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MS-158

Civil Aeronautics Manual 6

Rotorcraft Airworthiness; Normal Category

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FEDERAL AVIATION AGENCY

June 1962

Rec'd 11-5-62

FEDERAL AVIATION AGENCY

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For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington 25, D.C. - Price 55 cents

Introductory Note

This manual contains in consolidated form (1) Civil Air Regulations Part 6, Rotorcraft Airworthiness; Normal Category, dated December 20, 1956, Amendments 6–1 through 6–5, 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. 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.

With the discontinuance of the distribution of individual amendments of the Civil Air Regulations, it is believed that the preamble material contained in the amendments should be reproduced in the manuals. Therefore, the preambles of amendments to Part 6, beginning with Amendment 6–1 adopted February 25, 1957, are included as an addendum to this manual. In addition to the preamble, the date of adoption, the effective date, Federal Register citation, and the sections affected are given for each amendment.

This manual supersedes Civil Aeronautics Manual 6 dated October 1, 1959, and all supplements thereto. As amendments and other pertinent materials pertaining to Part 6 are issued, they will be included in this manual.

As a convenience to the users of this manual, the changes made by Amendment 6–5, which was adopted as a result of the First Federal Aviation Agency Airworthiness Review and which became effective May 3, 1962, are enclosed in black brackets.

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Addendum

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Rotorcraft Airworthiness; Normal Category

Subpart A—General

Applicability and Definitions

6.0 ***Applicability of this part.*** This part contains standards with which compliance shall be demonstrated for the issuance of and changes to type certificates for rotorcraft. This part, until superseded or rescinded, shall apply to rotorcraft of any weight for which applications for type certification under this part were made between the effective date of this part (January 15, 1951) and August 1, 1956. For applications for type certificates made after August 1, 1956, this part shall apply only to rotorcraft which have a maximum weight of 6,000 pounds or less.

(Part 6, 21 F.R. 10291, Dec. 22, 1956, effective Dec. 20, 1956.)

6.1 ***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 a rotorcraft 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. 6.18.)

(b) ***Rotorcraft types.***

(1) ***Rotorcraft:*** A rotorcraft is any aircraft deriving its principal lift from one or more rotors.

(2) ***Helicopter.*** A helicopter is a rotorcraft which depends principally for its support and motion in the air upon the lift generated by one or more power-driven rotors, rotating on substantially vertical axes.

(3) ***Gyroplane.*** A gyroplane is a rotorcraft which depends principally for its support upon the lift generated by one or more rotors which are not power driven, except for initial starting, and which are caused to rotate by the action of the air when the rotorcraft is in motion. The propulsion is independent of the rotor system and usually consists of conventional propellers.

(4) ***Gyrodyne.*** A gyrodyne is a rotorcraft which depends principally for its support upon the lift generated by one or more rotors which are partially power driven, rotating on substantially vertical axes. The propulsion is independent of the rotor system and usually consists of conventional propellers.

(c) ***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, and

(v) The density ρ_0 at sea level under the above conditions is 0.002377 lbs. 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. 6.451.)

(3) ***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).

(4) ***Autorotation.*** Autorotation is a rotorcraft flight condition in which the lifting rotor is driven entirely by the action of the air when the rotorcraft is in motion.

(5) ***Autorotative landing.*** An autorotative landing is any landing of a rotorcraft in

which the entire maneuver is accomplished without the application of power to the rotor.

(6) *Ground resonance.* Ground resonance is the mechanical instability encountered when the rotorcraft is in contact with the ground.

(7) *Mechanical instability.* Mechanical instability is an unstable resonant condition due to the interaction between the rotor blades and the rotorcraft structure, while the rotorcraft is on the ground or airborne.

(d) *Weights.*

(1) *Maximum weight.* The maximum weight of the rotorcraft is that maximum at which compliance with the requirements of this part is demonstrated. (See sec. 6.101.)

(2) *Minimum weight.* The minimum weight of the rotorcraft is that minimum at which compliance with the requirements of this part is demonstrated. (See sec. 6.101.)

(3) *Empty weight.* The empty weight of the rotorcraft is a readily reproducible weight which is used in the determination of the operating weights. (See sec. 6.104.)

(4) *Design maximum weight.* The design maximum weight is the maximum weight of the rotorcraft at which compliance is shown with the structural loading conditions. (See sec. 6.101.)

(5) *Design minimum weight.* The design minimum weight is the minimum weight of the rotorcraft at which compliance is shown with the structural loading conditions. (See sec. 6.101.)

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

(i) Gasoline 6 lbs. per U.S. gallon,

(ii) Lubricating oil 7.5 lbs. per U.S. gallon,

(iii) Crew and passengers 170 lbs. per person.

(e) *Speeds.*

(1) *IAS.* Indicated airspeed is equal to the pitot static airspeed indicator reading as installed in the rotorcraft without correction for airspeed indicator system errors but including the sea level standard adiabatic compressible flow correction. (This latter correction is included in the calibration of the airspeed instrument dials.) (See secs. 6.612 and 6.732.)

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

(3) *EAS.* Equivalent airspeed is equal to the airspeed 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 airspeed of the rotorcraft relative to undisturbed air.
($TAS = EAS\ (\rho_0/\rho)^{1/2}$)

(5) V_H. The maximum speed obtainable in level flight with rated rpm and power.

(6) V_{NE}. The never-exceed speed. (See sec. 6.711.)

(7) V_X. The speed for best angle of climb.

(8) V_Y. The speed for best rate of climb.

(f) *Structural.*

(1) *Limit load.* A limit load is the maximum load anticipated in normal conditions of operation. (See sec. 6.200.)

(2) *Ultimate load.* An ultimate load is a limit load multiplied by the appropriate factor of safety. (See sec. 6.200.)

(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. 6.200.)

(4) *Load factor.* The load factor is the ratio of a specified load to the total weight of the rotorcraft; 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) *Fitting.* A fitting is a part or terminal used to join one structural member to another. (See sec. 6.307 (d).)

(g) *Powerplant installation.*[1]

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

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

(2) *Takeoff power or thrust.*

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

(ii) Takeoff power for turbine engines is the brake horsepower developed under static conditions at specified altitudes and atmospheric temperatures, under the maximum conditions of engine rotor shaft rotational speed and gas temperature approved for normal takeoff, and limited in use to a maximum continuous period as indicated in the approved engine specification.

(iii) Takeoff thrust for turbine engines is the jet thrust developed under static conditions at specified altitudes and atmospheric temperatures, under the maximum conditions of engine rotor shaft rotational speed and gas temperature approved for the normal takeoff, and limited in use to a maximum continuous period as indicated in the approved engine specification.

(3) *Maximum continuous power or thrust.*

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

(ii) Maximum continuous power for turbine engines is the brake horsepower developed at specified altitudes, atmospheric temperatures, and flight speeds, under the maximum conditions of engine rotor shaft rotational speed and gas temperature, and approved for use during periods of unrestricted duration.

(iii) Maximum continuous thrust for turbine engines is the jet thrust developed at specified altitudes, atmospheric temperatures, and flight speeds, under the maximum conditions of engine rotor shaft rotational speed and gas temperature, and approved for use during periods of unrestricted duration.

(4) *Gas temperature.* Gas temperature for turbine engines is the temperature of the gas stream obtained as indicated in the approved engine specification.

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

(6) *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.

(h) Propellers and rotors.[2]

[2] For propeller airworthiness requirements see Part 14 of this subchapter.

(1) *Rotor.* Rotor is a system of rotating airfoils.

(2) *Main rotor.* The main rotor is the main system of rotating airfoils providing sustentation for the rotorcraft.

(3) *Auxiliary rotor.* An auxiliary rotor is one which serves either to counteract the effect of the main rotor torque on the rotorcraft, or to maneuver the rotorcraft about one or more of its three principal axes.

(4) *Axis of no feathering.* The axis of no feathering is the axis about which there is

no first harmonic feathering or cyclic pitch variation.[3]

[3] See NACA Technical Note No. 1604.

(5) *Plane of rotor disc.* The plane of rotor disc is a reference plane at right angles to the axis of no feathering.

(6) *Tip speed ratio.* The tip speed ratio is the ratio of the rotorplane flight velocity component in the plane of rotor disc to the rotational tip speed of the rotor blades expressed as follows:

$$\mu = \frac{V \cos \alpha}{\Omega R}$$

where:

V=airspeed of the rotorcraft along flight path (fps),

α=angle between projection in plane of symmetry of axis of no feathering and a line perpendicular to the flight path (radians, positive when axis is pointing aft),

Ω=angular velocity of rotor (radians per second),

R=rotor radius (ft.).

(i) *Fire protection.*

(1) *Fireproof.* Fireproof material means a 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.

(Part 6, 21 F.R. 10291, Dec. 22, 1956, effective Dec. 20, 1956; as amended by Amdt. 6-3, 23 F.R. 2592, Apr 19, 1958, effective May 17, 1958; Amdt. 6-4, 24 F.R. 7072, Sept. 1, 1959, effective Oct. 1, 1959.)

Certification

6.10 ***Eligibility for type certificates.*** A rotorcraft 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 rotorcraft which renders it unsafe.

(Part 6, 21 F.R. 10291, Dec. 22, 1956, effective Dec. 20, 1956.)

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

(a) Unless otherwise established by the Administrator, the rotorcraft 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, [notwithstanding the applicant may have been issued a provisional type certificate] 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 the type certificate (see sec. 6.13 (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 6.13 (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 rotorcraft, and the Administrator finds that the regulations incorporated by reference in the type certificate pursuant to section 6.13 (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 a new rotor system or a new electric power system.

(e) If changes listed in subparagraphs (1) through (3) of this paragraph are made, the rotorcraft 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 or rotors;

(2) A change to engines or rotors 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.

(Part 6, 21 F.R. 10291, Dec. 22, 1956, effective Dec. 20, 1956; as amended by Amdt. 6-5, 27 F.R. 2996, Mar. 30, 1962, effective May 3, 1962.)

6.12 *Recording of applicable regulations.* The Administrator, upon the issuance of a type certificate, shall record the applicable regulations with which compliance was demonstrated. Thereafter, the Administrator shall record the applicable regulations for each change in the type certificate which is accomplished in accordance with regulations other than those recorded at the time of issuance of the type certificate. (See sec. 6.11.)

(Part 6, 21 F.R. 10291, Dec. 22, 1956, effective Dec. 20, 1956.)

6.13 *Type certificate.*

(a) An applicant shall be issued a type certificate when he demonstrates the eligibility of the rotorcraft by complying with the requirements of this part in addition to the applicable requirements in Part 1 of this subchapter.

(b) The type certificate shall be deemed to include the type design (see sec. 6.14 (b)), the operating limitations for the rotorcraft (see sec. 6.700), and any other conditions or limitations prescribed by the regulations in this subchapter.

(c) The applicable provisions of this part recorded by the Administrator in accordance with section 6.12 shall be considered as incorporated in the type certificate as though set forth in full.

(Part 6, 21 F.R. 10291, Dec. 22, 1956, effective Dec. 20, 1956.)

6.14 *Data required.*

(a) The applicant for a type certificate shall submit to the Administrator such descriptive data, test reports, and computations as are necessary to demonstrate that the rotorcraft complies with the requirements of this part.

(b) The descriptive data required in paragraph (a) of this section shall be known as the type design and shall consist of such drawings and specifications as are necessary to disclose the configuration of the rotorcraft and all the design features covered in the requirements of this part, such information on dimensions, materials, and processes as is necessary to define the structural strength of the rotorcraft, and such other data as are necessary to permit by comparison the determination of the airworthiness of subsequent rotorcraft of the same type.

(Part 6, 21 F.R. 10291, Dec. 22, 1956, effective Dec. 20, 1956.)

6.15 *Inspections and tests.* Inspections and tests shall include all those found necessary by the Administrator to insure that the rotorcraft complies with the applicable airworthiness requirements and conforms to the following:

(a) All materials and products are in accordance with the specifications in the type design.

(b) All parts of the rotorcraft are constructed in accordance with the drawings in the type design.

(c) All manufacturing processes, construction, and assembly are as specified in the type design.

(Part 6, 21 F.R. 10291, Dec. 22, 1956, effective Dec. 20, 1956.)

6.16 *Flight tests.* After proof of compliance with the structural requirements contained in this part, and upon completion of all necessary inspections and testing on the ground, and proof of the conformity of the rotorcraft with the type design, and upon receipt from the applicant of a report of flight tests performed by him, the following shall be conducted:

(a) Such official flight tests as the Administrator finds necessary to determine compliance with the requirements of this part.

(b) After the conclusion of flight tests specified in paragraph (a) of this section, such additional flight tests as the Administrator finds necessary to ascertain whether there is reasonable assurance that the rotorcraft, its components, and equipment are reliable and function properly. The extent of such additional flight tests shall depend upon the complexity of the rotorcraft, the number and nature of new design features, and the record of previous tests and experience for the particular rotorcraft type, its components, and equipment. If practicable, these flight tests shall be conducted on the same rotorcraft used in the flight tests specified in paragraph (a) of this section and in the rotor drive endurance tests specified in section 6.412.

(Part 6, 21 F.R. 10291, Dec. 22, 1956, effective Dec. 20, 1956.)

6.17 *Airworthiness, experimental, and production certificates.* (For requirements with regard to these certificates see Part 1 of this subchapter.)

(Part 6, 21 F.R. 10291, Dec. 22, 1956, effective Dec. 20, 1956.)

6.18 *Approval of materials, parts, processes, and appliances.*

(a) Materials, parts, processes, and appliances shall be approved upon a basis and in a manner found necessary by the Administrator to implement the pertinent provisions of the regulations in this subchapter. The Administrator may adopt and publish such specifications as he finds necessary to administer this regulation, and shall incorporate therein such portions of the aviation industry, Federal, and military specifications respecting such materials, parts, processes, and appliances as he finds appropriate.

***Note:* The provisions of this paragraph are intended to allow approval of materials, parts, processes, and appliances under the system of Technical Standard Orders, or in conjunction with type certification procedures for a rotorcraft, or by any other form of approval by the Administrator.**

(b) Any material, part, process, or appliance 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.

(Part 6, 21 F.R. 10291, Dec. 22, 1956, effective Dec. 20, 1956.)

6.18–1 *Approval of aircraft components (FAA rules which apply to sec. 6.18).* Aircraft components made the subject of Technical

Standards Orders shall be approved upon the basis and in the manner provided in Part 514 of this title (Regulations of the Administrator).

(Supp. 5, 16 F.R. 672, Jan. 25, 1951, effective Jan. 25, 1951.)

6.18–2 *Manufacturer (FAA interpretations which apply to sec. 6.18(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.

(Supp. 17, 23 F.R. 10326, Dec. 25, 1958, effective Jan. 31, 1959.)

6.18–3 *Approval of products under the type certificate or modification procedures (FAA policies which apply to sec. 6.18).* 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 by 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 section 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 Technical Standard 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 section 6.10.

(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.

(Supp. 17, 23 F.R. 10326, Dec. 25, 1958, effective Jan. 31, 1959.)

6.19 *Changes in type design.* (For requirements with regard to changes in type design and the designation of applicable regulations therefor, see sec. 6.11 (d) and (e), and Part 1 of this subchapter.)

(Part 6, 21 F.R. 10291, Dec. 22, 1956, effective Dec. 20, 1956.)

Subpart B—Flight

General

6.100 ***Proof of compliance.***

(a) Compliance with the requirements prescribed in this subpart shall be established by flight or other tests conducted upon a rotorcraft of the type for which a certificate of airworthiness is sought or by calculations based on such tests, provided that the results obtained by calculations are equivalent in accuracy to the results of direct testing.

(b) Compliance with each requirement shall be established at all appropriate combinations of rotorcraft weight and center of gravity position within the range of loading conditions for which certification is sought by systematic investigation of all these combinations, except where compliance can be inferred reasonably from those combinations which are investigated.

(c) The controllability, stability, and trim of the rotorcraft shall be established at all altitudes up to the maximum anticipated operating altitude.

(d) The applicant shall provide a person holding an appropriate pilot certificate to make the flight tests, but a designated representative of the Administrator shall pilot the rotorcraft when it is found necessary for the determination of compliance with the airworthiness requirements.

(e) Official type tests shall be discontinued until corrective measures have been taken by the applicant when either:

(1) The applicant's test pilot is unable or unwilling to conduct any of the required flight tests, or

(2) It is found that requirements which have not been met are so substantial as to render additional test data meaningless or are of such a nature as to make further testing unduly hazardous.

(f) Adequate provision shall be made for emergency egress and for the use of parachutes by members of the crew during the flight tests.

(g) The applicant shall submit to the authorized representative of the Administrator a report covering all computations and tests required in connection with calibration of instruments used for test purposes and correction of test results to standard atmospheric conditions. The Administrator's representative shall conduct any flight tests which he finds necessary to check the calibration and correction report.

(Part 6, 21 F.R. 10291, Dec. 22, 1956, effective Dec. 20, 1956.)

