Introductory Note

This manual contains in consolidated form (1) Civil Air Regulations Part 3, Airplane Airworthiness; Normal, Utility, and Acrobatic Categories, dated May 15, 1956, Amendments 3–1 through 3–5, and the editorial changes required by Special Regulation SR–430, effective December 31, 1958; and (2) the rules, policies, and interpretations issued by the Administrator of the Federal Aviation Agency in application to the various sections of the regulations.

FAA *rules* are supplementary regulations issued pursuant to authority expressly conferred on the Administrator in the Civil Air Regulations. Such rules are mandatory and must be complied with.

FAA *policies* provide detailed technical information on recommended methods of complying with the Civil Air Regulations. Such policies are for the guidance of the public and are not mandatory in nature.

FAA *interpretations* define or explain words and phrases of the Civil Air Regulations. Such interpretations are for the guidance of the public and will be followed by the Agency in determining compliance with the regulations.

This manual is arranged to give the number, title, and text of each section of the regulations followed by any rules, policies, or interpretations applicable to that section. These rules, policies, or interpretations of the Administrator are identified by consecutive numbers appended by a dash to the regulation section number.

This manual supersedes Civil Aeronautics Manual 3 dated October 1956 and reprint dated March 1959, and all supplements thereto. As amendments and other pertinent materials pertaining to Part 3 are issued, they will be included in this manual.

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Airplane Airworthiness; Normal, Utility And Acrobatic Categories

Subpart A—General

Applicability and Definitions

3.0 *Applicability of this part.* This part establishes standards with which compliance shall be demonstrated for the issuance of and changes to type certificates for normal, utility, and acrobatic category airplanes. This part, until superseded or rescinded, shall apply to all airplanes for which applications for type certification under this part were made between the effective date of this part (November 13, 1945) and March 31, 1953. For applications for a type certificate made after March 31, 1953, this part shall apply only to airplanes which have a maximum weight of 12,500 pounds or less.

3.1 *Definitions.* As used in this part terms are defined as follows:

(a) *Administration.*

(1) *Administrator.* The Administrator is the Administrator of the Federal Aviation Agency.

(2) *Applicant.* An applicant is a person or persons applying for approval of an airplane or any part thereof.

(3) *Approved.* Approved, when used alone or as modifying terms such as means, devices, specifications, etc., shall mean approved by the Administrator. (See sec. 3.18.)

(b) *General design.*

(1) *Standard atmosphere.* The standard atmosphere is an atmosphere (see NACA Technical Report 1235) defined as follows:

(i) The air is a dry, perfect gas,

(ii) The temperature at sea level is 59° F.,

(iii) The pressure at sea level is 29.92 inches Hg,

(iv) The temperature gradient from sea level to the altitude at which the temperature equals −69.7° F. is −0.003566° F./ft. and zero thereabove,

(v) The density ρ_0 at sea level under the above conditions is 0.002377 lb. sec.^{2}/ft.^{4}

(2) *Maximum anticipated air temperature.* The maximum anticipated air temperature is a temperature specified for the purpose of compliance with the powerplant cooling standards. (See sec. 3.583.)

(3) *Airplane configuration.* Airplane configuration is a term referring to the position of the various elements affecting the aerodynamic characteristics of the airplane (e.g. wing flaps, landing gear).

(4) *Aerodynamic coefficients.* Aerodynamic coefficients are nondimensional coefficients for forces and moments. They correspond with those adopted [by the National Aeronautics and Space Administration (formerly the National Advisory Committee for Aeronautics).]

(5) *Critical engine(s).* The critical engine(s) is that engine(s) the failure of which gives the most adverse effect on the airplane flight characteristics relative to the case under consideration.

(c) *Weights.*

(1) *Maximum* weight. The maximum weight of the airplane is that maximum at which compliance with the requirements of this part of the Civil Air Regulations is demonstrated. (See sec. 3.74.)

(2) *Minimum weight.* The minimum weight of the airplane is that minimum at which compliance with the requirements of this part of the Civil Air Regulations is demonstrated. (See sec. 3.75.)

(3) *Empty weight.* The empty weight of the airplane is a readily reproducible weight which is used in the determination of the operating weights. (See sec. 3.73.)

(4) *Design maximum weight.* The design maximum weight is the maximum weight of the airplane at which compliance is shown with the structural loading conditions. (See sec. 3.181.)

(5) *Design minimum weight.* The design minimum weight is the minimum weight of the airplane at which compliance is shown

with the structural loading conditions. (See sec. 3.181.)

(6) *Design landing weight.* The design landing weight is the maximum airplane weight used in structural design for landing conditions at the maximum velocity of descent. (See sec. 3.242.)

(7) *Design unit weight.* The design unit weight is a representative weight used to show compliance with the structural design requirements:

(i) Gasoline 6 pounds per U.S. gallon.

(ii) Lubricating oil 7.5 pounds per U.S. gallon.

(iii) Crew and passengers 170 pounds per person.

(d) *Speeds.*

(1) *IAS.* Indicated air speed is equal to the pitot static air-speed indicator reading as installed in the airplane without correction for air-speed indicator system errors but including the sea level standard adiabatic compressible flow correction. (This latter correction is included in the calibration of the air-speed instrument dials.)

(2) *CAS.* Calibrated air speed is equal to the air-speed indicator reading corrected for position and instrument error. (As a result of the sea level adiabatic compressible flow correction to the air-speed instrument dial, CAS is equal to the true air speed TAS in standard atmosphere at sea level.)

(3) *EAS.* Equivalent air speed is equal to the air-speed indicator reading corrected for position error, instrument error, and for adiabatic compressible flow for the particular altitude. (EAS is equal to CAS at sea level in standard atmosphere.)

(4) *TAS.* True air speed of the airplane relative to undisturbed air. ($TAS = EAS(\rho_0/\rho)^{1/2}$.)

(5) V_c. The design cruising speed. (See sec. 3.184)

(6) V_d. The design diving speed. (See sec. 3.184.)

(7) V_f. The design flap speed for flight loading conditions with wing flaps in the landing position. (See sec. 3.190.)

(8) V_{fe}. The flap extended speed is a maximum speed with wing flaps in a prescribed extended position. (See sec. 3.742.)

(9) V_h. The maximum speed obtainable in level flight with rated rpm and power.

(10) V_{mc}. The minimum control speed with the critical engine inoperative. (See sec. 3.111.)

(11) V_{ne}. The never-exceed speed. (See sec. 3.739.)

(12) V_{no}. The maximum structural cruising speed. (See sec. 3.740.)

(13) V_p. The design maneuvering speed. (See sec. 3.184.)

(14) V_{sf}. The stalling speed computed at the design landing weight with the flaps fully extended. (See sec. 3.190.)

(15) V_{s0}. The stalling speed or the minimum steady flight speed with wing flaps in the landing position. (See sec. 3.82.)

(16) V_{s1}. The stalling speed or the minimum steady flight speed obtained in a specified configuration. (See sec. 3.82.)

(17) V_x. The speed for best angle of climb.

(18) V_y. The speed for best rate of climb.

(e) *Structural.*

(1) *Limit load.* A limit load is the maximum load anticipated in normal conditions of operation. (See sec. 3.171.)

(2) *Ultimate load.* An ultimate load is a limit load multiplied by the appropriate factor of safety. (See sec. 3.173.)

(3) *Factor of safety.* The factor of safety is a design factor used to provide for the possibility of loads greater than those anticipated in normal conditions of operation and for uncertainties in design. (See sec. 3.172.)

(4) *Load factor.* The load factor is the ratio of a specified load to the total weight of the airplane; the specified load may be expressed in terms of any of the following: aerodynamic forces, inertia forces, or ground or water reactions.

(5) *Limit load factor.* The limit load factor is the load factor corresponding with limit loads.

(6) *Ultimate load factor.* The ultimate load factor is the load factor corresponding with ultimate loads.

(7) *Design wing area.* The design wing area is the area enclosed by the wing outline (including wing flaps in the retracted position

and airelons, but excluding fillets or fairings) on a surface containing the wing chords. The outline is assumed to be extended through the nacelles and fuselage to the plane of symmetry in any reasonable manner.

(8) *Balancing tail load.* A balancing tail load is that load necessary to place the airplane in equilibrium with zero pitch acceleration.

(9) *Fitting.* A fitting is a part or terminal used to join one structural member to another. (See sec. 3.306.)

(f) *Power installation.*[1]

[1] For engine airworthiness requirements see Part 13 of this subchapter. For propeller airworthiness requirements see Part 14 of this subchapter.

(1) *Brake horsepower.* Brake horsepower is the power delivered at the propeller shaft of the engine.

(2) *Takeoff power.* Takeoff power is the brake horsepower developed under standard sea level conditions, under the maximum conditions of crankshaft rotational speed and engine manifold pressure approved for use in the normal takeoff, and limited in use to a maximum continuous period as indicated in the approved engine specifications.

(3) *Maximum continuous power.* Maximum continuous power is the brake horsepower developed in standard atmosphere at a specified altitude under the maximum conditions of crankshaft rotational speed and engine manifold pressure approved for use during periods of unrestricted duration.

(4) *Manifold pressure.* Manifold pressure is the absolute pressure measured at the appropriate point in the induction system, usually in inches of mercury.

(5) *Critical altitude.* The critical altitude is the maximum altitude at which in standard atmosphere it is possible to maintain at a specified rotational speed, a specified power or a specified manifold pressure. Unless otherwise stated, the critical altitude is the maximum altitude at which it is possible to maintain, at the maximum continuous rotational speed, one of the following:

(i) The maximum continuous power, in the case of engines for which this power rating is the same at sea level and at the rated altitude.

(ii) The maximum continuous rated manifold pressure, in the case of engines the maximum continuous power of which is governed by a constant manifold pressure.

(6) *Pitch setting.* Pitch setting is the propeller blade setting determined by the blade angle measured in a manner, and at a radius, specified in the instruction manual for the propeller.

(7) *Feathered pitch.* Feathered pitch is the pitch setting, which in flight, with the engines stopped, gives approximately the minimum drag and corresponds with a windmilling torque of approximately zero.

(8) *Reverse pitch.* Reverse pitch is the propeller pitch setting for any blade angle used beyond zero pitch (e.g., the negative angle used for reverse thrust).

(g) *Fire protection.*

(1) *Fireproof.* Fireproof material means material which will withstand heat at least as well as steel in dimensions appropriate for the purpose for which it is to be used. When applied to material and parts used to confine fires in designated fire zones, fireproof means that the material or part will perform this function under the most severe conditions of fire and duration likely to occur in such zones.

(2) *Fire-resistant.* When applied to sheet or structural members, fire-resistant material means a material which will withstand heat at least as well as aluminum alloy in dimensions appropriate for the purpose for which it is to be used. When applied to fluid-carrying lines, other flammable fluid system components, wiring, air ducts, fittings, and powerplant controls, this term refers to a line and fitting assembly, component, wiring, or duct, or controls which will perform the intended functions under the heat and other conditions likely to occur at the particular location.

(3) *Flame-resistant.* Flame-resistant material means material which will not support combustion to the point of propagating, beyond safe limits, a flame after the removal of the ignition source.

(4) *Flash-resistant.* Flash-resistant material means material which will not burn violently when ignited.

(5) *Flammable.* Flammable pertains to those fluids or gases which will ignite readily or explode.

Certification

3.10 *Eligibility for type certificate.* An airplane shall be eligible for type certification under the provisions of this part if it complies with the airworthiness provisions hereinafter established or if the Administrator finds that the provision or provisions not complied with are compensated for by factors which provide an equivalent level of safety: *Provided,* That the Administrator finds no feature or characteristic of the airplane which renders it unsafe for the category in which it is certificated.

3.11 *Designation of applicable regulations.* The provisions of this section shall apply to all airplane types certificated under this part irrespective of the date of application for type certificate.

(a) Unless otherwise established by the Administrator, the airplane shall comply with the provisions of this part together with all amendments thereto effective on the date of application for type certificate, except that compliance with later effective amendments may be elected or required pursuant to paragraphs (c), (d), and (e) of this section.

(b) If the interval between the date of application for type certificate and the issuance of the corresponding type certificate exceeds three years, a new application for type certificate shall be required, except that for applications pending on May 1, 1954, such three-year period shall commence on that date. At the option of the applicant, a new application may be filed prior to the expiration of the three-year period. In either instance the applicable regulations shall be those effective on the date of the new application in accordance with paragraph (a) of this section.

(c) During the interval between filing the application and the issuance of a type certificate, the applicant may elect to show compliance with any amendment of this part which becomes effective during that interval, in which case all other amendments found by the Administrator to be directly related shall be complied with.

(d) Except as otherwise provided by the Administrator pursuant to section 1.24 of this subchapter, a change to a type certificate (see sec. 3.13(b)) may be accomplished, at the option of the holder of the type certificate, either in accordance with the regulations incorporated by reference in the type certificate pursuant to section 3.13(c), or in accordance with subsequent amendments to such regulations in effect on the date of application for approval of the change, subject to the following provisions:

(1) When the applicant elects to show compliance with an amendment to the regulations in effect on the date of application for approval of a change, he shall show compliance with all amendments which the Administrator finds are directly related to the particular amendment selected by the applicant.

(2) When the change consists of a new design or a substantially complete redesign of a component, equipment installation, or system installation of the airplane, and the Administrator finds that the regulations incorporated by reference in the type certificate pursuant to section 3.13(c) do not provide complete standards with respect to such change, he shall require compliance with such provisions of the regulations in effect on the date of application for approval of the change as he finds will provide a level of safety equal to that established by the regulations incorporated by reference at the time of issuance of the type certificate.

NOTE: Examples of new or redesigned components and installations which might require compliance with regulations in effect on the date of application for approval, are: New powerplant installation which is likely to introduce additional fire or operational hazards unless additional protective measures are incorporated; the installation of an auto-pilot or a new electric power system.

(e) If changes listed in subparagraphs (1) through (3) of this paragraph are made, the airplane shall be considered as a new type, in which case a new application for type certificate shall be required and the regulations together with all amendments thereto effective on the date of the new application shall be made applicable in accordance with paragraphs (a), (b), (c), and (d) of this section.

(1) A change in the number of engines;

(2) A change to engines employing different principles of operation or propulsion;

(3) A change in design, configuration, power, or weight which the Administrator finds is so extensive as to require a substantially complete investigation of compliance with the regulations.

shall be deemed to have met the requirements for approval when it meets the pertinent specifications adopted by the Administrator, and the manufacturer so certifies in a manner prescribed by the Administrator.

3.18–1 *Approval of materials, parts, processes, and appliances (FAA rules which apply to sec. 3.18).* Aircraft materials, parts, processes, and appliances made the subject of Technical Standard Orders shall be approved upon the basis and in the manner prescribed in Part 514[6] of this title, Technical Standard Orders—C-Series—Aircraft Components.

(CAR, Supp. 14, 17 F. R. 9065, Oct. 11, 1952.)

3.18–2 *Application of the Technical Standard Orders (TSO) System; C Series (FAA policies which apply to sec. 3.18).*

(a) *Purpose of Technical Standard Orders.* Technical Standard Orders are a means by which the Administrator adopts and publishes the specifications for which authority is provided in section 3.18 (a).

(b) *Applicability of Technical Standard Order requirements.*

(1) The applicability of and effective dates for TSO items are set forth in each TSO.

(2) Each Technical Standard Order sets forth the conditions under which materials, parts, processes, and applicances approved by the Administrator prior to establishment of an applicable TSO, may continue to be used in aircraft.

(3) The establishment of a Technical Standard Order for any product does not preclude the possibility of establishing the acceptability of a similar product as part of an aircraft, engine, or propeller, under the type certification or modification procedures, if there is established a level of safety equivalent to that provided in the regulations in this subchapter as implemented by the appropriate Technical Standard Order and the product is identified as part of the airplane, engine, or propeller.

(c) *Administration of the Technical Standard Order (TSO) system.* The principles which apply in administering the Technical Standard Order system are as follows:

(1) Technical Standard Orders will reference performance provisions of recognized government specifications, or established industry specifications which have been found acceptable by the FAA. If no satisfactory specification exists, the Orders will include criteria prepared by the Administrator. In preparing criteria of this type, the Administrator will give consideration to recommendations made by the industry.

(2) Minimum performance requirements established by the Federal Aviation Agency and published in Technical Standard Orders will serve as a means by which materials, parts, processes, and appliances intended for use in certificated aircraft will be accepted.

(3) TSO's set forth the minimum requirements for safety. Every effort will be made by the FAA to keep the requirements at the minimum levels of safety and TSO's will not be used to set forth "desirable" standards.

(4) It will be the responsibility of the person submitting a statement of conformance to the FAA, certifying that his product meets the requirements of the TSO, to conduct the necessary tests demonstrating compliance therewith. This person will be held responsible for maintaining quality control adequate to assure that products which he guarantees to meet the requirements of a TSO do, in fact, meet these standards. The FAA will not formally approve such products as meeting the requirements of TSO's nor exercise direct inspection control over them. The statement of conformance with the provisions of a Technical Standard Order normally will be accepted by the FAA as sufficient indication that the applicable requirements have been fulfilled.

