or 50 percent spare fuses of each rating, whichever is greater.

§ 23.1361 Master switch arrangement.

(a) There must be a master switch arrangement to allow ready disconnection of electric power sources from the main bus. The point of disconnection must be adjacent to the sources controlled by the switch.

(b) Load circuits may be connected so that they remain energized after the switch is opened, if they are protected by circuit protective devices, rated at five amperes or less, adjacent to the electric power source.

(c) The master switch or its controls must be so installed that the switch is easily discernible and accessible to a crewmember in flight.

§ 23.1365 Electric cables.

(a) Each electric connecting cable must be of adequate capacity.

(b) Each cable that would overheat in the event of circuit overload or fault must be at least flame resistant and may not emit dangerous quantities of toxic fumes.

§ 23.1367 Switches.

Each switch must be—

(a) Able to carry its rated current;

(b) Constructed with enough distance or insulating material between current carrying parts and the housing so that vibration in flight will not cause shorting;

(c) Accessible to appropriate flight crewmembers; and

(d) Labeled as to operation and the circuit controlled.

LIGHTS

§ 23.1381 Instrument lights.

The instrument lights must—

(a) Make each instrument and control easily readable and discernible;

(b) Be installed so that their direct rays, and rays reflected from the windshield or other surface, are shielded from the pilot's eyes; and

(c) Have enough distance or insulating material between current carrying parts and the housing so that vibration in flight will not cause shorting.

A cabin dome light is not an instrument light.

§ 23.1383 Landing lights.

(a) Each installed landing light must be acceptable.

(b) Each landing light must be installed so that—

(1) No dangerous glare is visible to the pilot;

(2) The pilot is not seriously affected by halation; and

(3) It provides enough light for night landing.

§ 23.1385 Position light system installation.

(a) *General.* Each part of each position light system must meet the applicable requirements of this section and each system as a whole must meet the requirements of §§ 23.1387 through 23.1397.

(b) *Forward position lights.* Forward position lights must consist of a red and a green light spaced laterally as far apart as practicable and installed forward on the airplane so that, with the airplane in the normal flying position, the red light is on the left side and the green light is on the right side. Each light must be approved.

(c) *Rear position light.* The rear position light must be a white light mounted as far aft as practicable, and must be approved.

(d) *Circuit.* The two forward position lights and the rear position light must make a single circuit.

(e) *Light covers and color filters.* Each light cover or color filter must be at least flame resistant and may not change color or shape or lose any appreciable light transmission during normal use.

§ 23.1387 Position light system dihedral angles.

(a) Each forward and rear position light must, as installed, show unbroken light within the dihedral angles described in this section.

(b) Dihedral angle *L* (left) is formed by two intersecting vertical planes, the first parallel to the longitudinal axis of the airplane, and the other at 110 degrees to the left of the first, as viewed when looking forward along the longitudinal axis.

(c) Dihedral angle *R* (right) is formed by two intersecting vertical planes, the first parallel to the longitudinal axis of the airplane, and the other at 110 degrees to the right of the first, as viewed when looking forward along the longitudinal axis.

(d) Dihedral angle *A* (aft) is formed by two intersecting vertical planes making angles of 70 degrees to the right and to the left, respectively, to a vertical plane passing through the longitudinal axis, as viewed when looking aft along the longitudinal axis.

§ 23.1389 Position light distribution and intensities.

(a) *General.* The intensities prescribed in this section must be provided by new equipment with each light cover and color filter in place. Intensities must be determined with the light source operating at a steady value equal to the average luminous output of the source at the normal operating voltage of the airplane. The light distribution and intensity of each position light must meet the requirements of paragraph (b) of this section.

(b) *Forward and rear position lights.* The light distribution and intensities of forward and rear position lights must be expressed in terms of minimum intensities in the horizontal plane, minimum intensities in any vertical plane, and maximum intensities in overlapping beams, within dihedral angles *L*, *R*, and *A*, and must meet the following requirements:

(1) *Intensities in the horizontal plane.* Each intensity in the horizontal plane (the plane containing the longitudinal axis of the airplane and perpendicular to the plane of symmetry of the airplane) must equal or exceed the values in § 23.1391.

(2) *Intensities in any vertical plane.* Each intensity in any vertical plane (the plane perpendicular to the horizontal plane) must equal or exceed the appropriate value in § 23.1393, where *I* is the minimum intensity prescribed in § 23.1391 for the corresponding angles in the horizontal plane.

(3) *Intensities in overlaps between adjacent signals.* No intensity in any overlap between adjacent signals may exceed the values in § 23.1395, except that higher intensities in overlaps may be used with main beam intensities substantially greater than the minima specified in §§ 23.1391 and 23.1393, if the overlap intensities in relation to the main beam intensities do not adversely affect signal clarity. When the peak intensity of the forward position lights is more than 100 candles, the maximum overlap intensities between them may exceed the values in § 23.1395 if the overlap intensity in Area A is not more than 10 percent of peak position light intensity and the overlap intensity in Area B is not more than 2.5 percent of peak position light intensity.

(c) *Rear position light installation.* A single rear position light may be installed in a position displaced laterally from the plane of symmetry of an airplane if—

(1) The axis of the maximum cone of illumination is parallel to the flight path in level flight; and

(2) There is no obstruction aft of the light and between planes 70 degrees to the right and left of the axis of maximum illumination.

§ 23.1391 Minimum intensities in the horizontal plane of forward and rear position lights.

Each position light intensity must equal or exceed the applicable values in the following table:

Dihedral angle (light included)	Angle from right or left of longitudinal axis, measured from dead ahead	Intensity (candles)
L and *R* (forward red and green).	0° to 10°	40
	10° to 20°	30
	20° to 110°	5
A (rear white)	110° to 180°	20

§ 23.1393 Minimum intensities in any vertical plane of forward and rear position lights.

Each position light intensity must equal or exceed the applicable values in the following table:

Angle above or below the horizontal plane	Intensity
0°	1.00 *I*.
0° to 5°	0.90 *I*.
5° to 10°	0.80 *I*.
10° to 15°	0.70 *I*.
15° to 20°	0.50 *I*.
20° to 30°	0.30 *I*.
30° to 40°	0.10 *I*.
40° to 90°	0.05 *I*.

§ 23.1395 Maximum intensities in overlapping beams of forward and rear position lights.

No position light intensity may exceed the applicable values in the following table, except as provided in § 23.1389(b)(3):

Overlaps	Maximum intensity	
	Area A (candles)	Area B (candles)
Green in dihedral angle *L*	10	1
Red in dihedral angle *R*	10	1
Green in dihedral angle *A*	5	1
Red in dihedral angle *A*	5	1
Rear white in dihedral angle *L*	5	1
Rear white in dihedral angle *R*	5	1

Where—

(a) Area A includes all directions in the adjacent dihedral angle that pass through the light source and intersect the common boundary plane at more than 10 degrees but less than 20 degrees; and

(b) Area B includes all directions in the adjacent dihedral angle that pass through the light source and intersect the common boundary plane at more than 20 degrees.

§ 23.1397 Color specifications.

Each position light color must have the applicable International Commission on Illumination chromaticity coordinates as follows:

(a) *Aviation red—*

"y" is not greater than 0.335; and
"z" is not greater than 0.002.

(b) *Aviation green—*

"x" is not greater than $0.440-0.320y$;
"x" is not greater than $y-0.170$; and
"y" is not less than $0.390-0.170x$.

(c) *Aviation white—*

"x" is not less than 0.350;
"x" is not greater than 0.540; and
"$y-y_0$" is not numerically greater than 0.01, "y_0" being the y coordinate of the Planckian radiator for which $x_0=x$.

§ 23.1399 Riding light.

(a) Each riding (anchor) light required for a seaplane or amphibian, must be installed so that it can—

(1) Show a white light for at least two miles at night under clear atmospheric conditions; and

(2) Show the maximum unbroken light practicable when the airplane is moored or drifting on the water.

(b) Externally hung lights may be used.

§ 23.1401 Anticollision light system.

(a) *General.* If certification for night operation is requested, the airplane must have an anticollision light system that—

(1) Consists of one or more approved anticollision lights located so that their light will not impair the flight crewmembers' vision or detract from the conspicuity of the position lights; and

(2) Meets the requirements of paragraphs (b) through (f) of this section.

(b) *Field of coverage.* The system must consist of enough lights to illuminate the vital areas around the airplane, considering the physical configuration and flight characteristics of the airplane. The field of coverage must extend in each direction within at least 30 degrees above and 30 degrees below the horizontal plane of the airplane, except that there may be solid angles of obstructed visibility totaling not more than 0.5 steradians.

(c) *Flashing characteristics.* The arrangement of the system, that is, the number of light sources, beam width, speed of rotation, and other characteristics, must give an effective flash frequency of not less than 40, nor more than 100, cycles per minute. The effective flash frequency is the frequency at which the airplane's complete anticollision light system is observed from a distance, and applies to each sector of light including any overlaps that exist when the system consists of more than one light source. In overlaps, flash frequencies may exceed 100, but not 180, cycles per minute.

(d) *Color.* Each anticollision light must be aviation red and must meet the requirements of § 23.1397(a).

(e) *Light intensity.* The minimum light intensities in any vertical plane, measured with the red filter and expressed in terms of "effective" intensities, must meet the requirements of paragraph (f) of this section. The following relation must be assumed:

$$I_e = \frac{\int_{t_1}^{t_2} I(t)\,dt}{0.2+(t_2-t_1)};$$

where:

I_e = effective intensity (candles).

$I(t)$ = instantaneous intensity as a function of time.

t_2-t_1 = flash time interval (seconds).

Normally, the maximum value of effective intensity is obtained when t_2 and t_1 are chosen so that the effective intensity is equal to the instantaneous intensity at t_2 and t_1.

(f) *Minimum effective intensities for anticollision lights.* Each anticollision light effective intensity must equal or exceed the applicable values in the following table.

Angle above or below the horizontal plane:	*Effective intensity (candles)*
0° to 5°	100
5° to 10°	60
10° to 20°	20
20° to 30°	10

§ 23.1411 Accessibility.

Required safety equipment to be used by the flight crew in an emergency, such as automatic liferaft releases, must be readily accessible.

§ 23.1413 Safety belts.

(a) The rated strength of safety belts may not be less than that corresponding with the ultimate load factors specified in § 23.561(b); considering the dimensional characteristics of the belt installation for the specific seat or berth arrangement.

(b) Each belt must be attached so that no part of its anchorage can fail at any load lower than that corresponding with the ultimate load factors specified in § 23.561(b) times a factor of 1.33. This factor must be used instead of the fitting factor prescribed in § 23.625.

(c) For safety belts for berths parallel to the longitudinal axis of the airplane, the forward load factor specified in § 23.561(b) need not be applied.

§ 23.1415 Ditching equipment.

(a) Emergency flotation and signaling equipment required by any operating rule in this chapter must be installed so that it is readily available to the crew and passengers.

(b) Each raft and each life preserver must be approved.

(c) Each raft released automatically or by the pilot must be attached to the airplane by a line to keep it alongside the airplane. This line must be weak enough to break before submerging the empty raft to which it is attached.

(d) Each signaling device required by any operating rule in this chapter, must be accessible, function satisfactorily, and must be free of any hazard in its operation.

§ 23.1419 Deicers.

Each pneumatic deicer must be installed under approved data. There must be a positive means to deflate the pneumatic boots.

Miscellaneous Equipment

§ 23.1431 Electronic equipment.

Radio equipment and installations must be free from hazards in themselves, in their method of operation, and in their effects on other components.

§ 23.1435 Hydraulic systems.

(a) *Design.* Each hydraulic system and its elements must withstand, without yielding, the structural loads expected in addition to hydraulic loads.

(b) *Tests.* Each system must be substantiated by proof pressure tests. When proof tested, no part of any system may fail, malfunction, or experience a permanent set. The proof load of each system must be at least 1.5 times the maximum operating pressure of that system.

(c) *Accumulators.* No hydraulic accumulator or pressurized reservoir may be installed on the engine side of any firewall unless it is an integral part of an engine.

§ 23.1437 Accessories for multiengine airplanes.

For multiengine airplanes, engine-driven accessories essential to safe operation must be distributed among two or more engines so that the failure of any one engine will not impair safe operation through the malfunctioning of these accessories.

Subpart G—Operating Limitations and Information

§ 23.1501 General.

(a) Each operating limitation upon which the type design is based must be made available to the pilot and other appropriate crewmembers.

(b) Any information not covered in paragraph (a) of this section that is necessary for safety must be made available to the crewmembers.

(c) Each operating limitation specified in §§ 23.1505 through 23.1525, and each similar limitation must, if necessary for safety, be—

(1) Established for the airplane; and

(2) Made available to the crewmembers as prescribed in §§ 23.1541 through 23.1589.

§ 23.1505 Airspeed limitations.

(a) The never-exceed speed V_{NE} must be established so that it is—

(1) Not less than 0.9 times the minimum value of V_D allowed under § 23.335; and

(2) Not more than the lesser of—

(i) 0.9 V_D established under § 23.335; or

(ii) 0.9 times the maximum speed shown under § 23.251.

(b) The maximum structural cruising speed V_{NO} must be established so that it is—

(1) Not less than the minimum value of V_C allowed under § 23.335; and

(2) Not more than the lesser of—

(i) V_C established under § 23.335; or

(ii) 0.89 V_{NE} established under paragraph (a) of this section.

§ 23.1507 Maneuvering speed.

The maneuvering speed V_A, determined under § 23.335, must be established as an operating limitation.

§ 23.1511 Flap extended speed.

(a) The flap extended speed V_{FE} must be established so that it is—

(1) Not less than the minimum value of V_F allowed in §§ 23.345 and 23.457; and

(2) Not more than the lesser of—

(i) V_F established under § 23.345; or

(ii) V_F established under § 23.457.

(b) Additional combinations of flap setting, airspeed, and engine power may be established if the structure has been proven for the corresponding design conditions.

§ 23.1513 Minimum control speed.

The minimum control speed V_{MC}, determined under § 23.149, must be established as an operating limitation.

§ 23.1519 Weight and center of gravity.

The weight and center of gravity limitations determined under § 23.23 must be established as operating limitations.

§ 23.1521 Powerplant limitations.

(a) *General.* The powerplant limitations prescribed in this section must be established so that they do not exceed the corresponding limits for which the engines or propellers are type certificated.

(b) *Takeoff operation.* The powerplant takeoff operation must be limited by—

(1) The maximum rotational speed (rpm);

(2) The maximum allowable manifold pressure (for reciprocating engines);

(3) The maximum allowable gas temperature (for turbine engines);

(4) The time limit for the use of the power or thrust corresponding to the limitations established in subparagraphs (1) through (3) of this paragraph; and

(5) If the time limit in subparagraph (4) of this paragraph exceeds two minutes, the maximum allowable cylinder head (as applicable), liquid coolant, and oil temperatures.

(c) *Continuous operation.* The continuous operation must be limited by—

(1) The maximum rotational speed;

(2) The maximum allowable manifold pressure (for reciprocating engines);

(3) The maximum allowable gas temperature (for turbine engines); and

(4) The maximum allowable cylinder head, oil, and liquid coolant temperatures.

(d) *Fuel grade or designation.* The minimum fuel grade (for reciprocating engines), or fuel designation (for turbine engines), must be established so that it is not less than that required for the operation of the engines within the limitations in paragraphs (b) and (c) of this section.