6.101 ***Weight limitations.*** The maximum and minimum weights at which the rotorcraft will be suitable for operation shall be established as follows:

(a) Maximum weights shall not exceed any of the following:

(1) The weight selected by the applicant;

(2) The design weight for which the structure has been proven; or

(3) The maximum weight at which compliance with all of the applicable flight requirements has been demonstrated.

(b) The maximum weight shall not be less than the sum of the weights of the following:

(1) The empty weight in accordance with section 6.104;

(2) Usable fuel appropriate to the operation contemplated with full payload;

(3) The full oil capacity; and

(4) 170 pounds in all seats, except that when the maximum permissible weight to be carried in a seat is less than 170 pounds it shall be acceptable to use this lesser weight. (See sec. 6.738(a).)

(c) The minimum weight shall not be less than any of the following:

(1) The minimum weight selected by the applicant;

(2) The design minimum weight for which the structure has been proven; or

(3) The minimum weight at which compliance with all of the applicable flight requirements has been demonstrated.

(d) The minimum weight shall not exceed the sum of the weights of the following:

(1) The empty weight in accordance with section 6.104;

(2) The minimum crew necessary to operate the rotorcraft, assuming for each crew member the lowest of the following:

(i) 170 lbs.;

(ii) Weight selected by the applicant; and

(iii) Weight included in the loading instructions (see secs. 6.102 (b) and 6.738 (a)); and

(3) Oil in the quantity determined in accordance with the provisions of section 6.440 (b).

(Part 6, 21 F.R. 10291, Dec. 22, 1956, effective Dec. 20, 1956.)

6.102 *Center of gravity limitations.*

(a) Center of gravity limits shall be established as the most forward position permissible for each weight established in accordance with section 6.101 and the most aft position permissible for each of such weights. Such limits of the center of gravity range shall not exceed any of the following:

(1) The extremes selected by the applicant,

(2) The extremes for which the structure has been proven,

(3) The extremes at which compliance with all of the applicable flight requirements has been demonstrated.

(b) Loading instructions shall be provided if the center of gravity position under any possible loading condition between the maximum and minimum weights as specified in section 6.101, with assumed weights for individual passengers and crewmembers variable over the anticipated range of such weights, lies beyond:

(1) The extremes selected by the applicant,

(2) The extremes for which the structure has been proven,

(3) The extremes for which compliance with all of the applicable flight requirements has been demonstrated. (See sec. 6.741 (c).)

(Part 6, 21 F.R. 10291, Dec. 22, 1956, effective Dec. 20, 1956.)

6.103 *Rotor limitations and pitch settings.*

(a) *Power-on.* A range of power-on operating speeds for the main rotor(s) shall be established which will provide adequate margin to accommodate the variation of rotor rpm attendant to all maneuvers appropriate to the rotocraft type and consistent with the type of synchronizer or governor used, if any (see secs. 6.713 (b) (2) and 6.714 (b)). A means shall be provided to prevent rotational speeds substantially less than the approved minimum rotor rpm in any flight condition with pitch control of the main rotor(s) in the high-pitch position and with the engine(s) operating within the approved limitations. It shall be acceptable for such means to allow the use of higher pitch in an emergency, provided that the means incorporate provisions to prevent inadvertent transition from the normal operating range to the higher-pitch angles.

(b) *Power-off.* A range of power-off operating rotor speeds shall be established which will permit execution of all autorotative flight maneuvers appropriate to the rotorcraft type throughout the range of airspeeds and weights for which certification is sought (see secs. 6.713 (a) and 6.713 (b) (1)). A rotor blade low-pitch limiting device shall be positioned to provide rotational speeds within the approved rotor speed range in any autorotative flight condition under the most adverse combinations of weight and airspeed with the rotor pitch control in the full low-pitch position.

(Part 6, 21 F.R. 10291, Dec. 22, 1956, effective Dec. 20, 1956.)

6.104 *Empty weight.*

(a) The empty weight, and the corresponding center of gravity position, shall be determined by weighing the rotocraft. This weight shall exclude the weight of the crew and payload, but shall include the weight of all fixed ballast, unusable fuel supply (see sec. 6.421), undrainable oil, total quantity of engine coolant, and total quantity of hydraulic fluid.

(b) The condition of the rotorcraft at the time of weighing shall be one which can be easily repeated and easily defined, particularly as regards the contents of the fuel, oil, and coolant tanks, and the items of equipment installed. (See sec. 6.740.)

(Part 6, 21 F.R. 10291, Dec. 22, 1956, effective Dec. 20, 1956.)

6.105 *Use of ballast.* Removable ballast may be used to enable the rotorcraft to comply with the flight requirements. (See secs. 6.391, 6.738, and 6.740.)

(Part 6, 21 F.R. 10291, Dec. 22, 1956, effective Dec. 20, 1956.)

Performance

6.110 *General.* The performance information prescribed in sections 6.111 through 6.116 shall be determined, and the rotorcraft shall

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comply with the corresponding requirements in the standard atmosphere in still air.

(Part 6, 21 F.R. 10291, Dec. 22, 1956, effective Dec. 20, 1956; as amended by Amdt. 6-4, 24 F.R. 7072, Sept. 1, 1959, effective Oct. 1, 1959.)

6.111 *Takeoff.* The takeoff shall be demonstrated at maximum certificated weight, forward center of gravity, and using takeoff power at takeoff rpm and made in a manner such that a landing can be made safely at any point along the flight path in case of an engine failure and shall not require an exceptional degree of skill on the part of the pilot or exceptionally favorable conditions. Pertinent information concerning the takeoff procedure, including the type of takeoff surface and appropriate climbout airspeeds, shall be specified in the operating procedures section of the Rotorcraft Flight Manual. (See secs. 6.116, 6.740, 6.742, and 6.743.)

(Part 6, 21 F.R. 10291, Dec. 22, 1956, effective Dec. 20, 1956; as amended by Amdt. 6-4, 24 F.R. 7072, Sept. 1, 1959, effective Oct. 1. 1959.)

6.112 *Climb.*

(a) For all rotorcraft, except helicopters, the steady rate of climb at the best rate-of-climb speed with maximum continuous power and landing gear retracted shall be determined over the range of weights, altitudes, and temperatures for which certification is sought (see sec. 6.740). This rate of climb shall provide a steady angle of climb under standard sea level conditions of not less than 1:6.

(b) For helicopters the best rate-of-climb speed shall be determined at standard sea level conditions at maximum certificated weight with all engines operating at maximum continuous power.

(c) For multiengine helicopters the steady rate of climb or descent shall be determined at maximum certificated weight, at the best rate-of-climb or descent speed, with one engine inoperative, and the remaining engine(s) operating at maximum continuous power.

(Part 6, 21 F.R. 10291, Dec. 22, 1956, effective Dec. 20, 1956.)

6.113 *Minimum operating speed performance.*

(a) Hovering ceilings for helicopters shall be determined over the range of weights, altitudes, and temperatures for which certification is sought with takeoff power and landing gear extended in the ground effect at a height above the ground consistent with normal takeoff procedures.

(b) At maximum weight, under standard atmospheric conditions, and under conditions prescribed in paragraph (a) of this section, the hovering ceiling for helicopters shall not be less than 4,000 feet.

(c) For rotorcraft other than helicopters, the steady rate of climb at the minimum operating speed appropriate to the type with takeoff power and landing gear extended shall be determined over the range of weights, altitudes, and temperatures for which certification is sought.

(Part 6, 21 F.R. 10291, Dec. 22, 1956, effective Dec. 20, 1956.)

6.114 *Autorotative or one-engine-inoperative landing.* Landings shall be demonstrated in accordance with the provisions of paragraphs (a) through (d) of this section. Pertinent information concerning the landing procedure, including the type of landing surface and appropriate approach and glide airspeeds, shall be specified in the operating procedures section of the Rotorcraft Flight Manual (see secs. 6.740 and 6.742).

(a) The approach speed or speeds in the glide shall be appropriate to the type of rotorcraft and shall be chosen by the applicant.

(b) The approach and landings shall be made with power off for single-engine rotorcraft, and with one engine inoperative for multiengine rotorcraft.

(c) The approach and landing shall be entered from steady autorotation and shall be made in such a manner that its reproduction would not require an exceptional degree of skill on the part of the pilot or exceptionally favorable conditions.

(d) During the landing there shall be no excessive vertical acceleration and no tendency to bounce, nose over, ground loop, porpoise, or water loop.

(Part 6, 21 F.R. 10291, Dec. 22, 1956, effective Dec. 20, 1956.)

6.114-1 *Autorotative or one-engine-inoperative landing for helicopters with float installations (FAA policies which apply to sec. 6.114).*

(a) Helicopters equipped with float installations* should comply with the following:

(1) Landings should be conducted on water at wave heights selected by the applicant to show compliance with sections 6.114 and 6.715.

(2) When approval is requested under the air carrier operating regulations (see secs. 46.70, 46.71, and 46.206 of this chapter) for operations involving takeoff or landing over water with helicopters certificated under this part, compliance should be shown with subparagraph (1) of this paragraph.

(3) For approval of night operations, landings from cruising altitude should be conducted in accordance with subparagraph (1) or (2) of this paragraph.

(4) Pertinent information concerning the operating procedures investigated and the surface conditions prevailing during these landings should be included in the operating procedure section of the Rotorcraft Flight Manual.

(Supp. 18, 24 F.R. 965, Feb. 10, 1959, effective Feb. 26, 1959.)

6.115 *Power-off landings for multiengine rotorcraft.* For all multiengine rotorcraft it shall be possible to make a safe landing following complete failure of all power during normal operating conditions.

(Part 6, 21 F.R. 10291, Dec. 22, 1956, effective Dec. 20, 1956.)

6.116 *Limiting height and speeds for safe landing following power failure.* If a range of heights exists at any speed, including zero, within which it is not possible to make a safe landing following power failure, the range of heights and its variation with forward speed shall be established together with any other pertinent information, such as type of landing surface. Such an envelope shall be established in full autorotation for single-engine helicopters and with one engine inoperative for multiengine helicopters provided that engine isolation design features are incorporated to assure continued operation of the remaining engines. (See sec. 6.743(c).)

(Added by Amdt. 6-4, 24 F.R. 7072, Sept. 1, 1959, effective Oct. 1, 1959.)

*"Salvage float gear" constitutes means to keep the helicopter afloat for salvage purposes only and is not to be regarded as a float installation.

Flight Characteristics

6.120 *General.*

(a) The rotorcraft shall comply with the requirements prescribed in sections 6.120 through 6.123 at all normally expected operating altitudes, under all critical loading conditions within the range of weight and center of gravity, and for all speeds, power, and rotor rpm conditions for which certification is sought.

(b) It shall be possible to maintain a flight condition and to make a smooth transition from one flight condition to another 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 those conditions normally encountered in the event of sudden powerplant failure.

(c) For night or instrument certification the rotorcraft shall have such additional flight characteristics as the Administrator finds are required for safe operation under those conditions.

(Part 6, 21 F.R. 10291, Dec. 22, 1956, effective Dec. 20, 1956.)

6.121 *Controllability.*

(a) The rotorcraft shall be safely controllable and maneuverable during steady flight and during the execution of any maneuver appropriate to the type of rotorcraft, including takeoff, climb, level flight, turn, glide, and power-on or power-off landings.

(b) The margin of longitudinal and lateral cyclic control shall allow satisfactory pitching and rolling control at V_{NE} (see sec. 6.711) with: (1) Maximum weight, (2) critical center of gravity, (3) power on and power off, and (4) critical rotor rpm.

(c) Compliance with paragraph (b) of this section shall include a demonstration with a power failure at V_H or V_{NE} whichever is the lesser.

(d) There shall be established a wind velocity in which the rotorcraft can be operated without loss of control on or near the ground at the critical weight and center of gravity and the critical rotor rpm in any maneuver appropriate to the type of rotorcraft (e. g. crosswind

takeoffs, sideward or rearward flight). This wind velocity shall not be less than 20 mph.

(e) Controllability after power failure shall be demonstrated over the range of airspeeds and altitudes for which certification is sought, starting with maximum continuous power at critical weight. In taking corrective action, the time delay for all flight conditions shall be based on the normal pilot reaction time, except that for the cruise condition the time delay shall not be less than one second.

(Part 6, 21 F.R. 10291, Dec. 22, 1956, effective Dec. 20, 1956; as amended by Amdt. 6-4, 24 F.R. 7072, Sept. 1, 1959, effective Oct. 1, 1959.)

6.122 *Trim.* It shall be possible in steady level flight at any speed appropriate to the type of rotorcraft to trim the steady longitudinal and lateral control forces to zero. The trim device shall not introduce any undesirable discontinuities in the force gradients.

(Part 6, 21 F.R. 10291, Dec. 22, 1956, effective Dec. 20, 1956.)

6.123 *Stability.*

(a) *General.* It shall be possible to fly the rotorcraft in normal maneuvers, including a minimum of three takeoffs and landings, for a continuous period of time appropriate to the operational use of the particular type of rotorcraft without the pilot experiencing undue fatigue or strain. In addition, the rotorcraft shall comply with the requirements of paragraph (b) of this section.

(b) *Static longitudinal stability.* In the following configurations the characteristics of the longitudinal cyclic control shall be such that, with constant throttle and collective pitch settings, a rearward displacement of longitudinal control shall be necessary to obtain speeds below the specified trim speed and a forward displacement shall be necessary to obtain speeds above the specified trim speed for the ranges of altitude and rotor rpm for which certification is sought:

(1) *Climb.* At all speeds from $0.85V_Y$ to $1.2V_Y$ with:

(i) Critical weight and center of gravity,

(ii) Maximum continuous power,

(iii) Landing gear retracted, and

(iv) Trim at best rate-of-climb speed (V_Y).

(2) *Cruise.* At all speeds from $0.7V_H$ or $0.7V_{NE}$, whichever is less, to $1.1V_H$ or $1.1V_{NE}$, whichever is less, with:

(i) Critical weight and center of gravity,

(ii) Power for level flight at 0.9 V_H or 0.9 V_{NE}, whichever is less,

(iii) Landing gear retracted, and

(iv) Trimmed at 0.9 V_H or 0.9 V_{NE}, whichever is less.

(3) *Autorotation.* Throughout the speed range for which certification is sought, with:

(i) Critical weight and center of gravity,

(ii) Power off,

(iii) Landing gear both retracted and extended and,

(iv) trim at the speed for minimum rate of descent.

(4) *Hovering.* In the case of helicopters the stick position curve shall have a stable slope between the maximum approved rearward speed and a forward speed of 20 mph with:

(i) Critical weight and center of gravity,

(ii) Power required for hovering in still air,

(iii) Landing gear retracted, and

(iv) Trim for hovering.

Note: It is considered acceptable for the stick position versus speed curve to have a negative slope within the speed range specified for each of the conditions in subparagraphs (1) through (3) of this paragraph, provided the negative stick displacement required is not greater than 10 percent of the total stick travel.

(Part 6, 21 F.R. 10291, Dec. 22, 1956, effective Dec. 20, 1956; as amended by Amdt. 6-4, 24 F.R. 7072, Sept. 1, 1959, effective Oct. 1, 1959.)

Ground and Water Handling Characteristics

6.130 *General.* The rotorcraft shall be demonstrated to have satisfactory ground and water handling characteristics. There shall be no uncontrollable tendencies in any operating condition reasonably expected for the type.

(Part 6, 21 F.R. 10291, Dec. 22, 1956, effective Dec. 20, 1956.)

6.131 *Ground resonance.* **There shall be no uncontrollable tendency for the rotorcraft to oscillate when the rotor is turning and the rotorcraft is on the ground.**

(Part 6, 21 F.R. 10291, Dec. 22, 1956, effective Dec. 20, 1956.)

6.132 *Spray characteristics.* **For rotorcraft equipped with floats, the spray characteristics during taxiing, takeoff, and landing shall be such as not to obscure the vision of the pilot nor produce damage to the rotors, propellers, or other parts of the rotorcraft.**

(Part 6, 21 F.R. 10291, Dec. 22, 1956, effective Dec. 20, 1956.)

Miscellaneous Flight Requirements

6.140 *Flutter and vibration.* **All parts of the rotorcraft shall be demonstrated to be free from flutter and excessive vibration under all speed and power conditions appropriate to the operation of the type of rotorcraft. (See sec. 6.711.)**

(Part 6, 21 F.R. 10291, Dec. 22, 1956, effective Dec. 20, 1956; as amended by Amdt. 6-4, 24 F.R. 7072, Sept. 1, 1959, effective Oct. 1, 1959.)

Subpart C—Structure

General

6.200 *Loads.*

(a) Strength requirements of this subpart are specified in terms of limit and ultimate loads. Unless otherwise stated, the specified loads shall be considered as limit loads. In determining compliance with these requirements the provisions set forth in paragraphs (b) through (e) of this section shall apply.

(b) The factor of safety shall be 1.5 unless otherwise specified, and shall apply to the external and inertia loads, unless its application to the resulting internal stresses is more conservative.

(c) Unless otherwise provided, the specified air, ground, and water loads shall be placed in equilibrium with inertia forces, considering all items of mass in the rotorcraft.