Any TSO item which is modified must continue to comply with the requirements of the TSO; and the person authorizing the modification will be responsible for such compliance.

(d) *Numbering of Technical Standard Orders.* Each Technical Standard Order will be assigned a designation consisting of the letters "TSO," a series code letter "C" indicating aircraft materials, parts, processes, and appliances, and a serial number to be assigned in sequence for each of the TSO's issued in the "C" series, e. g., TSO–C–1, "Smoke Detectors." Revisions

[6] Copies of individual TSO's contained in Part 514 of this title are available upon application to the Administrative Services Division, Attn. MS-126, Federal Aviation Agency, Washington 25, D.C.

are indicated by the addition of letters a, b, c, etc., after the number.

(CAR, Supp. 14, 17 F. R. 9065, Oct. 11, 1952.)

3.18–3 *Manufacturer (FAA interpretation which applies to section* 3.18(*b*)).

(a) For the purpose of accepting a statement of conformance for a Technical Standard Order product, the word "manufacturer" is interpreted to mean a person who fabricates, or both fabricates and assembles, a product by cutting, drilling, bolting, riveting, glueing, soldering, sewing, or other fabrication and assembly techniques.

(*b*) A person is not regarded as the manufacturer solely by his engaging in the following activities:

(1) Distributing a completed product fabricated or fabricated and assembled by another person.

(2) Cleaning and reassembling products, repairing products, or replacing components or parts in products.

(23 F.R. 10323, Dec. 25, 1958, effective Jan. 31, 1959.)

3.18–4 *Approval of products under the type certificate or modification procedures (FAA policies which apply to section 3.18).* A material, part, process, or appliance (called "product" in this section may be approved as a part of the airplane type design under a type certificate or a supplemental type certificate in accordance with the procedures provided in this section.

Explanatory Note: Products previously approved by the CAA means of letters of approval, Repair and Alteration Form ACA–337, or listing on CAA Product and Process Specifications will continue to be eligible for installation in aircraft unless the eligibility is restricted by applicable regulations or airworthiness directives issued under § 1.24 of this subchapter.

(a) *Policies controlling where there is an applicable Technical Standard Order.* If a Technical Standard Order covering the product is in effect, the applicant for approval should submit type design data showing that the product meets the performance standards of the Technical Standard Order. Deviations from such performance standards may be allowed to the extent that the applicant for the type certificate or the supplemental type certificate substantiates that certain provisions of the Technical Standard Order are not required for the product as installed in the airplane.

(b) *Policies controlling in the absence of an applicable Standard Technical Order.* Where no TSO covering the product exists, the applicant for approval should submit type design data showing compliance with all the requirements of this part which are applicable to the product. Any deviation from standards prescribed in this part may be allowed only in accordance with § 3.10.

(c) *Methods of identifying products approved under this section.*

(1) Products approved as a part of the airplane type design under a type certificate should be identified by an airplane part number on the approved drawing list.

(2) Products approved as a part of the airplane type design under a supplemental type certificate should be identified by a part or drawing number on such certificate.

(3) Each TSO product that is approved as a part of the airplane should have the TSO identification removed and be identified as set forth in subparagraph (1) or (2) of this paragraph, whichever is applicable.

(23 F. R. 10323, Dec. 25, 1958, effective Jan. 31, 1959.)

3.19 *Changes in type design.* (For requirements with regard to changes in type design and the designation of applicable regulations therefor, see secs. 3.11 (d) and (e) and Part 1 of this subchapter.)

3.19–1 *Changes of engines (FAA policies which apply to sec. 3.19).*

(a) There are currently available newly designed engines of approximately the same size and weight as previously designed engines, but with considerable variations in power. It is possible to interchange these engines with little or no installation changes, and although minor changes in engine weight may be involved, it will still be practical to operate the aircraft at the originally approved gross weight. Under section 3.185, the maneuvering load factor is not dependent upon engine power, and under section 3.184 the design airspeeds can be independent of engine power. Therefore, a change which involves or permits a practical power increase by exchange of engines shall be approved by the Administrator: *Provided,* That such exchange of engines is not accompanied by an increase in the gross weight of the aircraft, or an increase in placard speeds. Under those conditions it will not be necessary to restrict the maximum continuous horsepower by a placard because of the airplane speed limitations since the latter are indicated on the speed placards.

(b) Aircraft alterations involving weight or speed changes beyond those set forth above will be approved by the Administrator, if the applicant shows compliance with the applicable airworthiness requirements.

(c) Under section 3.19, it will be necessary to require such investigations of local structure, weight and balance, power plant installations and flight tests as are normally involved in a change of engine type. However, every effort will be made by reference to data already on hand to minimize the amount of testing and structural analysis required of the applicant.

(CAR, Supp. 10, 16 F. R. 3281, Apr. 1951. Redesignated and amended by Supp. 14, 17 F. R. 9065, Oct. 11, 1952.)

Airplane Categories

3.20 *Airplane categories.*

(a) For the purpose of certification under this part, airplanes are divided upon the basis of their intended operation into the following categories:

(1) *Normal-suffix N.* Airplanes in this category are intended for nonacrobatic, nonscheduled passenger, and nonscheduled cargo operation.

(2) *Utility-suffix U.* Airplanes in this category are intended for normal operations and limited acrobatic maneuvers. These airplanes are not suited for use in snap or inverted maneuvers.

NOTE: The following interpretation of paragraph (a) (2) was issued May 15, 1947, 12 F. R. 3434: The phrase "limited acrobatic maneuvers" as used in section 3.6 (now sec. 3.20) is interpreted to include steep turns, spins, stalls (except whip stalls), lazy eights, and chandelles.

(3) *Acrobatic-suffix A.* Airplanes in this category will have no specific restrictions as to type of maneuver permitted unless the necessity therefor is disclosed by the required flight tests.

(b) An airplane may be certificated under the requirements of a particular category, or in more than one category, provided that all of the requirements of each such category are met. Sections of this part which apply to only one or more, but not all, categories are identified in this part by the appropriate suffixes added to the section number, as indicated in paragraph (a) of this section. All sections not identified by a suffix are applicable to all categories except as otherwise specified.

3.20–1 *Approved maneuvers for normal category aircraft (FAA interpretations which apply to sec. 3.20).* The phrase "nonacrobatic operation" as used in section 3.20 (a) (1) is interpreted to mean that type of operation in which the aircraft is limited to those maneuvers incidental to normal flying and including stalls (except whip stalls) and turns in which the angle of bank is not in excess of 60°.

(CAR, Supp. 10, 16 F. R. 3278, Apr. 14, 1951. Redesignated and amended by Supp. 14, 17 F. R. 9065, Oct. 11, 1952.)

3.20–2 *Approved limited acrobatic maneuvers for utility category aircraft (FAA interpretations which apply to sec. 3.20).* The phrase "limited craft certified for airworthiness under a combination of the requirements of this part and Part 4a of this subchapter as authorized by the provisions of section 3.2, the items of "normal climb" (sec. 3.85(a)) and "cooling test procedure for single-engine airplanes" (sec. 3.586), shall be construed by the Administrator as "related items."

(Supp. 1, 12 F.R. 3435, May 28, 1947, as amended by Amdt. 1, 14 F.R. 36, Jan. 5, 1949.)

3.85–3 *"Rapid retraction" (FAA interpretations which apply to sec. 3.85).* The Administrator will consider retraction of flaps in 2 seconds or less as compliance with the factor of "rapid retraction" as that phrase is used in section 3.85(c).

(Supp. 1, 12 F.R. 3435, May 28, 1947, as amended by Amdt. 1, 14 F.R. 36, Jan. 5, 1949.)

3.85–4 *Weight for items of performance and flight characteristics (FAA interpretations which apply to sec. 3.85).* For multiengine airplanes in which the design landing weight (sec. 3.242) is less than the maximum weight (sec. 3.74) for which certification is desired, the weight for items of performance and flight characteristics shall be construed by the Administrator as the maximum weight defined in section 3.74. Such items of performance and flight characteristics shall consist of balked landing (climb) conditions (sec. 3.74), landing over 50-foot obstacles (sec. 3.86), and all flight characteristics tests in the landing configuration. The design weight covered in section 3.242 is intended for use for structural design purposes only.

(Supp. 1, 12 F.R. 3435, May 28, 1947, as amended by Amdt. 1, 14 F.R. 36, Jan. 5, 1949.)

3.85–5 *Low-pitch propeller setting in normal climb position (FAA interpretations which apply to sec. 3.85(a)).*

(a) In the event an airplane has:

(1) An engine for which the takeoff and maximum continuous power ratings are identical, and

(2) A fixed-pitch, two-position or similar type propeller,

then the regulations provide that the best rate of climb speed specified in section 3.85(a) for normal climb should be determined with the low-pitch propeller setting which would restrain the engine to an r.p.m. at full throttle not exceeding its permissible takeoff r.p.m. (see sec. 3.419(a)).

(b) A relaxation of the propeller pitch setting requirement stipulated by section 3.419(a) may be granted, however, for an airplane falling into the foregoing classification, when it shows a marginal item of performance as, for example, when it can meet the rate of climb requirement of section 3.85(a) for normal climb, but may have difficulty in meeting the angle of climb requirements of section 3.85(a) for normal climb and/or section 3.85(c) for balked landing. In this case, it will be permissible to use a lower propeller pitch setting than specified in section 3.419(a), in order to obtain rated engine r.p.m. at the best angle of climb speed: *Provided*, Acceptable engine cooling can be demonstrated at the lower speed associated with the best angle of climb. In employing this procedure, consideration should also be given to the following:

(1) That the best angle of climb speed for the balked landing condition may be considerably lower than the best angle of climb speed for the normal climb condition.

(2) That as a result of subparagraph (1) of this paragraph, the engine would normally have to be part throttled to avoid exceeding rated r.p.m. at the higher speeds, and would therefore develop less than rated power for showing compliance with the normal climb and takeoff requirements of sections 3.85(a) and 3.84, respectively.

(Supp. 10, 16 F.R. 3283, Apr. 14, 1951.)

3.85a *Climb requirements; airplanes of 6,000 lbs. or less.* Airplanes having a maximum certificated takeoff weight of 6,000 lbs. or less shall comply with the requirements of this section.

(a) *Climb; takeoff climb condition.* The steady rate of climb at sea level shall not be less than 10 V_{s1} or 300 feet per minute, whichever is the greater, with:

(1) Takeoff power,

(2) Landing gear extended,

(3) Wing flaps in takeoff position,

(4) Cowl flaps in the position used in cooling tests specified in sections 3.581 through 3.596.

(b) *Climb with inoperative engine.* All multiengine airplanes having a stalling speed

V_{S_0} greater than 70 miles per hour shall have a steady rate of climb of at least 0.02 $V_{S_0}^2$ in feet per minute at an altitude of 5,000 feet with the critical engine inoperative and:

(1) The remaining engines operating at not more than maximum continuous power,

(2) The inoperative propeller in the minimum drag position,

(3) Landing gear retracted,

(4) Wing flaps in the most favorable position,

(5) Cowl flaps in the position used in cooling tests specified in sections 3.581 through 3.596.

(c) *Climb; balked landing conditions.* The steady rate of climb at sea level shall not be less than 5 V_{S_0} or 200 feet per minute, whichever is the greater, with:

(1) Takeoff power,

(2) Landing gear extended,

(3) Wing flaps in the landing position. If rapid retraction is possible with safety, without loss of altitude and without requiring sudden changes of angle of attack or exceptional skill on the part of the pilot, wing flaps may be retracted.

Landing

3.86 *Landing.*

(a) The horizontal distance required to land and to come to a complete stop (to a speed of approximately 3 miles per hour for seaplanes or float planes) from a point at a height of 50 feet above the landing surface shall be determined as follows:

(1) Immediately prior to reaching the 50-foot altitude, a steady gliding approach shall have been maintained, with a true indicated air speed of at least [1.5 V_{S_1}.]

(2) The landing shall be made in such a manner that there is no excessive vertical acceleration, no tendency to bounce, nose over, ground loop, porpoise, or water loop, and in such a manner that its reproduction shall not require any exceptional degree of skill on the part of the pilot or exceptionally favorable conditions.

(b) The distance so obtained, the type of landing surface on which made and the pertinent information with respect to cowl flap position, and the use of flight path control devices shall be entered in the Airplane Flight Manual.

3.86–1 *Landing distances (FAA policies which apply to sec. 3.86).* The Administrator will not approve the use of landing distances obtainable with reverse-thrust propellers in establishing landing field lengths until such time as sufficient experience with their use is available for proper consideration of all related factors involved in the establishment of adequate airport lengths for routine landings.

(Supp. 1, 12 F.R. 3437, May 28, 1947, as amended by Amdt. 1, 14 F.R. 36, Jan. 5, 1949.)

3.86–2 *Use of camera equipment (FAA policies which apply to sec. 3.86).* The landing distance should be determined photographically. FAA camera equipment is available on a loan basis.

(Supp. 10, 16 F.R. 3284, Apr. 14, 1951.)

3.87 *Landing requirements; airplanes of 6,000 lbs. or less.* For an airplane having a maximum certificated takeoff weight of 6,000 lbs. or less it shall be demonstrated that the airplane can be safely landed and brought to a stop without requiring an exceptional degree of piloting skill, and without excessive vertical acceleration, tendency to bounce, nose over, ground loop, porpoise, or water loop.

Flight Characteristics

3.105 *Requirements.* The airplane shall meet the requirements set forth in sections 3.106 to 3.124 at all normally expected operating altitudes under all critical loading conditions within the range of center of gravity and, except as otherwise specified, at the maximum weight for which certification is sought.

Controllability

3.106 *General.* The airplane shall be satisfactorily controllable and maneuverable during takeoff, climb, level flight, dive, and landing with or without power. It shall be possible to make a smooth transition from one flight condition to another, including turns and slips, without requiring an exceptional degree of skill, alertness, or strength on the part of the pilot, and without danger of exceeding the limit load factor under all conditions of operation

probable for the type, including for multiengine airplanes those conditions normally encountered in the event of sudden failure of any engine. Compliance with "strength of pilots" limits need not be demonstrated by quantitative tests unless the Administrator finds the condition to be marginal. In the latter case they shall not exceed maximum values found by the Administrator to be appropriate for the type but in no case shall they exceed the following limits:

	Pitch	Roll	Yaw
(a) For temporary application:			
Stick	60	30	150
Wheel [1]	75	60	150
(b) For prolonged application	10	5	20

[1] Applied to rim.

3.107–U *Approved acrobatic maneuvers.* It shall be demonstrated that the approved acrobatic maneuvers can be performed safely. Safe entry speeds shall be determined for these maneuvers.

3.108–A *Acrobatic maneuvers.* It shall be demonstrated that acrobatic maneuvers can be performed readily and safely. Safe entry speeds shall be determined for these maneuvers.

3.109 *Longitudinal control.* The airplane shall be demonstrated to comply with the following requirements:

(a) It shall be possible at all speeds below V_x to pitch the nose downward so that the rate of increase in air speed is satisfactory for prompt acceleration to V_x with:

(1) Maximum continuous power on all engines, 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.]

(3)(i) Wing flaps and landing gear extended and

(ii) Wing flaps and landing gear retracted.

(b) During each of the controllability demonstrations outlined below it shall not require a change in the trim control or the exertion of more control force than can be readily applied with one hand for a short period. Each maneuver shall be performed with the landing gear extended.

(1) With power off, flaps retracted, and the airplane trimmed as prescribed in paragraph (a)(2) of this section, the flaps shall be extended as rapidly as possible while maintaining the air speed at approximately 40 percent above the instantaneous value of the stalling speed.

(2) Same as subparagraph (1) of this paragraph, except the flaps shall be initially extended and the airplane trimmed as prescribed in paragraph (a)(2) of this section, then the flaps shall be retracted as rapidly as possible.

(3) Same as subparagraph (2) of this paragraph, except maximum continuous power shall be used.

(4) With power off, the flaps retracted, and the airplane trimmed as prescribed in paragraph (a)(2) of this section, take-off power shall be applied quickly while the same air speed is maintained.

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

(6) With power off, flaps extended, and the airplane trimmed as prescribed in paragraph (a)(2) of this section, air speeds within the range of 1.1 V_{S_1} to 1.7 V_{S_1} or V_f, whichever is the lesser, shall be obtained and maintained.

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

[(d) It shall be possible, to maintain a speed of not more than 1.5 V_{S_1} with a pilot control force of not more than 10 pounds during a power-off glide with landing gear and wing flaps extended, with the most forward center of gravity position approved at the maximum weight, and regardless of weight.]

[(e) It shall be possible without the use of the primary means of longitudinal control, to control the descent of the airplane with the use of all other normal flight and power controls to a zero rate of descent and to an altitude suitable for a controlled landing without requiring exceptional strength, skill, or alertness on the part of the pilot, or without exceeding the operational and the structural limitations of the airplane.]