§ 23.1523 Minimum flight crew.

The minimum flight crew for safe operation under VFR must be established, considering the availability and satisfactory operation of the necessary controls by each appropriate crewmember.

§ 23.1525 Kinds of operation.

The kinds of operation to which the airplane is limited are established by the category in which it is eligible for certification and by the installed equipment.

Markings and Placards

§ 23.1541 General.

(a) The airplane must contain—

(1) The markings and placards specified in §§ 23.1545 through 23.1567; and

(2) Any additional information, instrument markings, and placards required for the safe operation if it has unusual design, operating, or handling characteristics.

(b) Each marking and placard prescribed in paragraph (a) of this section—

(1) Must be displayed in a conspicuous place; and

(2) May not be easily erased, disfigured, or obscured.

(c) If the airplane is to be certificated in more than one category—

(1) The applicant must select one category on which the placards and markings are to be based;

(2) The placard and marking information for the other categories in which the airplane is to be certificated must be recorded in the Airplane Flight Manual; and

(3) A reference to this information must be on a placard that also indicates the category on which the placards and markings are based.

§ 23.1543 Instrument markings: general.

For each instrument—

(a) When markings are on the cover glass of the instrument, there must be means to maintain the correct alignment of the glass cover with the face of the dial; and

(b) Each arc and line must be wide enough and located to be clearly visible to the pilot.

§ 23.1545 Airspeed indicator.

(a) Each airspeed indicator must be marked to show calibrated airspeed.

(b) The following markings must be made:

(1) For the never-exceed speed V_{NE}, a radial red line.

(2) For the caution range, a yellow arc extending from the red line specified in subparagraph (1) of this paragraph to the upper limit of the green arc specified in subparagraph (3) of this paragraph.

(3) For the normal operating range, a green arc with the lower limit at V_{S_1} with maximum weight and with landing gear and wing flaps retracted, and the upper limit at the maximum structural cruising speed V_{NO} established under § 23.1505(b).

(4) For the flap operating range, a white arc with the lower limit at V_{S_0} at the maximum weight, and the upper limit at the flaps-extended speed V_{FE} established under § 23.1511.

(c) If V_{NE} or V_{NO} vary with altitude, there must be means to indicate to the pilot the appropriate limitations throughout the operating altitude range.

§ 23.1547 Magnetic direction indicator.

(a) A placard meeting the requirements of this section must be installed on or near the magnetic direction indicator.

(b) The placard must show the calibration of the instrument in level flight with the engines operating.

(c) The placard must state whether the calibration was made with radio receivers on or off.

(d) Each calibration reading must be in terms of magnetic headings in not more than 30 degree increments.

§ 23.1549 Powerplant instruments.

For each required powerplant instrument—

(a) Each maximum and, if applicable, minimum safe operating limit must be marked with a red radial line;

(b) Each normal operating range must be marked with a green arc not extending beyond the maximum and minimum continuous safe operating limits;

(c) Each takeoff and precautionary range must be marked with a yellow arc; and

(d) Each engine speed range that is restricted because of excessive vibration must be marked with a red arc.

§ 23.1551 Oil quantity indicator.

Each oil quantity indicator must be marked in sufficient increments to indicate readily and accurately the quantity of oil.

§ 23.1553 Fuel quantity indicator.

If the unusable fuel supply for any tank exceeds one gallon, or five percent of the tank capacity, whichever is greater, a red arc must be marked on its indicator extending from the calibrated zero reading to the lowest reading obtainable in level flight.

§ 23.1555 Control markings.

(a) Each cockpit control, other than primary flight controls and simple push button type starter switches, must be plainly marked as to its function and method of operation.

(b) Each secondary control must be suitably marked.

(c) For powerplant fuel controls—

(1) Each fuel tank selector control must be marked to indicate the position corresponding to each tank and to each existing cross feed position;

(2) If safe operation requires the use of any tanks in a specific sequence, that sequence must be marked on or near the selector for those tanks; and

(3) Each valve control for any engine of a multiengine airplane must be marked to indicate the position corresponding to each engine controlled.

(d) The usable capacity of each tank must be marked on or near each selector controlling that tank.

(e) For accessory, auxiliary, and emergency controls—

(1) If retractable landing gear is used, the indicator required by § 23.729 must be marked so that the pilot can, at any time, ascertain that the wheels are secured in the extreme positions; and

(2) Each emergency control must be red and must be marked as to method of operation.

§ 23.1557 Miscellaneous markings and placards.

(a) *Baggage and cargo compartments, and ballast location.* Each baggage and cargo compartment, and each ballast location, must have a placard stating any limitations on contents, including weight, that are necessary under the loading requirements.

(b) *Seats.* If the maximum allowable weight to be carried in a seat is less than 170 pounds, a placard stating the lesser weight must be permanently attached to the seat structure.

(c) *Fuel and oil filler openings.* The following must be marked on or near each appropriate filler cover:

(1) The word "fuel", the minimum fuel grade or designation for the engines, and the usable fuel tank capacity.

(2) The word "oil" and the oil tank capacity.

(d) *Emergency exit placards.* Each placard and operating control for each emergency exit must be red. A placard must be near each emergency exit control and must clearly indicate the location of that exit and its method of operation.

§ 23.1559 Operating limitations placard.

(a) There must be a placard in clear view of the pilot stating: "This airplane must be operated as a ______ or ______ category airplane in compliance with the operating limitations stated in the form of placards, markings, and manuals" (insert correct categories).

(b) There must be a placard in clear view of the pilot that specifies the kind of operations (such as VFR, IFR, day, or night) and the meteorological conditions (such as icing conditions) to which the operation of the airplane is limited, or from which it is prohibited, by the equipment installed.

§ 23.1561 Safety equipment.

(a) Safety equipment must be plainly marked as to method of operation.

(b) Stowage provisions for required safety equipment must be marked for the benefit of occupants.

§ 23.1563 Airspeed placards.

(a) *For all airplanes.* There must be an airspeed placard in clear view of the pilot and as close as practicable to the airspeed indicator. This placard must list:

(1) The maximum speed for landing gear operation V_{LO} and the maximum speed with landing gear extended V_{LE}, if the airplane has retractable landing gear;

(2) The design maneuvering speed V_A;

(3) The minimum control speed V_{MC}; and

(4) The demonstrated crosswind velocity.

(b) *For airplanes of more than 6,000 pounds.* The placard required by paragraph (a) of this section must also include—

(1) The recommended climb speed;

(2) The best angle of climb speed V_X;

(3) The engine-inoperative-climb speed; and

(4) The approach speeds.

§ 23.1567 Flight maneuver placard.

(a) For normal category airplanes, there must be a placard in front of and in clear view of the pilot stating: "No acrobatic maneuvers, including spins, approved."

(b) For utility category airplanes, there must be a placard in clear view of the pilot stating: "Acrobatic maneuvers are limited to the following ______" (list approved maneuvers).

(c) For acrobatic category airplanes, there must be a placard in clear view of the pilot listing the approved acrobatic maneuvers and the recommended entry airspeed for each. If inverted flight maneuvers are not approved, the placard must bear a notation to this effect.

AIRPLANE FLIGHT MANUAL

§ 23.1581 General.

(a) *Furnishing information.* The applicable information in §§ 23.1583 through 23.1589 must be furnished—

(1) For each airplane of more than 6,000 pounds maximum weight, in an Airplane Flight Manual; and

(2) For each airplane of 6,000 pounds or less maximum weight, in an Airplane Flight Manual or in any combination of manuals, markings, and placards.

(b) *Approval and segregation of information.* Each part of Airplane Flight Manual containing information prescribed in §§ 23.1583 through 23.1589 must be approved, segregated, identified, and clearly distinguished from each unapproved part of that manual.

(c) *Additional information.* Any information not specified in §§ 23.1583 through 23.1589 that is required for safe operation because of unusual design, operating, or handling characteristics, must be furnished.

§ 23.1583 Operating limitations.

(a) *Airspeed limitations.* Information necessary for the marking of the airspeed limits on the indicator as required in § 23.1545 must be furnished, including V_A and V_{LO}. The significance of each limitation and of the color coding must be explained.

(b) *Powerplant limitations.* Information must be furnished to explain the powerplant limitations and to allow marking the instruments under § 23.1549.

(c) *Weight.* The airplane flight manual must include—

(1) The maximum weight;

(2) The empty weight and center of gravity location;

(3) The useful load; and

(4) The composition of the useful load, including the total weight of fuel and oil with full tanks.

(d) *Load distribution.* The established center of gravity limits must be furnished. If the available loading space is adequately placarded or arranged so that no reasonable distribution of the useful load listed in paragraph (c) of this section will result in a center of gravity outside of the stated limits, the Airplane Flight Manual (where required) need not include any information other than the statement of center of gravity limits. In other cases, the manual must include enough information to indicate loading combinations that will keep the center of gravity within established limits.

(e) *Maneuvers.* The following authorized maneuvers, appropriate airspeed limitations, and unauthorized maneuvers must be furnished as prescribed in this section.

(1) *Normal category airplanes.* For normal category airplanes, acrobatic maneuvers, including spins, are unauthorized. If the airplane has been shown to be "characteristically incapable of spinning" under § 23.221(d), a statement to this effect must be entered. Other normal category airplanes must be placarded against spins.

(2) *Utility category airplanes.* For utility category airplanes, authorized

maneuvers shown in the type flight tests must be furnished, together with recommended entry speeds. No other maneuver is authorized. If the airplane has been shown to be "characteristically incapable of spinning" under § 23.221(d), a statement to this effect must be entered.

(3) *Acrobatic category airplanes.* For acrobatic category airplanes, the approved flight maneuvers shown in the type flight tests must be included, together with recommended entry speeds. A placard listing the use of the controls required to recover from spinning maneuvers must be in the cockpit.

(f) *Flight load factor.* The positive limit load factors, in *g*'s, must be furnished.

(g) *Flight crew.* If a flight crew of more than one is required for safety, the number and functions of the minimum flight crew must be furnished.

(h) *Kinds of operation.* The kinds of operation (such as VFR, IFR, day, or night) in which the airplane may or may not be used, and the meteorological conditions under which it may or may not be used, must be furnished. Any installed equipment that affects any operating limitation must be listed and identified as to operational function.

(i) If the unusable fuel supply in any tank exceeds five percent of the tank capacity, or one gallon, whichever is greater, information, showing that the fuel remaining in the tank when the quantity indicator reads "zero" cannot be safely used in flight, must be furnished. This information must be in the Airplane Flight Manual (if provided) and on a placard.

§ 23.1585 **Operating procedures.**

(a) For each airplane, information concerning normal and emergency procedures and other pertinent information necessary to safe operation must be furnished.

(b) For airplanes of more than 6,000 pounds maximum weight, procedures and pertinent information relating to the use of the airspeeds prescribed in § 23.1563 (b) must be furnished.

§ 23.1587 **Performance information.**

(a) *General.* For each airplane, the following information must be furnished:

(1) Any loss of altitude more than 100 feet, or any pitch more than 30 degrees below flight level, occurring during the recovery part of the maneuver prescribed in § 23.201(b).

(2) The conditions under which the full amount of usable fuel in each tank can safely be used. This information must be in the Airplane Flight Manual (if provided) or on a placard.

(b) *Airplanes of more than 6,000 pounds maximum weight.* For each airplane of more than 6,000 pounds maximum weight, the following information must be furnished:

(1) The stalling speed, V_{S_0} at maximum weight.

(2) The stalling speed, V_{S_1} at maximum weight and with landing gear and wing flaps retracted, and the effect upon this stalling speed of angles of bank up to 60 degrees.

(3) The takeoff distance determined under § 23.51(a), the airspeed at the 50-foot height, the airplane configuration (if pertinent), the kind of surface used in the tests, and the pertinent information with respect to cowl flap position, use of flight-path control devices, and use of the landing gear retraction system.

(4) The landing distance determined under § 23.75(a), the airplane configuration (if pertinent), the kind of surface used in the tests, and the pertinent information with respect to flap position and the use of flight-path control devices.

(5) The steady rate of climb, determined under §§ 23.65(a), 23.67(a) (if appropriate) and 23.77(a), the airspeed, power, and, if pertinent, the airplane configuration.

(6) The calculated approximate effect on takeoff distance (subparagraph (3) of this paragraph), landing distance (subparagraph (4) of this paragraph), and steady rate of climb (subparagraph (5) of this paragraph), of variations in—

(i) Altitude from sea level to 8,000 feet; and

(ii) Temperature at these altitudes from minus 60 degrees F. below standard to plus 40 degrees F. above standard.

For skiplanes, a statement in the Airplane Flight Manual of the approximate reduction in climb performance may be used instead of complete new data for the skiplane configuration if—

(i) The landing gear is fixed in both landplane and skiplane configurations;

(2) The climb requirements are not critical; and

(3) The climb reduction in the skiplane configurations is small (30 to 50 feet per minute).

(c) *Multiengine airplanes.* For multiengine airplanes, the following information must be furnished:

(1) The loss of altitude during the one engine inoperative stall shown under § 23.205 (as measured from the altitude at which the airplane starts to pitch uncontrollably to the altitude at which level flight is regained) and the pitch angle during that maneuver. This information must be furnished—

(i) In the Airplane Flight Manual, for airplanes of more than 6,000 pounds maximum weight; and

(ii) On a placard, for airplanes of 6,000 pounds or less maximum weight.

(2) The best climb speed, or the minimum descent speed, with one engine inoperative.

§ 23.1589 **Loading information.**

The following loading information must be furnished:

(a) The weight and location of each item of equipment installed when the airplane was weighed under § 23.25.

(b) Appropriate loading instructions for each possible loading condition between the maximum and minimum weights determined under § 23.25 that can result in a center of gravity beyond—

(1) The extremes selected by the applicant;

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

(3) The extremes within which compliance with each functional requirement is shown.

Appendix A—Simplified Design Load Criteria for Conventional, Single-Engine Airplanes of 6,000 Pounds or Less Maximum Weight

A23.1 *General.*

(a) The design load criteria in this Appendix are an approved equivalent of those in §§ 23.321 through 23.399 of this subchapter for the certification of conventional, single-engine airplanes of 6,000 pounds or less maximum weight.

(b) Unless otherwise stated, the nomenclature and symbols in this Appendix are the same as the corresponding nomenclature and symbols in Part 23.

A23.3 *Special symbols.*

n_1 = Airplane Positive Maneuvering Limit Load Factor.

n_2 = Airplane Negative Maneuvering Limit Load Factor.

n_3 = Airplane Positive 30 fps Gust Limit Load Factor at V_C.

n_4 = Airplane Negative 30 fps Gust Limit Load Factor at V_C.

n_{flap} = Airplane Positive Limit Load Factor With Flaps Fully Extended at V_F.

*$V_{F\ min}$ = Minimum Design Flap Speed = $12.5\sqrt{n_1 W/S}$

*$V_{A\ min}$ = Minimum Design Maneuvering Speed = $17.0\sqrt{n_1 W/S}$

*$V_{C\ min}$ = Minimum Design Cruising Speed = $19.5\sqrt{n_1 W/S}$

*$V_{D\ min}$ = Minimum Design Dive Speed = $27.3\sqrt{n_1 W/S}$

*Also see paragraph A23.7(e)(2) of this Appendix.