(d) All loads shall be distributed in a manner closely approximating or conservatively representing actual conditions.

(e) If deflections under load significantly change the distribution of external or internal loads, the redistribution shall be taken into account.

(Part 6, 21 F.R. 10291, Dec. 22, 1956, effective Dec. 20, 1956.)

6.201 *Strength and deformation.*

(a) The structure shall be capable of supporting limit loads without suffering detrimental permanent deformations.

(b) At all loads up to limit loads the deformation shall not be such as to interfere with safe operation of the rotorcraft.

(c) The structure shall be capable of supporting ultimate loads without failure. It shall support the load during a static test for at least 3 seconds, unless proof of strength is demonstrated by dynamic tests simulating actual conditions of load application.

(Part 6, 21 F.R. 10291, Dec. 22, 1956, effective Dec. 20, 1956.)

6.202 *Proof of structure.*

(a) Proof of compliance of the structure with the strength and deformation requirements of section 6.201 shall be made for all critical loading conditions.

(b) Proof of compliance by means of structural analysis shall be acceptable only when the structure conforms to types for which experience has shown such methods to be reliable. In all other cases substantiating tests shall be required.

(c) In all cases certain portions of the structure shall be tested as specified in section 6.203.

(Part 6, 21 F.R. 10291, Dec. 22, 1956, effective Dec. 20, 1956.)

6.203 *Structural and dynamic tests.* **At least the following structural tests shall be conducted to show compliance with the strength criteria:**

(a) Dynamic and endurance tests of rotors and rotor drives, including controls (see sec. 6.412).

(b) Control surface and system limit load tests (see sec. 6.323).

(c) Control system operation tests (see sec. 6.324).

(d) Flight stress measurements (see secs. 6.221, 6.250, [and 6.251]).

(e) Landing gear drop tests (see sec. 6.237).

(f) Such additional tests as may be found necessary by the Administrator to substantiate new and unusual features of the design.

(Part 6, 21 F.R. 10291, Dec. 22, 1956, effective Dec. 20, 1956; as amended by Amdt. 6–4, 24 F.R. 7072, Sept. 1, 1959, effective Oct. 1, 1959; Amdt. 6–5, 27 F.R. 2996, Mar. 30, 1962, effective May 3, 1962.)

6.203–1 *Fixed or ground adjustable stabilizing surfaces (FAA policies which apply to secs. 6.10 and 6.203 (b)).* The purpose of section 6.203 is to require the testing of certain components which in the details of their construction, operational characteristics, or loading, do not lend themselves to established and reliable methods of analysis. In this regard, proof testing such items as fixed or ground adjustable stabilizing surfaces is not considered a minimum requirement and will not be necessary provided sufficient experience has been accumulated from previous satisfactory designs, methods of analysis and tests to justify acceptance of these components on the basis of structural analysis. Therefore, these components may be regarded structurally the same as any other part of the basic airframe.

(Supp. 9, 18 F.R. 2877, May 19, 1953, effective June 15, 1953.)

6.204 *Design limitations.* The following values shall be established by the applicant for purposes of showing compliance with the structural requirements specified in this subpart:

(a) Maximum design weight,

(b) Power-on and power-off main rotor rpm ranges (see secs. 6.103 and 6.713 through 6.714 (b)),

(c) Maximum forward speeds for the power-on and power-off rotor rpm ranges established in accordance with paragraph (b) of this section (see sec. 6.711),

(d) Maximum rearward and sideward flight speeds,

(e) Extreme positions of rotorcraft center of gravity to be used in conjunction with the limitations of paragraphs (b), (c), and (d) of this section,

(f) Rotational speed ratios between the powerplant and all connected rotating components,

(g) Positive and negative limit maneuvering load factors.

(Part 6, 21 F.R. 10291, Dec. 22, 1956, effective Dec. 20, 1956.)

Flight Loads

6.210 *General.* Flight load requirements shall be complied with at all weights from the design minimum weight to the design maximum weight, with any practicable distribution of disposable load within prescribed operating limitations stated in the Rotorcraft Flight Manual (see sec. 6.741).

(Part 6, 21 F.R. 10291, Dec. 22, 1956, effective Dec. 20, 1956.)

6.211 *Flight load factors.* The flight load factors shall represent rotor load factors. The net load factor acting at the center of gravity of the rotorcraft shall be obtained by proper consideration of balancing loads acting in the specific flight conditions.

(Part 6, 21 F.R. 10291, Dec. 22, 1956, effective Dec. 20, 1956.)

6.212 *Maneuvering conditions.* The rotorcraft structure shall be designed for a positive maneuvering limit load factor of 3.5 and for a negative maneuvering limit load factor of 1.0, except that lesser values shall be allowed if the manufacturer shows by analytical study and flight demonstrations that the probability of exceeding the values selected is extremely remote. In no case shall the limit load factors be less than 2.0 positive and 0.5 negative. The resultant loads shall be assumed to be applied at the center(s) of the rotor hub(s) and to act in such directions as necessary to represent all critical maneuvering motions of the rotorcraft applicable to the particular type, including flight at the maximum design rotor tip speed ratio under power-on and power-off conditions.

(Part 6, 21 F.R. 10291, Dec. 22, 1956, effective Dec. 20, 1956.)

6.213 *Gust conditions.* The rotorcraft structure shall be designed to withstand the loading due to a vertical gust of 30 feet per second in velocity in conjunction with the critical rotorplane airspeeds, including hovering.

(Part 6, 21 F.R. 10291, Dec. 22, 1956, effective Dec. 20, 1956.)

Control Surface and System Loads

6.220 *General.* The structure of all auxiliary rotors (antitorque and control), fixed or movable stabilizing and control surfaces, and all systems operating any flight controls shall be designed to comply with the provisions of sections 6.221 through 6.225.

(Part 6, 21 F.R. 10291, Dec. 22, 1956, effective Dec. 20, 1956.)

6.221 *Auxiliary rotor assemblies.* Auxiliary rotor assemblies shall be tested in accordance with the provisions of section 6.412 for rotor drives. In addition, auxiliary rotor assemblies with detachable blades shall be substantiated for centrifugal loads resulting from the maximum design rotor rpm. In the case of auxiliary rotors with highly stressed metal components, the vibration stresses shall be determined in flight, and it shall be demonstrated that these stresses do not exceed safe values for continuous operation.

(Part 6, 21 F.R. 10291, Dec. 22, 1956, effective Dec. 20, 1956.)

6.221–1 *Service life of auxiliary rotor assemblies (FAA interpretations which apply to sec. 6.221).* The requirement in section 6.221 that vibration stresses in highly stressed metal components of auxiliary rotors must not exceed safe values for continuous operation is interpreted to mean that the service life of such components should be determined by fatigue tests or by other methods found acceptable by the Administrator. The methods of service life determination for main rotor structure outlined under section 6.250–1 are considered to be acceptable in showing compliance with the pertinent portion of section 6.221.

(Supp. 6, 16 F.R. 3405, Apr. 19, 1951, effective May 1, 1951.)

6.222 *Auxiliary rotor attachment structure.* The attachment structure for the auxiliary rotors shall be designed to withstand a limit load equal to the maximum loads in the structure occurring under the flight and landing conditions.

(Part 6, 21 F.R. 10291, Dec. 22, 1956, effective Dec. 20, 1956.)

6.223 *Tail rotor guard.* When a tail rotor is provided on a rotorcraft it shall not be possible for the tail rotor to contact the landing medium during a normal landing. If a tail rotor guard is provided which will contact the landing medium during landings and thus prevent tail rotor contact, suitable design loads for the guard shall be established, and the guard and its supporting structure shall be designed to withstand the established loads.

(Part 6, 21 F.R. 10291, Dec. 22, 1956, effective Dec. 20, 1956.)

6.224 *Stabilizing and control surfaces.* Stabilizing and control surfaces shall be designed to withstand the critical loading from maneuvers or from combined maneuver and gust. In no case shall the limit load be less than 15 lbs. per square foot or a load due to C_N=0.55 at the maximum design speed. The load distribution shall simulate closely the actual pressure distribution conditions.

(Part 6, 21 F.R. 10291, Dec. 22, 1956, effective Dec. 20, 1956.)

6.225 *Primary control systems.* [All] control systems shall comply with the provisions of paragraphs (a) and (b) of this section.

(a) From the pilot compartment to the stops which limit the range of motion of the pilots' controls, the controls shall be designed to withstand the limit pilot applied forces as set forth in subparagraphs (1) through (3) of this paragraph, unless it is shown that the pilot is unable to apply such loads to the system. In the latter event the system shall be designed for the maximum loads which the pilot is able to apply, except that in any case values less than 0.60 of those specified shall not be employed.

(1) Foot type controls—130 pounds,

(2) Stick type controls—fore and aft 100 pounds—laterally 67 pounds,

(3) Wheel type controls—fore and aft 100 pounds—laterally 53-pound couple applied on opposite sides of the control wheel.

(b) From the stops to the attachment of the control system to the rotor blades (or control areas) the control system shall be designed to withstand the maximum loads which can be obtained in normal operation of the rotorcraft, except that where jamming, ground gusts, control inertia, or friction can cause loads exceeding operational loads, the system shall be capable of supporting without yielding 0.60 of the

loads specified in paragraph (a) (1), (2), and (3) of this section.

(Part 6, 21 F.R. 10291, Dec. 22, 1956, effective Dec. 20, 1956; as amended by Amdt. 6-5, 27 F.R. 2996, Mar. 30, 1962, effective May 3, 1962.)

[6.226 *Dual primary flight control systems.* If a dual primary flight control system is provided, the system shall be designed for conditions when the pilots operate the controls in opposition and in conjunction. Individual pilot loads equal to 75 percent of those obtained in accordance with section 6.225 shall be applicable.]

(Added by Amdt. 6-5, 27 F.R. 2996, Mar. 30, 1962, effective May 3, 1962.

Landing Loads

6.230 *General.*

(a) *Loads and equilibrium.* The limit loads obtained in the landing conditions shall be considered as external loads which would occur in a rotorcraft structure if it were acting as a rigid body. In each of the conditions the external loads shall be placed in equilibrium with the linear and angular inertia loads in a rational or conservative manner. In applying the specified conditions the provisions of paragraphs (b) through (e) of this section shall be complied with.

(b) *Center of gravity positions.* The critical center of gravity positions within the certification limits shall be selected so that the maximum design loads in each of the landing gear elements are obtained.

(c) *Design weight.* The design weight used in the landing conditions shall not be less than the maximum weight of the rotorcraft. It shall be acceptable to assume a rotor lift, equal to one-half the design maximum weight, to exist throughout the landing impact and to act through the center of gravity of the rotorcraft. Higher values of rotor lift shall be acceptable if substantiated by tests and/or data which are applicable to the particular rotorcraft.

(d) *Load factor.* The structure shall be designed for a limit load factor, selected by the applicant, of not less than the value of the limit inertia load factor substantiated in accordance with the provisions of section 6.237, except in conditions in which other values of load factor are prescribed.

(e) *Landing gear position.* The tires shall be assumed to be in their static position, and the shock absorbers shall be assumed to be in the most critical position, unless otherwise prescribed.

(f) *Landing gear arrangement.* The provisions of sections 6.231 through 6.236 shall be applicable to landing gear arrangements where two wheels are located aft and one or more wheels are located forward of the center of gravity.

(Part 6, 21 F.R. 10291, Dec. 22, 1956, effective Dec. 20, 1956.)

6.231 *Level landing conditions.*

(a) Under loading conditions prescribed in paragraph (b) of this section, the rotorcraft shall be assumed to be in the following two level landing attitudes:

(1) All wheels contacting the ground simultaneously, and

(2) The aft wheels contacting the ground while the forward wheel(s) being just clear of the ground.

(b) The following two level landing loading conditions shall be considered. Where the forward portion of the landing gear has two wheels, the total load applied to the forward wheels shall be divided between the two wheels in a 40:60 proportion.

(1) Vertical loads shall be applied in accordance with the provisions of section 6.230.

(2) The vertical loads specified in subparagraph (1) of this paragraph shall be combined with a drag load at each wheel. The drag loads shall not be less than 25 percent of the respective vertical loads. For the attitude prescribed in paragraph (a) (1) of this section the resulting pitching moment shall be assumed resisted by the forward gear, while for the attitude prescribed in paragraph (a) (2) of this section the resulting pitching moment shall be assumed resisted by angular inertia forces.

(Part 6, 21 F.R. 10291, Dec. 22, 1956, effective Dec. 20, 1956.)

6.231-1 *Distribution of vertical ground reaction loads and determination of angular inertia loads (FAA interpretations which apply to sec. 6.231 (b) (2)).*

(a) Although section 6.231 (b) (2) states that the vertical loads are those specified in section 6.231 (b) (1), the distribution of the

vertical loads among the ground reaction points is not necessarily the same for the two subparagraphs since the requirements of section 6.230 must be met. Section 6.230 (a) states, in part, that the external loads shall be placed in equilibrium with the linear and angular inertia loads in a rational or conservative manner.

(b) Compliance with section 6.231 (b) (2) is interpreted to require that a vertical inertia load of nW and a horizontal inertia load of 0.25 nW be applied at the center of gravity. For the level landing with drag on all wheels, the vertical ground reaction loads should be distributed between the forward and rear wheels to place the ground reaction loads in equilibrium with the rotorcraft linear inertia loads. For the level landing with drag on main wheels only, the pitching moments arising from the vertical and horizontal ground reactions should be placed in equilibrium with an angular inertia load about the c. g.

(c) The drag load at each wheel, in both cases, is required to be equal to 0.25 times the respective wheel vertical load.

(Supp. 7, 17 F.R. 8322, Sept. 17, 1952, effective Sept. 17, 1952.)

6.232 *Nose-up landing condition.* The rotorcraft shall be assumed in the maximum nose-up attitude permitting clearance of the ground by all parts of the rotorcraft. The ground loads shall be applied perpendicularly to the ground.

(Part 6, 21 F.R. 10291, Dec. 22, 1956, effective Dec. 20, 1956.)

6.233 *One-wheel landing condition.* The rotorcraft shall be assumed in the level attitude to contact the ground on one of the wheels located aft of the center of gravity. The vertical load shall be the same as that obtained on the one side in the condition specified in section 6.231 (b) (1). The unbalanced external loads shall be reacted by the inertia of the rotorcraft.

(Part 6, 21 F.R. 10291, Dec. 22, 1956, effective Dec. 20, 1956.)

6.234 *Lateral-drift landing condition.*

(a) The rotorcraft shall be assumed in the level landing attitude. Side loads shall be combined with one-half the maximum ground reactions obtained in the level landing conditions of section 6.231 (b) (1). These loads shall be applied at the ground contact point, unless the landing gear is of the full-swiveling type in which case the loads shall be applied at the center of the axle. The conditions set forth in paragraphs (b) and (c) of this section shall be considered.

(b) Only the wheels aft of the center of gravity shall be assumed to contact the ground. Side loads equal to 0.8 of the vertical reaction acting inward (on one side) and 0.6 of the vertical reaction acting outward (on the other side) shall be combined with the vertical loads specified in paragraph (a) of this section.

(c) The forward and aft wheels shall be assumed to contact the ground simultaneously. Side loads on the wheels aft of the center of gravity shall be applied in accordance with paragraph (b) of this section. A side load at the forward gear equal to 0.8 of the vertical reaction shall be combined with the vertical load specified in paragraph (a) of this section.

(Part 6, 21 F.R. 10291, Dec. 22, 1956, effective Dec. 20, 1956.)

6.235 *Brake roll conditions.* The rotorcraft attitudes shall be assumed to be the same as those prescribed for the level landing conditions in section 6.231 (a), with the shock absorbers deflected to their static position. The limit vertical load shall be based upon a load factor of 1.33 when the rotorcraft attitude is as specified in sec. 6.231(a)(1); the limit vertical load factor may be reduced to 1.0 when the attitude is as specified in sec. 6.231(a)(2). A drag load equal to the vertical load multiplied by a coefficient of friction of 0.8 shall be applied at the ground contact point of each wheel equipped with brakes, except that the drag load need not exceed the maximum value based on limiting brake torque.

(Part 6, 21 F.R. 10291, Dec. 22, 1956, effective Dec. 20, 1956; as amended by Amdt. 6-4, 24 F.R. 7072, Sept. 1, 1959, effective Oct. 1, 1959.)

6.236 *Taxiing condition.* The rotorcraft and its landing gear shall be designed for loads which occur when the rotorcraft is taxied over the roughest ground which it is reasonable to expect in normal operation.

(Part 6, 21 F.R. 10291, Dec. 22, 1956, effective Dec. 20, 1956.)