3.110 *Lateral and directional control.*

(a) It shall be possible with multiengine airplanes to execute 15-degree banked turns both with and against the inoperative engine from steady climb at 1.4 V_{s_1} or V_y for the condition with:

(1) Maximum continuous power on the operating engines,

(2) Rearmost center of gravity,

(3)(i) Landing gear retracted and

(ii) Landing gear extended.

(4) Wing flaps in most favorable climb position.

(5) Maximum weight.

(6) The inoperative propeller in its minimum drag condition.

(b) It shall be possible with multiengine airplanes, while holding the wings level laterally within 5 degrees, to execute sudden changes in heading in both directions without dangerous characteristics being encountered. This shall be demonstrated at 1.4V_{s_1} or V_y up to heading changes of 15 degrees, except that the heading change at which the rudder force corresponds to that specified in section 3.106 need not be exceeded, with:

(1) The critical engine inoperative,

(2) Maximum continuous power on the operating engine(s),

(3)(i) Landing gear retracted and

(ii) Landing gear extended.

(4) Wing flaps in the most favorable climb position,

(5) The inoperative propeller in its minimum drag condition,

(6) The airplane center of gravity at its rearmost position.

3.111 *Minimum control speed (V_{mc}).*

(a) A minimum speed shall be determined under the conditions specified below, such that when any one engine is suddenly made inoperative at that speed, it shall be possible to recover control of the airplane, with the one engine still inoperative, and to maintain it in straight flight at that speed, either with zero yaw or, at the option of the applicant, with a bank not in excess of 5 degrees. Such speed shall not exceed 1.2 V_{s_1}, with:

(1) Take-off or maximum available power on all engines,

(2) Rearmost center of gravity,

(3) Flaps in take-off position,

(4) Landing gear retracted.

(b) In demonstrating this minimum speed, the rudder force required to maintain it shall not exceed forces specified in section 3.106, nor shall it be necessary to throttle the remaining engines. During recovery the airplane shall not assume any dangerous attitude, nor shall it require exceptional skill, strength, or alertness on the part of the pilot to prevent a change of heading in excess of 20 degrees before recovery is complete.

Trim

3.112 *Requirements.*

(a) The means used for trimming the airplane shall be such that, after being trimmed and without further pressure upon or movement of either the primary control or its corresponding trim control by the pilot or the automatic pilot, the airplane will maintain:

(1) Lateral and directional trim in level flight at a speed of 0.9 V_h or at V_c, if lower, with the landing gear and wing flaps retracted:

(2) Longitudinal trim under the following conditions:

(i) During a climb with maximum continuous power at a speed between V_x and 1.4 V_{s_1}.

(*a*) With landing gear retracted and wing flaps retracted,

(*b*) With landing gear retracted and wing flaps in the take-off position.

[(ii) During a power approach at 1.5V_{s_1} and while maintaining a 3 degree angle of descent,]

(*a*) With landing gear extended and wing flaps retracted,

(*b*) With landing gear extended and wing flaps extended under the forward center of gravity position approved with the maximum authorized weight,

(*c*) With landing gear extended and wing flaps extended under the most forward center of gravity position approved, regardless of weight.

(iii) During level flight at any speed from 0.9 V_h to V_x or 1.4 V_{s_1} with landing gear and wing flaps retracted.

(b) In addition to the above, multi-engine airplanes shall maintain longitudinal and directional trim at a speed between V_y and 1.4 V_{s1} during climbing flight with the critical of two or more engines inoperative, with:

(1) The other engine(s) operating at maximum continuous power,

(2) The landing gear retracted,

(3) Wing flaps retracted,

(4) Bank not in excess of 5 degrees.

Stability

3.113 *General.* The airplane shall be longitudinally, directionally, and laterally stable in accordance with the following sections. Suitable stability and control "feel" (static stability) shall be required in other conditions normally encountered in service, if flight tests show such stability to be necessary for safe operation.

3.114 *Static longitudinal stability.* In the configurations outlined in section 3.115 and with the airplane trimmed as indicated, the characteristics of the elevator control forces and the friction within the control system shall be such that:

(a) A pull shall be required to obtain and maintain speeds below the specified trim speed and a push to obtain and maintain speeds above the specified trim speed. This shall be so at any speed which can be obtained without excessive control force, except that such speeds need not be greater than the appropriate maximum permissible speed or less than the minimum speed in steady unstalled flight.

(b) The air speed shall return to within 10 percent of the original trim speed when the control force is slowly released from any speed within the limits defined in paragraph (a) of this section.

3.115 *Specific conditions.* In conditions set forth in this section, within the speeds specified, the stable slope of stick force versus speed curve shall be such that any substantial change in speed is clearly perceptible to the pilot through a resulting change in stick force.

(a) *Approach.* The stick force curve shall have a stable slope and the stick force shall not exceed 40 lbs. at any speed between 1.1 V_{s_1} and 1.8 V_{s_1} with:

(1) Wing flaps in the landing position,

(2) The landing gear extended,

(3) Maximum weight,

[(4) Airplane trimmed at 1.5 V_{s_1} and power on as required to maintain a 3 degree angle of descent.]

(b) *Climb.* The stick force curve shall have a stable slope at all speeds between 1.2 V_{s_1} and 1.6 V_{s_1} with:

(1) Wing flaps retracted,

(2) Landing gear retracted,

(3) Maximum weight,

(4) 75 percent of maximum continuous power,

(5) The airplane trimmed at 1.4 V_{s_1}.

(c) *Cruising.* (1) Between 1.3 V_{s_1} and the maximum permissible speed, the stick force curve shall have a stable slope at all speeds obtainable with a stick force not in excess of 40 pounds with:

(i) Landing gear retracted,

(ii) Wing flaps retracted,

(iii) Maximum weight,

(iv) 75 percent of maximum continuous power,

(v) The airplane trimmed for level flight with 75 percent of the maximum continuous power.

(2) Same as subparagraph (1) of this paragraph, except that the landing gear shall be extended and the level flight trim speed need not be exceeded.

3.116 *Instrumented stick force measurements.* Instrumented stick force measurements need not be made when changes in speed are clearly reflected by changes in stick forces and the maximum forces obtained in the above conditions are not excessive.

3.117 *Dynamic longitudinal stability.* Any short period oscillation occurring between stalling speed and maximum permissible speed shall be heavily damped with the primary controls (1) free, and (2) in a fixed position.

3.118 *Directional and lateral stability.*

[(a) *Three-control airplanes.*

(1) The static directional stability, as shown by the tendency to recover from a skid

with rudder free, shall be positive for all landing gear and flap positions appropriate to the takeoff, climb, cruise, and approach configurations, with symmetrical power up to maximum continuous power, and at all speeds from 1.2V_{S_1} up to the maximum permissible speed for the configuration being investigated. The angle of skid for these tests shall be appropriate to the type of airplane. At greater angles of skid up to that at which full rudder is employed or a control force limit specified in section 3.106 is obtained, whichever occurs first, and at speeds from 1.2V_{S_1} to V_P, the rudder pedal force shall not reverse.

[(2) The static lateral stability, as shown by the tendency to raise the low wing in a sideslip, shall be positive for all landing gear and flap positions with symmetrical power up to 75 percent maximum continuous power at all speeds above 1.2V_{S_1} up to the maximum permissible speed for the configuration investigated but shall not be negative at a speed of 1.2V_{S_1} The angle of sideslip for these tests shall be appropriate to the type of airplane but in no case shall the sideslip be less than that obtained with 10 degrees of bank.

[(3) In straight steady sideslips at a speed of 1.2V_{S_1} for all gear and flap positions and for all symmetrical power conditions up to 50 percent maximum continuous power, the aileron and rudder control movements and forces shall increase steadily, but not necessarily in constant proportion, as the angle of sideslip is increased up to the maximum appropriate to the type of airplane. At greater angles up to that at which the full rudder or aileron control is employed or a control force limit specified by section 3.106 is obtained, the rudder pedal force shall not reverse. Sufficient bank shall accompany sideslipping to prevent departure from a constant heading. Rapid entry into or recovery from a maximum sideslip shall not result in uncontrollable flight characteristics.]

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

(b) *Two-control (or simplified) airplanes.*

(1) The directional stability shall be shown to be adequate by demonstrating that the airplane in all configurations can be rapidly rolled from a 45-degree bank to a 45-degree bank in the opposite direction without exhibiting dangerous skidding characteristics.

(2) Lateral stability shall be shown to be adequate by demonstrating that the airplane will not assume a dangerous attitude or speed when all the controls are abandoned for a period of 2 minutes. This demonstration shall be made in moderately smooth air with the airplane trimmed for straight level flight at 0.9 V_h (or at V_c, if lower), flaps and gear retracted, and with rearward center of gravity loading.

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

3.118–1 Deleted.

(Supp. 1, 12 F.R. 3435, May 28, 1947, as amended (24 F.R. 7065, Sept. 1, 1959, eff. Oct. 1, 1959) by Amdt. 1, 14 F.R. 36, Jan. 5, 1949.)

3.118–2 *Large displacements of flight controls in directional and lateral stability tests (FAA policies which apply to sec. 3.118).*

(a) In performing flight tests to determine compliance with section 3.118, it should be borne in mind that the airplane structural requirements do not provide for large displacements of the flight controls at high speeds. Full application of rudder and aileron controls should be confined to speeds below the design maneuvering speed V_P. The following rules (approximations) will serve as a guide for the maximum permissible control surface deflections at speeds above V_P. (This does not imply that these maximum deflections must be used in the tests at high speeds.)

(1) The permissible rudder angle decreases approximately according to the ratio $(V_P/V)^2$, where V is the speed of the test.

(2) The permissible aileron deflection decreases approximately at the ratio (V_P/V) up to the design cruising speed, V_c. Above V_c, the permissible aileron deflection decreases at a faster rate.

(b) Thus, in a typical case, assuming V_p is 141 mph, V_c is 200 mph, and V_{NE} is 250 mph:

	V_c	V_{NE}
Permissible rudder deflection	50%	32%
Permissible aileron deflection	70%	32%

where 100 percent is the deflection obtainable at V_p.

(c) Control movements should be made smoothly and sudden reversals avoided.

(Supp. 10, 16 F.R. 3284, Apr. 14, 1951.)

Stalls

3.120 *Stalling demonstration.*

(a) Stalls shall be demonstrated under two conditions:

(1) With power off, and

(2) With a power setting of not less than that required to show compliance with the provisions of section 3.85(a) for airplanes of more than 6,000 pounds maximum weight, or with 90 percent of maximum continuous power for airplanes of 6,000 pounds or less maximum weight.

(b) In either condition required by paragraph (a) of this section it shall be possible, with flaps and landing gear in any position, with center of gravity in the position least favorable for recovery, and with appropriate airplane weights, to show compliance with the applicable requirements of paragraphs (c) through (f) of this section.

(c) For airplanes having independently controlled rolling and directional controls, it shall 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 until the time the airplane pitches in the maneuver prescribed in paragraph (g) of this section.

(d) For two-control airplanes having either interconnected lateral and directional controls or for airplanes having only one of these controls, it shall be possible to produce and to correct roll by unreversed use of the rolling control without producing excessive yaw up until the time the airplane pitches in the maneuver prescribed in paragraph (g) of this section.

(e) During the recovery portion of the maneuver, it shall be possible to prevent more than 15 degrees roll or yaw by the normal use of controls, and any loss of altitude in excess of 100 feet or any pitch in excess of 30 degrees below level shall be entered in the Airplane Flight Manual.

(f) A clear and distinctive stall warning shall precede the stalling of the airplane, with the flaps and landing gear in any position, both in straight and turning flight. The stall warning shall begin at a speed exceeding that of stalling by not less than 5 but not more than 10 miles per hour and shall continue until the stall occurs.

(g) In demonstrating the qualities required by paragraphs (c) through (f) of this section, the procedure set forth in subparagraphs (1) and (2) of this paragraph shall be followed.

[(1) With trim controls adjusted for straight flight at $1.5V_{S_1}$ or at the minimum trim speed, whichever is higher, the speed shall be reduced by means of the elevator control until the speed is slightly above the stalling speed; then]

(2) The elevator control shall be pulled back at a rate such that the airplane speed reduction does not exceed 1 mile per hour per second until a stall is produced as evidenced by an uncontrollable downward pitching motion of the airplane, or until the control reaches the stop. Normal use of the elevator control for recovery shall be allowed after such pitching motion has unmistakably developed.

3.120–1 *Measuring loss of altitude during stall (FAA policies which apply to sec. 3.120).* To meet the requirements of section 3.120, pertaining to the maximum loss of altitude permitted during the stall, it is necessary that a suitable method be used for the purpose of measuring such loss during the investigation of stalls. Unless special features of an individual type being investigated render the following instructions inapplicable, the procedure described shall be used for this purpose:

(a) The standard procedure for approaching a stall shall be used as specified in section 3.120.

(b) The loss of altitude encountered in the stall (power on or power off) shall be the distance as observed on the sensitive altimeter testing installation from the moment the airplane pitches to the observed altitude reading at which horizontal flight has been regained.

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(c) Power used during the recovery portions of a stall maneuver may be that which, at the discretion of the inspector, would be likely used by a pilot under normal operating conditions when executing this particular maneuver. However, the power used to regain level flight shall not be applied until the airplane has regained flying control at a speed of approximately 1.2 V_{s1}. This means that in the investigation of stalls with the critical engine inoperative, the power may be reduced on the operating engine(s) before reapplying power on the operating engine or engines for the purpose of regaining level flight.

(Supp. 1, 12 F.R. 3435, May 28, 1947, as amended by Amdt. 1, 14 F.R. 36, Jan. 5, 1949.)

3.120-2 *Indications of stall warnings (FAA policies which apply to sec. 3.120).*

(a) No precise and complete description of the various warnings that would comply with section 3.120 can be given at this time, but the following lists of items may be used as a guide:

(1) Satisfactory items include:

(i) Buffeting, which may be defined as general shaking or vibration of the airplane, elevator nibble, aileron nibble, rudder nibble, audible indications such as oil canning of structural members or covering roughness in riding qualities of the airplanes due to aerodynamic disturbances, etc.

(ii) Stall warning instrument, either visual or aural. A visual instrument could be either a light or a dial.

(iii) Stick force, defined as heavy.

(iv) Stick travel to hold attitude.

(v) Stick position.

3.382–1 *Openable window or openable portion of the windshield (FAA interpretations which apply to sec. 3.382).*

(a) The third sentence of section 3.382 is interpreted to mean that an openable window, or an openable portion of the windshield is required only when the windshield does not remain, or is not maintained (by means of windshield wipers or other devices) in a clean condition during a moderate rain.

(b) If deflectors or other means are provided, so that the elements do not fully impair the pilot's ability to see when an openable window, or a movable portion of the windshield is open, then the pilot should have an adequate view during the rain condition of the flight path in normal flight and landing with these deflectors or other devices installed (and, if applicable, in any position within the limits of adjustability).

(Supp. 10, 16 F.R. 3289, Apr. 14, 1951.)

3.382–2 *Pilot vision in rain conditions (FAA interpretations which apply to sec. 3.382).* The means for providing vision during flight in rain conditions should permit the pilot to view both the normal flight path and the instrument panel without difficulty or excessive head movement.

3.383 *Windshields, windows, and canopies.*

(a) All internal glass panes shall be of a nonsplintering safety type.

(b) The design of windshields, windows, and canopies on pressurized airplanes shall be based on factors peculiar to high altitude operation. (See also sec. 3.394.)

NOTE: Factors peculiar to high altitude operation normally include the effect of continuous and cyclic pressurization loadings, the inherent characteristics of the material used, the effects of temperatures and temperature gradients, etc.

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

3.383–1 *Plexiglas windshields and windows (FAA policies which apply to sec. 3.383).* A plastic material such as plexiglas is considered to be a nonsplintering material and can be used in windshields and widows.

(Supp. 10, 16 F.R. 3290, Apr. 14, 1951.)

3.384 ***Cockpit controls.***

(a) All cockpit controls shall be so located and, except for those the function of which is obvious, identified as to provide convenience in operation including provisions to prevent the possibility of confusion and consequent inadvertent operation. (See Fig. 3–14 for required sense of motion of cockpit controls.) The controls shall be so located and arranged that when seated it will be readily possible for the pilot to obtain full and unrestricted movement of each control without interference from either his clothing or the cockpit structure.