A23.5 *Certification in more than one category.*

The criteria in this Appendix may be used for certification in the normal, utility, and acrobatic categories, or in any combination of these categories. If certification in more than one category is desired, the design category weights must be selected to make the term "n_1W" constant for all categories or greater for one desired category than for others. The wings and control surfaces (including wing flaps and tabs) need only be investigated for the maximum value of "n_1W", or for the category corresponding to the maximum design weight, where "n_1W" is constant. If the acrobatic category is selected, a special unsymmetrical flight load investigation in accordance with subparagraphs A23.9(c)(2) and A23.11(c)(2) of this Appendix must be completed. The wing, wing carrythrough, and the horizontal tail structures must be checked for this condition. The basic fuselage structure need only be investigated for the highest load factor design category selected. The local supporting structure for dead weight items need only be designed for the highest load factor imposed when the particular items are installed in the airplane. The engine mount, however, must be designed for a higher side load factor, if certification in the acrobatic category is desired, than that required for certification in the normal and utility categories. When designing for landing loads, the landing gear and the airplane as a whole need only be investigated for the category corresponding to the maximum design weight. These simplifications apply to single-engine aircraft of conventional types for which experience is available, and the Administrator may require additional investigations for aircraft with unusual design features.

A23.7 *Flight loads.*

(a) Each flight load may be considered independent of altitude and, except for the local supporting structure for dead weight items, only the maximum design weight conditions must be investigated.

(b) Table 1 and figures 3 and 4 of this Appendix must be used to determine values of n_1, n_2, n_3, and n_4, corresponding to the maximum design weights in the desired categories.

(c) Figures 1 and 2 of this Appendix must be used to determine values of n_3 and n_4 corresponding to the minimum flying weights in the desired categories, and, if these load factors are greater than the load factors at the design weight, the supporting structure for dead weight items must be substantiated for the resulting higher load factors.

(d) Each specified wing and tail loading is independent of the center of gravity range. The applicant, however, must select a c.g. range, and the basic fuselage structure must be investigated for the most adverse dead weight loading conditions for the c.g. range selected.

(e) The following loads and loading conditions are the minimums for which strength must be provided in the structure:

(1) *Airplane equilibrium.* The aerodynamic wing loads may be considered to act normal to the relative wind, and to have a magnitude of 1.05 times the airplane normal loads (as determined from paragraphs A23.9 (b) and (c) of this appendix) for the positive flight conditions and a magnitude equal to the airplane normal loads for the negative conditions. Each chordwise and normal component of this wing load must be considered.

(2) *Minimum design airspeeds.* The minimum design airspeeds may be chosen by the applicant except that they may not be less than the minimum speeds found by using figure 3 of this Appendix. In addition, $V_{C\ min}$ need not exceed values of $0.9V_H$ actually obtained at sea level for the lowest design weight category for which certification is desired. In computing these minimum design airspeeds, n_1 may not be less than 3.8.

(3) *Flight load factor.* The limit flight load factors specified in Table 1 of this Appendix represent the ratio of the aerodynamic force component (acting normal to the assumed longitudinal axis of the airplane) to the weight of the airplane. A positive flight load factor is an aerodynamic force acting upward, with respect to the airplane.

A23.9 *Flight conditions.*

(a) *General.* Each design condition in paragraphs (b) and (c) of this section must be used to assure sufficient strength for each condition of speed and load factor on or within the boundary of a V–n diagram for the airplane similar to the diagram in figure 4 of this Appendix. This diagram must also be used to determine the airplane structural operating limitations as specified in §§ 23.1501(c) through 23.1513 and 23.1519.

(b) *Symmetrical flight conditions.* The airplane must be designed for symmetrical flight conditions as follows:

(1) The airplane must be designed for at least the four basic flight conditions, "A", "D", "E", and "G" as noted on the flight envelope of figure 4 of this Appendix. In addition, the following requirements apply:

(i) The design limit flight load factors corresponding to conditions "D" and "E" of figure 4 must be at least as great as those specified in Table 1 and figure 4 of this Appendix, and the design speed for these conditions must be at least equal to the value of V_D found from figure 3 of this Appendix.

(ii) For conditions "A" and "G" of figure 4, the load factors must correspond to those specified in Table 1 of this Appendix, and the design speeds must be computed using these load factors with the maximum static lift coefficient C_{N_A} determined by the applicant. However, in the absence of more precise computations, these latter conditions may be based on a value of $C_{N_A} = \pm 1.35$ and the design speed for condition "A" may be less than $V_{A\ min}$.

(iii) Conditions "C" and "F" of figure 4 need only be investigated when n_3W/S or n_4W/S are greater than n_1W/S or n_2W/S of this Appendix, respectively.

(2) If flaps or other high lift devices intended for use at the relatively low airspeed of approach, landing, and takeoff, are installed, the airplane must be designed for the two flight conditions corresponding to the values of limit flap-down factors specified in Table 1 of this Appendix with the flaps fully extended at not less than the design flap speed $V_{F\ min}$ from figure 3 of this Appendix.

(c) *Unsymmetrical flight conditions.* Each affected structure must be designed for unsymmetrical loadings as follows:

(1) The aft fuselage-to-wing attachment must be designed for the critical vertical surface load determined in accordance with subparagraphs A23.11(c) (1) and (2) of this Appendix.

(2) The wing and wing carry-through structures must be designed for 100 percent of condition "A" loading on one side of the plane of symmetry and 70 percent on the opposite side for certification in the normal and utility categories, or 60 percent on the opposite side for certification in the acrobatic category.

(3) The wing and wing carry-through structures must be designed for the loads resulting from a combination of 75 percent of the positive maneuvering wing loading on both sides of the plane of symmetry and the maximum wing torsion resulting from aileron displacement. The effect of aileron displacement on wing torsion at V_C or V_A using the basic airfoil moment coefficient modified over the aileron portion of the span, must be computed as follows:

(i) $C_m = C_m + 0.01\delta_u$ (up aileron side) wing basic airfoil.

(ii) $C_m = C_m - 0.01\delta_d$ (down aileron side) wing basic airfoil, where δ_u is the up aileron deflection and δ_d is the down aileron deflection.

(4) Δ critical, which is the sum of $\delta_u + \delta_d$, must be computed as follows:

(i) Compute Δ_a and Δ_b from the formulas:

$$\Delta_a = \frac{V_A}{V_C} \times \Delta_p \text{ and}$$

$$\Delta_b = 0.5\frac{V_A}{V_D} \times \Delta_p$$

where Δ_p = the maximum total deflection (sum of both aileron deflections) at V_A with V_A, V_C, and V_D described in subparagraph (2) of § 23.7(e) of this Appendix.

(ii) Compute K from the formula:

$$K = \frac{(C_m - 0.01\delta_b)V_D^2}{(C_m - 0.01\delta_a)V_C^2}$$

where δ_a is the down aileron deflection corresponding to Δ_a, and δ_b is the down aileron deflection corresponding to Δ_b as computed in step (i).

(iii) If K is less than 1.0, Δ_a is Δ critical and must be used to determine δ_u and δ_d. In this case, V_C is the critical speed which must be used in computing the wing torsion loads over the aileron span.

(iv) If K is equal to or greater than 1.0, Δ_b is Δ critical and must be used to determine δ_u and δ_d. In this case, V_D is the critical speed which must be used in computing the wing torsion loads over the aileron span.

(d) *Supplementary conditions; rear lift truss; engine torque; side load on engine mount.* Each of the following supplementary conditions must be investigated:

(1) In designing the rear lift truss, the special condition specified in § 23.369 may be investigated instead of condition "G" of figure 4 of this Appendix. If this is done, and if certification in more than one category is desired, the value of W/S used in the formula appearing in § 23.369 must be

that for the category corresponding to the maximum gross weight.

(2) Each engine mount and its supporting structures must be designed for the maximum limit torque corresponding to METO power and propeller speed acting simultaneously with the limit loads resulting from the maximum positive maneuvering flight load factor n_1. The limit torque must be obtained by multiplying the mean torque by a factor of 1.33 for engines with five or more cylinders. For 4, 3, and 2 cylinder engines, the factor must be 2, 3, and 4, respectively.

(3) Each engine mount and its supporting structure must be designed for the loads resulting from a lateral limit load factor of not less than 1.47 for the normal and utility categories, or 2.0 for the acrobatic category.

A23.11 *Control surface loads.*

(a) *General.* Each control surface load must be determined using the criteria of paragraph (b) of this section and must lie within the simplified loadings of paragraph (c) of this section.

(b) *Limit pilot forces.* In each control surface loading condition described in paragraphs (c) through (e) of this section, the airloads on the movable surfaces and the corresponding deflections need not exceed those which could be obtained in flight by employing the maximum limit pilot forces specified in the table in § 23.397(b). If the surface loads are limited by these maximum limit pilot forces, the tabs must either be considered to be deflected to their maximum travel in the direction which would assist the pilot or the deflection must correspond to the maximum degree of "out of trim" expected at the speed for the condition under consideration. The tab load, however, need not exceed the value specified in Table 2 of this Appendix.

(c) *Surface loading conditions.* Each surface loading condition must be investigated as follows:

(1) Simplified limit surface loadings and distributions for the horizontal tail, vertical tail, aileron, wing flaps, and trim tabs are specified in Table 2 and figures 5 and 6 of this Appendix. If more than one distribution is given, each distribution must be investigated.

(2) If certification in the acrobatic category is desired, the horizontal tail must be investigated for an unsymmetrical load of 100 percent $\overline{w}$ on one side of the airplane centerline and 50 percent on the other side of the airplane centerline.

(d) *Outboard fins.* Outboard fins must meet the requirements of § 23.455.

(e) *Special devices.* Special devices must meet the requirements of § 23.459.

A23.13 *Control system loads.*

(a) *Primary flight controls and systems.* Each primary flight control and system must be designed as follows:

(1) The flight control system and its supporting structure must be designed for loads corresponding to 125 percent of the computed hinge moments of the movable control surface in the conditions prescribed in A23.11 of this Appendix. In addition—

(i) The system limit loads need not exceed those that could be produced by the pilot and automatic devices operating the controls; and

(ii) The design must provide a rugged system for service use, including jamming, ground gusts, taxiing downwind, control inertia, and friction.

(2) Acceptable maximum and minimum limit pilot forces for elevator, aileron, and rudder controls are shown in the table in § 23.397(b). These pilots loads must be assumed to act at the appropriate control grips or pads as they would under flight conditions, and to be reacted at the attachments of the control system to the control surface horn.

(b) *Dual controls.* If there are dual controls, the systems must be designed for pilots operating in opposition, using individual pilot loads equal to 75 percent of those obtained in accordance with paragraph (a) of this section, except that individual pilot loads may not be less than the minimum limit pilot forces shown in the table in § 23.397(b).

(c) *Ground gust conditions.* Ground gust conditions must meet the requirements of § 23.415.

(d) *Secondary controls and systems.* Secondary controls and systems must meet the requirements of § 23.405.

TABLE 1—LIMIT FLIGHT LOAD FACTORS

LIMIT FLIGHT LOAD FACTORS			Normal category	Utility category	Acrobatic category
FLIGHT Load Factors	Flaps Up	n_1	3.8	4.4	6.0
		n_2		$-0.5n_1$	
		n_3		Find n_3 from Fig. 1	
		n_4		Find n_4 from Fig. 2	
	Flaps Down	n_{flap}		$0.5n_1$	
		n_{flap}		Zero*	

*Vertical wing load may be assumed equal to zero and only the flap part of the wing need be checked for this condition.

TABLE 2—AVERAGE LIMIT CONTROL SURFACE LOADING

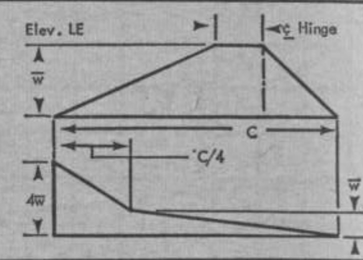
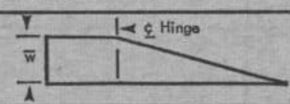
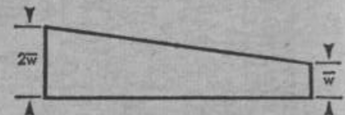
AVERAGE LIMIT CONTROL SURFACE LOADING			
SURFACE	DIRECTION OF LOADING	MAGNITUDE OF LOADING	CHORDWISE DISTRIBUTION
HORIZONTAL TAIL I	a) Up and Down	Figure 5 Curve (2)	(A) (B) 
	b) Unsymmetrical loading (Up and Down)	100% $\overline{w}$ on one side airplane ℄ 65% $\overline{w}$ on other side of airplane ℄ for the normal and utility categories. For the acrobatic category see A23.11(c).	
VERTICAL TAIL II	a) Right and Left	Figure 5 Curve (1)	Same as (A) above
	b) Right and Left	Figure 5 Curve (1)	Same as (B) above
AILERON III	a) Up and Down	Figure 6 Curve (5)	(C) 
WING FLAP IV	a) Up	Figure 6 Curve (4)	(D) 
	b) Down	.25 x Up Load (a)	
TRIM TAB V	a) Up and Down	Figure 6 Curve (3)	Same as (D) above