6.237 *Shock absorption tests.* **Drop tests shall be conducted in accordance with paragraphs (a) and (b) of this section to substantiate the landing limit inertia load factor (see sec. 6.230 (d)) and to demonstrate the reserve energy absorption capacity of the landing gear. The drop tests shall be conducted with the complete rotorcraft or on units consisting of wheel, tire, and shock absorber in their proper relation.**

(a) *Limit drop test.* **The drop height in the limit drop test shall be 13 inches measured from the lowest point of the landing gear to the ground. A lesser drop height shall be permissible if it results in a drop test contact velocity found by the Administrator to be equal to the greatest probable sinking speed of the rotorcraft at ground contact in power-off landings likely to be made in normal operation of the rotorcraft. In no case shall the drop height be less than 8 inches. If rotor lift is considered (see sec. 6.230 (c)), it shall be introduced in the drop test by the use of appropriate energy absorbing devices or by the use of an effective mass. The attitude in which the landing gear unit is tested shall be such as to simulate the landing condition which is critical from the standpoint of the energy to be absorbed by the particular unit.**

Note: In lieu of more rational computations, the following may be employed when use is made of an effective mass:

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

where:

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

$W = W_M$ for main gear units (lbs.), equal to the static reaction on the particular unit with the rotorcraft in the most critical attitude. A rational method may be used in computing a main gear static reaction, taking into consideration the distance between the direction of the main wheel reaction and the aircraft c. g.

$W = W_N$ for nose gear units (lbs.), equal to the vertical component of the static reaction which would exist at the nose wheel, assuming the mass of the rotorcraft acting at the center of gravity and exerting a force of 1.0g downward and 0.25g forward;

[$W = W_T$ for tailwheel units (pounds) equal to whichever of the following is critical:

[(1) The static weight on the tailwheel with the rotorcraft resting on all wheels; or

[(2) The vertical component of the ground reaction which would occur at the tailwheel assuming the mass of the rotorcraft acting at the center of gravity and exerting a force of 1g downward with the rotorcraft in the maximum nose-up attitude considered in the nose-up landing conditions. (See sec. 6.246 (b) and (c).)]

h = specified free drop height (inches);

L = ratio of assumed rotor lift to the rotorcraft weight;

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

n = limit inertia load factor;

n_j = the load factor during impact developed on the mass used in the drop test (i. e., the acceleration dv/dt in g's recorded in the drop test plus 1.0).

(b) *Reserve energy absorption drop test.* **The reserve energy absorption capacity shall be demonstrated by a drop test in which the drop height is equal to 1.5 times the drop height prescribed in paragraph (a) of this section, and the rotor lift is assumed to be not greater than 1.5 times the rotor lift used in the limit drop tests, except that the resultant inertia load factor need not exceed 1.5 times the limit inertia load factor determined in accordance with paragraph (a) of this section. In this test the landing gear shall not collapse.**

Note: The effect of rotor lift may be considered in a manner similar to that prescribed in paragraph (a) of this section.

(Part 6, 21 F.R. 10291, Dec. 22, 1956, effective Dec. 20, 1956; as amended by Amdt. 6-2, 22 F.R. 5568, July 16, 1957, effective Aug. 12, 1957; Amdt. 6-4, 24 F.R. 7072, Sept. 1, 1959, effective Oct. 1, 1959; Amdt. 6-5, 27 F.R. 2996, Mar. 30, 1962, effective May 3, 1962.)

6.240 *Ski landing conditions.* **The structure of a rotorcraft equipped with skis shall be designed in compliance with the loading conditions set forth in paragraphs (a) through (c) of this section:**

(a) *Up load conditions.*

(1) A vertical load of Pn and a horizontal load of $Pn/4$ shall be applied simultaneously at the pedestal bearings, P being the maximum static weight on each ski when the rotorcraft is loaded to the maximum design weight. The

limit load factor n shall be determined in accordance with section 6.230 (d).

(2) A vertical load equal to 1.33 P shall be applied at the pedestal bearings. (For P see subparagraph (1) of this paragraph.)

(b) *Side load condition.* A side load of 0.35 Pn shall be applied in a horizontal plane perpendicular to the center line of the rotorcraft at the pedestal bearings. (For P and n see subparagraph (a) (1) of this section.)

(c) *Torque load condition.* A torque load equal to 1.33 P (ft.-lb.) shall be applied to the ski about the vertical axis through the center line of the pedestal bearings. (For P see subparagraph (a) (1) of this section.)

(Part 6, 21 F.R. 10291, Dec. 22, 1956, effective Dec. 20, 1956.)

6.245 *Float landing conditions.* The structure of a rotorcraft equipped with floats shall be designed in compliance with the loading conditions set forth in paragraphs (a) and (b) of this section:

(a) *Up load conditions.*

(1) With the rotorcraft assumed in the static level attitude a load shall be applied so that the resultant water reaction passes vertically through the center of gravity of the rotorcraft. The limit load factor shall be determined in accordance with section 6.230 (d) or shall be assumed to be the same as the load factor determined for the ground type landing gear.

(2) The vertical load prescribed in subparagraph (1) of this paragraph shall be applied together with an aft component equal to 0.25 the vertical component.

(b) *Side load condition.* The vertical load in this condition equal to 0.75 the vertical load prescribed in paragraph (a) (1) of this section, divided equally between the floats, shall be applied together with a side component. The total side component shall be equal to 0.25 the total vertical load in this condition and shall be applied to one float only.

(Part 6, 21 F.R. 10291, Dec. 22, 1956, effective Dec. 20, 1956.)

6.246 *Tailwheel type landing gear ground loading conditions.* The structure of a rotorcraft equipped with landing gears arranged such that two wheels are located forward and one wheel is located aft of the center of gravity shall be assumed to be subjected to the loading conditions in accordance with paragraphs (a) through (h) of this section:

(a) *Level landing on forward gear only.* The rotorcraft shall be assumed to be in the level landing attitude with only the forward wheels contacting the ground.

(1) Vertical loads shall be applied in accordance with the provisions of section 6.230.

(2) The vertical loads specified in subparagraph (1) of this paragraph shall be combined with a drag load at each wheel axle of not less than 25 percent of the respective vertical load.

(3) In the conditions of subparagraphs (1) and (2) of this paragraph, unbalanced pitching moments shall be assumed resisted by angular inertia forces.

(b) *Level landing; all wheels contacting simultaneously.* The rotorcraft shall be assumed to be in the level landing attitude with all wheels contacting the ground simultaneously.

(1) Vertical loads shall be applied in accordance with the provisions of section 6.230.

(2) The vertical loads specified in subparagraph (1) of this paragraph shall be combined with a drag load at each wheel axle of not less than 25 percent of the respective vertical load. Unbalanced pitching moments shall be assumed resisted by angular inertia forces.

(c) *Nose-up landing condition.* The rotorcraft shall be assumed to contact the ground on the rear wheel only at the maximum nose-up attitude to be expected under all operational landing conditions including landings in autorotation. The conditions of this paragraph need not be applied if it can be demonstrated that the probability of landing with initial contact on the rear wheel is extremely remote. In determining the applicable ground loads, it shall be acceptable to use a rational method to account for the distance between the direction of the rear wheel ground reactions and the rotorcraft c. g.

(1) Vertical loads shall be applied in accordance with the provisions of section 6.230.

(2) The vertical loads specified in subparagraph (1) of this paragraph shall be combined with a drag load at the wheel axle of not less than 25 percent of the vertical load.

(d) *One-wheel landing condition.* The rotorcraft shall be assumed in the level attitude to contact the ground on one of the wheels located forward of the c. g. The vertical load shall be the same as that obtained on the one side in the condition specified in paragraph (a) (1) of this section. Unbalanced moments shall be assumed resisted by angular inertia forces.

(e) *Side load landing condition.* The rotorcraft shall be assumed in the landing attitudes of paragraphs (a) and (b) of this section. Side loads in combination with one-half the maximum vertical ground reactions obtained in the landing conditions of paragraphs (a) (1) and (b) (1) of this section shall be applied at each wheel. The magnitude of the side loads on the forward wheels in each case shall be 0.8 of the vertical reaction (on one side) acting inward and 0.6 of the vertical reaction (on the other side) acting outward. The magnitude of the side load on the rear wheel shall be equal to 0.8 of the vertical reaction. These loads shall be applied at the ground contact point, unless the landing gear is of the full-swiveling type in which case the loads shall be applied at the center of the axle. When a lock, steering device, or shimmy damper is provided, the swiveled wheel shall also be assumed to be in the trailing position with the side load acting at the ground contact point.

(f) *Braked roll condition.* The rotorcraft attitudes shall be assumed to be the same as those prescribed in paragraphs (a) and (b) of this section with the shock absorbers deflected to their static position. The limit vertical load shall be based upon a load factor of 1.33 when the rotorcraft attitude is as specified in paragraph (b) of this section; the limit vertical load factor may be reduced to 1.0 when the attitude is as specified in paragraph (a) of this section. A drag load equal to the vertical load multiplied by a coefficient of friction of 0.8 shall be applied at the ground contact point of each wheel equipped with brakes, except that the drag load need not exceed the maximum value based on limiting brake torque.

(g) *Rear wheel turning condition.* The rotorcraft shall be assumed to be in the static ground attitude with the shock absorbers and tires deflected to their static position. A vertical ground reaction equal to the static load on the rear wheel in combination with a side component of equal magnitude shall be assumed. When a swivel is provided, the rear wheel shall be assumed to be swiveled 90 degrees to the rotorcraft longitudinal axis with the resultant load passing through the axle. When a lock, steering device, or shimmy damper is provided, the rear wheel shall also be assumed to be in the trailing position with the side load acting at the ground contact point.

(h) *Taxiing condition.* The rotorcraft and its landing gear shall be designed for loads which occur when the rotorcraft is taxied over the roughest ground which it is reasonable to expect in normal operation.

(Added by Amdt. 6-2, 22 F.R. 5568, July 16, 1957, effective Aug. 12, 1957; amended by Amdt. 6-4, 24 F.R. 7072, Sept. 1, 1959, effective Oct. 1, 1959.)

6.247 *Skid gear ground loading condition.* The structure of a rotorcraft equipped with skid type landing gear shall be assumed to be subjected to the loading conditions in accordance with paragraphs (a) through (d) of this section.

(a) The design weight, center of gravity, and load factor shall be in accordance with the provisions of section 6.230. Structural yielding of the elastic spring member under the limit loading conditions shall be acceptable. The design ultimate loads considered for the elastic spring member need not exceed those obtained in a drop test of the skid gear from a drop height equal to 1.5 times that specified in section 6.237 (a) with the assumed rotor lift not to exceed 1.5 times the rotor lift used in the limit drop tests prescribed in section 6.237(a).

(b) The ground loads resulting from the landing conditions specified in paragraph (c) of this section shall be applied to the skid gear in its most critically deflected position for the particular landing condition being considered and a rational distribution of the ground reactions along the skid tube bottom shall be made.

(c) The following landing conditions shall be considered:

(1) *Level landing; vertical reactions.* The rotorcraft shall be assumed to contact the ground along the bottom of both skids. Vertical ground reactions shall be applied in accordance with the provisions of paragraphs (a) and (b) of this section.

(2) *Level landing with drag.* The rotorcraft shall be assumed to contact the ground along the bottom of both skids with vertical ground reactions in combination with a horizontal drag reaction equal to 50 percent of the vertical reaction applied at the ground. The resultant ground load shall be equal to the vertical load specified in subparagraph (1) of this paragraph and shall be directed through the center of gravity of the rotorcraft.

(3) *Level landing with side load.* The rotorcraft shall be assumed to contact the ground along the bottom of both skids with vertical ground reactions in combination with a horizontal side reaction equal to 25 percent of the vertical ground reaction. The vertical ground reaction shall be equal to the vertical load specified in subparagraph (1) of this paragraph and shall be equally divided between the two skids. The total side load shall be applied along the length of one skid only. Unbalanced moments shall be assumed resisted by angular inertia forces. Both the inward and outward acting side loading conditions for the skid gear shall be investigated.

(4) *One-skid landing condition.* In the level attitude, the rotorcraft shall be assumed to contact the ground on one skid only. The vertical load shall be the same as that obtained on the one side in the condition specified in subparagraph (1) of this paragraph. Unbalanced moments shall be assumed to be resisted by angular inertia forces.

(d) *Special conditions for the skid gear.*

(1) A ground reaction load equal to 1.33 times the maximum weight of the rotorcraft acting up and aft at an angle of 45 degrees to the horizontal shall be assumed. The load shall be distributed symmetrically between the two skids and shall be assumed concentrated at the forward end of the straight portion of the skid tube. This loading condition shall apply only to the forward end of skid tube and its attachment to the rotorcraft.

(2) A vertical ground reaction load equal to one-half the vertical load of paragraph (c) (1) of this section shall be assumed with the rotorcraft in the level attitude. This load shall be applied to the skid tube and shall be assumed concentrated at a point midway between the skid tube attachments. This loading condition shall apply only to the skid tube and its attachment to the rotorcraft.

(Added by Amdt. 6-2, 22 F.R. 5568, July 16, 1957, effective Aug. 12, 1957; amended by Amdt. 6-4, 24 F.R. 7072, Sept. 1, 1959, effective Oct. 1, 1959.)

Main Component Requirements

6.250 *Main rotor structure.* The requirements of paragraphs (a) through (f) of this section shall apply to the main rotor assemblies including hubs and blades.

(a) The hubs, blades, blade attachments, and blade controls which are subject to alternating stresses shall be designed to withstand repeated loading conditions. The stresses of critical parts shall be determined in flight in all attitudes appropriate to the type of rotorcraft throughout the ranges of limitations prescribed in section 6.204. The service life of such parts shall be established by the applicant on the basis of fatigue tests or by other methods found acceptable to the Administrator.

(b) The main rotor structure shall be designed to withstand the critical flight loads prescribed in sections 6.210 through 6.213.

(c) The main rotor structure shall be designed to withstand the limit loads prescribed in sections 6.210 through 6.213 under conditions of autorotation necessary for normal operation. The rotor rpm used shall be such as to include the effects of altitude.

(d) The rotor blades, hubs, and flapping hinges shall be designed to withstand a loading condition simulating the force of the blade impact against its stop during operation on the ground.

(e) The rotor assembly shall be designed to withstand loadings simulating other critical conditions which might be encountered in normal operation.

(f) The rotor assembly shall be designed to withstand, at all rotational speeds including zero, the maximum torque likely to be transmitted thereto in both directions. If a torque limiting device is provided in the transmission

system the design limit torque need not be greater than the torque defined by the limiting device, except that in no case shall the design limit torque be less than the limit torque specified in section 6.251 (c). The design torque shall be distributed to the rotor blades in a rational manner.

(Part 6, 21 F.R. 10291, Dec. 22, 1956, effective Dec. 20, 1956.)

6.250–1 *Service life of main rotors (FAA policies which apply to sec. 6.250 (a))*. Several methods which have been found acceptable by the Administrator for determining the service life of main rotors are outlined in appendix A for the guidance of the industry in complying with section 6.250 (a).

(Supp. 6, 16 F.R. 3405, Apr. 19, 1951, effective May 1, 1951.)

6.251 *Fuselage, landing gear, and rotor pylon structure.* The requirements of paragraphs (a) through [(e)] of this section shall apply to the fuselage, landing gear, and rotor pylon structure.

(a) The structure shall be designed to withstand the critical loads prescribed in sections 6.210 through 6.213. It shall be permissible to represent the resultant rotor force as a single force applied at the hub attachment point. The balancing and inertia loads occurring under the accelerated flight conditions as well as the thrust from auxiliary rotors shall be considered.

(b) The structure shall be designed to withstand the applicable ground loads prescribed in sections 6.230 through 6.245.

(c) The engine mount and adjacent fuselage structure shall be designed to withstand loads occurring in the rotorcraft under the accelerated flight and landing conditions, including the effects of engine torque loads. In the case of engines having 5 or more cylinders, the limit torque shall be obtained by multiplying the mean torque, as defined by the power conditions in section 6.1 (g) (3), by a factor of 1.33. For 4-, 3-, and 2-cylinder engines the factors shall be 2, 3, and 4, respectively.

(d) The structure shall be designed to withstand the loads prescribed in section 6.250 [(e)] and (f).

[(e) Parts of the basic structure which are directly subjected to alternating stresses, the sudden failure of which would threaten the structural integrity of the rotorcraft, shall be designed to withstand the repeated loading conditions likely to occur within the established service life for such parts. The stresses of critical parts shall be determined in flight in all attitudes appropriate to the type of rotorcraft throughout the ranges of limitations prescribed in section 6.204. The service life of such parts shall be established by the applicant on the basis of fatigue tests or other acceptable methods.]

(Part 6, 21 F.R. 10291, Dec. 22, 1956, effective Dec. 20, 1956; as amended by Amdt. 6–5, 27 F.R. 2996, Mar. 30, 1962, effective May 3, 1962.)

Emergency Landing Conditions

6.260 *General.* The requirements of paragraphs (a) through (c) of this section deal with emergency conditions of landing on land or water in which the safety of the occupants is considered, although it is accepted that parts of the rotorcraft may be damaged.

(a) The structure shall be designed to give every reasonable probability that all of the occupants, if they make proper use of the seats, belts, and other provisions made in the design (see sec. 6.355), will escape serious injury in the event of a minor crash landing (with wheels up if the rotorcraft is equipped with retractable landing gear) in which the occupants experience the following ultimate inertia forces relative to the surrounding structure.

(1) Upward 1.5g (downward 4.0g).