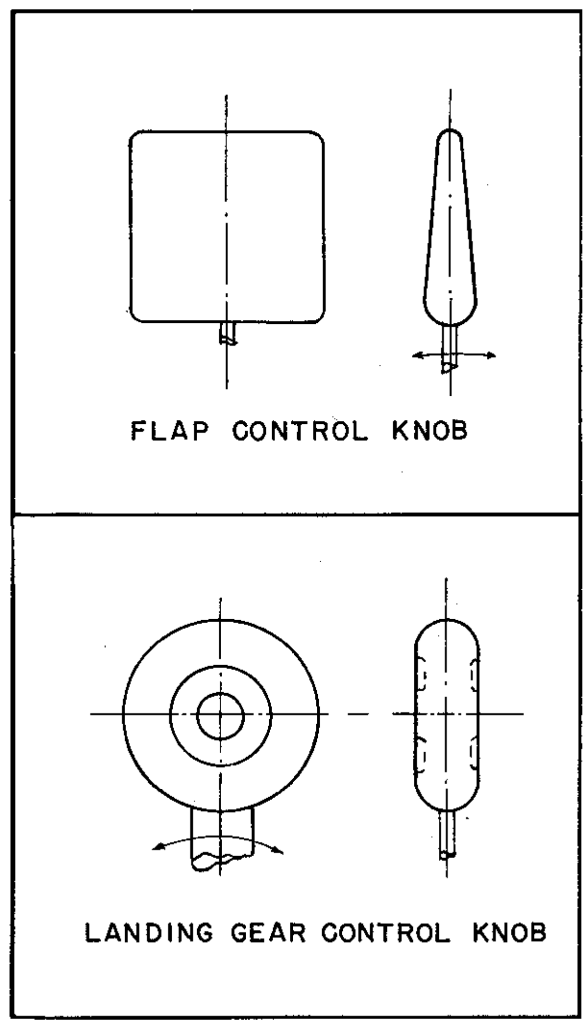

Figure 3–13.—Control knob shapes.

(b) Identical powerplant controls for the several engines in the case of multiengine airplanes shall be so located as to prevent any misleading impression as to the engines to which they relate.

[(c) The wing flap and landing gear controls shall comply with the following:

[(1) The wing flap or auxiliary lift device control shall be located centrally or to the right of the pedestal centerline or of the powerplant throttle control centerline and shall be sufficiently displaced from the landing gear control to avoid confusion.

[(2) The landing gear control shall be located to the left of the throttle centerline or of the pedestal centerline.

[(3) The control knobs shall be shaped in accordance with figure 3–13.]

NOTE: Figure 3–13 is not intended to indicate the exact size or proportion of the control knobs.

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

Figure 3–14.—Cockpit controls.

3.385 *Instruments and markings.* See section 3.661 relative to instrument arrangement. The operational markings, instructions, and placards required for the instruments and controls are specified in sections 3.756 to 3.765.

Emergency Provisions

3.386 *Protection.* The fuselage shall be designed to give reasonable assurance that each occupant, if he makes proper use of belts or harness for which provisions are made in the design, will not suffer serious injury during minor crash conditions as a result of contact of any vulnerable part of his body with any penetrating or relatively solid object, although it is accepted that parts of the airplane may be damaged.

(a) The ultimate accelerations to which occupants are assumed to be subjected shall be as follows:

	N, U	A
Upward	3.0*g*	4.5*g*
Forward	9.0*g*	9.0*g*
Sideward	1.5*g*	1.5*g*

(b) For airplanes having retractable landing gear, the fuselage in combination with other portions of the structure shall be designed to afford protection of the occupants in a wheels-up landing with moderate descent velocity.

(c) If the characteristics of an airplane are such as to make a turnover reasonably probable, the fuselage of such an airplane in combination with other portions of the structure shall be designed to afford protection of the occupants in a complete turnover.

NOTE: In section 3.386 (b) and (c), a vertical ultimate acceleration of 3*g* and a friction coefficient of 0.5 at the ground may be assumed.

(d) The inertia forces specified for N, U, and A category airplanes in paragraph (a) of this section shall be applied to all items of mass which would be apt to injure the passengers or crew if such items became loose in the event of a minor crash landing, and the supporting structure shall be designed to restrain these items.

3.386–1 *Crash protection (FAA interpretations which apply to sec. 3.386).*

(a) Cockpit arrangements and collapse of cabin structure have been found to cause excessive injuries in crashes. Close study of crash results shows that the human body, when properly supported, can tolerate crash forces which exceed those necessary to demolish contemporary aircraft structure.

(b) The following points are of general significance:

(1) Many survivable accidents are "fatal" because of insufficient design consideration when mocking up the cabin and its installation.

(2) The torso is rarely exposed to dangerous injury when the safety belts hold and control wheels provide reasonable support for the chest.

(3) Fractures of the extremities occur in severe crashes but are not normally regarded as dangerous injuries.

(4) Head injuries are the principal cause of crash fatalities. Increased protection for the head can be provided by elimination, shielding, or redesigning of elements of the cabin which permit solid head blows in a crack-up, such as turnovers during a bad landing.

(c) In view of the fact that injuries and fatalities in many moderate and severe accidents are purely mechanical results of poor cockpit design, the following guide rules for design are suggested:

(1) Typical injurious objects, from the standpoint of crash injury, are listed as follows:

(i) Those which present a hard surface and are so attached or have sufficient mass to produce a severe impact when struck by the head or other vulnerable part of the body as it swings forward under the specified inertia forces.

(ii) Those which present corners, knobs, or similar projections which are likely to penetrate a vulnerable part of the body, even when the impact forces are not as high as in paragraph (a) of this section.

(2) A flat or curved sheet metal panel which will dent upon impact by the head is not considered dangerous, whereas a magnetic compass case having appreciable mass and a rigid mounting might cause fatal head injuries.

(3) Heavy transverse braces or other structures immediately behind a light instrument panel have changed many accident reports from "Instrument panel depressed six inches by pilot's head" to "Fatal head injury; depressed fracture of the skull." Pilot's chances can be greatly improved by spacing solid braces several inches behind the ductile skirt of an instrument panel.

(4) The solid tubing used as a backrest of the front seats of tandem aircraft is a set-up for excessive head injury. The suggestion has been made that backs of forward seats be allowed to pivot forward so that the head of the occupant of the rearward set would not contact the solid members when the body pivots about the belt.

(5) Panels should be smooth, with top edge curved in a substantial radius.

(6) Apertures for instruments should preferably have bevelled instead of sharp edges.

(7) In personal aircraft, every consideration should be given to holding the body by adequate safety belt installations, and by the support which can be provided in control wheels and instrument panels. The present "1000 pound" safety belts have failed in a high percentage of accidents without causing internal injuries or bruising of the hips. In failing, the have exposed the pilot to excessive injuries.

(8) Control wheels should be designed to provide broad areas of support for the chest. Wheels which break under heavy loads from the hands or deform to permit contact between the chest and a small hub, localize force and set up chances of unnecessary chest injury.

(Supp. 10, 16 F.R. 3290, Apr. 14, 1951.)

3.387 *Exits.*

(a) Closed cabins on airplanes carrying more than 5 persons shall be provided with emergency exits consisting of movable windows or panels or of additional external doors which provide a clear and unobstructed opening, the minimum dimensions of which shall be such that a 19-by-26-inch ellipse may be completely inscribed therein. The exits shall be readily accessible, shall not require exceptional agility of a person using them, and shall be distributed

sure differential valves and of the emergency release valve.

(2) All parts of the pressurization system shall be tested to show proper functioning under all possible conditions of pressure, temperature, and moisture up to the maximum altitude selected for certification.

(3) Flight tests shall be conducted to demonstrate the performance of the pressure supply, pressure and flow regulators, indicators, and warning signals in steady and stepped climbs and descents at rates corresponding with the maximum attainable without exceeding the operating limitations of the airplane up to the maximum altitude selected for certification.

(4) All doors and emergency exits shall be tested to ascertain that they operate properly after being subjected to the flight tests prescribed in subparagraph (3) of this paragraph.

Miscellaneous

3.401 ***Leveling marks.*** **Leveling marks shall be provided for leveling the airplane on the ground.**

Subpart E—Powerplant Installations; Reciprocating Engines

General

3.411 ***Components.***

(a) The powerplant installation shall be considered to include all components of the airplane which are necessary for its propulsion. It shall also be considered to include all components which affect the control of the major propulsive units of which affect their continued safety of operation.

(b) All components of the powerplant installation shall be constructed, arranged, and installed in a manner which will assure the continued safe operation of the airplane and powerplant. Accessibility shall be provided to permit such inspection and maintenance as is necessary to assure continued airworthiness.

3.411-1 *Powerplant installation components (FAA interpretations which apply to sec. 3.411).* The term "all components" includes engines and propellers and their parts, appurtenances, and accessories which are furnished by the engine or propeller manufacturer and all other components of the powerplant installation which are furnished by the airplane manufacturer. For example: fuel pumps, lines, valves, and other components of the fuel system which are integral parts of the type certificated engine are also components of the airplane powerplant installation.

(23 F.R. 9018, Nov. 20, 1958, effective Dec. 22, 1958.)

Engines and Propellers

3.415 ***Engines.*** **Engines installed in certificated airplanes shall be of a type which has been certificated in accordance with the provisions of Part 13 of this subchapter.**

3.416 ***Propellers.***

(a) Propellers installed in certificated airplanes shall be of a type which has been certificated in accordance with the provisions of Part 14 of this subchapter.

(b) The maximum engine power and propeller shaft rotational speed permissible for use in the particular airplane involved shall not exceed the corresponding limits for which the propeller has been certificated.

[(c) When propeller control design permits stopping of crankshaft rotation of any engine in flight by feathering the propeller, means shall be provided for unfeathering each propeller individually in flight.]

3.417 ***Propeller vibration.*** **In the case of propellers with metal blades or other highly stressed metal components, the magnitude of the critical vibration stresses under all normal conditions of operation shall be determined by actual measurements or by comparison with similar installations for which such measurements have been made. The vibration stresses thus determined shall not exceed values which have been demonstrated to be safe for continuous operation. Vibration tests may be waived and the propeller installation accepted on the basis of service experience, engine or ground tests which show adequate margins of safety, or other considerations which satisfactorily substantiate its safety in this respect. In addition to metal propellers, the Administrator may require that similar substantiation of the vibration characteristics be accomplished**

for other types of propellers, with the exception of conventional fixed-pitch wood propellers.

3.418 ***Propeller pitch and speed limitations.*** **The propeller pitch and speed shall be limited to values which will assure safe operation under all normal conditions of operation and will assure compliance with the performance requirements specified in sections 3.81–3.86.**

3.419 ***Speed limitations for fixed-pitch propellers, ground adjustable pitch propellers, and automatically varying pitch propellers which cannot be controlled in flight.***

(a) During takeoff and initial climb at best rate-of-climb speed, the propeller, in the case of fixed-pitch or ground adjustable types, shall restrain the engine to a speed not exceeding its maximum permissible takeoff speed and, in the case of automatic variable-pitch types, shall limit the maximum governed engine revolutions per minute to a speed not exceeding the maximum permissible takeoff speed. In demonstrating compliance with this provision the engine shall be operated at full throttle or the throttle setting corresponding to the maximum permissible takeoff manifold pressure.

(b) During a closed throttle glide at the placard, "never-exceed speed" (see sec. 3.739), the propeller shall not cause the engine to rotate at a speed in excess of 110 percent of its maximum allowable continuous speed.

3.419–1 *Propeller pitch and speed limitations (FAA interpretations which apply to sec. 3.419).*

(a) The low pitch setting should comply with section 3.419(a) which states that the propeller shall not exceed the rated engine takeoff r.p.m. with takeoff power (full throttle unless limited by manifold pressure) during takeoff and initial climb at best rate of climb speed. It is not permissible to use a lower pitch setting than that specified above in order to obtain takeoff r.p.m. at the best angle of climb speed for the purpose of showing compliance with section 3.85(c), Balked Landing Conditions. An exception to the above may be granted in the specific case covered by section 3.85–5 when satisfactory engine cooling can be demonstrated at the best angle of climb speed in the balked landing configuration (sec. 3.85(c)). However, in cases where the interpretation of section 3.85 does not govern, it will be necessary to conduct the balked landing climb with whatever r.p.m. is possible without exceeding the engine takeoff limitations with the low pitch setting determined in accordance with section 3.419(a).

(b) In cases where the airplane is to be operated using either the water injection or dry takeoff power ratings of the engines, the low pitch stop setting shall be determined on the basis of whichever rating will result in the lower pitch. This will generally be the "dry" rating. In instances where the airplane is intended to be operated only at the water injection takeoff power ratings of the engines, the low pitch stop for the propellers should be determined on that basis. These settings are to be determined in the usual manner with the airplane static unless there are unconventional features in the propeller installation requiring this determination by some other means.

(c) In cases where dual engines drive a single propeller through free wheeling clutches, the setting of the low pitch stop should be such that the propeller will not overspeed when takeoff power is applied to one engine at an airplane speed of V_2.

(Supp. 10, 16 F. R. 3291, Apr. 14, 1951.)

3.420 ***Speed and pitch limitations for controllable pitch propellers without constant speed controls.*** **The stops or other means incorporated in the propeller mechanism to restrict the pitch range shall limit (a) the lowest possible blade pitch to a value which will assure compliance with the provisions of section 3.419 (a), and (b) the highest possible blade pitch to a value not lower than the flattest blade pitch with which compliance with the provisions of section 3.419(b) can be demonstrated.**

3.421 ***Variable pitch propellers with constant speed controls.***

(a) Suitable means shall be provided at the governor to limit the speed of the propeller. Such means shall limit the maximum governed engine speed to a value not exceeding its maximum permissible takeoff revolutions per minute.

(b) The low pitch blade stop, or other means incorporated in the propeller mechanism to restrict the pitch range, shall limit the speed of

the engine to a value not exceeding 103 percent of the maximum permissible takeoff revolutions per minute under the following conditions:

(1) Propeller blades set in the lowest possible pitch and the governor inoperative.

(2) Engine operating takeoff manifold pressure with the airplane stationary and with no wind.

3.422 *Propeller clearance.* With the airplane loaded to the maximum weight and most adverse center of gravity position and the propeller in the most adverse pitch position, propeller clearances shall not be less than the following, unless smaller clearances are properly substantiated for the particular design involved:

(a) *Ground clearance.*

(1) Seven inches (for airplanes equipped with nose wheel type landing gears) or 9 inches (for airplanes equipped with tail wheel type landing gears) with the landing gear statically deflected and the airplane in the level, normal takeoff, or taxiing attitude, whichever is most critical.

(2) In addition to subparagraph (1) of this paragraph, there shall be positive clearance between the propeller and the ground when, with the airplane in the level takeoff attitude, the critical tire is completely deflated and the corresponding landing gear strut is completely bottomed.

(b) *Water clearance.* A minimum clearance of 18 inches shall be provided unless compliance with section 3.147 can be demonstrated with lesser clearance.

(c) *Structural clearance.*

(1) One inch radial clearance between the bladetips and the airplane structure, or whatever additional radial clearance is necessary to preclude harmful vibration of the propeller or airplane.

(2) One-half inch longitudinal clearance between the propeller blades or cuffs and stationary portions of the airplane. Adequate positive clearance shall be provided between other rotating portions of the propeller or spinner and stationary portions of the airplane.

3.422–1 *Propeller clearance on tricycle gear airplanes (FAA interpretations which apply to sec. 3.422(a)(1)).* In determining minimum propeller clearance for aircraft equipped with tricycle gear, dynamic effects need not be considered.

(Supp. 10, 16 F.R. 3291, Apr. 14, 1951.)

3.422–2 *Propeller clearance on aircraft with leaf spring type shock struts (FAA interpretations which apply to sec. 3.422(a)(2)).* Section 3.422(a)(2) applies only to conventional landing gear struts employing fluid and for mechanical means for absorbing landing shocks. For aircraft employing struts of the leaf spring type, a deflection corresponding to 1.5g should be used to determine whether positive clearance exists.

(Supp. 10, 16 F.R. 3291, Apr. 14, 1951.)

Fuel System

3.429 *General.* The fuel system shall be constructed and arranged in a manner to assure the provision of fuel to each engine at a flow rate and pressure adequate for proper engine functioning under all normal conditions of operation, including all maneuvers and acrobatics for which the airplane is intended.

Arrangement

3.430 *Fuel system arrangement.* Fuel systems shall be so arranged as to permit any one fuel pump to draw fuel from only one tank at a time. Gravity feed systems shall not supply fuel to any one engine from more than one tank at a time unless the tank air spaces are interconnected in such a manner as to assure that all interconnected tanks will feed equally. (See also sec. 3.439.)

3.431 *Multiengine fuel system arrangement.*

(a) The fuel systems of multiengine airplanes shall be arranged to permit operation in at least one configuration in such a manner that the failure of any one component except the fuel tanks will not result in the loss of power of more than one engine and will not require immediate action by the pilot to prevent the loss of power of more than one engine. Unless other provisions are made to comply with this requirement, the fuel system shall be arranged to permit supplying fuel to each engine through a system entirely independent of any portion of the system supplying fuel to the other engines.

[(b) If multiengine aircraft employ a single fuel tank or series of fuel tanks interconnected to function as a single fuel tank, the following provisions shall apply:

[(1) Independent tank outlets to each engine. Each outlet shall incorporate a shutoff valve at the tank. This valve may also serve as the fire wall shutoff valve required by section 3.551 provided the line between the valve and the engine compartment does not contain a hazardous amount of fuel which can drain into the engine compartment.

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

[(3) Filler cap(s) designed to minimize the possibility of incorrect installation or loss in flight.

[(4) The remainder of the fuel system from the tank outlet to the engine shall be entirely independent of any portion of the system supplying fuel to the other engine(s).]