FIGURE 1 – CHART FOR FINDING n_3 FACTOR AT SPEED V_C

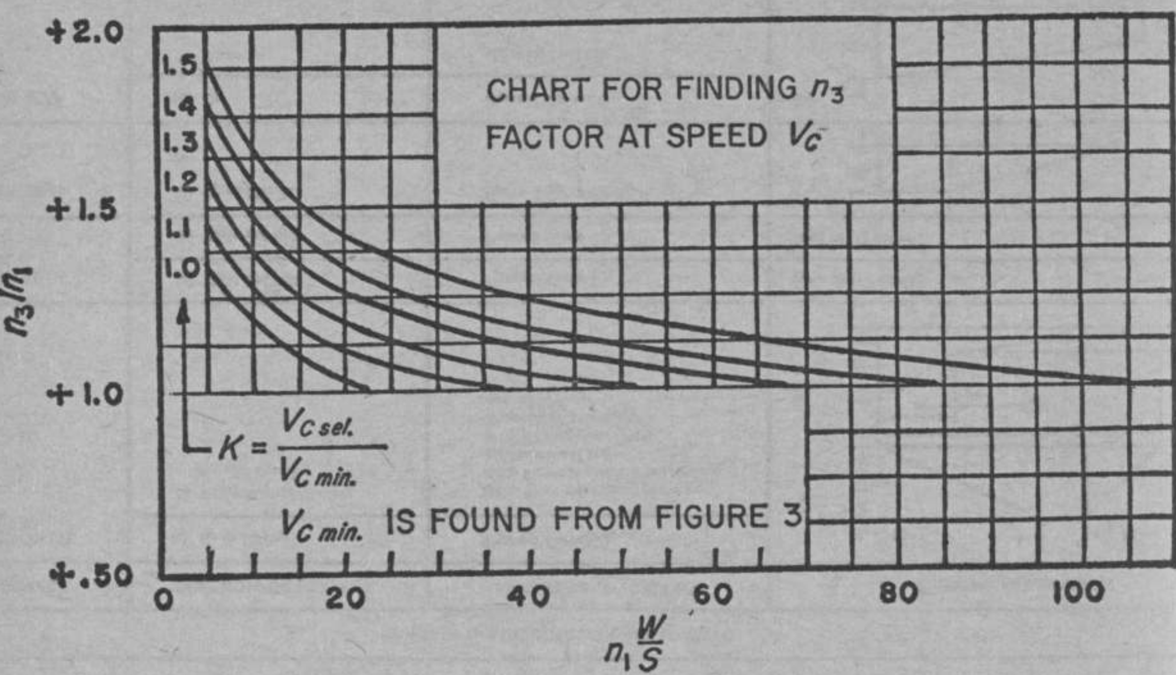


FIGURE 2 – CHART FOR FINDING n_4 FACTOR AT SPEED V_C

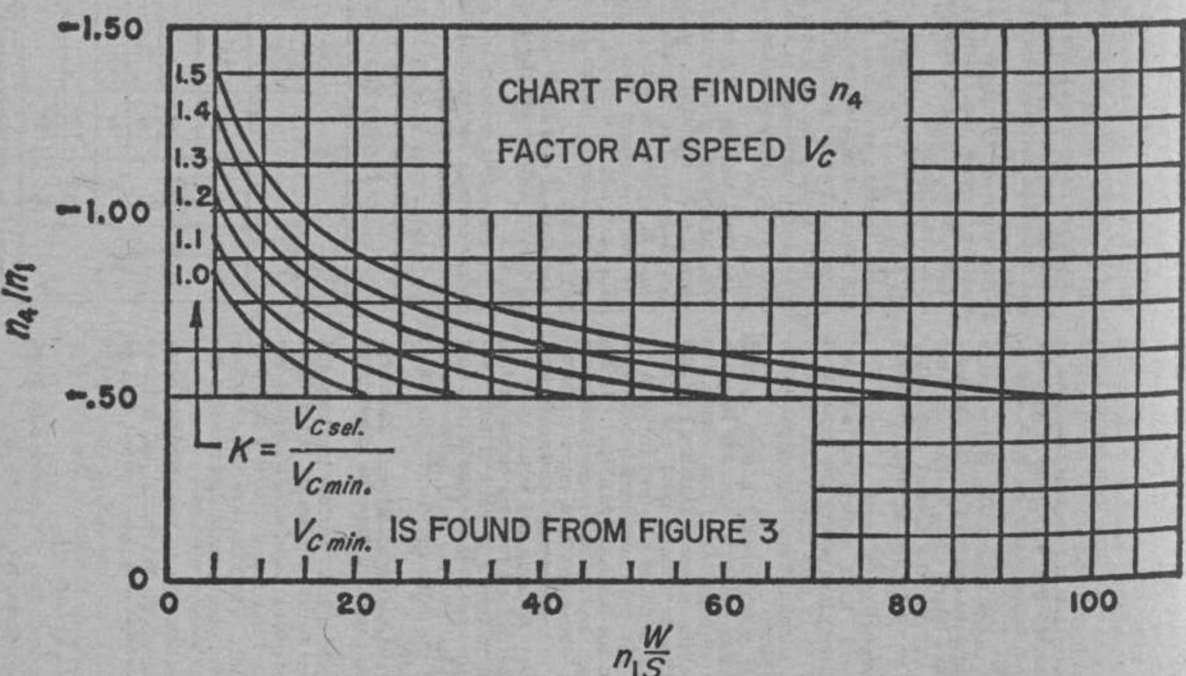


FIGURE 3 - MINIMUM DESIGN AIRSPEEDS

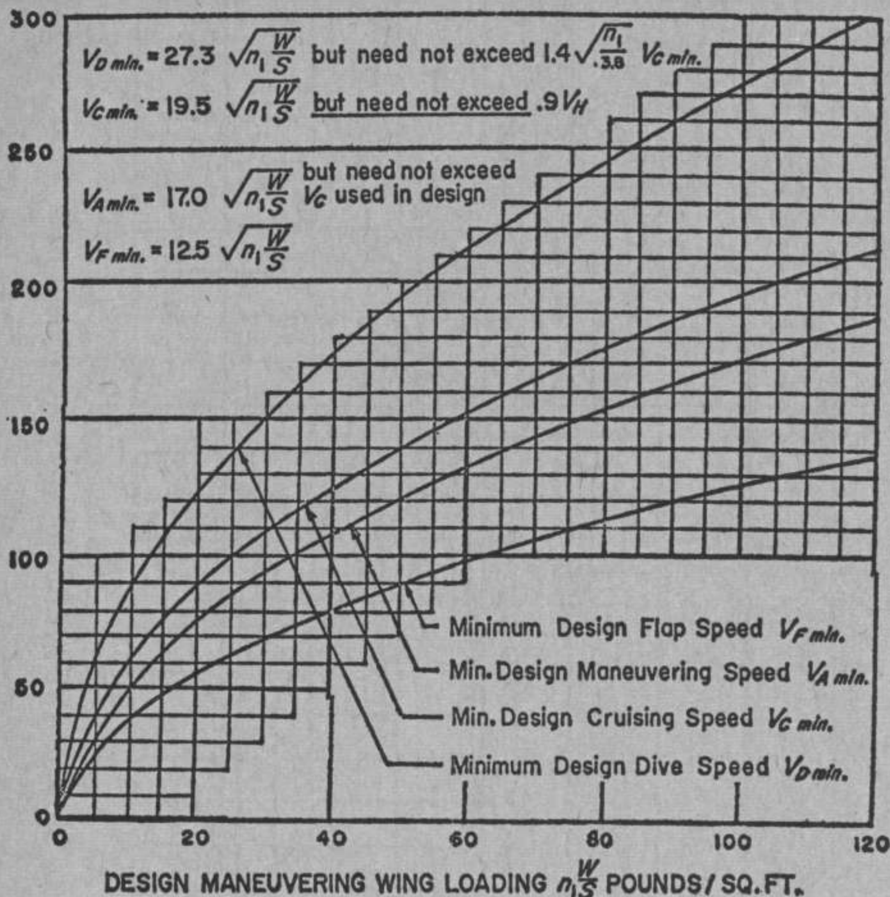
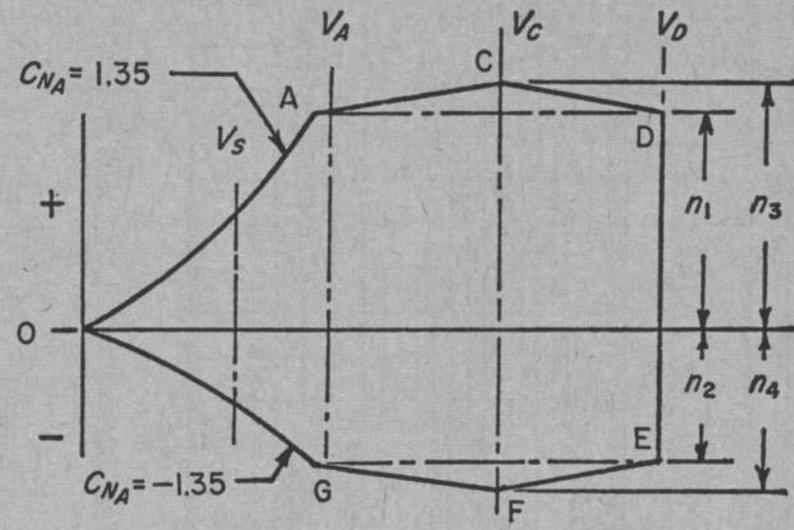


FIGURE 4—FLIGHT ENVELOPE



1. Conditions "C" or "F" need only be investigated when $n_3\frac{W}{S}$ or $n_4\frac{W}{S}$ is greater than $n_1\frac{W}{S}$ or $n_2\frac{W}{S}$, respectively.

2. Condition "G" need not be investigated when the supplementary condition specified in § 23.369 is investigated.

FIGURE 5 - AVERAGE LIMIT CONTROL SURFACE LOADING

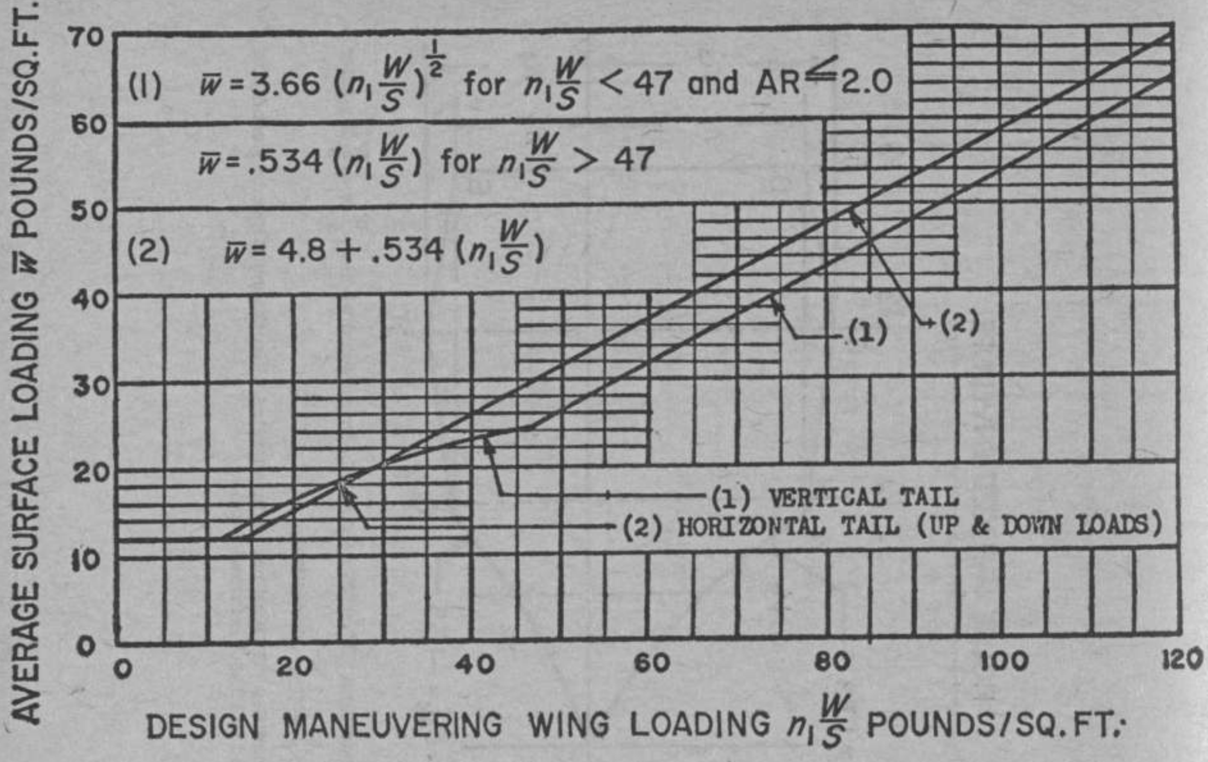
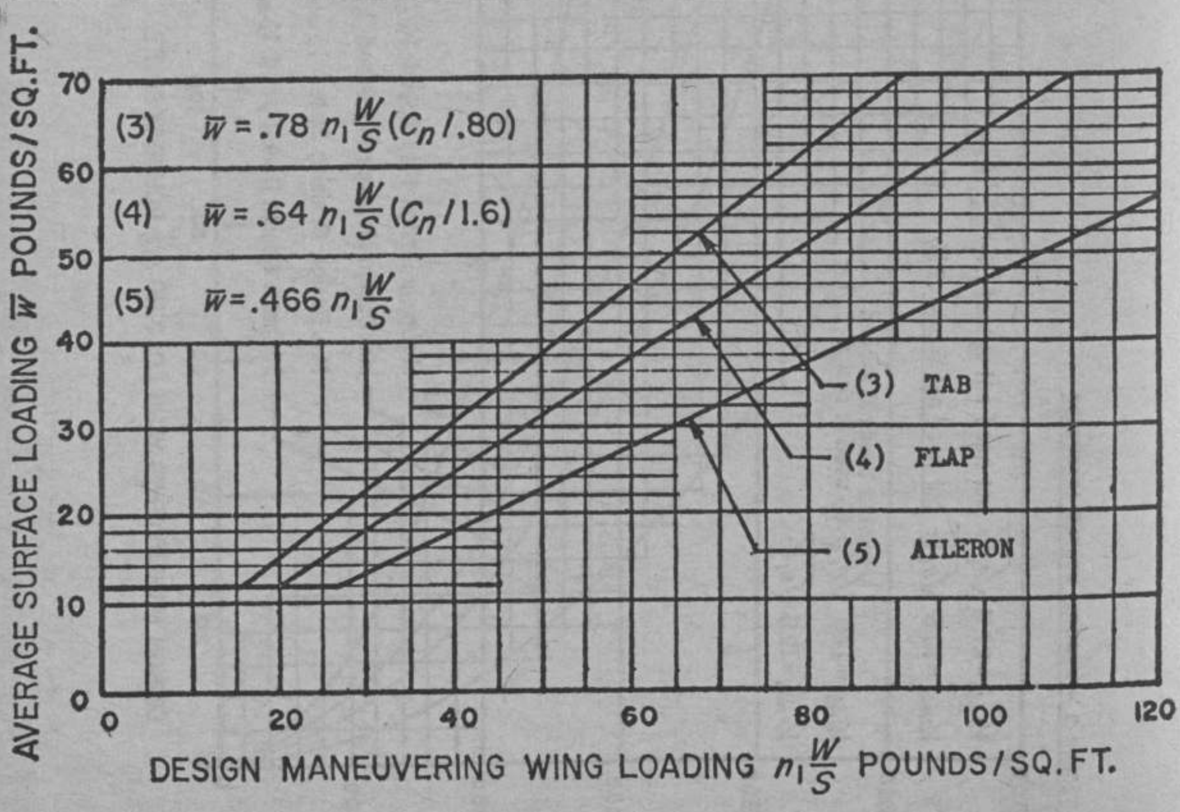


FIGURE 6 - AVERAGE LIMIT CONTROL SURFACE LOADING



APPENDIX B—CONTROL SURFACE LOADINGS

B23.1 *General.*

(a) If allowed by the specific requirements in this part, the values of control surface loading in this appendix may be used to determine the detailed rational requirements of §§ 23.397 through 23.459 unless the Administrator finds that these values result in unrealistic loads.

(b) For a seaplane version of a landplane, the landplane wing loadings may be used to determine the limit maneuvering control surface loadings (in accordance with B23.11 and figure 1 of Appendix B) if—

(1) The power of the seaplane engines does not exceed the power of the landplane engines;

(2) The placard maneuver speed of the seaplane does not exceed the placard maneuver speed of the landplane;

(3) The maximum weight of the seaplane does not exceed the maximum weight of the landplane by more than 10 percent;

(4) The landplane service experience does not show any serious control-surface load problem; and

(5) The landplane service experience is of sufficient scope to ascertain with reasonable accuracy that no serious control-surface load problem will develop on the seaplane.

B23.11 *Control surface loads.*

Acceptable values of limit average maneuvering control-surface loadings may be obtained from figure 1 of this Appendix in accordance with the following:

(a) For horizontal tail surfaces—

(1) With the conditions in § 23.423(a), obtain $\overline{w}$ as a function of W/S and surface deflection, using—

(i) Curve C of figure 1 for a deflection of 10° or less;

(ii) Curve B of figure 1 for a deflection of 20°;

(iii) Curve A for a deflection of 30° or more;

(iv) Interpolation for all other deflections; and

(v) The distribution of figure 7; and

(2) With the conditions in § 23.423(b), obtain $\overline{w}$ from curve B of figure (1) using the distribution of figure 7.