(2) Forward 4.0g.

(3) Sideward 2.0g.

(b) The use of a lesser value of the downward inertia force specified in paragraph (a) of this section shall be acceptable if it is shown that the rotorcraft structure can absorb the landing loads corresponding with the design maximum weight and an ultimate descent velocity of 5 fps without exceeding the value chosen.

(c) The inertia forces specified 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.

(Part 6, 21 F.R. 10291, Dec. 22, 1956, effective Dec. 20, 1956.)

Subpart D—Design and Construction

General

6.300 *Scope.* The rotorcraft shall not incorporate design features or details which experience has shown to be hazardous or unreliable. The suitability of all questionable design details or parts shall be established by tests.

(Part 6, 21 F.R. 10291, Dec. 22, 1956, effective Dec. 20, 1956.)

6.301 *Materials.* The suitability and durability of all materials used in the rotorcraft structure shall be established on the basis of experience or tests and shall conform to approved specifications which will insure their having the strength and other properties assumed in the design data.

(Part 6, 21 F.R. 10291, Dec. 22, 1956, effective Dec. 20, 1956.)

6.302 *Fabrication methods.* The methods of fabrication employed in constructing the rotorcraft structure shall be such as to produce a consistently sound structure. When a fabrication process such as gluing, spot welding, or heat treating requires close control to attain this objective, the process shall be performed in accordance with an approved process specification.

(Part 6, 21 F.R. 10291, Dec. 22, 1956, effective Dec. 20, 1956.)

6.303 *Standard fastenings.* All bolts, pins, screws, and rivets used in the structure shall be of an approved type. The use of an approved locking device or method is required for all such bolts, pins, and screws. Self-locking nuts shall not be used on bolts which are subject to rotation in operation.

(Part 6, 21 F.R. 10291, Dec. 22, 1956, effective Dec. 20, 1956.)

6.304 *Protection.*

(a) All members of the structure shall be suitably protected against deterioration or loss of strength in service due to weathering, corrosion, abrasion, or other causes.

(b) Provision for ventilation and drainage of all parts of the structure shall be made where necessary for protection.

(c) In rotorcraft equipped with floats, special precautions shall be taken against corrosion from salt water, particularly where parts made from different metals are in close proximity.

(Part 6, 21 F.R. 10291, Dec. 22, 1956, effective Dec. 20, 1956.)

6.305 *Inspection provisions.* Means shall be provided to permit the close examination of those parts of the rotorcraft which require periodic inspection, adjustment for proper alignment and functioning, and lubrication of moving parts.

(Part 6, 21 F.R. 10291, Dec. 22, 1956, effective Dec. 20, 1956.)

6.306 *Material strength properties and design values.*

(a) Material strength properties shall be based on a sufficient number of tests of material conforming to specifications to establish design values on a statistical basis.

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

[(c) Values contained in MIL–HDBK–5, MIL–HDBK–17 Part I, ANC–17 Part II, ANC–18, MIL–HDBK–23 Part I, and ANC–23 Part II shall be used unless shown to be inapplicable in a particular case.

Note: MIL–HDBK–5, "Strength of Metal Aircraft Elements"; MIL–HDBK–17, "Plastics for Flight Vehicles, Part I—Reinforced Plastics"; ANC–17, "Plastics for Aircraft, Part II—Transparent Glazing Materials"; ANC–18, "Design of Wood Aircraft Structures"; MIL–HDBK–23, "Composite Construction for Flight Vehicles, Part I—Fabrication Inspection Durability and Repair"; and ANC–23, "Sandwich Construction for Aircraft, Part II—Material Properties and Design Criteria", are published by the Department of Defense and the Federal Aviation Agency and may be obtained from the Superintendent of Documents, Government Printing Office, Washington 25, D.C.]

(d) The strength, detail design, and fabrication of the structure shall be such as to minimize the probability of disastrous fatigue failure.

Note: Points of stress concentration are one of the main sources of fatigue failure.

(Part 6, 21 F.R. 10291, Dec. 22, 1956, effective Dec. 20, 1956; as amended by Amdt. 6–5, 27 F.R. 2996, Mar. 30, 1962, effective May 3, 1962.)

6.307 *Special factors.*

(a) *General.* Where there is uncertainty concerning the actual strength of a particular part of the structure, or where the strength is likely to deteriorate in service prior to normal replacement of the part, or where the strength is subject to appreciable variability due to uncertainties in manufacturing processes and inspection methods, the factor of safety prescribed in section 6.200 (b) shall be multiplied by a special factor of a value such as to make the probability of the part being understrength from these causes extremely remote. The special factors set forth in paragraphs (b) through (d) of this section shall be acceptable for this purpose.

[(b) *Casting factors.* For structural castings, the factor of safety prescribed in section 6.200 shall be multiplied by the casting factors specified in subparagraph (1) and (2) of this paragraph. The prescribed tests and inspections shall be in addition to those necessary to establish foundry quality control. Castings shall be inspected in accordance with approved specifications.

[(1) Each casting, the failure of which would preclude continued safe flight and landing of the rotorcraft or which would result in serious injury to occupants, shall have a casting factor of at least 1.25 and shall receive 100 percent inspection by visual, radiographic, and magnetic particle or penetrant inspection methods or approved equivalent nondestructive inspection methods. Where such castings have a casting factor less than 1.50, 3 sample castings shall be static tested. The test castings shall comply with the strength requirements of section 6.201 at an ultimate load corresponding with a casting factor of 1.25 and shall comply with the deformation requirements at a load equal to 1.15 times limit load.

[*Note:* Examples of castings to which this subparagraph applies are: structural attachment fittings; parts of flight control systems; control surface hinges and balance weight attachments; seat, berth, safety belt, and fuel and oil tank supports and attachments; cabin pressure valves.

[(2) For structural castings other than those specified in subparagraph (1) of this paragraph, the casting factors and inspections shall be in accordance with the following table except that it shall be acceptable to reduce the percentage of castings inspected by nonvisual methods when an approved quality control procedure is established. For castings procured to a specification which guarantees the mechanical properties of the material in the castings and provides for demonstration of these properties by test of coupons cut from castings on a sampling basis, it shall be acceptable to use a casting factor of 1.0. The inspection requirements for such castings shall be in accordance with those specified in the following table for casting factors of 1.25 to 1.50, and the testing requirements shall be in accordance with subparagraph (1) of this paragraph.

[Casting factor	Inspections
2.0 or greater	100 percent visual.
Less than 2.0 greater than 1.5.	100 percent visual, and magnetic particle or penetrant or equivalent nondestructive inspection methods.
1.25 to 1.50	100 percent visual, magnetic particle or penetrant, and radiographic, or approved equivalent nondestructive inspection methods.

[(3) Castings which are pressure tested as parts of a hydraulic or other fluid system shall not be required to comply with the provisions of this section unless such castings support rotorcraft structural loads.

[(4) The casting factor need not exceed 1.25 with regard to bearing stresses regardless of the method of inspection employed. A casting factor need not be employed with respect to the bearing surface of a part if the bearing factor used (see paragraph (c) of this section) is greater than the casting factor.]

(c) *Bearing factors.*

(1) Bearing factors of sufficient magnitude shall be used to provide for the effects of normal relative motion between parts and in joints with clearance (free fit) which are subject to pounding or vibration.

(2) A bearing factor need not be employed on a part if another special factor prescribed in this section is of greater magnitude than the bearing factor.

(d) *Fitting factors.*

(1) A fitting factor of at least 1.15 shall be used on all fittings the strength of which is not proven by limit and ultimate load tests

in which the actual stress conditions are simulated in the fitting and the surrounding structure. This factor shall apply to all portions of the fitting, the means of attachment, and the bearing on the members joined.

(2) In the case of integral fittings the part shall be treated as a fitting up to the point where the section properties become typical of the member.

(3) The fitting factor need not be employed where a type of joint made in accordance with approved practices is based on comprehensive test data, e. g. continuous joints in metal plating, welded joints, and scarf joints in wood.

(4) A fitting factor need not be employed with respect to the bearing surface of a part if the bearing factor used (see paragraph (c) of this section) is of greater magnitude than the fitting factor.

(Part 6, 21 F.R. 10291, Dec. 22, 1956, effective Dec. 20, 1956; as amended by Amdt. 6-5, 27 F.R. 2996, Mar. 30, 1962, effective May 3, 1962.

Main Rotor

6.310 *Main rotor blades; pressure venting and drainage.* Internal pressure venting of the main rotor blades shall be provided. Drain holes shall be provided and, in addition, the blades shall be designed to preclude the possibility of water becoming trapped in any section of the blade.

(Part 6, 21 F.R. 10291, Dec. 22, 1956, effective Dec. 20, 1956.)

6.311 *Stops.* The rotor blades shall be provided with stops, as required for the particular design, to limit the travel of the blades about their various hinges. Provision shall be made to keep the blades from hitting the droop stops except during the starting and stopping of the rotor.

(Part 6, 21 F.R. 10291, Dec. 22, 1956, effective Dec. 20, 1956.)

6.312 *Rotor and blade balance.* Rotors and blades shall be mass balanced to the degree necessary to prevent excessive vibration and to safeguard against flutter at all speeds up to the maximum forward speed.

(Part 6, 21 F.R. 10291, Dec. 22, 1956, effective Dec. 20, 1956.)

6.313 *Rotor blade clearance.* Clearance shall be provided between the main rotor blades and all other parts of the structure to prevent the blades from striking any part of the structure during any operating condition of the rotorcraft.

(Part 6, 21 F.R. 10291, Dec. 22, 1959, effective Dec. 20, 1956.)

Control Systems

6.320 *General.* All controls and control systems shall operate with ease, smoothness, and positiveness appropriate to their function. The elements of the flight control system shall be designed or shall be distinctively and permanently marked to minimize the possibility of incorrect assembly which could result in the malfunctioning of the control system. (See also secs. 6.350 and 6.353.)

(Part 6, 21 F.R. 10291, Dec. 22, 1956, effective Dec. 20, 1956: as amended by Amdt. 6-4, 24 F.R. 7072, Sept. 1, 1959, effective Oct. 1, 1959.)

6.321 *Control system stops.*

(a) All control systems shall be provided with stops which positively limit the range of motion of the pilot's controls.

(b) Control system stops shall be so located in the system that wear, slackness, or take-up adjustments will not affect appreciably the range of travel.

(c) Control system stops shall be capable of withstanding the loads corresponding with the design conditions for the control system.

(Part 6, 21 F.R. 10291, Dec. 22, 1956, effective Dec. 20, 1956.)

6.322 *Control system locks.* If a device is provided for locking the control system while the rotorcraft is on the ground or water, the provisions of paragraphs (a) and (b) of this section shall apply.

(a) A means shall be provided to give unmistakable warning to the pilot when the locking device is engaged.

(b) Means shall be provided to preclude the possibility of the lock becoming engaged during flight.

(Part 6, 21 F.R. 10291, Dec. 22, 1956, effective Dec. 20, 1956.)

6.323 *Static tests.* Tests shall be conducted on control systems to show compliance

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with limit load requirements in accordance with the provisions of paragraphs (a) through (c) of this section.

(a) The direction of the test loads shall be such as to produce the most severe loading in the control system.

(b) The tests shall include all fittings, pulleys, and brackets used in attaching the control system to the main structure.

(c) Analyses or individual load tests shall be conducted to demonstrate compliance with the special factor requirements for control system joints subjected to angular motion. (See secs. 6.307 and 6.325.)

(Part 6, 21 F.R. 10291, Dec. 22, 1956, effective Dec. 20, 1956.)

6.324 *Operation tests.* An operation test shall be conducted for each control system by operating the controls from the pilot compartment with the entire system loaded to correspond with loads specified for the control system. In this test there shall be no jamming, excessive friction, or excessive deflection.

(Part 6, 21 F.R. 10291, Dec. 22, 1956, effective Dec. 20, 1956.)

6.325 *Control system details.* All details of control systems shall be designed and installed to prevent jamming, chaffing, and interference from cargo, passengers, and loose objects. Precautionary means shall be provided in the cockpit to prevent the entry of foreign objects into places where they would jam the control systems. Provisions shall be made to prevent the slapping of cables or tubes against other parts of the rotorcraft.

(Part 6, 21 F.R. 10291, Dec. 22, 1956, effective Dec. 20, 1956.)

6.326 *Spring devices.* The reliability of any spring devices used in the control system shall be established by tests simulating service conditions, unless it is demonstrated that failure of the spring will not cause flutter or unsafe flight characteristics.

(Part 6, 21 F.R. 10291, Dec. 22, 1956, effective Dec. 20, 1956.)

6.327 *Autorotation control mechanism.* The main rotor blade pitch control mechanism shall be arranged to permit rapid entry into autorotative flight in the event of power failure.

(Part 6, 21 F.R. 10291, Dec. 22, 1956, effective Dec. 20, 1956.)

6.328 *Power boost and power-operated control systems.* When a power boost or power-operated control system is used, an alternate system shall be immediately available, such that the rotorcraft can be flown and landed safely in the event of any single failure in the power portion of the system or in the event of failure, of all engines. Such alternate system may be a duplicate power portion or a manually operated mechanical system. The power portion shall include the power source (e.g., hydraulic pumps), and such items as valves, lines, and actuators. The failure of mechanical parts (such as piston rods and links) and the jamming of power cylinders need not be considered if such failure or jamming is considered to be extremely remote.

(Added by Amdt. 6-4, 24 F.R. 7072, Sept. 1, 1959, effective Oct. 1959.)

Landing Gear

6.335 *Wheels.* Landing gear wheels shall be of an approved type. The maximum static load rating of each wheel shall not be less than the corresponding static ground reaction under the maximum weight of the rotorcraft and the critical center of gravity position. The maximum limit load rating of each wheel shall not be less than the maximum radial limit load determined in accordance with the applicable ground load requirements of this part.

(Part 6, 21 F.R. 10291, Dec. 22, 1956, effective Dec. 20, 1956.)

6.336 *Brakes.* A braking device shall be installed, controllable by the pilot and usable during power-off landings, which is adequate to insure:

(a) Counteraction of any normal unbalanced torque when starting or stopping the rotor,

(b) Holding the rotorcraft parked on a 10° slope on a dry, smooth pavement.

(Part 6, 21 F.R. 10291, Dec. 22, 1956, effective Dec. 20, 1956.)

6.337 *Tires.* Landing gear wheels shall be equipped with any make or type of tire provided that the tire is a proper fit on the rim of the wheel and provided that the approved tire rating is not exceeded. The maximum static load rating of the tire shall not be less than the static ground reaction obtained at the wheel, assuming the maximum design weight con-

centrated at the most unfavorable center of gravity position.

(Part 6, 21 F.R. 10291, Dec. 22, 1956, effective Dec. 20, 1956.)

6.338 *Skis.* The maximum limit load rating of each ski shall not be less than the maximum limit load determined in accordance with the applicable ground load requirements of this part.

(Part 6, 21 F.R. 10291, Dec. 22, 1956, effective Dec. 20, 1956.)

[Hulls and] Floats

6.340 *Floats.* The requirements of sections 6.341 and 6.342 shall apply to the design of [hulls and] floats.

(Part 6, 21 F.R. 10291, Dec. 22, 1956, effective Dec. 20, 1956; as amended by Amdt. 6-5, 27 F.R. 2996, Mar. 30, 1962, effective May 3, 1962.)

6.341 *Buoyancy.*

(a) Main floats shall have a buoyancy in excess of that required to support the maximum weight of the rotorcraft in fresh water as follows:

(1) 50 percent in the case of single floats;

(2) 60 percent in the case of multiple floats.

(b) Main floats shall contain at least four watertight compartments of approximately equal volume.

[(c) If a rotorcraft, constructed with a hull and auxiliary floats, is to be approved for both taking off from and alighting on water, the hull and auxiliary floats shall be divided into watertight compartments so that, with any single compartment flooded, the buoyancy of the hull and auxiliary floats (and wheel tires if used) will provide a sufficient margin of positive stability to minimize capsizing. (See sec. 6.741 (e).)]

(Part 6, 21 F.R. 10291, Dec. 22, 1956, effective Dec. 20, 1956; as amended by Amdt. 6-5, 27 F.R. 2996, Mar. 30, 1962, effective May 3, 1962.)

6.342 *Float strength.* Floats shall be designed for the conditions set forth in paragraphs (a) and (b) of this section:

(a) *Bag type floats.* Bag type floats shall withstand the maximum pressure differential which might be developed at the maximum altitude for which certification with floats is sought. In addition, the float shall withstand the vertical loads prescribed in section 6.245 (a) distributed along the length of the log over three-quarters of the projected log area.

(b) *Rigid floats.* Rigid type floats shall withstand the vertical, horizontal, and side loads prescribed in section 6.245. The loads specified may be distributed along the length of the floats.

(Part 6, 21 F.R. 10291, Dec. 22, 1956, effective Dec. 20, 1956.)

Personnel and Cargo Accommodations

6.350 *Pilot compartment; general.*

(a) The arrangement of the pilot compartment and its appurtenances shall provide safety and assurance that the pilot will be able to perform all of his duties and operate the controls in the correct manner without unreasonable concentration and fatigue.