3.431–1 *Multiengine single tank fuel system (FAA policies which apply to sec. 3.431).* [If the shutoff valve also serves as a firewall shutoff valve, the line between the valve and the engine compartment should not contain more than 1 quart of fuel which can drain into the engine compartment.]

(22 F.R. 4877, July 11, 1957, effective Aug. 1, 1957; as amended in 22 F.R. 7065, Sept. 1, 1959, eff. Oct. 1, 1959.)

3.432 *Pressure cross feed arrangements.* Pressure cross feed lines shall not pass through portions of the airplane devoted to carrying personnel or cargo, unless means are provided to permit the flight personnel to shut off the supply of fuel to these lines, or unless any joints, fittings, or other possible sources of leakage installed in such lines are enclosed in a fuel- and fume-proof enclosure which is ventilated and drained to the exterior of the airplane. Bare tubing need not be enclosed but shall be protected where necessary against possible inadvertent damage.

Operation

3.433 *Fuel flow rate.* The ability of the fuel system to provide the required fuel flow rate and pressure shall be demonstrated when the airplane is in the attitude which represents the most adverse condition from the standpoint of fuel feed and quantity of unusable fuel in the tank. During this test fuel shall be delivered to the engine at the applicable flow rate (see secs. 3.434–3.436) and at a pressure not less than the minimum required for proper carburetor operation. A suitable mock-up of the

not required. Emergency pumps shall be available for immediate use in case of the failure of any other pump. If both the normal pump and emergency pump operate continuously, means shall be provided to indicate to the crew when either pump is malfunctioning.

3.449-1 *Fuel injection pump (FAA interpretations which apply to sec. 3.449(b)).* The phrase "fuel injection pump" means a pump that supplies proper flow and pressure conditions for fuel injection[7a1] when such injection is not accomplished in a carburetor.

(23 F.R. 7481, Sept. 26, 1958, effective Oct. 20, 1958.)

Lines, Fittings, and Accessories

3.550 *Fuel system lines and fittings.* (See sec. 3.638.)

(a) Fuel lines shall be installed and supported to prevent excessive vibration and to withstand loads due to fuel pressure and due to accelerated flight conditions.

(b) Fuel lines which are connected to components of the airplane between which relative motion could exist shall incorporate provisions for flexibility.

(c) Provisions for flexibility in fuel lines which may be under pressure and subjected to axial loading shall employ flexible hose assemblies rather than hose-clamp connections.

(d) Flexible hose shall be of an approved type or shall be shown to be suitable for the particular application.

(e) Flexible hoses which might be adversely affected by exposure to high temperatures shall not be employed in locations where excessive temperatures will exist during operation or after engine shutdown.

3.551 *Fuel valves.*

(a) Means shall be provided to permit the flight personnel to shut off rapidly the flow of fuel to any engine individually in flight. Valves provided for this purpose shall be located on the side of the fire wall most remote from the engine.

[(b) Means shall be provided to guard against inadvertent operation of the shutoff valves and to make it possible for the flight personnel to reopen the valves rapidly after they have been closed.]

(c) Valves shall be provided with either positive stops or "feel" in the on and off positions and shall be supported in such a manner that loads resulting from their operation or from accelerated flight conditions are not transmitted to the lines connected to the valve. Valves shall be so installed that the effect of gravity and vibration will tend to turn their handles to the open rather than the closed position.

(d) Fuel valve handles and their connections to the valve mechanism shall incorporate design features to minimize the possibility of incorrect installation.

3.552 *Fuel strainer.* A fuel strainer shall be provided between the fuel tank outlet and the carburetor inlet. If an engine-driven fuel pump is provided, the strainer shall be located between the tank outlet and the engine-driven pump inlet. The strainer shall be accessible for drainage and cleaning, and the strainer screen shall be removable.

Drains and Instruments

3.553 *Fuel system drains.* Drains shall be provided to permit safe drainage of the entire fuel system and shall incorporate means for locking in the closed position. The provisions for drainage shall be effective in the normal ground attitude.

3.554 *Fuel system instruments.* (See sec. 3.655 and secs. 3.670 through 3.673.)

Oil System

3.561 *Oil system.* Each engine shall be provided with an independent oil system capable of supplying the engine with an ample quantity of oil at a temperature not exceeding the maximum which has been established as safe for continuous operation. The usable oil tank capacity shall 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 assure adequate system circulation and cooling.

[7a1] Fuel injection is a special form of carburetion: the charging of air or gas with volatile carbon compounds. It is either an intermittent charging of air by discrete, metered quantities of fuel such as occurs in a Diesel cylinder or it is a continuous charging of air by fuel, the fuel flow being proportioned to the airflow through the engine Examples of continuous injection are injections into the supercharger section of a reciprocating engine or into the combustion chambers of a turbine engine.

3.561-1 *"Capacity" (FAA interpretations which apply to sec. 3.561)*. The word "capacity" as used in section 3.561 is interpreted by the Administrator as follows:

(a) Only the usable fuel system capacity need be considered.

(b) In a conventional oil system (no transfer system provided) only the usable oil tank capacity shall be considered. The quantity of oil in the engine oil lines, the oil radiator, or in the feathering reserve shall not be included. When an oil transfer system is installed, and the transfer pump is so located that it can pump some of the oil in the transfer lines into the main engine oil tanks, the quantity of oil in these lines which can be pumped by the transfer pump may be added to the oil capacity.

(Supp. 1, 12 F.R. 3438, May 28, 1947, as amended by Amdt. 1, 14 F.R. 36, Jan. 5, 1949.)

3.562 *Oil cooling*. See section 3.581 and pertinent sections.

Oil Tanks

3.563 *Oil tanks.* Oil tanks shall be capable of withstanding without failure all vibration, inertia, and fluid loads to which they might be subjected in operation. Flexible oil tank liners shall be of an acceptable type.

3.564 *Oil tank tests.* Oil tank tests shall be the same as fuel tank tests (see sec. 3.441), except as follows:

(a) The applied pressure shall be 5 p.s.i. for all tank constructions instead of those specified in section 3.441(a).

(b) In the case of tanks with nonmetallic liners, the test fluid shall be oil rather than fuel as specified in section 3.441(d) and the slosh test on a specimen liner shall be conducted with oil at a temperature of 250° F.

3.565 *Oil tank installation.* Oil tank installations shall comply with the requirements of section 3.442 (a) and (b).

3.566 *Oil tank expansion space.* Oil tanks shall be provided with an expansion space of not less than 10 percent of the tank capacity or ½ gallon, whichever is greater. It shall not be possible inadvertently to fill the oil tank expansion space when the airplane is in the normal ground attitude.

3.567 *Oil tank filler connection.* Oil tank filler connections shall be marked as specified in section 3.767.

3.568 *Oil tank vent.*

(a) Oil tanks shall be vented to the engine crankcase from the top of the expansion space in such a manner that the vent connection is not covered by oil under any normal flight conditions. Oil tank vents shall be so arranged that condensed water vapor which might freeze and obstruct the line cannot accumulate at any point.

(b) *Category A.* Provision shall be made to prevent hazardous loss of oil during acrobatic maneuvers including short periods of inverted flight.

3.569 *Oil tank outlet.* The oil tank outlet shall not be enclosed or covered by any screen or other guard which might impede the flow of oil. The diameter of the oil tank outlet shall not be less than the diameter of the engine oil pump inlet. (See also sec. 3.577.)

Lines, Fittings, and Accessories

3.570 *Oil system lines, fittings, and accessories.* Oil lines shall comply with the provisions of section 3.550, except that the inside diameter of the engine oil inlet and outlet lines shall not be less than the diameter of the corresponding engine oil pump inlet and outlet.

3.571 *Oil valves.* See section 3.637.

3.572 *Oil radiators.* Oil radiators and their support shall be capable of withstanding without failure any vibration, inertia, and oil pressure loads to which they might normally be subjected.

3.573 *Oil filters.* If the engine is equipped with an oil filter, the filter shall be constructed and installed in such a manner that complete blocking of the flow through the filter element will not jeopardize the continued operation of the engine oil supply system.

3.574 *Oil system drains.* Drains shall be provided to permit safe drainage of the entire oil system and shall incorporate means for positive locking in the closed position.

3.575 *Engine breather lines.*

(a) Engine breather lines shall be so arranged that condensed water vapor which

might freeze and obstruct the line cannot accumulate at any point. Breathers shall discharge in a location which will not constitute a fire hazard in case foaming occurs and so that oil emitted from the line will not impinge upon the pilot's windshield. The breather shall not discharge into the engine air induction system.

(b) *Category A.* In the case of acrobatic type airplanes, provision shall be made to prevent excessive loss of oil from the breather during acrobatic maneuvers including short periods of inverted flight.

3.576 *Oil system instruments.* See sections 3.655, 3.670, 3.671, and 3.674.

3.577 *Propeller feathering system.* If the propeller feathering system is dependent upon the use of the engine oil supply, provision shall be made to trap a quantity of oil in the tank in case the supply becomes depleted due to failure of any portion of the lubricating system other than the tank itself. The quantity of oil so trapped shall be sufficient to accomplish the feathering operation and shall be available only to the feathering pump. The ability of the system to accomplish feathering when the supply of oil has fallen to the above level shall be demonstrated.

Cooling

3.581 *General.* The powerplant cooling provisions shall be capable of maintaining the temperatures of all powerplant components, engine parts, and engine fluids (oil and coolant), at or below the maximum established safe values under critical conditions of ground and flight operation.

Tests

3.582 *Cooling tests.* Compliance with the provisions of section 3.581 shall be demonstrated under critical ground, water, and flight operating conditions. If the tests are conducted under conditions which deviate from the highest anticipated summer air temperature (see sec. 3.583), the recorded powerplant temperatures shall be corrected in accordance with the provisions of sections 3.584 and 3.585. The corrected temperatures determined in this manner shall not exceed the maximum established safe values. The fuel used during the cooling tests shall be of the minimum octane number approved for the engines involved, and the mixture settings shall be those appropriate to the operating conditions. The test procedures shall be as outlined in sections 3.586 and 3.587.

3.582–1 *Water taxiing tests (FAA interpretations which apply to sec. 3.582).* No water taxiing tests need be conducted on aircraft certificated under this part, except in the case of flying boats which may reasonably be expected to be taxied for extended periods.

(Supp. 10, 16 F.R. 3291, Apr. 14, 1951.)

3.583 *Maximum anticipated summer air temperatures.* The maximum anticipated summer air temperature shall be considered to be 100° F. at sea level and to decrease from this value at the rate of 3.6° F. per thousand feet of altitude above sea level.

3.583–1 *Powerplant winterization equipment (FAA interpretations which apply to sec. 3.583).*

(a) Cooling test results for winterization installations may be corrected to any temperature desired by the manufacturer rather than the conventional 100° F. hot day. For example, if a manufacturer chooses to demonstrate cooling to comply with requirements for a 50° or 60° F. day with winterization equipment installed, he may do so. In such a case the sea level temperature for correction purposes should be considered to be the value elected by the manufacturer with a rate of temperature drop of 3.6° F. per thousand feet above sea level.

(b) Cooling tests and temperature correction methods should be the same as for conventional cooling tests.

(c) The airplane flight manual should clearly indicate that winterization equipment must be removed whenever the temperature reaches the limit for which adequate cooling has been demonstrated. The cockpit should also be placarded accordingly. In addition, the airplane should be equipped with an ambient air temperature gauge or, alternatively, a cylinder head, barrel, or oil inlet temperature gauge (depending upon which is critical).

(d) If practical, winterization equipment such as baffles for oil radiators or for engine cooling air openings should be marked clearly to indicate the limiting temperature at which this equipment should be removed.

(e) Since winterization equipment is often supplied in kit form, accompanied by instructions for its installation, suitable information regarding temperature limitations should be included in the installation instructions for such kits.

(Supp. 10, 16 F.R. 3291, Apr. 14, 1951.)

3.584 *Correction factor for cylinder head, oil inlet, carburetor air, and engine coolant inlet temperatures.* These temperatures shall be corrected by adding the difference between the maximum anticipated summer air temperature and the temperature of the ambient air at the time of the first occurrence of maximum head, air, oil, or coolant temperature recorded during the cooling test.

3.585 *Correction factor for cylinder barrel temperatures.* Cylinder barrel temperatures shall be corrected by adding 0.7 of the difference between the maximum anticipated summer 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 colling test.

3.586 *Cooling test procedure for single-engine airplanes.* The engine cooling tests shall be conducted by stabilizing the engine temperatures in flight with the engines operating at not less than 75 percent of the maximum continuous power rating. After engine temperatures have stabilized, the climb shall be started at the lowest practicable altitude and continued for 1 minute with the engines operating at the take-off rating. At the end of 1 minute, the climb shall be continued at maximum continuous power until at least 5 minutes after the occurrence of the highest temperature recorded. The climb shall not be conducted at a speed greater than the best rate-of-climb speed with maximum continuous power unless:

(a) 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 (see sec. 3.85(a)), and

(b) A cylinder head temperature indicator is provided as specified in section 3.675.

3.587 *Cooling test procedure for multi-engine airplanes.*

(a) *Airplanes which meet the minimum one-engine-inoperative climb performance specified in section 3.85(b).* The engine cooling test for these airplanes shall be conducted with the airplane in the configuration specified in section 3.85(b), except that the operating engine(s) shall be operated at maximum continuous power or at full throttle when above the critical altitude. Temperatures of the operating engines shall be stabilized in flight with the engines operating at not less than 75 percent of the maximum continuous power rating. After stabilizing temperatures in flight, the climb shall be started at the lower of the two following altitudes and shall be continued until at least 5 minutes after the highest temperature has been recorded:

(1) 1,000 feet below the engine critical altitude or at the lowest practicable altitude (when applicable).

(2) 1,000 feet below the altitude at which the single-engine-inoperative rate of climb is $0.02\ V_{s_0}^2$.

The climb shall be conducted at a speed not in excess of the highest speed at which compliance with the climb requirement of section 3.85(b) can be shown. However, if the speed used exceeds the speed for best rate of climb with one engine inoperative, a cylinder head temperature indicator shall be provided as specified in section 3.675.

(b) *Airplanes which cannot meet the minimum one-engine-inoperative climb performance specified in section 3.85(b).* The engine cooling test for these airplanes shall be the same as in paragraph (a) of this section, except that after stabilizing temperatures in flight, the climb (or descent, in the case of airplanes with zero or negative one-engine-inoperative rate of climb) shall be commenced at as near sea level as practicable and shall be conducted at the best rate-of-climb speed (or the speed of minimum rate of descent, in the case of airplanes with zero or negative one-engine-inoperative rate of climb).

3.587–1 *Cooling test procedure for twin-engine aircraft which do not meet the minimum one-engine-inoperative climb performance (FAA in-*

to shut off quickly all ignition on multiengine airplanes, either by grouping of the individual switches or by providing a master ignition control. If a master control is provided, suitable means shall be incorporated to prevent its inadvertent operation.

3.630 *Mixture controls.* If mixture controls are provided, a separate control shall be provided for each engine. The controls shall be grouped and arranged in such a manner as to permit both separate and simultaneous control of all engines.

3.631 *Propeller speed and pitch controls.* (See also sec. 3.421(a).) If propeller speed or pitch controls are provided, the controls shall be grouped and arranged in such a manner as to permit control of all propellers, both separately and together. The controls shall permit ready synchronization of all propellers on multiengine airplanes.

3.632 *Propeller feathering controls.* If propeller feathering controls are provided, a separate control shall be provided for each propeller. Propeller feathering controls shall be provided with means to prevent inadvertent operation.

3.633 *Fuel system controls.* Fuel system controls shall comply with requirements of section 3.551(c).

3.634 *Carburetor air preheat controls.* Separate controls shall be provided to regulate the temperature of the carburetor air for each engine.

Accessories

3.635 *Powerplant accessories.* Engine-driven accessories shall be of a type satisfactory for installation on the engine involved and shall utilize the provisions made on the engine for the mounting of such units. Items of electrical equipment subject to arcing or sparking shall be installed so as to minimize the possibility of their contact with any inflammable fluids or vapors which might be present in a free state.

3.636 *Engine battery ignition systems.*

(a) Battery ignition systems shall be supplemented with a generator which is automatically made available as an alternate source of electrical energy to permit continued engine operation in the event of the depletion of any battery.

(b) The capacity of batteries and generators shall be sufficient to meet the simultaneous demands of the engine ignition system and the greatest demands of any of the airplane's electrical system components which may draw electrical energy from the same source. Consideration shall be given to the condition of an inoperative generator, and to the condition of a completely depleted battery when the generator is running at its normal operating speed. If only one battery is provided, consideration shall also be given to the condition in which the battery is completely depleted and the generator is operating at idling speed.

(c) Means shall be provided to warn the appropriate flight personnel if malfunctioning of any part of the electrical system is causing the continuous discharging of a battery used for engine ignition. (See sec. 3.629 for ignition switches.)

Powerplant Fire Protection

3.637 *Flammable fluids; shutoff means.* The provisions of paragraphs (a) through (d) of this section shall be applicable to multiengine aircraft which are required to comply with the provisions of section 3.85(b).