(b) For vertical tail surfaces—

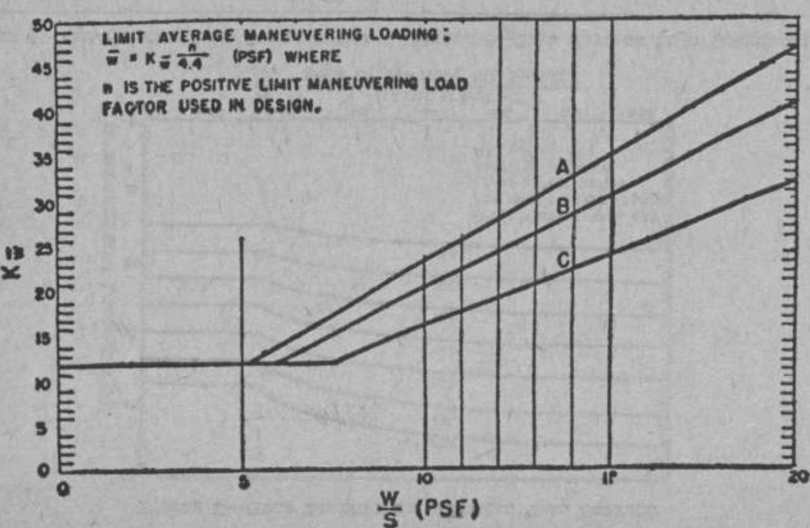
(1) With the conditions in § 23.441(a)(1), obtain $\overline{w}$ as a function of W/S and surface deflection using the same requirements as used in subdivisions (a)(1)(i) through (a)(1)(v);

(2) With the conditions in § 23.441(a)(2), obtain $\overline{w}$ from Curve C, using the distribution of figure 6; and

(3) With the conditions in § 23.441(a)(3), obtain $\overline{w}$ from Curve A, using the distribution of figure 8.

(c) For ailerons, obtain $\overline{w}$ from Curve B, acting in both the up and down directions, using the distribution of figure 9.

FIGURE 1—LIMIT AVERAGE MANEUVERING CONTROL SURFACE LOADING



Note: In no case may $\overline{w}$ be less than 12 psf.

FIGURE 2—MANEUVERING TAIL LOAD INCREMENT (UP OR DOWN)

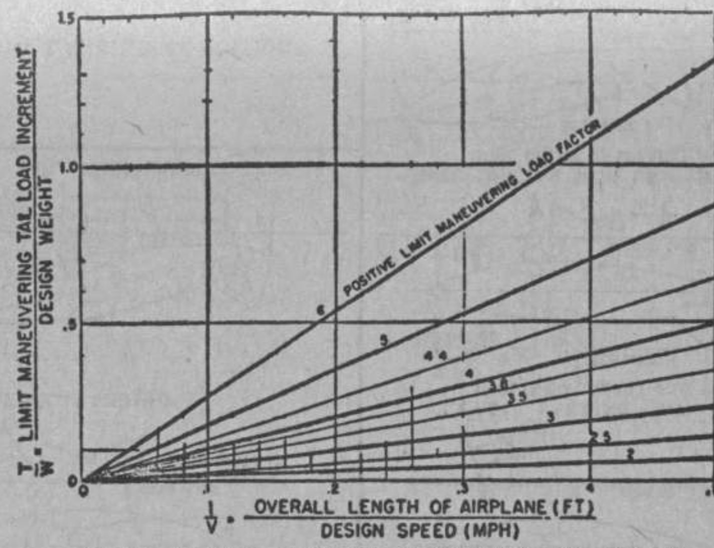


FIGURE 3—DOWN GUST LOADING ON HORIZONTAL TAIL SURFACE

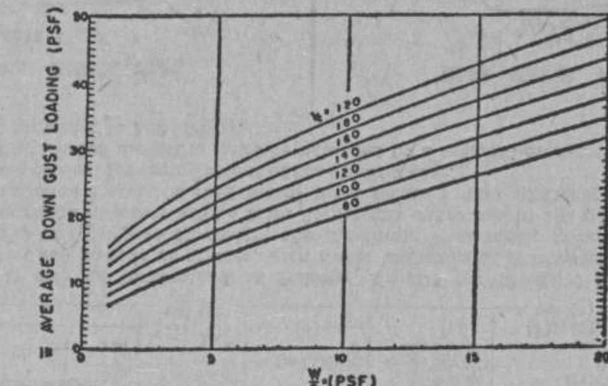


FIGURE 4—UP GUST LOADING ON HORIZONTAL TAIL SURFACE

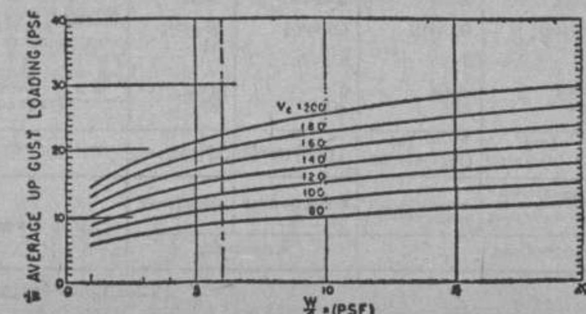


FIGURE 5—GUST LOADING ON VERTICAL TAIL SURFACE

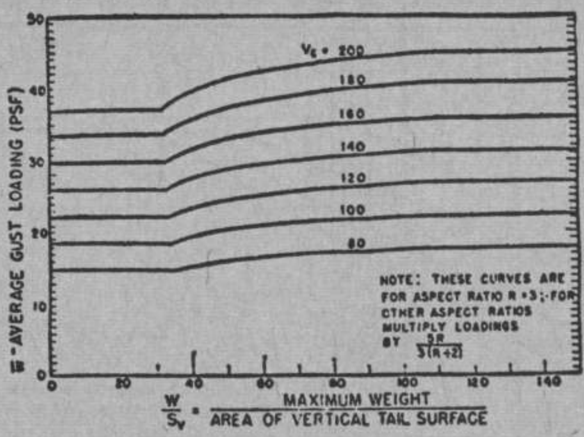
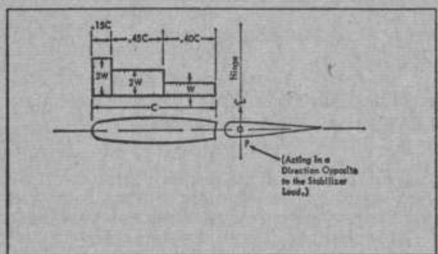


FIGURE 6—TAIL SURFACE LOAD DISTRIBUTION



Notes:

(a) In the balancing conditions in § 23.421—P=40% of net balancing load (flaps retracted); and P=0 (flaps deflected).

(b) In the condition in § 23.441(a)(2), P=20% of net tail load.

FIGURE 7—TAIL SURFACE LOAD DISTRIBUTION

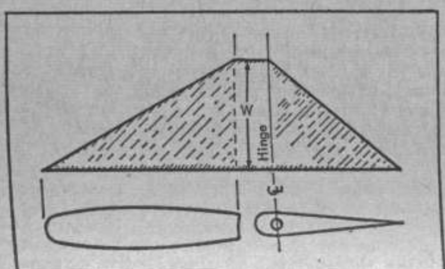


FIGURE 8—TAIL SURFACE LOAD DISTRIBUTION

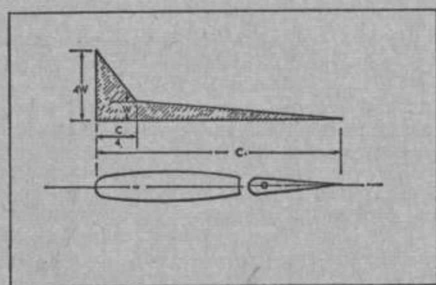
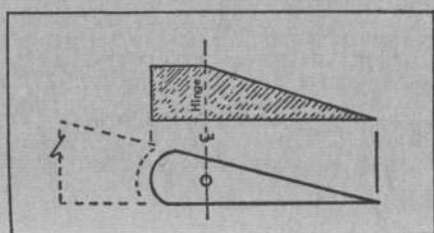


FIGURE 9—AILERON LOAD DISTRIBUTION



APPENDIX C—BASIC LANDING CONDITIONS

C23.1 *Basic landing conditions.*

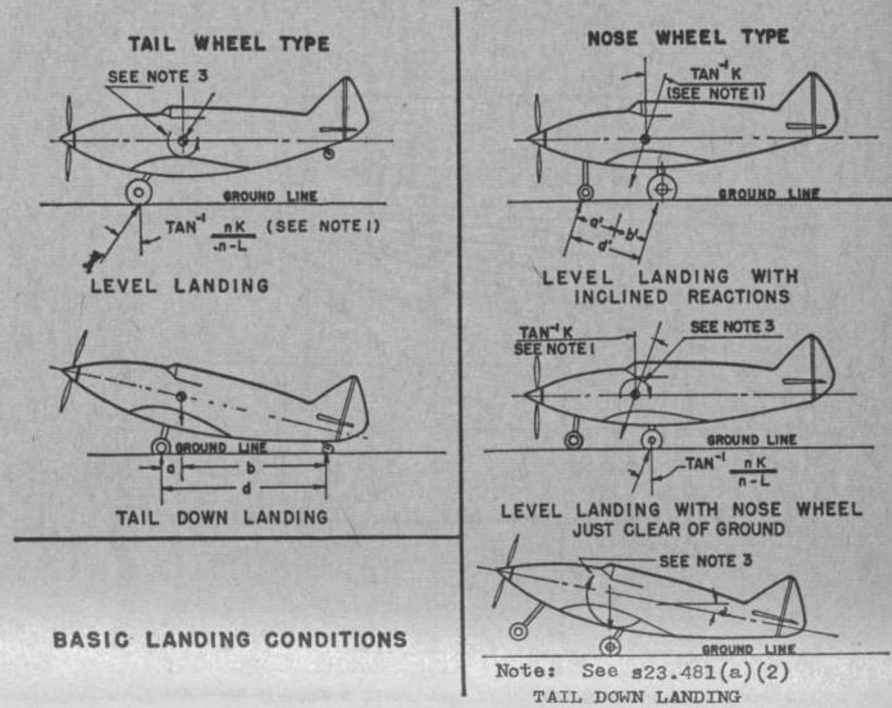
Condition	Tail wheel type		Nose wheel type		
	Level landing	Tail-down landing	Level landing with inclined reactions	Level landing with nose wheel just clear of ground	Tail-down landing
Reference section	23.479(a)(1)	23.481(a)(1)	23.479(a)(2)(i)	23.479(a)(2)(ii)	23.481(a)(2) and (b)
Vertical component at c. g.	nW	nW	nW	nW	nW
Fore and aft component at c. g.	KnW	0	KnW	KnW	0
Lateral component in either direction at c. g.	0	0	0	0	0
Shock absorber extension (hydraulic shock absorber)	Note (2)	Note (2)	Note (2)	Note (2)	Note (2)
Shock absorber deflection (rubber or spring shock absorber)	100%	100%	100%	100%	100%
Tire deflection	Static	Static	Static	Static	Static
Main wheel loads (both wheels) V_r	$(n-L)W$	$(n-L)Wb/d$	$(n-L)Wa'/d'$	$(n-L)W$	$(n-L)W$
Main wheel loads (both wheels) D_r	KnW	0	$KnWa'/d'$	KnW	0
Tail (nose) wheel loads V_f	0	$(n-L)Wa/d$	$(n-L)Wb'/d'$	0	0
Tail (nose) wheel loads D_f	0	0	$KnWb'/d'$	0	0
Notes	(1), (3), and (4)	(4)	(1)	(1), (3), and (4)	(3) and (4)

NOTE (1). K may be determined as follows: K=0.25 for W=3,000 pounds or less; K=0.33 for W=6,000 pounds or greater, with linear variation of K between these weights.

NOTE (2). For the purpose of design, the maximum load factor is assumed to occur throughout the shock absorber stroke from 25 percent deflection to 100 percent deflection unless otherwise shown and the load factor must be used with whatever shock absorber extension is most critical for each element of the landing gear.

NOTE (3). Unbalanced moments must be balanced by a rational or conservative method.

NOTE (4). L is defined in § 23.725(b).



BASIC LANDING CONDITIONS

APPENDIX D—WHEEL SPIN-UP LOADS

D23.1 *Wheel spin-up loads.*

(a) The following method for determining wheel spin-up loads for landing conditions is based on NACA T.N. 863. However, the drag component used for design may not be less than the drag load prescribed in § 23.479(b).

$$F_{H\,max}=\frac{1}{r_e}\sqrt{\frac{2I_w(V_H-V_c)nF_{V\,max}}{t_z}}$$

where—

$F_{H\,max}$=maximum rearward horizontal force acting on the wheel (in pounds);

r_e=effective rolling radius of wheel under impact based on recommended operating tire pressure (which may be assumed to be equal to the rolling radius under a static load of n_jW_e) in feet;

I_w= rotational mass moment of inertia of rolling assembly (in slug feet);

V_H= linear velocity of airplane parallel to ground at instant of contact (assumed to be 1.2 V_{S_0}, in feet per second);

V_c= peripheral speed of tire, if pre-rotation is used (in feet per second) (there must be a positive means of pre-rotation before pre-rotation may be considered);

n=effective coefficient of friction (0.80 may be used);

$F_{V\,max}$=maximum vertical force on wheel (pounds) $=n_jW_e$, where W_e and n_j are defined in § 23.725;

t_z= time interval between ground contact and attainment of maximum vertical force on wheel (seconds). (However, if the value of $F_{V\,max}$, from the above equation exceeds 0.8 $F_{V\,max}$, the latter value must be used for $F_{H\,max}$.)

(b) This equation assumes a linear variation of load factor with time until the peak load is reached and under this assumption, the equation determines the drag force at the time that the wheel peripheral velocity at radius r_e equals the airplane velocity. Most shock absorbers do not exactly follow a linear variation of load factor with time. Therefore, rational or conservative allowances must be made to compensate for these variations. On most landing gears, the time for wheel spin-up will be less than the time required to develop maximum vertical load factor for the specified rate of descent and forward velocity. For exceptionally large wheels, a wheel peripheral velocity equal to the ground speed may not have been attained at the time of maximum vertical gear load. However, as stated above, the drag spin-up load need not exceed 0.8 of the maximum vertical loads.

DISTRIBUTION TABLE

Former section	Revised section
3.0	23.1.
3.1	Executed or transferred to Part 1 [New].
3.10–3.19	Transferred to Part 21 [New].
3.20 (less 2d sentence of (a) (2) and 2d and 3d sentences of (b)).	23.3.
3.20(a)(2) (2d sentence)	Surplusage.
3.20(b) (2d and 3d sentences)	Obsolete.
3.20–1	23.3.
3.20–2 (1st sentence)	23.3.
3.20–2 (less 1st sentence)	Not a rule.
3.61	23.21
3.62–3.65	Transferred to Part 21 [New].
3.71	23.23.
3.71–1	23.21.
3.72	23.31.
3.72–1	Not a rule.
3.73 (1st sentence)	23.29.
3.73 (less 1st sentence)	23.1591.
3.73–1	Transferred to Part 21 [New].
3.72–2	Not a rule.
3.73–3(a)	Not a rule.
3.73–3(b)	23.29.
3.73–3 (less (a) and (b))	23.1589.
3.74	23.25.
3.75	23.25.
3.76	23.1589.
3.76–1	Not a rule.
3.80	Surplusage.
3.81	23.45.
3.82	23.49.
3.82–1	23.49.
3.83	23.49.
3.84 (less (c))	23.51.
3.84(c)	23.1587.
3.84–1	Not a rule.
3.84–2	23.51.
3.84–3	Not a rule.
3.84a	23.51.
3.85(a)	23.65.
3.85(b)	23.67.
3.85 (less (a) and (b))	23.77.
3.85–1	Not a rule.
3.85–2	Obsolete.
3.85–3	23.67.
3.85–4 (last sentence)	23.473.
3.85–4 (less last sentence)	Surplusage.
3.85–5(b) (less (1) and (2))	23.65.
3.85–5(b) (1) and (2)	Not a rule.
3.85–5 (less (b))	Not a rule.
3.85a(a)	23.65.
3.85a(b)	23.67.
3.85a (less (a) and (b))	23.77.
3.86(a)	23.75.