(b) When provision is made for a second pilot, the rotorcraft shall be controllable with equal safety from both seats.

(c) Vibration and noise characteristics of cockpit appurtenances shall not interfere with the safe operation of the rotorcraft.

(Part 6, 21 F.R. 10291, Dec. 22, 1956, effective Dec. 20, 1956.)

6.351 *Pilot compartment vision.* The pilot compartment shall be arranged to afford the pilot a sufficiently extensive, clear, and undistorted view for the safe operation of the rotorcraft. During flight in a moderate rain condition the pilot shall have an adequate view of the flight path in normal flight and landing, and have sufficient protection from the elements so that his vision is not unduly impaired. The pilot compartment shall be free of glare and reflections which would interfere with the pilot's vision. For rotocraft intended for night operation, the demonstration of these qualities shall include night flight tests.

(Part 6, 21 F.R. 10291, Dec. 22, 1956, effective Dec. 20, 1956.)

6.352 *Pilot windshield and windows.* All glass panes shall be of a nonsplintering safety type.

(Part 6, 21 F.R. 10291, Dec. 22, 1956, effective Dec. 20, 1956.)

6.353 *Controls.*

(a) All cockpit controls shall be located to provide convenience in operation and in a manner tending to prevent confusion and inadvertent operation. (See also sec. 6.737.)

(b) The controls shall be so located and arranged with respect to the pilots' seats that there exists full and unrestricted movement of each control without interference from either the cockpit structure or the pilots' clothing when seated. This shall be demonstrated for individuals ranging from 5′ 2″ to 6′ 0″ in height.

(Part 6, 21 F.R. 10291, Dec. 22, 1956, effective Dec. 20, 1956.)

6.354 *Doors.* Closed cabins shall be provided with at least one adequate and easily accessible external door. No passenger door shall be so located with respect to the rotor discs as to endanger persons using the door.

(Part 6, 21 F.R. 10291, Dec. 22, 1956, effective Dec. 20, 1956.)

6.355 *Seats and berths.* On rotorcraft, manufactured on or after the effective date of this part (January 15, 1951), all seats and berths, including their supporting structure shall be designed for the loads resulting from all specified flight and landing conditions, including the emergency landing conditions of section 6.260. Reactions from safety belts and harness shall be taken into account. In addition, pilot seats shall be designed for the reactions resulting from the application of pilot forces to the flight controls as prescribed in section 6.225 (a). (See sec. 6.101 (b) (4) for weight of occupants.)

(Part 6, 21 F.R. 10291, Dec. 22, 1956, effective Dec. 20, 1956.)

6.355–1 *Application of loads (FAA policies which apply to sec. 6.355).* The actual forces acting on seats, berths, and supporting structure in the various flight, ground and emergency landing conditions will consist of many possible combinations of forward, sideward, downward, upward, and aft loads. However, in order to simplify the structural analysis and testing of these structures, it will be permissible to assume that the critical load in each of these directions, as determined from the prescribed flight, ground, and emergency landing conditions, acts separately. If the applicant desires, selected combinations of loads may be used, provided the required strength in all specified directions is substantiated. (TSO C–25 Aircraft Seats and Berths, sec. 514.25 of this title, outlines acceptable methods for testing seats and berths.)

(Supp. 8, 18 F.R. 5564, Sept. 17, 1953, effective Sept. 30, 1953.)

6.356 *Cargo and baggage compartments.* (See also sec. 6.382.)

(a) Each cargo and baggage compartment shall be designed for the placarded maximum weight of contents and the critical load distributions at the appropriate maximum load factors corresponding with all specified flight and ground load conditions, excluding the emergency landing conditions of section 6.260.

(b) Provision shall be made to prevent the contents in the compartments from becoming a hazard by shifting under the loads specified in paragraph (a) of this section.

(c) Provision shall be made to protect the passengers and crew from injury by the contents of any compartment when the ultimate inertia force acting forward is 4g.

(Part 6, 21 F.R. 10291, Dec. 22, 1956, effective Dec. 20, 1956.)

6.357 *Emergency exits.*

(a) Closed cabins on rotorcraft carrying more than 5 persons shall be provided with an emergency exit. Additional exits shall be provided where the total seating capacity is more than 15. The provisions of subparagraphs (1) through (6) of this paragraph shall apply. (See also sec. 6.738 (c).)

(1) An emergency exit shall consist of a movable window or panel or of an additional external door which provides a clear and unobstructed opening, the minimum dimensions of which shall be such that a 19 inch by 26 inch ellipse may be completely inscribed therein.

(2) An emergency exit shall be readily accessible, shall not require exceptional agility of a person using it, and shall be so located as to facilitate egress without crowding in all probable attitudes in which the rotorcraft may be after a crash.

(3) The method of opening an emergency exit shall be simple and obvious, and the exit shall be so arranged and marked as to be readily located and operated even in darkness.

(4) Reasonable provisions shall be made against the jamming of emergency exits as a result of fuselage deformation.

(5) At least one emergency exit shall be on the opposite side of the cabin from the main door.

(6) The proper functioning of emergency exits shall be demonstrated by tests.

(Part 6, 21 F.R. 10291, Dec. 22, 1956, effective Dec. 20, 1956.)

6.358 *Ventilation.* The ventilating system for the pilot and passenger compartments shall be so designed as to preclude the presence of excessive quantities of fuel fumes and carbon monoxide. The concentration of carbon monoxide shall not exceed 1 part in 20,000 parts of air under conditions of forward flight or hovering in zero wind. For other conditions of operation, if the carbon monoxide concentration exceeds this value, suitable operating restrictions shall be provided.

(Part 6, 21 F.R. 10291, Dec. 22, 1956, effective Dec. 20, 1956.)

Fire Prevention

6.380 *General.* The fire prevention requirements of this subpart apply to personnel and cargo compartments. Additional fire prevention requirements are prescribed in Subpart E, Powerplant Installation, and Subpart F, Equipment.

(Part 6, 21 F.R. 10291, Dec. 22, 1956, effective Dec. 20, 1956.)

6.381 *Cabin interiors.* All compartments occupied or used by the crew or passengers shall comply with the provisions of paragraphs (a) through (c) of this section.

(a) The materials in no case shall be less than flash-resistant.

(b) The wall and ceiling linings, the covering of all upholstery, floors, and furnishings shall be flame-resistant.

(c) Compartments where smoking is to be permitted shall be equipped with ash trays of the self-contained type which are completely removable. All other compartments shall be placarded against smoking.

(Part 6, 21 F.R. 10291, Dec. 22, 1956, effective Dec. 20, 1956.)

6.382 *Cargo and baggage compartments.* Cargo and baggage compartments shall be constructed of or completely lined with fire-resistant material, except that flame-resistant materials shall be acceptable in compartments which are readily accessible to a crewmember in flight. Compartments shall include no controls, wiring, lines, equipment, or accessories the damage or failure of which would affect the safe operation of the rotorcraft, unless such items are shielded, isolated, or otherwise protected so that they cannot be damaged by movement of cargo in the compartment, and so that any breakage or failure of such items will not create a fire hazard.

(Part 6, 21 F.R. 10291, Dec. 22, 1956, effective Dec. 20, 1956.)

6.383 *Heating systems.*

(a) *General.* Heating systems involving the passage of cabin air over or in close proximity to the exhaust manifold shall not be used unless precautions are incorporated in the design to prevent the introduction of carbon monoxide into the cabin or pilot compartment.

(b) *Heat exchangers.* Heat exchangers shall be constructed of suitable materials, shall be cooled adequately under all conditions, and shall be capable of easy disassembly for inspection.

(c) *Combustion heaters.* Gasoline-operated combustion heaters shall be of an approved type and shall be installed so as to comply with the applicable sections of the powerplant installation requirements covering fire hazards and precautions. All applicable requirements concerning fuel tanks, lines, and exhaust systems shall be considered. (See secs. 6.422 through 6.428 and 6.463.) In addition to the components provided for normal continuous control of air temperature, airflow, and fuel flow, means independent of such components shall be provided for each heater to automatically shut off and hold off the ignition and fuel supply to the heater at a point remote from the heater when the heat exchanger temperature or ventilating air temperature exceeds safe limits or when either the combustion airflow or the ventilating airflow becomes inadequate for safe operation.

(Part 6, 21 F.R. 10291, Dec. 22, 1956, effective Dec. 20, 1956; as amended by Amdt. 6-2, 22 F.R. 5568, July 16, 1957, effective Aug. 12, 1957.)

6.384 ***Fire protection of structure, controls, and other parts.*** **All structure, controls, rotor mechanism, and other parts essential to a controlled landing of the rotorcraft which would be affected by powerplant fires shall either be of fireproof construction or shall be otherwise protected, so that they can perform their essential functions for at least 5 minutes under all foreseeable powerplant fire conditions. (See also secs. 6.480 and 6.483 (a).)**

(Part 6, 21 F.R. 10291, Dec. 22, 1956, effective Dec. 20, 1956.)

Miscellaneous

6.390 ***Leveling marks.*** **Reference marks shall be provided for use in leveling the rotorcraft to facilitate weight and balance determinations on the ground.**

(Part 6, 21 F.R. 10291, Dec. 22, 1956, effective Dec. 20, 1956.)

6.391 ***Ballast provisions.*** **Ballast provisions shall be so designed and constructed as to prevent the inadvertent shifting of the ballast in flight. (See also secs. 6.105, 6.738, and 6.741 (c).)**

(Part 6, 21 F.R. 10291, Dec. 22, 1956, effective Dec. 20, 1956.)

Subpart E—Powerplant Installation

General

6.400 ***Scope and general design.***

(a) The powerplant installation shall be considered to include all components of the rotorcraft which are necessary for its propulsion with the exception of the structure of the main and auxiliary rotors. It shall also be considered to include all components which affect the control of the major propulsive units or which affect their safety of operation between normal inspections or overhaul periods. (See secs. 6.604 and 6.613 for instrument installation and marking.) The general provisions of paragraphs (b) through (d) of this section shall be applicable.

(b) All components of the powerplant installation shall be constructed, arranged, and installed in a manner which will assure their continued safe operation between normal inspections or overhaul periods.

(c) Accessibility shall be provided to permit such inspection and maintenance as is necessary to assure continued airworthiness.

(d) Electrical interconnections shall be provided to prevent the existence of differences of potential between major components of the powerplant installation and other portions of the rotorcraft.

(Part 6, 21 F.R. 10291, Dec. 22, 1956, effective Dec. 20, 1956.)

6.400–1 *Powerplant installation components (FAA interpretations which apply to sec. 6.400).* The term "all components" includes engines and their parts, appurtenances, and accessories which are furnished by the engine manufacturer and all other components of the powerplant installation which are furnished by the rotorcraft 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 rotorcraft powerplant installation.

(Supp. 16, 23 F.R. 9018, Nov. 20, 1958, effective Dec. 22, 1958.)

6.401 ***Engines.***

(a) ***Engine type certification.*** **All engines shall be type certificated in accordance with the provisions of Part 13 of this subchapter.**

(b) ***Engine cooling fan blade protection.*** **If an engine cooling fan is installed, means shall be provided to protect the rotorcraft and to permit a safe landing in the event of a fan blade failure. Compliance shall be shown with any one of the provisions of subparagraphs (1) through (3) of this paragraph.**

(1) It shall be demonstrated that the fan blades will be contained in the event of failure;

(2) The fan is so located that a fan blade failure will not jeopardize the safety of the rotorcraft or its occupants; or

(3) It shall be demonstrated that the fan blade can withstand an ultimate load of

1.5 times the centrifugal force resulting from engine rpm limited by either:

(i) The engine terminal rpm which can occur under uncontrolled conditions, or

(ii) An overspeed limiting device.

(Part 6, 21 F.R. 10291, Dec. 22, 1956, effective Dec. 20, 1956; as amended by Amdt. 6-3, 23 F.R. 2592, Apr. 19, 1958, effective May 17, 1958.)

6.402 *Engine vibration.* The engine shall be installed to preclude harmful vibration of any of the engine parts or any of the components of the rotorcraft. It shall be demonstrated by means of a vibration investigation that the addition of the rotor and the rotor drive system to the engine does not result in modification of engine vibration characteristics to the extent that the principal rotating portions of the engine are subjected to excessive vibratory stresses. It shall also be demonstrated that no portion of the rotor drive system is subjected to excessive vibratory stresses.

(Part 6, 21 F.R. 10291, Dec. 22, 1956, effective Dec. 20, 1956.)

Rotor Drive System

6.410 *Rotor drive mechanism.* The rotor drive mechanism shall incorporate a unit which will automatically disengage the engine from the main and auxiliary rotors in the event of power failure. The rotor drive mechanism shall be so arranged that all rotors necessary for control of the rotorcraft in autorotative flight will continue to be driven by the main rotor(s) after disengagement of the engine from the main and auxiliary rotors. If a torque limiting device is employed in the rotor drive system (see sec. 6.250 (f)), such device shall be located to permit continued control of the rotorcraft after it becomes operative.

(Part 6, 21 F.R. 10291, Dec. 22, 1956, effective Dec. 20, 1956.)

6.411 *Rotor brakes.* If a means is provided to control the rotation of the rotor drive system independent of the engine, the limitations on the use of such means shall be specified, and the control for this means shall be guarded to prevent inadvertent operation.

(Part 6, 21 F.R. 10291, Dec. 22, 1956, effective Dec. 20, 1956.)

6.412 *Rotor drive and control mechanism endurance tests.*

(a) The rotor drive and control mechanism shall be tested for not less than 100 hours. The test shall be conducted on the rotorcraft, and the power shall be absorbed by the actual rotors to be installed, except that the use of other ground or flight test facilities with any other appropriate method of power absorption shall be acceptable provided that all conditions of support and vibration closely simulate the conditions which would exist during a test on the actual rotorcraft. The endurance tests shall include the tests prescribed in paragraphs (b) through (g) of this section. At the conclusion of the endurance testing, all parts shall be in a serviceable condition.

(b) A 60-hour portion of the endurance test shall be run at not less than the maximum continuous engine speed in conjunction with maximum continuous engine power. In this test the main rotor shall be set in the position which will give maximum longitudinal cyclic pitch change to simulate forward flight. The auxiliary rotor controls shall be in the position for normal operation under the conditions of the test.

(c) A 30-hour portion of the endurance test shall be run at not less than 90 percent of maximum continuous engine speed and 75 percent of maximum continuous engine power. The main and auxiliary rotor controls during this test shall be in the position for normal operation under the conditions of the test.

(d) A 10-hour portion of the endurance test shall be run at not less than takeoff engine power and speed. The main and auxiliary rotor controls shall be in the normal position for vertical ascent during this test.

(e) The portions of the endurance test prescribed in paragraphs (b) and (c) of this section shall be conducted in intervals of not less than 30 minutes and may be accomplished either on the ground or in flight. The portion of the endurance test prescribed in paragraph (d) of this section may be conducted in intervals of 5 minutes or more.

(f) At intervals of not more than every 5 hours during the endurance tests prescribed in paragraphs (b), (c), and (d) of this section the engine shall be stopped rapidly enough to

allow the engine and rotor drive to be automatically disengaged from the rotors.

(g) There shall be accomplished under the operating conditions specified in paragraph (b) of this section 500 complete cycles of lateral control and 500 complete cycles of longitudinal control of the main rotors, and 500 complete cycles of control of all auxiliary rotors. A complete control cycle shall be considered to involve movement of the controls from the neutral position, through both extreme positions, and back to the neutral position, except that control movement need not produce loads or flapping motions exceeding the maximum loads or motions encountered in flight. The control cycling may be accomplished during the testing prescribed in paragraph (b) of this section or may be accomplished separately.

(Part 6, 21 F.R. 10291, Dec. 22, 1956, effective Dec. 20, 1956.)

6.413 *Additional tests.* Such additional dynamic, endurance, and operational tests or vibratory investigations shall be conducted as are found necessary by the Administrator to substantiate the airworthiness of the rotor drive mechanism.

(Part 6, 21 F.R. 10291, Dec. 22, 1956, effective Dec. 20, 1956.)

6.414 *Shafting critical speed.* The critical speeds of all shafting shall be determined by actual demonstration, except that analytical methods shall be acceptable for determining these speeds if the Administrator finds that reliable methods of analysis are available for the particular design. If the critical speeds lie within or close to the operating ranges for idling, power-on, and autorotative conditions, it shall be demonstrated by tests that the resultant stresses are within safe limits. If analytical methods are used and indicate that no critical speeds lie within the permissible operating ranges, the margins between the calculated critical speeds and the limits of the permissible operating ranges shall be adequate to allow for possible variations of the computed values from actual values.

(Part 6, 21 F.R. 10291, Dec. 22, 1956, effective Dec. 20, 1956.)

6.415 *Shafting joints.* All universal joints, slip joints, and other shafting joints shall have provision for lubrication, unless it is demonstrated that lack of lubrication will have no adverse effect on the operation of the rotorcraft.

(Part 6, 21 F.R. 10291, Dec. 22, 1956, effective Dec. 20, 1956.)