(a) Means for each individual engine shall be provided for shutting off or otherwise preventing hazardous quantities of fuel, oil, deicer, and other flammable fluids from flowing into, within, or through the engine compartment except that means need not be provided to shut off flow in lines forming an integral part of an engine. Closing the fuel shutoff valve for any engine shall not make any of the fuel supply unavailable to the remaining engines.

(b) Operation of the shutoff means shall not interfere with the subsequent emergency operation of other equipment, such as feathering the propeller.

(c) The shutoff means shall be located outside of the engine compartment unless an equally high degree of safety is otherwise provided. It shall be shown that no hazardous quantity of flammable fluid could drain into the engine compartment after shutting off has been accomplished.

(d) Provisions shall be made to guard against inadvertent operation of the shutoff means and to make it possible for the crew to

reopen the shutoff means in flight after it has once been closed.

3.638 ***Lines and fittings.***

[(a) All lines and fittings carrying flammable fluids in the engine compartment shall be fire resistant, except as otherwise provided in this section. If flexible hose is used, the assembly of hose and end fittings shall be of an approved type. The provisions of this paragraph need not apply to those lines and fittings which form an integral part of the engine.

[(b) Vent and drain lines and their fittings shall be subject to the provisions of paragraph (a) of this section unless a failure of such line or fitting will not result in, or add to, a fire hazard.]

Subpart F—Equipment

3.651 ***General.*** **The equipment specified in section 3.655 shall be the minimum installed when the airplane is submitted to determine its compliance with the airworthiness requirements. Such additional equipment as is necessary for a specific type of operation is specified in other pertinent parts of this subchapter, but, where necessary, its installation and that of the items mentioned in section 3.655 is covered by this part.**

3.652 ***Functional and installational requirements.*** **Each item of equipment which is essential to the safe operation of the airplane shall be found by the Administrator to perform adequately the functions for which it is to be used, shall function properly when installed, and shall be adequately labeled as to its identification, function, operational limitations, or any combination of these, whichever is applicable.**

3.652–1 *Radio equipment and installations (FAA interpretations which apply to sec. 3.652).*[7a]

(a) The phrase "Each item of equipment which is essential to the safe operation of the airplane . . ." includes radio communication and navigation equipment installed on the airplane.

(b) The phrase "shall function properly when installed" is interpreted to mean that the installation shall comply with the requirements specified in section 3.721.

(22 F.R. 135, Jan. 5, 1957, effective Jan. 31, 1957.)

3.652–2 *Radio installation performance (FAA policies which apply to sec. 3.652).* The prototype installation should be flight tested by the airplane manufacturer to determine that it performs the intended function.

(22 F.R. 135, Jan. 5, 1957, effective Jan. 31, 1957.)

Basic Equipment

3.655 ***Required basic equipment.*** **The following table shows the basic equipment required for type and airworthiness certification of an airplane:**

(a) ***Flight and navigational instruments.***

(1) Air-speed indicator (see sec. 3.663).

(2) Altimeter.

(3) Magnetic direction indicator (see sec. 3.666).

(b) ***Powerplant instruments.***

(1) ***For each engine or tank.***

(i) Fuel quantity indicator (see sec. 3.672).

(ii) Oil pressure indicator.

(iii) Oil temperature indicator.

(iv) Tachometer.

(2) ***For each engine or tank (if required in reference section).***

(i) Cylinder head temperature indicator (see sec. 3.675).

(ii) Fuel pressure indicator (if pump-fed engines used).

(iii) Manifold pressure indicator (if altitude engines used).

(iv) Oil quantity indicator (see sec. 3.674).

(c) ***Electrical equipment (if required by reference section).***

(1) Master switch arrangement (see sec. 3.688).

(2) Adequate source(s) of electrical energy (see secs. 3.682 and 3.685).

(3) Electrical protective devices (see sec. 3.690).

(d) ***Miscellaneous equipment.***

(1) Approved safety belts for all occupants (see sec. 3.715).

(2) Airplane Flight Manual if required by section 3.777.

[7a] See sections 3.721 and 3.721–2.

Instruments; Installation

General

3.661 *Arrangement and visibility of instrument installations.*

(a) Flight, navigation, and powerplant instruments for use by each pilot shall be easily visible to him.

(b) On multiengine airplanes, identical powerplant instruments for the several engines shall be so located as to prevent any confusion as to the engines to which they relate.

3.662 *Instrument panel vibration characteristics.* Vibration characteristics of the instrument panel shall not be such as to impair the accuracy of the instruments or to cause damage to them.

Flight and Navigational Instruments

3.663 *Air-speed indicating system.* This system shall be so installed that the air-speed indicator shall indicate true air speed at sea level under standard conditions to within an allowable installational error of not more than plus or minus 3 percent of the calibrated air speed or 5 miles per hour, whichever is greater, throughout the operating range of the airplane with flaps up from V_c to 1.3 V_{s_1} and with flaps down at 1.3 V_{s_1}. The calibration shall be made in flight.

3.664 *Air-speed indicator marking.* The air-speed indicator shall be marked as specified in section 3.757.

3.665 *Static air vent system.* All instruments provided with static air case connections shall be so vented that the influence of airplane speed, the opening and closing of windows, air-flow variation, moisture, or other foreign matter will not seriously affect their accuracy.

3.666 *Magnetic direction indicator.* The magnetic direction indicator shall be so installed that its accuracy shall not be excessively affected by the airplane's vibration or magnetic fields. After the direction indicator has been compensated, the installation shall be such that the deviation in level flight does not exceed 10 degrees on any heading. A suitable calibration placard shall be provided as specified in section 3.758.

3.667 *Automatic pilot system.* If an automatic pilot system is installed, compliance shall be shown with the provisions of paragraphs (a) through (e) of this section.

(a) The system shall be so designed that the automatic pilot can either be quickly and positively disengaged by the human pilot to prevent it from interfering with the control of the airplane, or be overpowered by the human pilot to enable him to control the airplane.

(b) A means shall be provided to indicate readily to the pilot the alignment of the actuating device in relation to the control system which it operates, except when automatic synchronization is provided.

(c) The manually operated control(s) for the system's operation shall be readily accessible to the pilot. Controls shall operate in the same plane and sense of motion as specified for the cockpit controls in section 3.384 and Figure 3-14. The direction of motion shall be plainly indicated on or adjacent to each control.

(d) The automatic pilot system shall be of such design and so adjusted that, within the range of adjustment available to the human pilot, it cannot produce hazardous loads on the airplane or create hazardous deviations in the flight path under any conditions of flight appropriate to its use either during normal operation or in the event of malfunctioning, assuming that corrective action is initiated within a reasonable period of time.

(e) The system design shall be such that a single malfunction will not produce a hardover signal in more than one control axis. When the automatic pilot integrates signals from auxiliary controls or furnishes signals for operation of other equipment, positive interlocks and sequencing of engagement shall be provided to preclude improper operation. Protection against adverse interaction of integrated components resulting from a malfunction shall be provided.

3.668 *Gyroscopic indicators.* All gyroscopic instruments installed in airplanes shall derive their energy from a power source of sufficient capacity to maintain their required accuracy at all airplane speeds above the best rate-of-climb speed. They shall be installed to preclude malfunctioning due to rain, oil, and other detrimental elements. Means shall be provided for indicating the adequacy of the power being supplied to the instruments. In addition, the following provisions shall be applicable to multiengine airplanes:

(a) There shall be provided at least two independent sources of power, a manual or an automatic means for selecting the power source, and a means for indicating the adequacy of the power being supplied by each source.

[NOTE: Power sources are not considered independent if both sources are driven by the same engine.]

(b) The installation and power supply systems shall be such that failure of one instrument or of the energy supply from one source will not interfere with the proper supply of energy to the remaining instruments or from the other source.

3.669 *Flight director instrument.* If a flight director instrument is installed, its installation shall not affect the performance and accuracy of the required instruments. A means for disconnecting the flight director instrument from the required instruments or their installations shall be provided.

Powerplant Instruments

3.670 *Operational markings.* Instruments shall be marked as specified in section 3.759.

3.671 *Instrument lines.* Powerplant instrument lines shall comply with the provisions of section 3.550. In addition, instrument lines carrying inflammable fluids or gases under pressure shall be provided with restricted orifices or other safety devices at the source of the pressure to prevent escape of excessive fluid or gas in case of line failure.

3.672 *Fuel quantity indicator.* Means shall be provided to indicate to the flight personnel the quantity of fuel in each tank during flight. Tanks, the outlets and air spaces of which are interconnected, may be considered as one tank and need not be provided with separate indicators. Exposed sight gauges shall be so installed and guarded as to preclude the possibility of breakage or damage. Sight gauges which form a trap in which water can collect and freeze shall be provided with means to permit drainage on the ground. Fuel quantity gauges shall be calibrated to read zero during level flight when the quantity of fuel remaining in the tank is equal to the unusable fuel supply as defined by section 3.437. Fuel gauges need not be provided for small auxiliary tanks which are used only to transfer fuel to other tanks, provided that the relative size of the tanks, the rate of fuel transfer, and the instructions pertaining to the use of the tanks are adequate to guard against overflow and to assume that the crew will receive prompt warning in case transfer is not being achieved as intended.

3.672-1 *Means to indicate fuel quantity (FAA policies which apply to sec. 3.672).* The Administrator will accept, as a "means to indicate to the flight personnel the quantity of fuel in each tank during flight," a fuel tank calibrated to read in either gallons or pounds, providing the gauge is clearly marked to indicate which scale is being used.

(Supp. 1, 12 F. R. 3438, May 28, 1947, as amended by Amdt. 1, 14 F. R. 36, Jan. 5, 1949.)

3.673 *Fuel flowmeter system.* When a fuel flowmeter system is installed in the fuel line(s), the metering component shall be of such design as to include a suitable means for bypassing the fuel supply in the event that malfunctioning of the metering component offers a severe restriction to fuel flow.

3.674 *Oil quantity indicator.* Ground means, such as a stick gauge, shall be provided to indicate the quantity of oil in each tank. If an oil transfer system or a reserve oil supply system is installed, means shall be provided to indicate to the flight personnel during flight the quantity of oil in each tank.

3.675 *Cylinder head temperature indicating system for air-cooled engines.* A cylinder head temperature indicator shall be provided for each engine on airplanes equipped with cowl flaps. In the case of airplanes which do not have cowl flaps, an indicator shall be provided if compliance with the provisions of section 3.581 is demonstrated at a speed in excess of the speed of best rate of climb.

Electrical Systems and Equipment

3.681 *Installation.*

(a) Electrical systems in airplanes shall be free from hazards in themselves, in their method of operation, and in their effects on

other parts of the airplane. Electrical equipment shall be of a type and design adequate for the use intended. Electrical systems shall be installed in such a manner that they are suitably protected from fuel, oil, water, other detrimental substances, and mechanical damage.

(b) Items of electrical equipment required for a specific type of operation are listed in other pertinent parts of this subchapter.

3.681–1 *Shielding of flare circuits (FAA policies which apply to sec. 3.681).*

Flare circuits should be shielded or separated from other circuits far enough to preclude induction of other current into flare circuit.

(Supp. 10, 16 F. R. 3292, Apr. 14, 1951.)

3.681–2 *Generator capacity (FAA policies which apply to sec. 3.681).* When a generator is required,[7b] its capacity should be sufficient to supply during flight all probable combinations of continuous loads,[7c] with adequate reserve for storage battery charging. In no case should the maximum probable continuous load exceed 80 percent of total generator rating.

(22 F. R. 1025, Feb. 20, 1957, effective Mar. 15, 1957.)

Batteries

3.682 *Batteries.* When an item of electrical equipment which is essential to the safe operation of the airplane is installed, the battery required shall have sufficient capacity to supply the electrical power necessary for dependable operation of the connected electrical equipment.

3.682–1 *Dry-cell batteries (FAA policies which apply to sec. 3.682).* When a battery is installed to provide power for electrical equipment which is essential to the safe operation of the airplane, it should be of a type whose preflight state of charge can readily be determined by simple and reliable means. Dry-cell batteries are not considered to be of this type, and should not be used to supply essential electrical equipment.

3.683 [*Storage battery design and installation.* Storage batteries shall be of such design and be so installed that:

[(a) Safe cell temperatures and pressures are maintained during any probable charging or discharging condition. No uncontrolled increase in cell temperature shall result when the storage battery is recharged (after previous complete discharge) at maximum regulated voltage, during a flight of maximum duration, under the most adverse cooling condition likely to occur in service. Tests to demonstrate compliance with this regulation shall not be required if satisfactory operating experience with similar batteries and installations has shown that maintaining safe cell temperatures and pressures presents no problem.

[(b) Explosive or toxic gases, emitted by the storage battery in normal operation or as the result of any probable malfunction in the charging system or battery installation, shall not accumulate in hazardous quantities within the airplane.

[(c) Corrosive fluids or gases which may be emitted or spilled from the storage battery shall not damage surrounding airplane structure or adjacent essential equipment.]

Generators

3.685 *Generator.* Generators shall be capable of delivering their continuous rated power.

3.686 *Generator controls.*

(a) Generator voltage control equipment shall be capable of dependably regulating the generator output within rated limits.

(b) A generator reverse current cut-out shall be incorporated and designed to disconnect the generator from the battery and other generators when the generator is developing a voltage of such value that current sufficient to cause malfunctioning can flow into the generator.

Instruments

3.687 *Electric power system instruments.* Means shall be provided to indicate to appropriate crew members those electric power system quantities which are essential for the safe operation of the system.

NOTE: For direct current systems an ammeter which can be switched into each generator feeder would be acceptable. When only one generator is installed, the ammeter may be in the battery feeder.

[7b] A generator of adequate capacity is required by section 43.30 (c) (7) of this subchapter for operation under instrument flight rules.

[7c] Continuous loads are those which draw current continuously during flight, such as radio equipment and position lights. Occasional intermittent loads (such as landing gear, flaps, or landing lights) are not considered.

Master Switch

3.688 *Arrangement.* If electrical equipment is installed, a master switch arrangement shall be provided which will disconnect all sources of electrical power from the main distribution system at a point adjacent to the power sources.

3.688–1 *Load circuit connections with respect to master switch (FAA policies which apply to sec. 3.688).* All load circuits should be connected to electric power sources in such manner that the master switch can interrupt service, unless such interruption of service[7d] would result in the inability to maintain controlled flight or to effect a safe landing.

(21 F. R. 3002, May 5, 1956, effective May 25, 1956.)

3.688–2 *Electric stall warning indicator circuit (FAA policies which apply to sec. 3.688).* Electric stall warning indicator circuits, when installed, should be connected to the electric power system in such manner that the master switch can interrupt service. If the indicator is required for type certification as a result of the particular stall characteristics of the airplane, the FAA approved Airplane Flight Manual should contain the information that the stall warning system is inoperative with the master switch open. When such a manual is not required, this information should be displayed on a placard or contained in the manual furnished by the manufacturer as required by section 3.777 (b).

(21 F. R. 3002, May 5, 1956, effective May 25, 1956.)

3.689 *Master switch installation.* The master switch or its controls shall be so installed that it is easily discernible and accessible to a member of the crew in flight.

Protective Devices

3.690 *Fuses or circuit breakers.* If electrical equipment is installed, protective devices (fuses or circuit breakers) shall be installed in the circuits to all electrical equipment, except that such items need not be installed in the main circuits of starter motors or in other circuits where no hazard is presented by their omission.

3.690–1 *Automatic reset circuit breakers (FAA policies which apply to sec. 3.690).* Automatic reset circuit breakers (which automatically reset themselves periodically) should not be applied as circuit protective devices.[8] They may be used as integral protectors for electrical equipment (e. g., thermal cut-outs) provided that circuit protection is also installed to protect the cable to the equipment.

(19 F. R. 8140, Dec. 10, 1954, effective Dec. 15, 1954.)

3.690–2 *Circuit breakers (FAA policies which apply to sec. 3.690).* All resettable type circuit protective devices should be so designed that, when an overload or circuit fault exists, they will open the circuit irrespective of the position of the operating control.[8a]

(21 F. R. 3002, May 5, 1956, effective May 25, 1956.)

3.691 *Protective devices installation.* Protective devices in circuits essential to safety in flight shall be so located and identified that fuses may be replaced or circuit breakers reset readily in flight.

3.692 *Spare fuses.* If fuses are used, one spare of each rating or 50 percent spare fuses of each rating, whichever is greater, shall be provided.

Electric Cables

3.693 *Electric cables.* If electrical equipment is installed, the connecting cables used shall be in accordance with recognized standards for electric cable of a slow burning type and of suitable capacity.

[7d] Interruption of service due to master switch operation may be only temporary. After the master switch is opened (in the event of electrical fire or smoke), service may be restored to a circuit which is essential to safety by first opening all circuit protective devices, then reclosing the master switch and finally reclosing the circuit protective device in the circuit desired.