DISTRIBUTION TABLE—Continued

Former section	Revised section
3.86(b)	23.1587.
3.86–1	Not a rule.
3.86–2	Not a rule.
3.87	23.75.
3.105	23.141.
3.106	23.143.
3.107	23.151.
3.108	23.151.
3.109	23.145.
3.110	23.147.
3.111	23.149.
3.112	23.161.
3.113	23.171.
3.114	23.173.
3.115 (less (a)–(c))	23.173.
3.115(a)–(c)	23.175.
3.116	23.179.
3.117	23.181.
3.118	23.177.
3.118–2	Not a rule.
3.120(a)	23.201.
3.120(b)	23.201.
3.120(c)	23.203.
3.120(d)	23.203.
3.120(e) (1st through 26th words).	23.203.
3.120(e) (less 1st through 26th words).	23.1587.
3.120(f)	23.207.
3.120 (less (a)–(f))	23.201.
3.120–1	23.201.
3.120–2	Not a rule.
3.121	23.203.
3.121–1	Not a rule.
3.122 (2d sentence)	23.201.
3.122 (less 2d sentence)	23.203.
3.123(a)	23.205.
3.123(b) (1) and (2)	23.205.
3.123(b) (less (1) and (2))	23.1587.
3.124(a) (less last sentence)	23.221.
3.124(a) (last sentence)	23.1583.
3.124(b)	23.221.
3.124(c) (less (4))	23.221.
3.124(c)(4)	23.1583.
3.124(d)	23.221.
3.143	Surplusage.
3.144	23.231.
3.145	23.233.
3.146	23.235.
3.147	23.239.
3.159	23.251.
3.171	23.301.
3.171–1	23.301.
3.171–2	Not a rule.
3.172	23.303.
3.173	23.305.
3.173–1	Not a rule.
3.174	23.307.
3.174–1 through 8	Surplusage or not rules.
3.181	23.321.
3.182	23.321.

DISTRIBUTION TABLE—Continued

Former section	Revised section
3.183	23.331.
3.184	23.335.
3.185	23.333.
3.186	23.337.
3.187	23.333.
3.188	23.341.
3.188-1	23.341.
3.189	23.331.
3.190 and note	23.345.
3.190-1	23.345.
3.191 (less (a) and (b))	23.347.
3.191(a) and note	23.349.
3.191(b)	23.351.
3.191-1	Not a rule.
3.194 and note	23.369.
3.195	23.361.
3.196	23.363.
3.197	23.365.
3.211	23.391.
Note following 3.211	Appendix B.
3.211-1	Not a rule.
3.212	23.397.
3.212-1	23.397.
3.213	23.407.
3.214	Surplusage.
3.215 and note	23.421.
3.216 and notes	23.423.
3.216-1	Not a rule.
3.216-2	Not a rule.
3.216-3	Not a rule.
3.216-4 (a) and (b)	23.423.
3.216-4 (less (a) and (b))	Not a rule.
3.216-5	Not a rule.
3.216-6	Not a rule.
3.217 and notes	23.425.
3.217-1	Not a rule.
3.218	23.427.
3.219 and notes	23.441.
3.219-1	Not a rule.
3.220	23.443.
3.220-1	Not a rule.
3.221	23.445.
3.222 (a), (b), and (e)	23.455.
3.222 (less (a), (b) and (e))	Not a rule.
3.223	23.457.
3.223-1	Not a rule.
3.224	23.409.
3.224-1	Not a rule.
3.225	23.459.
3.231	23.395.
3.231-1 (1st and 4th sentences).	23.395.
3.231-1 (less 1st and 4th sentences).	Not a rule.
3.231-2	23.395.
3.231-3	Not a rule.
3.232	23.399.
3.233	23.415.
3.233-1	23.415.
3.234	23.405.
3.241	23.471.
3.241-1	Not a rule.
3.241-2	Not a rule.
3.242	23.473.

DISTRIBUTION TABLE—Continued

Former section	Revised section
3.243	23.473.
3.244	23.477.
3.244-1	Not a rule.
3.245	23.479.
3.245-1(a)	Not a rule.
3.245-1(b) (before equation)	23.479.
3.245-1(b) (equation and following).	Appendix D.
3.245-1 (less (a) and (b))	Not a rule.
3.245-2	Not a rule.
3.246	23.481.
3.247	23.483.
3.248	23.493.
3.249	23.485.
3.250	23.497.
3.251	23.497.
3.252	23.497.
3.253	23.499.
3.254	23.499.
3.255	23.499.
3.256	23.499.
3.257	23.505.
3.257-1	Obsolete.
3.257-2	Not a rule.
3.257-3	Not a rule.
3.265	23.521.
3.265-1(a)	23.521.
3.265-1 (less (a))	Not a rule.
3.265-2	23.521.
3.270	23.571.
3.291	23.601.
3.292	23.603.
3.293	23.605.
3.294 (less last sentence)	Not a rule.
3.294 (last sentence)	23.607.
3.295	23.609.
3.296	23.611.
3.301 and note	23.613.
3.301-1	23.615.
3.301-2	23.617.
3.302	23.619.
3.303	23.619.
3.304	23.621.
3.305	23.623.
3.306	23.625.
3.307	23.627.
3.311	23.629.
3.311-1	23.629.
3.311-2(a)	23.629.
3.311-2 (less (a))	Not a rule.
3.317	23.641.
3.318	23.643.
3.318-1	Not a rule.
3.327	23.651.
3.328	23.655.
3.328-1	Not a rule.
3.329	23.657.
3.330	23.659.
3.335	23.671.
3.336	23.673.
3.336-1	Not a rule.
3.337	23.677.
3.337-1	Not a rule.
3.337-2	Not a rule.

DISTRIBUTION TABLE—Continued

Former section	Revised section
3.337-3	Not a rule.
3.338 (less 2d and 3d sentences).	23.697.
3.338 (2d and 3d sentences)	23.699.
3.338-1	23.699.
3.339	23.701.
3.340	23.675.
3.341	23.679.
3.342	23.681.
3.343	23.683.
3.344	23.685.
3.345	23.689.
3.345-1	23.689.
3.345-2	Not a rule.
3.345-3	Not a rule.
3.346	23.693.
3.347	23.687.
3.351	23.721.
3.352	23.723.
3.352-1	Not a rule.
3.353	23.725.
3.354	23.725.
3.355	23.727.
3.356	23.729.
3.356-1(b) (last sentence)	23.729.
3.356-1 (less (b) (last sentence)).	Not a rule.
3.357	23.729.
3.358	23.729.
3.359 and last sentence of note.	23.729.
3.360	Surplusage.
3.361	23.731.
3.362	23.733.
3.362-1	23.733.
3.362-2	Not a rule.
3.363	23.735.
3.364	23.737.
3.364-1	Not a rule.
3.371 (introductory paragraph (1st sentence)).	23.753.
3.371 (less introductory paragraph (1st sentence)).	23.751.
3.372	23.755.
3.373	23.757.
3.381	23.771.
3.382	23.773.
3.382-1	Not a rule.
3.382-2	Not a rule.
3.383 (including note following (b)).	23.775.
3.383-1	Not a rule.
3.384(a) (less parenthetical note).	23.777.
3.384(a) (parenthetical note)	23.779.
3.384(c) (1) and (2)	23.777.
3.384(c) (less (1) and (2))	23.781.
3.384 (less (a) and (c))	23.777.
3.385	Surplusage.
3.386	23.561.
3.386-1	Not a rule.
3.387	23.807.
3.388(a)	23.853.

DISTRIBUTION TABLE—Continued

Former section	Revised section
3.388 (less (a))	23.859.
3.388-1	Not a rule.
3.388-2	Not a rule.
3.388-3	Not a rule.
3.388-4	Not a rule.
3.389	23.783.
3.390	23.785.
3.390-1	Surplusage.
3.390-2	23.785.
3.390-3	Not a rule.
3.392	23.787.
3.392-1	Not a rule.
3.393	23.831.
3.394	Surplusage.
3.395	23.841.
3.396	23.843.
3.401	23.871.
3.411	23.901.
3.411-1	Not a rule.
3.415	23.903.
3.416	23.905.
3.417	23.907.
3.418	23.33.
3.419	23.33.
3.419-1(a) (2d sentence)	23.65.
3.419-1 (less 2d sentence of (a)).	Not a rule.
3.420	23.33.
3.421	23.33.
3.422	23.925.
3.422-1	Not a rule.
3.422-2	23.925.
3.429	23.951.
3.430	23.951.
3.431	23.953.
3.431-1	Not a rule.
3.433	23.955.
3.434	23.955.
3.435	23.955.
3.436	23.955.
3.437(a) (less last sentence)	23.959.
3.437(a) (last sentence)	23.1587.
3.437 (less (a))	23.959.
3.438	23.961.
3.439	23.957.
3.440 (less last two sentences)	23.963.
3.440 (next to last sentence)	23.1587.
3.440 (last sentence)	Surplusage.
3.441	23.965.
3.442	23.967.
3.442-1	23.967.
3.443	23.969.
3.444	23.971.
3.445	23.973.
3.446	23.975.
3.447A	23.975.
3.448	23.977.
3.449	23.991.
3.449-1	23.991.
3.550	23.993.
3.551	23.995.
3.552	23.997.
3.553	23.999.
3.554	Surplusage.

DISTRIBUTION TABLE—Continued

Former section	Revised section
3.561	23.1011.
3.561–1(b)	23.1011.
3.561–1 (less (b))	Not a rule.
3.562	Surplusage.
3.563	23.1013.
3.564	23.1015.
3.565	23.1013.
3.566	23.1013.
3.567	23.1013.
3.568	23.1013.
3.569	23.1013.
3.570	23.1017.
3.571	Surplusage.
3.572	23.1023.
3.573	23.1019.
3.574	23.1021.
3.575	23.1017
3.576	Surplusage.
3.577	23.1027.
3.581	23.1041.
3.582	23.1043.
3.582–1	23.1043.
3.583	23.1043.
3.583–1 (1st sentence)	23.1043.
3.583–1 (less 1st sentence)	Surplusage.
3.584	23.1043.
3.585	23.1043.
3.586	23.1045.
3.587	23.1047.
3.587–1	Not a rule.
3.588	23.1061.
3.589	23.1061.
3.590	23.1063.
3.591	23.1061.
3.592	23.1061.
3.593	23.1061.
3.594	23.1061.
3.595	23.1061.
3.596	Surplusage.
3.605	23.1091.
3.606	23.1093.
3.606–1	Not a rule.
3.607	23.1095.
3.608	23.1097.
3.609	23.1099.
3.610	23.1101.
3.611	23.1103.
3.612	23.1105.
3.615	23.1121.
3.616	23.1123.
3.617	23.1125.
3.618	23.1125.
3.623	23.1191.
3.623–1	23.1191.
3.624	23.1191.
3.625	23.1193.
3.627	23.1141.
3.628	23.1143.
3.629	23.1145.
3.630	23.1147.
3.631	23.1149.
3.632	23.1153.
3.633	23.995.

DISTRIBUTION TABLE—Continued

Former section	Revised section
3.634	23.1157.
3.635	23.1163.
3.636	23.1165.
3.637	23.1189.
3.638	23.1183.
3.651 (less 1st sentence)	23.1301.
3.651 (1st sentence)	Surplusage.
3.652	23.1301.
3.652–1	23.1301.
3.652–2	Not a rule.
3.655(a)	23.1303.
3.655(b)	23.1305.
3.655(d)(1)	23.1307.
3.655(d) (less (1))	Surplusage.
3.655 (less (a), (b), and (d))	23.1307.
3.661	23.1321.
3.662	23.1321.
3.663	23.1323.
3.664	Surplusage.
3.665	23.1325.
3.666	23.1327.
3.667	23.1329.
3.668	23.1331.
3.669	23.1335.
3.670	Surplusage.
3.671	23.1337.
3.672	23.1337.
3.672–1	23.1337.
3.673	23.1337.
3.674	23.1337.
3.675	23.1337.
3.681	23.1351.
3.682	23.1351.
3.683	23.1353.
3.685	23.1351.
3.686	23.1351.
3.687	23.1351.
3.688	23.1361.
3.689	23.1361.
3.690	23.1357.
3.691	23.1357.
3.692	23.1357.
3.693	23.1365.
3.694	23.1367.
3.695	23.1367.
3.696	23.1381.
3.696–1	23.1381.
3.697	23.1381.
3.698	23.1383.
3.699	23.1383.
3.700	23.1385.
3.700–1	Not a rule.
3.701	23.1387.
3.702	23.1389.
3.702–1	23.1389.
3.702–2	23.1389.
3.703	23.1397.
3.704	23.1399.
3.705	23.1401.
3.705–1 (1st sentence)	23.1401.
3.705–1 (less 1st sentence)	Not a rule.
3.711 (1st through 27th words).	23.1411.

DISTRIBUTION TABLE—Continued

Former section	Revised section
3.711 (less 1st through 27th words).	23.1561.
3.712	23.1419.
3.713	Obsolete.
3.714	Obsolete.
3.715	23.1413.
3.716	23.1415.
3.716–1	Surplusage.
3.717	23.1415.
3.718	23.1415.
3.721	23.1431.
3.721–1	Not a rule.
3.721–2	Not a rule.
3.725	23.1437.
3.726	23.1435.
3.727	23.1435.
3.728	23.1435.
3.735	23.1501.
3.737	23.1501.
3.738	23.1505.
3.739	23.1505.
3.740	23.1505.
3.741	23.1507.
3.742	23.1511.
3.743	23.1513.
3.744	23.1521.
3.748	23.1519.
3.749	23.1523.
3.750	23.1525.
3.755	23.1541.
3.755–1	Not a rule.
3.755–2	Not a rule.
3.756	23.1543.
3.757	23.1545.
3.757–1	Not a rule.
3.758	23.1547.
3.759	23.1549.
3.759–1	Not a rule.
3.760	23.1551.
3.761 (less 49th through 85th words).	23.1553.
3.761 (49th through 85th words).	23.1583.
3.762	23.1555.
3.762–1	23.1555.
3.763	23.1555.
3.764	23.1555.
3.765	23.1555.
3.766	23.1557.
3.767	23.1557.
3.768	23.1557.
3.769	23.1567.
3.770	23.1559.
3.771	23.1563.
3.772	23.1559.
3.777	23.1581.
3.777–1	Not a rule.
3.777–2	Not a rule.
3.777–3	Not a rule.
3.777–4	Not a rule.
3.778	23.1583.
3.779	23.1585.
3.780	23.1587.
3.780–2	Not a rule.