Fuel System

[6.418 *General.*

[(a) The fuel system shall be constructed and arranged in a manner to insure a flow of fuel at a rate and pressure which have been established for proper engine functioning under all likely operating conditions, including all maneuvers for which the rotorcraft is intended. (For fuel system instruments see section 6.604.)

[(b) The fuel system shall be arranged so that no one fuel pump can draw fuel from more than one tank at a time unless means are provided to prevent introducing air into the system.]

(Added by Amdt. 6-5, 27 F.R. 2996, Mar. 30, 1962, effective May 3, 1962.)

[6.419] *Fuel system independence.* The design of the fuel system for multiengine rotorcraft shall be such as to permit fuel to be supplied to each engine through a system independent of all portions of the systems supplying fuel to other engines, except that separate fuel tanks need not be provided for each engine. The following features shall be provided if a single fuel tank is employed on a multiengine rotorcraft:

(a) Independent tank outlets for each engine. Each outlet shall incorporate a shutoff valve at the tank. This valve may also serve as the firewall shutoff valve required by section 6.426 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.

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

(c) Filler caps designed to minimize the possibility of incorrect installation or loss in flight.

(d) 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).

(Added by Amdt. 6-4, 24 F.R. 7072, Sept. 1, 1959, effective Oct. 1, 1959; redesignated by Amdt. 6-5, 27 F.R. 2996, Mar. 30, 1962, effective May 3, 1962.)

[6.420 *Fuel flow.*

[(a) The fuel system shall provide not less than 100 percent of the fuel flow required by the engines when the rotorcraft is operated under all intended operating conditions and maneuvers.

[(b) In determining compliance with the provisions of paragraph (a) of this section, the provisions of subparagraphs (1) through (3) of this paragraph shall apply.

[(1) Fuel shall be delivered to the engine at a pressure within the limits specified in the engine type certificate.

[(2) The quantity of fuel in the tank being considered shall not exceed the sum of the amount established as the unusable fuel supply for that tank, as determined in accordance with the provisions of section 6.421, and whatever minimum quantity of fuel it may be necessary to add for the purpose of determining compliance.

[(3) Such main pumps shall be used as are necessary for each operating condition and rotorcraft attitude for which compliance is determined and, in addition, for each main pump so used, the appropriate emergency pump shall be substituted. (See sec. 6.424.)

[(c) If an engine can be supplied with fuel from more than one tank, the fuel system shall feed promptly when the fuel supply becomes low in one tank and another tank is turned on.]

(Part 6, 21 F.R. 10291, Dec. 22, 1956, effective Dec. 20, 1956; as amended by Amdt. 6-4, 24 F.R. 7072, Sept. 1, 1959, effective Oct. 1, 1959; Amdt. 6-5, 27 F.R. 2996, Mar. 30, 1962, effective May 3, 1962.)

[6.421 *Unusable fuel supply.* The unusable fuel supply shall be selected by the applicant and shall be established for each tank as not less than the quantity at which the first evidence of malfunctioning occurs under the most adverse condition from the standpoint of fuel feed during all intended operations and flight maneuvers involving use of that tank.]

(Part 6, 21 F.R. 10291, Dec. 22, 1956, effective Dec. 20, 1956; as amended by Amdt. 6-4, 24 F.R. 7072, Sept. 1, 1959, effective Oct. 1, 1959; Amdt. 6-5, 27 F.R. 2996, Mar. 30, 1962, effective May 3, 1962.)

6.422 *Fuel tank construction and installation.* Fuel tanks shall be designed and installed in accordance with the provisions of paragraphs (a) through (e) of this section.

(a) Fuel tanks shall be capable of withstanding without failure all vibration, inertia, fluid, and structural loads to which they may be subjected in operation.

(b) Fuel tanks shall be capable of withstanding, without failure or leakage, an internal pressure equal to the pressure developed during the maximum limit acceleration with full tanks, except that in no case shall the minimum internal pressure be less than 3.5 lb./sq. in. for conventional type tanks or less than 2.0 lb./sq. in. for bladder type tanks.

(c) Fuel tanks of 10 gallons or greater capacity shall incorporate internal baffles unless external support is provided to resist surging.

(d) Fuel tanks shall be separated from the engine compartment by a firewall. At least one-half inch clear airspace shall be provided between the tank and firewall.

(e) Spaces adjacent to the surfaces of fuel tanks shall be ventilated so that fumes cannot accumulate in the tank compartment in case of leakage. If two or more tanks have their outlets interconnected, they shall be considered as one tank. The airspaces in such tanks shall be interconnected to prevent the flow of fuel from one tank to another as a result of a difference in pressure in the respective tank airspaces.

(Part 6, 21 F.R. 10291, Dec. 22, 1956, effective Dec. 20, 1956.)

6.423 *Fuel tank details.*

(a) *Expansion space.* Fuel tanks shall be provided with an expansion space of not less than 2 percent of the tank capacity. It shall not be possible to fill the fuel tank expansion space inadvertently when the rotorcraft is in the normal ground attitude.

(b) *Sump.* Each fuel tank shall incorporate a sump and drain located at the point in the tank which is the lowest when the rotorcraft is in the normal ground attitude. The main fuel supply shall not be drawn from the bottom of the sump.

(c) *Filler connection.* The design of fuel tank filler connections shall be such as to prevent the entrance of fuel into the fuel tank compartment or to any other portion of the rotor-

craft other than the tank itself. (See also sec, 6.738 (b) (1).)

(d) *Vents.* Fuel tanks shall be vented from the top portion of the expansion space in such a manner that venting of the tank is effective under all normal flight conditions. The air vents shall be arranged to minimize the possibility of stoppage by dirt or ice formation.

(e) *Outlet.* Fuel tank outlets shall be provided with large-mesh finger strainers.

(Part 6, 21 F.R. 10291, Dec. 22, 1956, effective Dec. 20, 1956.)

[6.424 *Fuel pumps.*

[(a) *Main pumps.*

[(1) Any fuel pump which is required for proper engine operation or to meet the fuel system requirements of this supbart, except for the provisions of paragraph (b) of this section, shall be considered a main pump.

[(2) Provision shall be made to permit the bypass of all positive displacement fuel pumps except fuel injection pumps approved as part of the engine.

[*Note:* The phrase "fuel injection pump" means a pump which supplies the proper flow and pressure conditions for fuel injection when such injection is not accomplished in a carburetor. 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.

[(b) *Emergency pumps.* Pumps shall be provided to permit supplying all engines with fuel immediately after the failure of any one main fuel pump except fuel injection pumps approved as part of the engine. The emergency pump shall be actuated automatically or operated continuously so that sufficient fuel pressure will be maintained to prevent engine stoppage.]

(Part 6, 21 F.R. 10291, Dec. 22, 1956, effective Dec. 20, 1956; as amended by Amdt. 6-4, 24 F.R. 7072, Sept. 1, 1959, effective Oct. 1, 1959; Amdt. 6-5, 27 F.R. 2996, Mar. 30, 1962, effective May 3, 1962.)

6.425 *Fuel system lines and fittings.*

(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 rotorcraft between which relative motion could exist shall incorporate provisions for flexibility.

(c) Flexible hose shall be of an approved type.

(d) All fuel lines and fittings shall be of sufficient size so that the fuel flow, with the fuel being supplied to the carburetor at the minimum pressure for proper carburetor operation, is not less than the following:

(1) For gravity feed systems: 1.5 times the normal flow required to operate the engine at takeoff power;

(2) For pump systems: 1.25 times the normal flow required to operate the engine at takeoff power.

(e) Rotocraft with suction lift fuel systems or other fuel system features conducive to vapor formation shall be demonstrated to be free from vapor lock when using fuel at a temperature of 110° F. under critical operating conditions.

(f) A test for proof of compliance with the applicable flow requirements shall be conducted.

(Part 6, 21 F.R. 10291, Dec. 22, 1956, effective Dec. 20, 1956; as amended by Amdt. 6-2, 22 F.R. 5568, July 16, 1957, effective Aug. 12, 1957.)

6.426 *Valves.* A positive and quick-acting valve which will shut off all fuel to each engine individually shall be provided. The control for this valve shall be within easy reach of appropriate flight personnel. In the case of rotorcraft employing more than one source of fuel supply, provision shall be made for independent feeding from each source. The shutoff valve shall not be located closer to the engine than the remote side of the firewall.

(Part 6, 21 F.R. 10291, Dec. 22, 1956, effective Dec. 20, 1956.)

6.427 *Strainers.* A strainer incorporating a sediment trap and drain shall be provided in the fuel system between the fuel tanks and the engine and shall be installed in an accessible position. The screen shall be easily removable for cleaning. If an engine-driven fuel pump

is provided, the strainer shall be located between the fuel tank and the pump.

(Part 6, 21 F.R. 10291, Dec. 22, 1956, effective Dec. 20, 1956.)

6.428 *Drains.* One or more accessible drains shall be provided at the lowest point in the fuel system to drain completely all parts of the system when the rotorcraft is in its normal postion on level ground. Such drains shall discharge clear of all parts of the rotorcraft and shall be equipped with safety locks to prevent accidental opening.

(Part 6, 21 F.R. 10291, Dec. 22, 1956, effective Dec. 20, 1956.)

6.429 *Fuel quantity indicator.* The fuel quantity indicator (see sec. 6.613 (b)) shall be installed to indicate clearly to the flight crew the quantity of fuel in each tank while in flight. When two or more tanks are closely interconnected by a gravity feed system and vented, and when it is impossible to feed from each tank separately, only one fuel quantity indicator need be installed. If exposed sight gauges are employed they shall be installed and guarded to preclude the possibility of breakage or damage.

(Part 6, 21 F.R. 10291, Dec. 22, 1956, effective Dec. 20, 1956.)

Oil System

6.440 *General.*

(a) Each engine shall be provided with an independent oil system capable of supplying the engine with an appropriate quantity of oil at a temperature not exceeding the maximum which has been established as safe for continuous operation. (For oil system instruments see secs. 6.604 and 6.735.)

(b) The usable oil capacity shall not be less than the product of the endurance of the rotorcraft under critical operating conditions and the maximum oil consumption of the engine under the same conditions, to which product a suitable margin shall be added to assure adequate circulation and cooling of the oil system. In lieu of a rational analysis of rotorcraft endurance and oil consumption, the usable oil capacity of 1 gallon for each 40 gallons of usable fuel quantity shall be considered acceptable. (See also sec. 6.101 (d) (3).)

(c) The ability of the oil cooling provisions to maintain the oil inlet temperature to the engine at or below the maximum established value shall be demonstrated by flight tests.

(Part 6, 21 F.R. 10291, Dec. 22, 1956, effective Dec. 20, 1956.)

6.441 *Oil tank construction and installation.* Oil tanks shall be designed and installed in accordance with the provisions of paragraphs (a) through (e) of this section.

(a) Oil tanks shall be capable of withstanding without failure all vibration, inertia, fluid, and structural loads to which they may be subjected in operation.

(b) Oil tanks shall be capable of withstanding without failure or leakage an internal pressure of 5 lb./sq. in.

(c) Oil tanks shall be provided with an expansion space of not less than 10 percent of the tank capacity, nor less than one-half gallon. It shall not be possible inadvertently to fill the oil tank expansion space when the rotorcraft is in the normal ground attitude.

(d) Oil tanks shall be vented.

(e) Provision shall be made in the filler opening to prevent oil overflow from entering the compartment in which the oil tank is located. (See also sec. 6.738 (b) (2).)

(Part 6, 21 F.R. 10291, Dec. 22, 1956, effective Dec. 20, 1956; as amended by Amdt. 6–2, 22 F.R. 5568, July 16, 1957, effective Aug. 12, 1957.)

6.442 *Oil lines and fittings.*

(a) Oil lines shall be supported to prevent excessive vibration.

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

(c) Flexible hose shall be of an approved type.

(d) Oil lines shall have an inside diameter not less than the inside diameter of the engine inlet or outlet, and shall have no splices between connections.

(Part 6, 21 F.R. 10291, Dec. 22, 1956, effective Dec. 20, 1956.)

6.443 *Oil drains.* One or more accessible drains shall be provided at the lowest point in the oil system to drain completely all parts of the system when the rotorcraft is in its normal

position on level ground. Such drains shall discharge clear of all parts of the rotorcraft and shall be equipped with safety locks to prevent accidental opening.

(Part 6, 21 F.R. 10291, Dec. 22, 1956, effective Dec. 20, 1956.)

6.444 *Oil quantity gauge.* An oil quantity indicator (see sec. 6.735) shall be installed to indicate during the filling operation the amount of oil in the oil tank.

(Part 6, 21 F.R. 10291, Dec. 22, 1956, effective Dec. 20, 1956.)

[6.447 *Oil filters.* If the powerplant installation incorporates an oil filter (strainer), the filter shall be constructed and installed so that oil will continue to flow at the normal rate through the remainder of the system when the flow of oil through the filter element is completely blocked.]

(Added by Amdt. 6-5, 27 F.R. 2296, Mar. 30, 1962, effective May 3, 1962.)

Cooling System

6.450 *General.* The cooling system shall be capable of maintaining engine temperatures within safe operating limits under all conditions of flight during a period at least equal to that established by the fuel capacity of the rotorcraft, assuming normal engine power and speeds.

(Part 6, 21 F.R. 10291, Dec. 22, 1956, effective Dec. 20, 1956.)

6.451 *Cooling tests.* Compliance with the provisions of section 6.450 shall be demonstrated in flight tests in which engine temperature measurements are obtained under critical flight conditions. Such tests shall be conducted in air at temperatures corresponding with the maximum anticipated air temperatures as specified in paragraph (a) of this section. If the tests are conducted under conditions which deviate from the maximum anticipated air temperature, the recorded powerplant temperatures shall be corrected in accordance with the provisions of paragraphs (b) and (c) of this section. 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 used in normal operation.

(a) *Maximum anticipated air temperature.* The maximum anticipated air temperature (hot day condition) shall be 100° F. at sea level, decreasing from this value at the rate of 3.6° F. per thousand feet of altitude above sea level until a temperature of −67° F. is reached above which altitude the temperature shall be constant at −67° F.

(b) *Correction factor for cylinder head and oil inlet temperatures.* The cylinder head and oil inlet temperatures shall be corrected by adding the difference between the maximum anticipated air temperature and the temperature of the ambient air at the time of the first occurrence of maximum cylinder head or oil inlet temperature recorded during the cooling test, unless a more rational correction is shown to be applicable.

(c) *Correction factor for cylinder barrel temperatures.* Cylinder barrel temperatures shall be corrected by adding 0.7 of the difference between the maximum anticipated air temperature and the temperature of the ambient air at the time of the first occurrence of the maximum cylinder barrel temperature recorded during the cooling test, unless a more rational correction is shown to be applicable.

(Part 6, 21 F.R. 10291, Dec. 22, 1956, effective Dec. 20, 1956.)

Induction and Exhaust Systems

6.460 *General.* The induction and exhaust systems shall be designed in accordance with accepted practice.

(Part 6, 21 F.R. 10291, Dec. 22, 1956, effective Dec. 20, 1956.)

6.461 *Air induction.*

(a) The engine air induction system shall be designed to supply the proper quantity of air to the engine under all conditions of operation.

(b) Cold air intakes shall open completely outside the cowling unless the emergence of backfire flames is positively prevented.

(c) Carburetor air intakes shall be provided with drains. The drains shall not discharge fuel in the possible path of exhaust flames.

(Part 6, 21 F.R. 10291, Dec. 22, 1956, effective Dec. 20, 1956.)

6.461–1 *Induction system air filters (FAA policies which apply to sec. 6.461).* When air filters or equivalent fine mesh screens are provided in both the cold and warm air inlets a suitable bypass arrangement should be incorporated to assure continued engine operation in the event both filters become clogged with dirt, ice, or other foreign matter. The bypass may be operated either automatically or manually [1] or both.

(a) The bypass should comply with the deicing and anti-icing provisions of section 6.462.

(b) A bypass need not be provided for an induction system which employs an air filter or screen when:

(1) The induction system is provided with sufficient preheat [2] to assure deicing of the filter or screen, and

(2) The filter or screen is the self-cleaning type and so located that it can be deiced by the application of the heated air.

(Supp. 12, 22 F.R. 4877, July 11, 1957, effective Aug. 1, 1957.)

6.462 *Induction system deicing and anti-icing provisions.*

(a) The engine air induction system shall incorporate means for the prevention and elimination of ice accumulations. Unless it is demonstrated that this can be accomplished by other means, compliance with the following heat rise provisions shall be demonstrated in air free of visible moisture at a temperature of 30° F. when the engine is operating at 75 percent of its maximum continuous power.

(b) Rotorcraft equipped with sea level engines employing conventional venturi carburetors shall have a preheater capable of providing a heat rise of 90° F.

(c) Rotorcraft 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.

(d) Rotorcraft equipped with altitude engines employing conventional venturi carburetors shall have a preheater capable of providing a heat rise of 120° F.