[8] Circuit protective devices are normally installed to limit the hazardous consequences of overloaded or faulted circuits. These devices are resettable (circuit breakers) or replaceable (fuses) to permit the crew to restore service when nuisance trips occur or when the abnormal circuit condition can be corrected in flight. If the abnormal circuit condition can *not* be corrected in flight, the decision to restore power to the circuit involves a careful analysis of the flight situation. It is necessary to weigh the essentiality of the circuit for continued safe flight against the hazards of resetting on a possibly faulted circuit. Such evaluation is properly an aircraft crew function which cannot be performed by automatic reset circuit breakers. To assure crew supervision over the reset operation, circuit protective devices should be of such design that a manual operation is required to restore service after tripping.

[8a] Circuit protective devices which conform to the above description are known commercially as "trip-free," that is, the tripping mechanism cannot be overridden by the operating control. Such circuit protective devices can be reset on an overload or circuit fault, but will trip subsequently in accordance with their current-time characteristics.

terpretations which apply to sec. 3.587(b)). In order to provide a practicable test procedure for compliance with this requirement, the engine temperatures should be stabilized in flight at the lowest practicable altitude above the ground, with maximum continuous power from the engine on which cooling is being investigated, and with just sufficient power on the other engine to maintain level flight at the speed for minimum rate of descent.

(Supp. 10, 16 F.R. 3292, Apr. 14, 1951.)

Liquid Cooling Systems

3.588 *Independent systems.* Each liquid cooled engine shall be provided with an independent cooling system. The cooling system shall be so arranged that no air or vapor can be trapped in any portion of the system, except the expansion tank, either during filling or during operation.

3.589 *Coolant tank.* A coolant tank shall be provided. The tank capacity shall not be less than 1 gallon plus 10 percent of the cooling system capacity. Coolant tanks shall be capable of withstanding without failure all vibration, inertia, and fluid loads to which they may be subjected in operation. Coolant tanks shall be provided with an expansion space of not less than 10 percent of the total cooling system capacity. It shall not be possible inadvertently to fill the expansion space with the airplane in the normal ground attitude.

3.590 *Coolant tank tests.* Coolant tank tests shall be the same as fuel tank tests (see sec. 3.441), except as follows:

(a) The 3.5 pounds per square inch pressure test of section 3.441(a) shall be replaced by 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.

(b) In the case of tanks with nonmetallic liners, the test fluid shall be coolant rather than fuel as specified in section 3.441(d), and the slosh test on a specimen liner shall be conducted with coolant at operating temperature.

3.591 *Coolant tank installation.* Coolant tanks shall be supported in a manner so as to distribute the tank loads over a large portion of the tank surface. Pads shall be provided to prevent chafing between the tank and the support. Material used for padding shall be nonabsorbent or shall be treated to prevent the absorption of inflammable fluids.

3.592 *Coolant tank filler connection.* Coolant tank filler connections shall be marked as specified in section 3.767. Provisions shall be made to prevent the entrance of spilled coolant into the coolant tank compartment or any portions of the airplane other than the tank itself. Recessed coolant filler connections shall be drained and the drain shall discharge clear of all portions of the airplane.

3.593 *Coolant lines, fittings, and accessories.* Coolant lines shall comply with the provisions of section 3.550, except that the inside diameter of the engine coolant inlet and outlet lines shall not be less than the diameter of the corresponding engine inlet and outlet connections.

3.594 *Coolant radiators.* Coolant radiators shall be capable of withstanding without failure any vibration, inertia, and coolant pressure loads to which they may normally be subjected. Radiators shall be supported in a manner which will permit expansion due to operating temperatures and prevent the transmittal of harmful vibration to the radiator. If the coolant employed is inflammable, the air intake duct to the coolant radiator shall be so located that flames issuing from the nacelle in case of fire cannot impinge upon the radiator.

3.595 *Cooling system drains.* One or more drains shall be provided to permit drainage of the entire cooling system, including the coolant tank, radiator, and the engine, when the airplane is in the normal ground attitude. Drains shall discharge clear of all portions of the airplane and shall be provided with means for positively locking the drain in the closed position. Cooling system drains shall be accessible.

3.596 *Cooling system instruments.* (See secs. 3.655, 3.670, and 3.671.)

Induction System

3.605 *General.*

(a) The engine air induction system shall permit supplying an adequate quantity of air to the enginer under all conditions of operation.

(b) Each engine shall be provided with at least two separate air intake sources, except that in the case of an engine equipped with a fuel injector only one air intake source need be provided, if the air intake, opening, or passage is unobstructed by a screen, filter, or other part on which ice might form and so restrict the air flow as to affect adversely engine operation. It shall be permissible for primary air intakes to open within the cowling only if that portion of the cowling is isolated from the engine accessory section by means of a fire-resistant diaphragm or if provision is made to prevent the emergence of backfire flames. Alternate air intakes shall be located in a sheltered position and shall not open within the cowling unless they are so located that the emergence of backfire flames will not result in a hazard. Supplying air to the engine through the alternate air intake system of the carburetor air preheater shall not result in the loss of excessive power in addition to the power lost due to the rise in the temperature of the air.

3.606 *Induction system de-icing and anti-icing provisions.* The engine air induction system shall incorporate means for the prevention and elimination of ice accumulations in accordance with the provisions in this section. It shall be demonstrated that compliance with the provisions outlined in the following paragraphs can be accomplished when the airplane is operating in air at a temperature of 30° F. when the air is free of visible moisture.

(a) Airplanes equipped with sea level engines employing conventional venturi carburetors shall be provided with a preheater capable of providing a heat rise of 90° F. when the engine is operating at 75 percent of its maximum continuous power.

(b) Airplanes equipped with altitude engines employing conventional venturi carburetors shall be provided with a preheater capable of providing a heat rise of 120° F. when the engine is operating at 75 percent of its maximum continuous power.

(c) Airplanes equipped with altitude engines employing carburetors which embody features tending to reduce the possibility of ice formation shall be provided with a preheater capable of providing a heat rise of 100° F. when the engine is operating at 60 percent of its maximum continuous power. However, the preheater need not provide a heat rise in excess of 40° F. if a fluid de-icing system complying with the provisions of sections 3.607–3.609 is also installed.

(d) [Single-engine] airplanes equipped with sea level engines employing carburetors which embody features tending to reduce the possibility of ice formation shall be provided with a sheltered alternate source of air. The preheat supplied to this alternate air intake shall be not less than that provided by the engine cooling air downstream of the cylinders.

[(e) Multiengine airplanes equipped with sea level engines employing carburetors which embody features tending to reduce the possibility of ice formation shall be provided with a preheater capable of providing a heat rise of 90° F. when the engine is operating at 75 percent of its maximum continuous power.]

3.606–1 *Induction system de-icing provisions (FAA policies which apply to sec. 3.606).*

(a) A series of pressure type carburetors for small engines has been developed which incorporate the feature of injecting fuel into the intake air at a point downstream from the throttle and carburetor venturi. This feature tends to greatly reduce the possibility of ice formation in the engine induction system and the results of extensive tests have demonstrated the carburetors to be relatively free of icing hazards.

(b) In order to outline the limitations of our approval for the elimination of preheat on the carburetors, and to provide what are considered equivalent safety margins the following is stipulated:

(1) This approval applies only to sea level engines of the general power class with which the largest of these pressure carburetors has been tested. No tests have as yet been conducted on any altitude engines. The largest of these carburetors which has been tested at present is a model which is intended for use on engines in the general range of approximately 220 horsepower.

(2) Unless the main carburetor air intake is located in a sheltered position where it is free from impact icing possibilities, a sheltered alternate air intake should be provided even though there is no preheater.

(c) During tests of the non-icing qualities of these carburetors, it was found that in some cases poor idling of the engine was encountered and this was attributed to a possible ice formation in the internal carburetor passage which acts as the air bleed for the main discharge nozzle. As a result, it is necessary to provide a small intensifier tube to supply hot air to the air bleed side of the main discharge nozzle on installation in which the carburetor and a portion of the induction system are exposed to the exterior of the airplane. When the installation is completely cowled, the hot air bleed will not be necessary.

(Supp. 10, 16 F.R. 3292, Apr. 14, 1951.)

3.607 *Carburetor de-icing fluid flow rate.* The system shall be capable of providing each engine with a rate of fluid flow, expressed in pounds per hour, of not less than 2.5 multiplied by the square root of the maximum continuous power of the engine. This flow shall be available to all engines simultaneously. The fluid shall be introduced into the air induction system at a point close to, and upstream from, the carburetor. The fluid shall be introduced in a manner to assure its equal distribution over the entire cross section of the induction system air passages.

3.608 *Carburetor fluid de-icing system capacity.* The fluid de-icing system capacity shall not be less than that required to provide fluid at the rate specified in section 3.607 for a time equal to 3 percent of the maximum endurance of the airplane. However, the capacity need not in any case exceed that required for 2 hours of operation nor shall it be less than that required for 20 minutes of operation at the above flow rate. If the available preheat exceeds 50° F. but is less than 100° F., it shall be permissible to decrease the capacity of the system in proportion to the heat rise available in excess of 50° F.

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3.693–1 *Electric cable for power distribution (FAA policies which apply to sec. 3.693).* The design of power distribution cable [8b] should be such that probable environmental conditions [8c] will not produce hazardous deterioration of the cable insulation or cause a failure of the conductor. Cable insulation should be flame-resistant and should not emit toxic fumes when overheated. Cable conforming to Military Specification MIL–W–5086 or the equivalent is acceptable for this application.

(22 F. R. 6883, Aug. 27, 1957, effective Sept. 15, 1957.)

Switches

3.694 *Switches.* Switches shall be capable of carrying their rated current and shall be of such construction that there is sufficient distance or insulating material between current carrying parts and the housing so that vibration in flight will not cause shorting.

3.695 *Switch installation.* Switches shall be so installed as to be readily accessible to the appropriate crew member and shall be suitably labeled as to operation and the circuit controlled.

Instrument Lights

3.696 *Instrument lights.* If instrument lights are [installed], they shall be of such construction that there is sufficient distance or insulating material between current carrying parts and the housing so that vibration in flight will not cause shorting. They shall provide sufficient illumination to make all instruments and controls easily readable and discernible, respectively.

3.696–1 *Instrument lights (FAA interpretations which apply to sec. 3.696).* The use of the cabin dome light is not considered adequate to comply with the provision of section 3.696.

(Supp. 10, 16 F. R. 3992, Apr. 14, 1951.)

3.697 *Instrument light installation.* Instrument lights shall be installed in such a manner that their direct rays are shielded from the pilot's eyes. Direct rays shall not be reflected from the windshield or other surfaces into the pilot's eyes.

Landing Lights

3.698 *Landing lights.* If landing lights are installed, they shall be of an acceptable type.

3.699 *Landing light installation.* Landing lights shall be so installed that there is no dangerous glare visible to the pilot and also so that the pilot is not seriously affected by halation. They shall be installed at such a location that they provide adequate illumination for night landing.

Position Lights

3.700 *Position light system installation.*

(a) *General.* The provisions of sections 3.700 through 3.703 shall be applicable to the position light system as a whole. The position light system shall include the items specified in paragraphs (b) through (e) of this section.

(b) *Forward position lights.* Forward position lights shall consist of a red and a green light spaced laterally as far apart as practicable and installed forward on the airplane in such a location that, with the airplane in normal flying position, the red light is displayed on the left side and the green light is displayed on the right side. The individual lights shall be of an approved type.

(c) *Rear position light.* The rear position light shall be a white light mounted as far aft as practicable. The light shall be of an approved type.

(d) *Circuit.* The two forward position lights and the rear position light shall constitute a single circuit.

(e) *Light covers and color filters.* Light covers or color filters used shall be of [flame-resistant] material and shall be constructed so that they will not change color or shape or suffer any appreciable loss or light transmission during normal use.

3.700–1 *Red passing lights (FAA policies which apply to sec. 3.700 (a)).* When it is desired to improve the conspicuity of the aircraft, a steady red light, commonly known as a passing light, may be installed. This light is not considered to be a position light and therefore

[8b] For the purpose of this section, the term "power distribution cable" includes all electric cable transmitting electric power from generators or batteries to load equipment, but does not include cable confined within metallic enclosures, such as in radio equipment.

[8c] Environmental conditions which should be considered: ambient temperature range which may exceed design limits of the cable; vibration leading to abrasive wear of cable insulation or conductor failure; presence of aircraft fluids, such as oil, gasoline, or water, which may have detrimental effects on cable insulation or increase its inflammability. (See sec. 3.681.)

need not be type certificated. When installed, its location should be one of the following:

(a) Within the left landing light unit.

(b) On the centerline of the aircraft nose.

(c) In the leading edge of the left wing, outboard of the propeller disc.

(Supp. 11, 16 F. R. 3211, Apr. 12, 1951.)

3.701 *Position light system dihedral angles.* The forward and rear position lights as installed on the airplane shall show unbroken light within dihedral angles specified in paragraphs (a) through (c) of this section.

(a) Dihedral angle L (left) shall be considered formed by two intersecting vertical planes, one parallel to the longitudinal axis of the airplane and the other at 110° to the left of the first, when looking forward along the longitudinal axis.

(b) Dihedral angle R (right) shall be considered formed by two intersecting vertical planes, one parallel to the longitudinal axis of the airplane and the other at 110° to the right of the first, when looking forward along the longitudinal axis.

(c) Dihedral angle A (aft) shall be considered formed by two intersecting vertical planes making angles of 70° to the right and 70° to the left, respectively, looking aft along the longitudinal axis, to a vertical plane passing through the longitudinal axis.

3.702 *Position light distribution and intensities.*

(a) *General.* The intensities prescribed in this section are those to be provided by new equipment with all light covers and color filters in place. Intensities shall be determined with the light source operating at a steady value equal to the average luminous output of the light source at the normal operating voltage of the airplane. The light distribution and intensities of position lights shall comply with the provisions of paragraph (b) of this section.

(b) *Forward and rear position lights.* The light distribution and intensities of forward and rear position lights shall 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 shall comply with the provisions of subparagraphs (1) through (3) of this paragraph.

(1) *Intensities in horizontal plane.* The intensities in the horizontal plane shall not be less than the values given in Figure 3–15. (The horizontal plane is the plane containing the longitudinal axis of the airplane and is perpendicular to the plane of symmetry of the airplane.)

(2) *Intensities above and below horizontal.* The intensities in any vertical plane shall not be less than the appropriate value given in Figure 3–16, where I is the minimum intensity prescribed in Figure 3–15 for the corresponding angles in the horizontal plane. (Vertical planes are planes perpendicular to the horizontal plane.)

(3) *Overlaps between adjacent signals.* The intensities in overlaps between adjacent signals shall not exceed the values given in Figure 3–17, except that higher intensities in the overlaps shall be acceptable with the use of main beam intensities substantially greater than the minima specified in Figures 3–15 and 3–16 if the overlap intensities in relation to the main beam intensities are such as not to affect adversely signal clarity.

Dihedral angle (light involved)	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

Figure 3–15.—Minimum Intensities in the Horizontal Plane of Forward and Rear Position Lights.

Angle above or below horizontal	Intensity
0°	1.00 I.
0° to 5°	.90 I.
5° to 10°	.80 I.
10° to 15°	.70 I.
15° to 20°	.50 I.
20° to 30°	.30 I.
30° to 40°	.10 I.
40° to 90°	At least 2 candles.

Figure 3–16.—Minimum Intensities in any Vertical Plane of Forward and Rear Position Lights.

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

Note: Area A includes all directions in the adjacent dihedral angle which pass through the light source and which intersect the common boundary plane at more than 10 degrees but less than 20 degrees. Area B includes all directions in the adjacent dihedral angle which pass through the light source and which intersect the common boundary plane at more than 20 degrees.

Figure 3–17.—Maximum Intensities in Overlapping Beams of Forward and Rear Position Lights.

3.702–1 *Rear position light installation (FAA interpretations which apply to sec. 3.702).* A single rear position light may be installed in a position displaced laterally from the plane of symmetry of an airplane if the axis of the maximum cone of illumination is parallel to the flight path in level flight, and if there is no obstruction aft of the light and between planes 70° to the right and left of the axis of maximum illumination.

(Supp. 10, 16 F. R. 3292, Apr. 14, 1951.)

3.702–2 *Overlaps between high intensity forward position lights (FAA policies which apply to sec. 3.702 (b) (3)).* When the peak intensity of the forward position lights is greater than 100 candles, the maximum overlap intensities between them may exceed the values given in figure 3–17 provided the overlap intensity in Area A is not greater than 10 percent of peak position light intensity and the overlap intensity in Area B is not greater than 2.5 percent of peak position light intensity.[8d]

(23 F. R. 1001, Feb. 15, 1958, effective Mar. 10, 1958.)

[8d] Overlap intensities should be determined with the position lights installed in their actual aircraft locations, since adjacent aircraft structure will often provide some cutoff in the overlap area.

3.703 *Color specifications.* The colors of the position lights shall have the International Commission on Illumination chromaticity coordinates as set forth in paragraphs (a) through (c) of this section.