DISTRIBUTION TABLE—Continued

Former section	Revised section
3.780–3(a) (1st sentence)	23.51 and 23.75.
3.780–3(a) (less 1st sentence)	Not a rule.
3.780–3(b) (1st sentence)	23.1587.
3.780–3 (less (a) and (b) 1st sentence).	Not a rule.
3.791	Transferred to Part 45 [New]
3.792	Transferred to Part 45 [New]
Figure 3–1	23.333.
Figure 3–3(a)	Appendix B.
Figure 3–3(b)	Appendix B.
Figure 3–4	Appendix B.
Figure 3–5(a)	Appendix B.
Figure 3–5(b)	Appendix B.
Figure 3–6	Appendix B.
Figure 3–7	Appendix B.
Figure 3–8	Appendix B.
Figure 3–9	Appendix B.
Figure 3–10	Appendix B.
Figure 3–11	23.397.
Figure 3–12(a)	Appendix C.
Figure 3–12(b)	Appendix C.
Figure 3–13	23.781.
Figure 3–14	23.779.
Figure 3–15	23.1391.
Figure 3–16	23.1393.
Figure 3–17	23.1395.
Figure 3–18	23.1401.
Appendix A former section	*Revised section*
1.0	23.217.
1.1 (less last sentence)	A23.1.
1.1 (last sentence)	Not a rule.
1.2 (1st and 2d sentences)	23.217.
1.2 (less 1st and 2d sentences)	Not a rule.
2.1	Not a rule.
2.2	Not a rule.
2.30	Not a rule.
2.31	Not a rule.
2.32	Not a rule.
2.33	Not a rule.
2.4	Not a rule.
3.1 (introductory paragraph)	A23.1.
3.1 (less introductory paragraph).	A23.3.
4.0	A23.5.
5.1 (1st sentence)	A23.7.
5.1 (2d sentence)	A23.7.
5.10	A23.7.
5.11	A23.7.
5.12	A23.7.
5.2 (less 3d sentence)	A23.7.
5.2 (3d sentence)	Surplusage.
5.3	A23.7.
5.4	A23.7.
6.1	A23.9.
6.20	A23.9.
6.201	A23.9.
6.202	A23.9.
6.203	A23.9.

DISTRIBUTION TABLE—Continued

Former section	Revised section
6.21	A23.9.
6.3	A23.9.
6.30	A23.9.
6.31	A23.9.
6.32 (1st and 2d sentences)	A23.9.
6.32 (3d sentence to end)	A23.9.
6.4	A23.9.
6.40	A23.9.
6.41	A23.9.
6.42	A23.9.
7.1	A23.11.
7.2	A23.11.
7.30	A23.11.
7.31	A23.11.
7.4	A23.11.
7.5	A23.11.
8.10	A23.13.
8.101	A23.13.
8.102	A23.13.
8.11	A23.13.
8.2	A23.13.
8.3	A23.13.
8.4	A23.13.
Figure 4	Follow A23.13.

DISTRIBUTION TABLE—Continued

Former section	Revised section
Figure 5	Follow A23.13.
Table 1	Follow A23.13.
Table 2	Follow A23.13.
Figure 6	Follow A23.13.
Figure 7	Follow A23.13.
Figure 8	Follow A23.13.
Figure 9	Follow A23.13.
Appendix B	Nonregulatory.
Appendix C	Nonregulatory.
Appendix D:	
SR 392D	Obsolete.
SR 425C	Transferred to Parts 21 [New], and 121 [New].

[F.R. Doc. 64-12987; Filed, Dec. 17, 1964; 8:45 a.m.]

[Docket No. 6387; Amdt. 151-6]

PART 151—FEDERAL AID TO AIRPORTS [NEW]

Davis-Bacon Act Fringe Benefit Requirements

The purpose of this amendment to Part 151 [New] of the Federal Aviation Regulations is to incorporate the "Fringe Benefit Requirements" of the Davis-Bacon Act to the extent required by the regulations of the Secretary of Labor (29 CFR Part 5) as amended effective September 30, 1964 (29 F.R. 13462), issued under the Contract Work Hours Standards Act (49 U.S.C. 327-330), and under the Davis-Bacon Act (40 U.S.C. 276a—276a-5). Also, editorial changes in the form of the affected provisions are made that do not involve any substantive change.

Section 15(b) of the Federal Airport Act (49 U.S.C. 1114(b)) requires that "all contracts in excess of $2,000 * * * which involve labor" must contain provisions establishing the minimum wage rates contractors and subcontractors must pay to laborers, and that these minimum wage rates are to be predetermined by the Secretary of Labor. Public Law 88-349 added a provision to section 15(b) stating that the wage determinations of the Secretary of Labor are to be "in accordance with the Davis-Bacon Act, as amended". On September 30, 1964, the Secretary of Labor issued amendments to his regulations, to implement the amendments to the Davis-Bacon Act requiring that locally prevailing fringe benefits be included in future wage determinations, and revising the contract provisions (required by the Contract Work Hours Standards Act) to reflect the new fringe benefit requirements.

Paragraph (c) of § 151.47, "Procedure for the Secretary of Labor's wage determinations", is amended to require sponsors to furnish available pertinent information as to locally prevailing fringe benefits, as well as wage payment information, with Form DB-11. The reference to Form DB-11(a) is deleted as inapplicable. Paragraph (d) of § 151.47, "Use and effectiveness of the Secretary of Labor's wage determination", is amended to allow the Administrator, upon a finding that there is a reasonable time to notify bidders, to give effect to the modified wage determinations of the Secretary of Labor received less than 10 days before bid opening. A new paragraph (f) is added to § 151.47 to make the interpretations of the Secretary of Labor of the fringe benefit provisions of the Davis-Bacon Act (29 CFR 5.20-5.32) applicable to § 151.47.

At present, all provisions that sponsors must insert in full in construction contracts are contained in § 151.49(a). To clearly distinguish between the contract provisions the FAA requires and those the regulations of the Secretary of Labor require, the form of § 151.49(a) is substantially revised, and a new Appendix H is added. The FAA-required contract provisions remain in § 151.49(a), and the contract provisions required by the Secretary of Labor are transferred to new Appendix H.

Revised § 151.49(a) contains subparagraphs (1) through (7), representing all of old subparagraphs (1) through (4), (7) and (14) respectively, and new subparagraphs (8) and (9), representing pertinent parts of old subparagraphs (15) and (16). Since subparagraph (17) of § 151.49(a) was superseded by Amdt. 151-5 to Part 151 [New], effective December 21, 1964, it is deleted as inapplicable to construction contracts made under grant agreements entered into after that date. Also, the statement of applicability of old subparagraph (17) is deleted from amended § 151.49(b). Of course, the deleted provision remains effective as to construction contracts made under grant agreements entered into before December 21, 1964, as each grant agreement provides. The Director of Airports Service is delegated authority in revised § 151.49(a) to amend Appendix H to the extent required from time to time by the rule-making action of the Secretary of Labor. Also, two new paragraphs are added to § 151.49. New paragraph (d), "Corrected wage determinations", reflects the rule of the Secretary of Labor that any wage determinations may be corrected by the Secretary of Labor to rectify clerical errors at the Administrator's request or on his own motion. New paragraph (e) makes the Secretary of Labor's interpretations of the fringe benefit provisions of the Davis-Bacon Act applicable to all provisions of § 151.49.

New Appendix H contains the contract provisions required by the Secretary of Labor. For convenience, the provisions are presented in the form of one article to be inserted in the contracts. Paragraphs are numbered A through H, representing old subparagraphs (5), (6) and (8) through (13), and paragraphs I and J, representing pertinent parts of old subparagraphs (15) and (16) of §151.49(a). Several of these provisions are directly affected by the amendments to § 5.5 of the Department of Labor regulations (29 CFR 5.5). Paragraph A, "Minimum wages", is amended to add new subparagraphs (3) and (4). Subparagraph (3) provides for the establishment of cash equivalents for required fringe benefits. Subparagraph (4) requires the approval of the Secretary of Labor before the contractor may consider the cost of specified fringe benefits as part of the wages of laborers and mechanics. Paragraph C, "Payrolls and payroll records", is substantially revised. Amended subparagraph (1) requires the contractor to keep additional records concerning required fringe benefits. Amended subparagraph (2) requires the contractor to submit with its "Weekly Statement of Compliance" additional information when approval under § 151.49(a)(5)(iv) is required, and makes the contractor responsible for the submission of subcontractors' payroll records. Paragraph D, "Apprentices", is amended to require the contractor to submit to the sponsor proof of registration of its apprentice program and its apprentices before any apprentices are used.

Since the amendments to §§ 151.47 and 151.49 are so extensive, these sections are published in full as amended. Also, several minor editorial changes are included, and catchlines are added where appropriate. The practice of citing underlying sections of the regulations of the Secretary of Labor is retained in Appendix H only, and these citations are deleted throughout revised §§ 151.47 and 151.49. Section 151.54(b) is also amended to delete a similar citation.

The procedural and effective date requirements of section 4 of the Administrative Procedure Act (5 U.S.C. 1003) do not apply to this amendment because it is within the exception in that section relating to public loans, grants, benefits and contracts.

In consideration of the foregoing, effective January 18, 1965, Part 151 [New] of Chapter I of Title 14 of the Code of Federal Regulations, is amended as hereinafter set forth.

This amendment is made under the authority of the Federal Airport Act, as amended (49 U.S.C. 1101–1120) and Part 5 of Title 29 of the Code of Federal Regulations, as amended.

Issued in Washington, D.C., on December 11, 1964.

N. E. HALABY,
Administrator.

1. Section 151.47 is amended to read as follows:

§ 151.47 Performance of construction work: letting of contracts.

(a) *Advertising required; exceptions.* Unless the Administrator approves another method for use on a particular airport development project, each contract for construction work on a project in the amount of more than $2,000 must be awarded on the basis of public advertising and open competitive bidding under the local law applicable to the letting of public contracts. Any oral or written agreement or understanding between a sponsor and another public agency that is not a sponsor of the project, under which that public agency undertakes construction work for or as agent of the sponsor, is not considered to be a construction contract for the purposes of this section, or §§ 151.45, 151.49, and 151.51.

(b) *Advertisement; conditions and contents.* There may be no advertisement for bids on, or negotiation of, a construction contract until the Administrator has approved the plans and specifications. The advertisement shall inform the bidders of the contract and reporting provisions required by § 151.54. Unless the estimated contract price or construction cost is $2,000 or less, there may be no advertisement for bids or negotiation until the Administrator has given the sponsor a copy of a decision of the Secretary of Labor establishing the minimum wage rates for skilled and unskilled labor under the proposed contract. In each case, a copy of the wage determination decision must be set forth in the initial invitation for bids or proposed contract or incorporated therein by reference to a copy set forth in the advertised or negotiated specifications.

(c) *Procedure for the Secretary of Labor's wage determinations.* At least 60 days before the intended date of advertising or negotiating under paragraph (b) of this section, the sponsor shall send to the District Airport Engineer, completed Department of Labor Form DB–11, with only the classifications needed in the performance of the work checked. General entries (such as "entire schedule" or "all applicable classifications") may not be used. Additional necessary classifications not on the form may be typed in the blank spaces or on an attached separate list. A classification that can be fitted into classifications on the form, or a classification that is not generally recognized in the area or in the industry, may not be used. Except in areas where the wage patterns are clearly established, the Form must be accompanied by any available pertinent wage payment or locally prevailing fringe benefit information.

(d) *Use and effectiveness of the Secretary of Labor's wage determinations.* (1) Wage determinations are effective only for 120 days from the date of the determinations. If it appears that a determination may expire between bid opening and award, the sponsor shall so advise the FAA as soon as possible. If he wishes a new request for wage determination to be made and if any pertinent circumstances have changed, he shall submit a new Form DB–11 and accompanying information. If he claims that the determination expires before award and after bid opening due to unavoidable circumstances, he shall submit proof of the facts which he claims support a finding to that effect.

(2) The Secretary of Labor may modify any wage determination before the award of the contract or contracts for which it was sought. If the proposed contract is awarded on the basis of public advertisement and open competitive bidding, any modification that the FAA receives less than 10 days before the opening of bids is not effective, unless the Administrator finds that there is reasonable time to notify bidders. A modification may not continue in effect beyond the effective period of the wage determination to which it relates. The Administrator sends any modification to the sponsor as soon as possible. If the modification is effective, it must be incorporated in the invitation for bids, by issuing and addendum to the specifications or otherwise.

(e) *Requirements for awarding construction contracts.* A sponsor may not award a construction contract without the written concurrence of the Administrator (through the District Airport Engineer) that the contract prices are reasonable and that the contract conforms to the sponsor's grant agreement with the United States. A sponsor that awards contracts on the basis of public advertising and open competitive bidding, shall, after the bids are opened, send a tabulation of the bids and its recommendations for award to the District Airport Engineer. The allowable project costs of the work, on which the Federal participation is computed, may not be more than the bid of the lowest responsible bidder. The sponsor may not accept a bid by a contractor whose name appears on the current list of ineligible contractors published by the Comptroller General of the United States under § 5.6(b) of Title 29 of the regulations of the Secretary of Labor (29 CFR Part 5), or a bid by any firm, corporation, partnership, or association in which that contractor has a substantial interest.

(f) *Secretary of Labor's interpretations apply.* Where applicable by their terms, the regulations of the Secretary of Labor (29 CFR 5.20–5.32) interpreting the fringe benefit provisions of the Davis-Bacon Act apply to this section.

2. Section 151.49 is amended to read as follows:

§ 151.49 Performance of construction work: contract requirements.

(a) *Contract provisions.* In addition to any other provisions necessary to ensure completion of the work in accordance with the grant agreement, each sponsor entering into a construction contract for an airport development project shall insert in the contract the provisions required by the Secretary of Labor, as set forth in Appendix H of this Part. The Director, Airports Service, may amend any provision in Appendix H from time to time to accord with rule-making action of the Secretary of Labor. The provisions in the following subparagraphs also must be inserted in the contract:

(1) *Federal Aid to Airport Program Project.* The work in this contract is included in Federal-aid Airport Project No. ______ which is being undertaken and accomplished by the [insert sponsor's name] in accordance with the terms and conditions of a grant

agreement between the [insert sponsor's name] and the United States, under the Federal Airport Act (49 U.S.C. 1101) and Part 151 of the Federal Aviation Regulations (14 CFR Part 151), pursuant to which the United States has agreed to pay a certain percentage of the costs of the project that are determined to be allowable project costs under that Act. The United States is not a party to this contract and no reference in this contract to the FAA or any representative thereof, or to any rights granted to the FAA or any representative thereof, or the United States, by the contract, makes the United States a party to this contract.

(2) *Consent to assignment.* The contractor shall obtain the prior written consent of the [insert sponsor's name] to any proposed assignment of any interest in or part of this contract.

(3) *Convict labor.* No convict labor may be employed under this contract.

(4) *Veterans' preference.* In the employment of labor (except in executive, administrative, and supervisory positions), preference shall be given to qualified individuals who have served in the military service of the United States (as defined in section 101(1) of the Soldiers' and Sailors' Civil Relief Act of 1940) and have been honorably discharged from that service, except that preference may be given only where that labor is available locally and is qualified to perform the work to which the employment relates.