(a) *Aviation red.*

y is not greater than 0.335,

z is not greater than 0.002;

(b) *Aviation green.*

x is not greater than $0.440-0.320y$,

x is not greater than $y-0.170$,

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,

$y-y_0$ is not numerically greater than 0.01, y_0 being the y coordinate of the Planckian radiator for which $x_0=x$.

Riding Light

3.704 *Riding light.*

(a) When a riding (anchor) light is required for a seaplane, flying boat, or amphibian, it shall be capable of showing a white light for at least 2 miles at night under clear atmospheric conditions.

(b) The riding light shall be installed to show the maximum unbroken light practicable when the airplane is moored or drifting on the water. Externally hung lights shall be acceptable.

Anti-collision Light System

3.705 *Anti-collision light system.* An airplane to be eligible for night operation shall have installed an anti-collision light system. Such system shall consist of one or more approved anti-collision lights so located that the emitted light will not be detrimental to the crew's vision and will not detract from the conspicuity of the position lights. The system shall comply with the provisions of paragraphs (a) through (d) of this section.

(a) *Field of coverage.* The system shall consist of such lights as will afford coverage of all vital areas around the airplane with due consideration to the physical configuration and the flight characteristics of the airplane. In any case, the field of coverage shall extend in all directions within 30° above and 30° below the horizontal plane of the airplane, except that a solid angle or angles of obstructed visibility totaling not more than .03 steradians shall be

permissible within a solid angle equal to .15 steradians centered about the longitudinal axis in the rearward direction.

(b) *Flashing characteristics.* The arrangement of the system, i. e., number of light sources, beam width, speed of rotation, etc., shall be such as to give an effective flash frequency of not less than 40 and not more than 100 cycles per minute. The effective flash frequency shall be the frequency at which the airplane's complete anti-collision light system is observed from a distance, and shall apply to all sectors of light including the overlaps which might exist when the system consists of more than one light source. In overlaps, flash frequencies higher than 100 cycles per minute shall be permissible, except that they shall not be higher than 180 cycles per minute.

(c) *Color.* The color of the anti-collision lights shall be aviation red in accordance with the specifications of section 3.703 (a).

(d) *Light intensity.* The minimum light intensities in all vertical planes, measured with the red filter and expressed in terms of "effective" intensities, shall be in accordance with Figure 3–18. The following relation shall 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).

NOTE: Normally, the maximum value of effective intensity is obtained when t_2 and t_1 are so chosen that the effective intensity is equal to the instantaneous intensity at t_2 and t_1.

Angle above or below horizontal plane	Effective intensity (candles)
0° to 5°	100
5° to 10°	60
10° to 20°	20
20° to 30°	10

Figure 3–18.—Minimum Effective Intensities for Anticollision Lights.

3.705–1 *Anticollision light standards (FAA policies which apply to sec. 3.705).* The anticollision light standards in section 3.705 apply to aircraft for which an application for a type certificate is made on or after April 1, 1957. When anticollision lights are installed on aircraft for which an application for a type certificate was made before April 1, 1957, the applicant may conform either to section 3.705 or to the standards listed below:

(a) Anticollision lights (when installed) should be of the rotating beacon type installed on top of the fuselage or tail in such a location that the light will not be detrimental to the flight crew's vision and will not detract from the conspicuity of the position lights. If there is no acceptable location on top of the fuselage or tail, a bottom fuselage installation may be used.

(b) The color of the anticollision light should be aviation red in accordance with the specifications of section 3.703.

(c) The arrangement of the anticollision light, i. e., number of light sources, beam width, speed of rotation, etc., should be such as to give an effective flash frequency of not less than 40 and not more than 100 cycles per minute, with an on-off ratio not less than 1:75.

(22 F. R. 3653, May 24, 1957, effective June 15, 1957 as amended 22 F. R. 6883, Aug. 27, 1957, effective Sept. 15, 1957.)

Safety Equipment; Installation

3.711 *Marking.* Required safety equipment which the crew is expected to operate at a time of emergency, such as flares and automatic life raft releases, shall be readily accessible and plainly marked as to its method of operation. When such equipment is carried in lockers, compartments, or other storage places, such storage places shall be marked for the benefit of passengers and crew.

Airplane Weight

3.748 *Airplane weight.* The airplane weight and center of gravity limitations are those required to be determined by section 3.71.

Minimum Flight Crew

3.749 *Minimum flight crew.* The minimum flight crew shall be established as that number of persons required for the safe operation of the airplane during any contact flight as determined by the availability and satisfactory operation of all necessary controls by each operator concerned.

Types of Operation

3.750 *Types of operation.* The type of operation to which the airplane is limited shall be established by the category in which it has been found eligible for certification and by the equipment installed. (See the appropriate operating parts of the Civil Air Regulations.)

Markings and Placards

3.755 *Markings and placards.*

(a) The markings and placards specified are required for all airplanes. Placards shall be displayed in a conspicuous place and both shall be such that they cannot be easily erased, disfigured, or obscured. Additional informational placards and instrument markings having a direct and important bearing on safe operation may be required by the Administrator when unusual design, operating, or handling characteristics so warrant.

(b) When an airplane is certificated in more than one category, the applicant shall select one category on which all placards and markings on the airplane shall be based. The placard and marking information for the other categories in which the airplane is certificated shall be entered in the Airplane Flight Manual. A reference to this information shall be included on a placard which shall also indicate the category on which the airplane placards and markings are based.

3.755–1 *Markings and placards for an airplane certificated in more than one category (FAA policies which apply to sec. 3.755(b)).*

(a) The following suggestions are given to assist in making placards and markings as simple and straightforward as possible:

(1) The applicant (who may be the manufacturer or an individual operator) should select a "basic" category on which all markings and placards will be based and installed on a particular airplane. However, this does not prevent the selection of some other category as "basic" for the placarding and marking of other airplane of the same model.

(2) Placards of markings pertaining to other categories should be installed only when this can be done without confusing the placards or markings for the "basic" category. For example, previous attempts to put dual sets of markings on airspeed indicators have proven unsatisfactory. On the other hand, it may be desirable to install baggage capacity and number of persons placards which cover both normal and utility categories.

(3) A statement on the placard, required by sections 3.769 and 3.770, should refer the operator to the "Approved Airplane Flight Manual" for information on the placards and markings appropriate to the other categories in which the airplane is certificated.

(4) All placards should be arranged to present the necessary information to the pilot in as simple and practical a manner as possible. In many cases, it may be convenient to consolidate various placards.

(5) The following is an example of a possible (but not necessarily complete) form for a consolidated placard for an airplane certificated in Normal and Utility Categories, using the Normal Category as the "basic" category for purposes of placarding and marking.

> THIS AIRPLANE MUST BE OPERATED AS A NORMAL OR UTILITY CATEGORY AIRPLANE IN COMPLIANCE WITH THE APPROVED AIRPLANE FLIGHT MANUAL.
>
> All markings and placards on this airplane apply to its operation as a Normal Category Airplane. For Utility Category operations, refer to the Airplane Flight Manual.
>
> NO ACROBATIC MANEUVERS (INCLUDING SPINS) ARE APPROVED FOR NORMAL CATEGORY OPERATIONS.

(6) When the category selected for marking and placarding is the Utility Category, the appropriate placards for limiting the weight to the approved utility value should, of course, be posted. This may, for example, require placards on some of the seats, "Not to be occupied during Utility operations," and "Maximum baggage capacity during Utility Category operations, ______ pounds."

When the number of occupants permitted for the Utility Category is less than the number of seats, but the seating arrangement makes no difference, it may be more convenient to omit the seat placards and substitute a statement such as the following on the consolidated placard, "Maximum number of persons for Utility Category Operations, ______."

(7) For Utility Category maneuvering limitations, see section 3.20–2.

(Supp. 10, 16 F.R. 3292, Apr. 14, 1951.)

3.755–2 *Markings and placards for flap settings (FAA policies which apply to sec. 3.755 (a)).*

(a) *Flap settings as related to performance.* Instructions on flap settings relating to airplane performance should be included in the "performance information" section of the Manual, and should be identified with the corresponding performance data given in section 3.777–1(g). If the applicant has demonstrated compliance with the pertinent performance requirements for a range of flap settings, the range may be given instead of a single setting. In this case, performance data should be shown for both extremes of the range, or for the critical setting within the range, plus explanation of the qualitative effect on performance of using other settings within the range.

(b) *Flap settings resulting in unsafe characteristics.* If improper setting of the flaps can result in dangerous characteristics, a suitable item should be included in the "operating limitations" section of the Flight Manual, and on a placard in view of the pilot.

Typical examples of "dangerous characteristics" would be cases in which a flap takeoff setting less than that marked on the flap indicator would cause unusual difficulty in takeoff by greatly extending the takeoff distance, or affecting controllability (e.g., porpoising, or inability to raise nose wheel). Reasonable and gradual variations in performance with change in flap setting would not be considered dangerous. Cases of obvious pilot error need not be considered such as takeoff with flaps in landing setting, provided the pertinent settings are adequately marked on the flap indicator.

(Supp. 10, 16 F.R. 3292, Apr. 14, 1951.)

Instrument Markings

3.756 *Instrument markings.* The instruments listed in sections 3.757–3.761 shall have the following limitations marked thereon. When these markings are placed on the cover glass of the instrument, adequate provision shall be made to maintain the correct alignment of the glass cover with the face of the dial. All arcs and lines shall be of sufficient width and so located as to be clearly and easily visible to the pilot.

3.757 *Air-speed indicator.*

(a) [Calibrated] air speed shall be used:

(1) The never-exceed speed, V_{ne}—a radial red line (see sec. 3.739).

(2) The caution range—a yellow arc extending from the red line in (1) above to the upper limit of the green arc specified in (3) below.

(3) The normal operating range—a green arc with the lower limit at V_{S_1} as determined in section 3.82 with maximum weight, landing gear and wing flaps retracted, and the upper limit at the maximum structural cruising speed established in section 3.740.

(4) The flap operating range—a white arc with the lower limit at V_{S_0} as determined in section 3.82 at the maximum weight, and the upper limit at the flaps-extended speed in section 3.742.

(b) When the never-exceed and maximum structural cruising speeds vary with altitude, means shall be provided which will indicate the appropriate limitations to the pilot throughout the operating altitude range.

3.757–1 *White arc on air-speed indicator (FAA interpretations which apply to sec. 3.757 (a)(4)).* The white arc on the air-speed indicator should extend to the "basic" flaps extended speed specified in section 3.742. Additional combinations of flap setting, airspeed and

(2) Airplane empty weight and center of gravity location,

(3) Useful load,

(4) The composition of the useful load, including the total weight of fuel and oil with tanks full.

(d) *Load distribution.*

(1) All authorized center of gravity limits shall be stated. If the available space for loading the airplane is adequately placarded or so arranged that any reasonable distribution of the useful load listed in weight above will not result in a center of gravity location outside of the state limits, this section need not include any other information than the statement of center of gravity limits.

(2) In all other cases this section shall also include adequate information to indicate satisfactory loading combinations which will assure maintaining the center of gravity position within approved limits.

(e) *Maneuvers.* All authorized maneuvers and the appropriate air-speed limitations as well as all unauthorized maneuvers shall be included in accordance with the following:

(1) *Normal category.* All acrobatic maneuvers, including spins, are unauthorized. If the airplane has been demonstrated to be characteristically incapable of spinning in accordance with section 3.124(d), a statement to this effect shall be entered here.

(2) *Utility category.* All authorized maneuvers demonstrated in the type flight tests shall be listed, together with recommended entry speeds. All other maneuvers are not approved. If the airplane has been demonstrated to be characteristically incapable of spinning in accordance with section 3.124(d), a statement to this effect shall be entered here.

(3) *Acrobatic category.* All approved flight maneuvers demonstrated in the type flight tests shall be included, together with recommended entry speeds.

(f) *Flight load factor.* The positive limit load factors made good by the airplane's structure shall be described here in terms of accelerations.

(g) *Flight crew.* When a flight crew of more than one is required to operate the airplane safely, the number and functions of the minimum flight crew shall be included.

3.779 *Operating procedures.* This section shall contain information concerning normal and emergency procedures and other pertinent information peculiar to the airplane's operating characteristics which are necessary to safe operation.

3.780 *Performance information.*

(a) For airplanes with a maximum certificated takeoff weight of more than 6,000 lbs., information relative to the items of performance set forth in subparagraphs (1) through (5) of this paragraph shall be included:

(1) The stalling speed V_{s0}, at maximum weight,

(2) The stalling speed, V_{s1}, at maximum weight and with landing gear and wing flaps retracted,

(3) The takeoff distance determined in accordance with section 3.84, including the air speed at the 50-foot height, and the airplane configuration, if pertinent,

(4) The landing distance determined in accordance with section 3.86, including the airplane configuration, if pertinent,

(5) The steady rate of climb determined in accordance with section 3.85 (a), (c), and, as appropriate, (b), including the air speed, power, and airplane configuration, if pertinent.

(b) The effect of variation in paragraph (a)(2) of this section with angle of bank up to 60 degrees shall be included.

(c) The calculated approximate effect of variations in paragraph (a) (3), (4) and (5) of this section with altitude and temperature shall be included.

[(d) The best climb/minimum descent speed with one engine inoperative for multiengine airplanes shall be included.]

3.780–1 *Calculated effects of temperature and altitude variations* (*FAA policies which apply to sec. 3.780*). Section 3.780 requires that the calculated effects of variations in temperature and altitude on the takeoff distance (sec. 3.84 (a)(2)), the landing distance (sec. 3.86), and the steady rate of climb (sec. 3.85 (a), (b), and (c)), shall be included in the Airplane Flight Manual. The following ranges of these variables will be considered acceptable by the Administrator:

(a) The altitudes and temperatures for which performance in takeoff distance, landing distance, takeoff climb and balked landing climb shall be calculated are sea level to 7,000 feet and 0° F. to 100° F. respectively, except that take-off and landing distances for a seaplane need not show temperatures below 30° F. at altitudes above 1,000 feet.

(b) For multiengined aircraft, the climb with the critical engine inoperative shall be calculated for an altitude range of sea level to absolute ceiling and a temperature range from 60° F. below the standard temperature to 40° F. above the standard temperature at the altitude involved.

(Supp. 1, 12 F.R. 3438, May 28, 1947, as amended by Amdt. 1, 14 F.R. 36, Jan. 5, 1949.)

3.780–2 *Performance data for altered airplanes of this part (FAA policies which apply to sec. 3.780).* Performance data for altered airplanes of this part must be changed in the Airplane Flight Manual if the alteration decreases the performance below that given in the existing manual. If performance can be shown to equal or exceed original values then a statement in the manual to this effect is sufficient.

(Supp. 10, 16 F.R. 3295, Apr. 14, 1951.)

3.780–3 *Performance data and flight tests for ski installations on airplanes of this part (FAA policies which apply to sec. 3.780).*

(a) *Takeoff and landing distances.* It will not be necessary, in complying with section 3.780(a) (3) and (4), to make takeoff and landing distance tests on skiplane installations where landplane distances are given in the Airplane Flight Manual. The following, or similar, statements should be given in the performance information section of the Airplane Flight Manual.

(1) *Takeoff.* Under the most favorable conditions of smooth packed snow at temperatures approximating 32° F. the skiplane takeoff distance is approximately 10 percent greater than that shown for the landplane.

NOTE: *In estimating takeoff distances for other* conditions caution should be exercised in that lower temperatures or other snow conditions will usually increase these distances.

(2) *Landing.* Under the most favorable conditions of smooth packed snow at temperatures approximating 32° F. the skiplane landing distance is approximately 20 percent greater than that shown for the landplane.

NOTE: *In estimating landing distances for other* conditions caution should be exercised in that other temperatures or other snow conditions may either decrease or increase these distances.

(b) *Climb performance.* In cases where the landing gear is fixed (both landplane and skiplane), where the climb requirements are not critical, and the climb reduction is small (30 to 50 feet per minute), the FAA will accept a statement of the approximate reduction in climb performance placed in the Airplane Flight Manual performance information section. For larger variations in climb performance, or where the minimum requirements are critical, or where the landing gear of the landplane was retractable, appropriate climb data should be obtained to determine the changes, and new curves, tables, or a note should be incorporated in the Airplane Flight Manual.

(c) *Flight and handling tests.* At least a general flight check should be made prior to approval. This should include more than one landing to determine the ground handling characteristics as well as takeoff and landing characteristics. Note should be taken of ski angle at landing contact during tail high and tail low landings to avoid having the ski dig in or fail from localized stress. Ground control should be sufficient to satisfactorily complete a landing run with a turn off at slow speed in cases where brakes are not provided. In flight the ski should ride steady with no unusual drag and produce no unsatisfactory flight characteristics. Spin checks should be made on all aircraft in which spins are an approved maneuver. When spins are approved under section 3.124(a), investigation with ski installations need not be made unless the spin characteristics of the type are known to be marginal.

(Supp. 10, 16 F.R. 3295, Apr. 14, 1951.)

Subpart H—Identification Data

3.791 *Identification plate.* A fireproof identification plate shall be securely attached to the structure in an accessible location where it will not likely be defaced during normal service. The identification plate shall not be