(5) *Withholding: Sponsor from contractor.* Whether or not payments or advances to the [insert sponsor's name] are withheld or suspended by the FAA, the [insert sponsor's name] may withhold or cause to be withheld from the contractor so much of the accrued payments or advances as may be considered necessary to pay laborers and mechanics employed by the contractor or any subcontractor on the work the full amount of wages required by this contract.

(6) *Nonpayment of wages.* If the contractor or subcontractor fails to pay any laborer or mechanic employed or working on the site of the work any of the wages required by this contract the [insert sponsor's name] may, after written notice to the contractor, take such action as may be necessary to cause the suspension of any further payment or advance of funds until the violations cease.

(7) *FAA inspection and review.* The contractor shall allow any authorized representative of the FAA to inspect and review any work or materials used in the performance of this contract.

(8) *Subcontracts.* The contractor shall insert in each of his subcontracts the provisions contained in paragraphs [insert designations of 6 paragraphs of contract corresponding to subparagraphs (1), (3), (4), (5), (6) and (7) of this paragraph], and also a clause requiring the subcontractors to include these provisions in any lower tier subcontracts which they may enter into, together with a clause requiring this insertion in any further subcontracts that may in turn be made.

(9) *Contract termination.* A breach of paragraphs [insert designation of 3 paragraphs corresponding to subparagraphs (5), (6) and (7) of this paragraph] may be grounds for termination of the contract.

(b) *Exemption of certain contracts.* Appendix H to this Part and paragraph (a)(5) of this section do not apply to prime contracts of $2,000 or less.

(c) *Adjustment in liquidated damages.* A contractor or subcontractor who has become liable for liquidated damages under paragraph G of Appendix H and who claims that the amount administratively determined as liquidated damages under section 104(a) of the Contract Work Hours Standards Act is incorrect or that he violated inadvertently the Contract Work Hours Standards Act notwithstanding the exercise of due care, may—

(1) If the amount determined is more than $100, apply to the Administrator for a recommendation to the Secretary of Labor that an appropriate adjustment be made or that he be relieved of liability for such liquidated damages; or

(2) If the amount determined is $100 or less, apply to the Administrator for an appropriate adjustment in liquidated damages or for release from liability for the liquidated damages.

(d) *Corrected wage determinations.* The Secretary of Labor corrects any wage determination included in any contract under this section whenever the wage determination contains clerical errors. A correction may be made at the Administrator's request or on the initiative of the Secretary of Labor.

(e) *Secretary of Labor's interpretations apply.* Where applicable by their terms, the regulations of the Secretary of Labor (29 CFR 5.20–5.32) interpreting the "fringe benefit provisions" of the Davis-Bacon Act apply to the contract provisions in Appendix H, and to this section.

§ 151.54 [Amended]

3. Section 151.54(b) is amended by striking out the citation "(29 CFR 5.6 (a)(1))" at the end thereof.

4. Appendix H is added to Part 151 [New] to read as follows:

APPENDIX H

There is set forth below the contract provision required by the regulations of the Secretary of Labor in Part 5 of Title 29 of the Code of Federal Regulations. Section 151.49(a) requires sponsors to insert this provision in full in each construction contract.

PROVISION REQUIRED BY THE REGULATIONS OF THE SECRETARY OF LABOR

A. Minimum wages. (1) All mechanics and laborers employed or working upon the site of the work will be paid unconditionally and not less often than once a week, and without subsequent deduction or rebate on any account (except such payroll deductions as are permitted by regulations issued by the Secretary of Labor under the Copeland Act [29 CFR Part 3]), the full amounts due at time of payment computed at wage rates not less than those contained in the wage determination decision(s) of the Secretary of Labor which is (are) attached hereto and made a part hereof, regardless of any contractual relationship which may be alleged to exist between the contractor and such laborers and mechanics; and the wage determination decision(s) shall be posted by the contractor at the site of the work in a prominent place where it (they) can be easily seen by the workers. For the purpose of this paragraph, contributions made or costs reasonably anticipated under section 1(b)(2) of the Davis-Bacon Act on behalf of laborers or mechanics are considered wages paid to such laborers or mechanics, subject to the provisions of subparagraph (4) below. Also for the purpose of this paragraph, regular contributions made or costs incurred for more than a weekly period under plans, funds, or programs, but covering the particular weekly period, are deemed to be constructively made or incurred during such weekly period (29 CFR 5.5(a)(1)(i)).

(2) Any class of laborers or mechanics which is not listed in the wage determination(s) and which is to be employed under the contract, shall be classified or reclassified conformably to the wage determination(s), and a report of the action taken shall be sent by the [insert sponsor's name] to the FAA for approval and transmittal to the Secretary of Labor. In the event that the interested parties cannot agree on the proper classification or reclassification of a particular class of laborers and mechanics to be used, the question accompanied by the recommendation of the FAA shall be referred to the Secretary of Labor for final determination (29 CFR 5.5(a)(1)(ii)).

(3) Whenever the minimum wage rate prescribed in the contract for a class of laborers or mechanics includes a fringe benefit which is not expressed as an hourly wage rate and the contractor is obligated to pay a cash equivalent of such a fringe benefit, an hourly cash equivalent thereof shall be established. In the event the interested parties cannot agree upon a cash equivalent of the fringe benefit, the question, accompanied by the recommendation of the FAA shall be referred to the Secretary of Labor for determination (29 CFR 5.5(a)(1)(iii)).

(4) The contractor may consider as part of the wages of any laborer or mechanic the amount of any costs reasonably anticipated in providing benefits under a plan or program described in section 1(b)(2)(B) of the Davis-Bacon Act, or any bona fide fringe benefits not expressly listed in section 1(b)(2) of the Davis-Bacon Act or otherwise not listed in the wage determination decision(s) of the Secretary of Labor which is included in this contract, only when the Secretary of Labor has found, upon the written request of the contractor, that the applicable standards of the Davis-Bacon Act have been met. Whenever practicable, the contractor should request the Secretary of Labor to make such findings before the making of the contract. In the case of unfunded plans and programs, the Secretary of Labor may require the contractor to set aside in a separate account assets for the meeting of obligations under the plan or program (29 CFR 5.5(a)(1)(iv)).

B. Withholding: FAA from sponsor. Pursuant to the terms of the grant agreement between the United States and [insert sponsor's name], relating to Federal-aid Airport Project No. ______, and Part 151 of the Federal Aviation Regulations (14 CFR Part 151), the FAA may withhold or cause to be withheld from the [insert sponsor's name] so much of the accrued payments or advances as may be considered necessary to pay laborers and mechanics employed by the contractor or any subcontractor on the work the full amount of wages required by this contract. In the event of failure to pay any laborer or mechanic employed or working on the site of the work all or part of the wages required by this contract, the FAA may, after written notice to the [insert sponsor's name], take such action as may be necessary to cause the suspension of any further payment or advance of funds until such violations have ceased (29 CFR 5.5(a)(2)).

C. Payrolls and basic records. (1) Payrolls and basic records relating thereto will be maintained during the course of the work and preserved for a period of three years thereafter for all laborers and mechanics working at the site of the work. Such records will contain the name and address of each such employee, his correct classification, rates of pay (including rates of contributions or costs anticipated of the types described in section 1(b)(2) of the Davis-Bacon Act), daily and weekly number of hours worked, deductions made and actual wages paid. Whenever the Secretary of Labor has found, under 29 CFR 5.5(a)(1)(iv) (see subparagraph (4) of paragraph (A) above), that the wages of any laborer or mechanic include the amount of any costs reasonably anticipated in providing benefits under a plan or program described in section 1(b)(2)(B) of the Davis-Bacon Act, the contractor shall maintain records which show that the commitment to provide such benefits is enforceable, that the plan or program is financially responsible, and that the plan or program has been communicated in writing to the laborers or mechanics affected, and records which show the costs anticipated or the actual cost incurred in providing such benefits (29 CFR 5.5(a)(3)(i)).

(2) The contractor will submit weekly a copy of all payrolls to the [insert sponsor's name] for transmission to the FAA, as required by § 151.53(a). The copy shall be accompanied by a statement signed by the employer or his agent indicating that the payrolls are correct and complete, that the wage rates contained therein are not less than those determined by the Secretary of Labor and that the classifications set forth for each laborer or mechanic conform with the work he performed. A submission of a "Weekly Statement of Compliance" which is required under this contract and the Copeland regulations of the Secretary of Labor (29 CFR Part 3) and the filing with the initial payroll or any subsequent payroll of a copy of any findings by the Secretary of Labor, under 29 CFR 5.5(a)(1)(iv) (see subparagraph (4) of paragraph (A) above), shall satisfy this requirement. The prime contractor shall be responsible for the submission of copies of payrolls of all subcontractors. The contractor will make the records required under the labor standards clauses of the contract available for inspection by authorized representatives of the FAA and the Department of Labor, and will permit such representatives to interview employees during working hours on the job (29 CFR 5.5(a)(3)(ii)).

D. Apprentices. Apprentices will be permitted to work as such only when they are registered, individually, under a bona fide apprenticeship program registered with a State apprenticeship agency which is recognized by the Bureau of Apprenticeship and Training, United States Department of Labor; or, if no such recognized agency exists in a State, under a program registered with the Bureau of Apprenticeship and Training, United States Department of Labor. The allowable ratio of apprentices to journeymen in any craft classification shall not be greater than the ratio permitted to the contractor as to his entire work force under the registered program. Any employee listed on a payroll at an apprentice wage rate, who is not registered as above, shall be paid the wage rate determined by the Secretary of Labor for the classification of work he actually performed. The contractor or subcontractor will be required to furnish to the [insert sponsor's name] written evidence of the registration of his program and apprentices as well as of the appropriate ratios and wage rates, for the area of construction prior to using any apprentices on the contract work (29 CFR 5.5(a)(4)).

E. Compliance with Copeland Regulations. The contractor shall comply with the Copeland Regulations (29 CFR Part 3) of the Secretary of Labor which are herein incorporated by reference (29 CFR 5.5(a)(5)).

F. Overtime requirements. No contractor or subcontractor contracting for any part of the contract work which may require or involve the employment of laborers or mechanics shall require or permit any laborer or mechanic in any workweek in which he is employed on such work to work in excess of eight hours in any calendar day or in excess of forty hours in such workweek unless such laborer or mechanic received compensation at a rate not less than one and one-half times his basic rate of pay for all hours worked in excess of eight hours in any calendar day or in excess of forty hours in such workweek, as the case may be (29 CFR 5.5(c)(1)).

G. Violations; liability for unpaid wages; liquidated damages. In the event of any violation of paragraph F of this provision, the contractor and any subcontractor responsible therefore shall be liable to any affected employee for his unpaid wages. In addition, such contractor and subcontractor shall be liable to the United States for liquidated damages. Such liquidated damages shall be computed, with respect to each individual laborer or mechanic employed in violation of said paragraph F of this provision, in the sum of $10 for each calendar day on which such employee was required or permitted to work in excess of eight hours or in excess of the standard workweek of forty hours without payment of the overtime wages required by said paragraph F of this provision (29 CFR 5.5(c)(2)).

H. Withholding for unpaid wages and liquidated damages. The FAA may withhold or cause to be withheld, from any moneys payable on account of work performed by the contractor or subcontractor, such sums as may administratively be determined to be necessary to satisfy any liabilities of such contractor or subcontractor for unpaid wages and liquidated damages as provided in paragraph G of this provision (29 CFR 5.5(c)(3)).

I. Subcontracts. The contractor will insert in each of his subcontracts the clauses contained in paragraphs A through H and J of this provision, and also a clause requiring the subcontractors to include these provisions in any lower tier subcontracts which they may enter into, together with a clause requiring this insertion in any further subcontracts that may in turn be made (29 CFR 5.5(a)(6), 5.5(c)(4)).

J. Contract termination; debarment. A breach of paragraphs A through I of this provision may be grounds for termination of the contract. A breach of paragraphs A through E and I may also be grounds for debarment as provided in 29 CFR 5.6 of the regulations of the Secretary of Labor (29 CFR 5.5(a)(7)).

[F.R. Doc. 64-12955; Filed, Dec. 17, 1964; 8:45 a.m.]

Title 5—ADMINISTRATIVE PERSONNEL

Chapter I—Civil Service Commission

PART 213—EXCEPTED SERVICE

Department of Defense

Section 213.3306 is amended to show the exception under Schedule C of two positions of Secretary, one to the Assistant Secretary of Defense (Administration) and one to the Special Assistant to the Secretary. The section is also amended to show that the position of Secretary to the Assistant Secretary of Defense (Medical and Health) is no longer excepted under Schedule C. Effective upon publication in the Federal Register, subparagraphs (2) and (16) of paragraph (a) of § 213.3306 are amended as set out below.

§ 213.3306 Department of Defense.

(a) *Office of the Secretary.* * * *

(2) Two Private Secretaries to the Deputy Secretary of Defense and one Private Secretary to each of the following: The Director of Defense Research and Engineering; the Assistant Secretary of Defense (Manpower); the Assistant Secretary of Defense (International Security Affairs); the Senior Military Aide to the President; the Assistant Secretary of Defense (Public Affairs); the Assistant Secretary of Defense (Installations and Logistics); the Assistant Secretary of Defense (Administration); the General Counsel; and the Assistant to the Secretary of Defense (Atomic Energy).

* * * * *

(16) Three Private Secretaries to the Special Assistant to the Secretary of Defense.

* * * * *

(R.S. 1753, sec. 2, 22 Stat. 403, as amended; 5 U.S.C. 631, 633; E.O. 10577, 19 F.R. 7521, 3 CFR, 1954-1958 Comp., p. 218)

United States Civil Service Commission,
[seal] Mary V. Wenzel,
Executive Assistant to the Commissioners.

[F.R. Doc. 64-12989; Filed, Dec. 17, 1964; 8:49 a.m.]

Title 7—AGRICULTURE

Chapter VII—Agricultural Stabilization and Conservation Service (Agricultural Adjustment), Department of Agriculture

SUBCHAPTER B—FARM MARKETING QUOTAS AND ACREAGE ALLOTMENTS

PART 722—COTTON

Subpart—1965 Crop of Extra Long Staple Cotton—National Marketing Quota; National Allotment and Apportionment to the States and Counties; Referendum Date

County Reserve

(a) Section 722.354 is issued pursuant to the Agricultural Adjustment Act of 1938, as amended (52 Stat. 31, as amended; 7 U.S.C. 1281 et seq.). This section establishes the county reserve for the 1965 crop of extra long staple cotton. Such determination was made initially by the respective county committees and is hereby approved and made effective by the Administrator, ASCS, pursuant to delegated authority (19 F.R. 74, 21 F.R. 1665, 25 F.R. 3925, 28 F.R. 4368).

(b) Notice that the Secretary was preparing to establish State and county allotments was published in the Federal Register on September 12, 1964 (29 F.R. 12878) in accordance with section 4 of the Administrative Procedure Act (60 Stat. 238; 5 U.S.C. 1003). No written submissions were received in response to such notice.

(c) Since the establishment of county reserves under this section requires immediate action by the Agricultural Stabilization and Conservation State and county committees, it is essential that § 722.354 be made effective as soon as possible. Accordingly, it is hereby determined and found that compliance with the 30-day effective date requirement of section 4 of the Administrative Procedure Act is impracticable and contrary