(e) Rotorcraft equipped with altitude engines employing carburetors which embody features tending to reduce the possibility of ice formation shall have a preheater capable of providing a heat rise of 100° F., except that if a fluid deicing system is used the heat rise need not be greater than 40° F.

(Part 6, 21 F.R. 10291, Dec. 22, 1956, effective Dec. 20, 1956.)

6.463 *Exhaust manifolds.* (See also sec. 6.383.)

(a) Exhaust manifolds shall be designed to provide for expansion, and shall be arranged and cooled so that local hot points cannot form.

(b) Exhaust manifolds shall be installed in accordance with the provisions of subparagraphs (1) through (3) of this paragraph:

(1) Exhaust manifolding shall be such that exhaust gases are discharged clear of cowling, rotorcraft structure, carburetor air intake, and fuel system parts or drains.

(2) Exhaust manifolding shall not be located immediately adjacent to or under the carburetor or fuel system parts unless such parts are protected against leakage.

(3) Exhaust manifolding shall be such that exhaust gases do not discharge in a manner which would impair pilot vision at night due to glare.

(Part 6, 21 F.R. 10291, Dec. 22, 1956, effective Dec. 20, 1956.)

Powerplant Controls and Accessories

6.470 *Powerplant controls; general.* The provisions of section 6.353 shall be applicable to all powerplant controls with respect to location and arrangement, and the provisions of section 6.737 shall be applicable to all powerplant controls with respect to marking. All flexible powerplant controls shall be of an approved type.

(Part 6, 21 F.R. 10291, Dec. 22, 1956, effective Dec. 20, 1956.)

6.471 *Throttle controls.*

(a) A separate throttle control shall be provided for each engine. Throttle controls shall

[1] For manual operation, the normal means for detecting engine power or rpm losses due to restriction in carburetor airflow may be considered adequate warning for the crew to operate the bypass.

[2] Recommended preheat is 100° F.

be grouped and arranged to permit separate control of each engine and also simultaneous control of all engines.

(b) Throttle controls shall afford a positive and immediately responsive means of controlling the engines.

(Part 6, 21 F.R. 10291, Dec. 22, 1956, effective Dec. 20, 1956.)

6.472 *Ignition switches.*

(a) Means shall be provided for quickly shutting off all ignition by the grouping of switches or by providing a master ignition control.

(b) If a master ignition control is provided, a guard shall be incorporated to prevent inadvertent operation of the control.

(Part 6, 21 F.R. 10291, Dec. 22, 1956, effective Dec. 20, 1956.)

6.473 *Mixture controls.* If mixture controls are provided, a separate control shall be provided for each engine. The mixture controls shall be grouped and arranged to permit separate control of each engine and also simultaneous control of all engines.

(Part 6, 21 F.R. 10291, Dec. 22, 1956, effective Dec. 20, 1956.)

6.474 *Powerplant accessories.* Engine mounted accessories shall be of a type approved for installation on the engine involved, and shall utilize the provisions made on the engine for mounting.

(Part 6, 21 F.R. 10291, Dec. 22, 1956, effective Dec. 20, 1956.)

Powerplant Fire Protection

6.480 *General.* The powerplant installation shall be protected against fire in accordance with sections 6.481 through 6.486. Additional fire prevention requirements are prescribed in Subpart D, Design and Construction, and Subpart F, Equipment.

Note: The powerplant fire protection provisions are intended to insure that the main and auxiliary rotors and controls remain operable, the essential rotorcraft structure remains intact, and that the passengers and crew are otherwise protected for a period of at least 5 minutes after the start of an engine fire to permit a controlled autorotational landing.

(Part 6, 21 F.R. 10291, Dec. 22, 1956, effective Dec. 20, 1956; as amended by Amdt. 6–4, 24 F.R. 7072, Sept. 1, 1959, effective Oct. 1, 1959.)

6.481 *Ventilation.* Compartments which include powerplant installation shall have provision for ventilation.

(Part 6, 21 F.R. 10291, Dec. 22, 1956, effective Dec. 20, 1956; as amended by Amdt. 6–4, 24 F.R. 7072, Sept. 1, 1959, effective Oct. 1, 1959.)

6.482 *Shutoff means.* Means shall be provided to shut off the flow in all lines carrying flammable fluids into the engine compartment, except that a shutoff means need not be provided in lines forming an integral part of an engine. Provision 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. Shutoff valves and their controls shall be located on the remote side of the firewall from the engine, unless it is shown that the valve will perform its intended functions under all fire conditions likely to result from an engine fire. In installations using engines of less than 500 cu. in. displacement, shutoff means need not be provided for engine oil systems.

(Part 6, 21 F.R. 10291, Dec. 22, 1956, effective Dec. 20, 1956; as amended by Amdt. 6–4, 24 F.R. 7072, Sept. 1, 1959, effective Oct. 1, 1959.)

6.483 *Firewall.*

(a) Engines shall be isolated from personnel compartments by means of firewalls, shrouds, or other equivalent means. They shall be similarly isolated from the structure, controls, rotor mechanism, and other parts essential to a controlled landing of the rotorcraft, unless such parts are protected in accordance with the provisions of section 6.384. All auxiliary power units, fuel-burning heaters, and other combustion equipment which are intended for operation in flight shall be isolated from the remainder of the rotorcraft by means of firewalls, shrouds, or other equivalent means. In complying with the provisions of this paragraph, account shall be taken of the probable path of a fire as affected by the airflow in normal flight and in autorotation. (See also sec. 6.486.)

(b) Firewalls and shrouds shall be constructed in such a manner that no hazardous quantity of air, fluids, or flame can pass from the engine compartment to other portions of the rotorcraft.

(c) All openings in the firewall or shroud shall be sealed with close fitting fireproof grommets, bushings, or firewall fittings.

(d) Firewalls and shrouds shall be constructed of fireproof material and shall be protected against corrosion.

(Part 6, 21 F.R. 10291, Dec. 22, 1956, effective Dec. 20, 1956.)

6.484 *Engine cowling and engine compartment covering.*

(a) Cowling or engine compartment covering shall be constructed and supported so as to make it capable of resisting all vibration, inertia, and air loads to which it would be subjected in operation.

(b) Provision shall be made to permit rapid and complete drainage of all portions of the cowling or engine compartment in all normal ground and flight attitudes. Drains shall not discharge in locations which might cause a fire hazard.

(c) Cowling or engine compartment covering shall be constructed of fire-resistant material.

(d) Those portions of the cowling or engine compartment covering which would be subject to high temperatures due to their proximity to exhaust system parts or exhaust gas impingement shall be constructed of fireproof material.

(Part 6, 21 F.R. 10291, Dec. 22, 1956, effective Dec. 20, 1956.)

6.485 *Lines and fittings.*

(a) All lines and fittings carrying flammable fluids in areas subject to engine fire conditions 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 shall 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.

(Part 6, 21 F.R. 10291, Dec. 22, 1956, effective Dec. 20, 1956; as amended by Amdt. 6-4, 24 F.R. 7072, Sept. 1, 1959, effective Oct. 1, 1959.)

6.486 *Flammable fluids.*

(a) Fuel tanks shall be isolated from the engine by a firewall or shroud. On all rotorcraft having engines of more than 900 cu. in. displacement, oil tanks and other flammable fluid tanks shall be similarly isolated unless the fluid contained, the design of the system, the materials used in the tank, the shutoff means, all connections, lines, and controls are such as to provide an equally high degree of safety.

(b) Not less than one-half inch of clear airspace shall be provided between any tank and the isolating firewall or shroud, unless other equivalent means are used to protect against heat transfer from the engine compartment to the flammable fluid.

(Part 6, 21 F.R. 10291, Dec. 22, 1956, effective Dec. 20, 1956.)

Subpart F—Equipment

General

6.600 *Scope.* The required basic equipment as prescribed in this subpart is the minimum which shall be installed in the rotorcraft for certification. Such additional equipment as is necessary for a specific type of operation is prescribed in the operating rules of the regulations in this subchapter.

(Part 6, 21 F.R. 10291, Dec. 22, 1956, effective Dec. 20, 1956.)

6.601 *Functional and installational requirements.* Each item of equipment installed in a rotorcraft shall be:

(a) Of a type and design appropriate to perform its intended function,

(b) Labeled as to its identification, function, or operational limitations, or any combination of these, whichever is applicable,

(c) Installed in accordance with specified limitations of the equipment,

(d) Demonstrated to function properly in the rotorcraft.

(Part 6, 21 F.R. 10291, Dec. 22, 1956, effective Dec. 20, 1956.)

6.602 *Required basic equipment.* The equipment listed in sections 6.603 through 6.605

shall be the required basic equipment. (See sec. 6.600.)

(Part 6, 21 F.R. 10291, Dec. 22, 1956, effective Dec. 20, 1956.)

6.603 *Flight and navigational instruments.* (See sec. 6.612 for installation requirements.) There shall be installed:

(a) An airspeed indicator. (See sec. 6.612 (a).)

(b) An altimeter.

(c) A magnetic direction indicator. (See sec. 6.612 (c).)

(Part 6, 21 F.R. 10291, Dec. 22, 1956, effective Dec. 20, 1956.)

6.604 *Powerplant instruments.* (See sec. 6.613 for installation requirements.)

(a) Carburetor air temperature indicator for each engine equipped with a preheater which is capable of providing a heat rise in excess of 60° F.

(b) Cylinder head temperature indicator for each air-cooled engine or rotorcraft equipped with cooling shutters. In the case of rotorcraft which do not have cooling shutters, an indicator shall be provided if compliance with the provisions of section 6.451 is demonstrated in a condition other than the most critical cooling flight condition.

(c) Fuel pressure indicator for each engine (if pump-fed engines are used).

(d) Fuel quantity indicator for each tank. (See sec. 6.420(a).)

(e) Manifold pressure indicator for each engine (if altitude engines are used).

(f) Oil temperature warning device to indicate when the oil temperature exceeds a safe value in each main rotor drive gearbox (including those gearboxes essential to rotor phasing) having an oil system independent of the engine oil system.

(g) Oil pressure warning device to indicate when the oil pressure falls below a safe value in each pressure lubricated main rotor drive gearbox (including those gearboxes essential to rotor phasing) having an oil system independent of the engine oil system.

(h) Oil pressure indicator for each engine.

(i) Oil quantity indicator for each oil tank. (See sec. 6.613(d).)

(j) Oil temperature indicator for each engine.

(k) Tachometer to indicate engine rpm and rotor rpm for the main rotor, or for each main rotor, the speed of which can vary appreciably with respect to another main rotor.

[(l) A warning device to indicate low fuel in each tank if an engine can be supplied with fuel from more than one tank. The fuel in any tank shall be considered to be low if a five-minute usable fuel supply remains when the rotorcraft is in the most adverse condition, from the standpoint of fuel feed from that tank, whether or not that condition can be sustained for five minutes.

[(m) Means to indicate to the pilot when emergency pumps are in operation.]

(Part 6, 21 F.R. 10291, Dec. 22, 1956, effective Dec. 20, 1956; as amended by Amdt. 6-4, 24 F.R. 7072, Sept. 1, 1959, effective Oct. 1, 1959; Amdt. 6-5, 27 F.R. 2996, Mar. 30, 1962, effective May 3, 1962.)

6.605 *Miscellaneous equipment.* There shall be installed:

(a) Approved seats for all occupants. (See sec. 6.355.)

(b) Approved safety belts for all occupants. (See sec. 6.643.)

(c) A master switch arrangement. (See secs. 6.623 and 6.624.)

(d) A source(s) of electrical energy (see secs. [6.618 through 6.621]) where such electrical energy is necessary for operation of the rotorcraft.

(e) Electrical protective devices. (See sec. 6.625.)

(Part 6, 21 F.R. 10291, Dec. 22, 1956, effective Dec. 20, 1956; as amended by Amdt. 6-5, 27 F.R. 2996, Mar. 30, 1962, effective May 3, 1962.)

6.606 *Equipment, systems, and installations.*

(a) *Functioning and reliability.* All equipment, systems, and installations, the functioning of which is necessary in showing compliance with the regulations in this subchapter, shall be designed and installed to insure that they will perform their intended function reliably under all reasonably foreseeable operating conditions.

(b) *Hazards.* All equipment, systems, and installations shall be designed to safeguard

against hazards to the rotorcraft in the event of their malfunctioning or failure.

(Part 6, 21 F.R. 10291, Dec. 22, 1956, effective Dec. 20, 1956; as amended by Amdt. 6-4, 24 F.R. 7072, Sept. 1, 1959, effective Oct. 1, 1959.)

Instruments; Installation

6.610 ***General.*** The provisions of sections 6.611 through 6.613 shall apply to the installation of instruments in rotorcraft.

(Part 6, 21 F.R. 10291, Dec. 22, 1956, effective Dec. 20, 1956.)

6.611 ***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 rotorcraft, identical powerplant instruments for the several engines shall be so located as to prevent any confusion as to the engines to which they relate.

(c) The vibration characteristics of the instrument panel shall be such as not to impair seriously the readability or the accuracy of the instruments or to damage them.

(Part 6, 21 F.R. 10291, Dec. 22, 1956, effective Dec. 20, 1956.)

6.612 ***Flight and navigational instruments.***

(a) ***Airspeed indicating system.*** The airspeed indicating system shall be so installed that the airspeed indicator shall indicate true airspeed at sea level under standard conditions to within an allowable installational error of not more than plus or minus 3 percent of the calibrated airspeed or 5 mph, whichever is greater. The calibration shall be made in flight at all forward speeds of 10 mph or over. The allowable installation error shall not be exceeded at any forward speed above 80 percent of the climbout speed. (See sec. 6.732.)

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

(c) ***Magnetic direction indicator.*** The magnetic direction indicator shall be so installed that its accuracy shall not be excessively affected by the rotorcraft'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° on any heading. A suitable calibration placard shall be provided as specified in section 6.733.

(Part 6, 21 F.R. 10291, Dec. 22, 1956, effective Dec. 20, 1956; as amended by Amdt. 6-4, 24 F.R. 7072, Sept. 1, 1959, effective May 3, 1962.)

6.613 ***Powerplant instruments.***

(a) ***Instrument lines.*** Instrument lines shall comply with the provisions of section 6.425. In addition, instrument lines carrying flammable fluids or gases under pressure shall be provided with restricted orifices or equivalent safety devices at the source of the pressure to prevent the escape of excessive fluid or gas in case of line failure.

(b) ***Fuel quantity indicator.*** Fuel quantity indicators 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 6.421. (See also sec. 6.736.)

(c) ***Fuel flowmeter system.*** When a flowmeter system is installed, the metering component shall include a means for by-passing the fuel supply in the event that malfunctioning of the metering component results in a severe restriction to fuel flow.

(d) ***Oil quantity indicator.***

(1) Means shall be provided to indicate the quantity of oil in each tank when the rotorcraft is on the ground. (See sec. 6.735.)

(2) If an oil transfer system or a reserve oil supply system is installed, means shall be provided to indicate to the crew during flight the quantity of oil in each tank.

(Part 6, 21 F.R. 10291, Dec. 22, 1956, effective Dec. 20, 1956; as amended by Amdt. 6-4, 24 F.R. 7072, Sept. 1, 1959, effective May 3, 1962.)

Electrical Systems and Equipment

6.617 ***Installation.*** Electrical systems in rotorcraft shall be free from hazards in themselves, in their method of operation, and in their effects on other parts of the rotorcraft. 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 protected from fuel, oil,

water, other detrimental substances, and mechanical damage.

(Added by Amdt. 6–5, 27 F.R. 2996, Mar. 30, 1962, effective May 3, 1962.)

6.618 ***Electric power sources.***

(a) Electric power sources, their transmission cables, and their associated control and protective devices shall have sufficient capacity to furnish the required power at the proper voltage to all load circuits which are essential to the safe operation of the rotorcraft.

(b) Compliance with paragraph (a) of this section shall be shown by means of an electrical load analysis, or by electrical measurements, which take into account all electrical loads applied to the electrical system, in probable combinations and for probable durations.

(c) At least one generator shall be installed if the electrical system supplies power to load circuits which are essential to the safe operation of the rotorcraft.

(d) Electric power sources shall function properly when connected in combination or independently. The failure or malfunction of any electric power source shall not impair the ability of any remaining source to supply load circuits which are essential to the safe operation of the rotorcraft.

(e) Electric power source controls shall be such as to permit independent operation of each source.

(Added by Amdt. 6–5, 27 F.R. 2996, Mar. 30, 1962, effective May 3, 1962.)

6.619 ***Storage battery design and installation.*** **Storage batteries shall be of such design and 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 rotorcraft.

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

(Part 6, 21 F.R. 10291, Dec. 22, 1956, effective Dec. 20, 1956; as amended by Amdt. 6–4, 24 F.R. 7072, Sept. 1, 1959, effective Oct. 1, 1959; redesignated by Amdt. 6–5, 27 F.R. 2996, Mar. 30, 1962, effective May 3, 1962.)

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

(Part 6, 21 F.R. 10291, Dec. 22, 1956, effective Dec. 20, 1956; as amended by Amdt. 6–5, 27 F.R. 2996, Mar. 30, 1962, effective May 3, 1962.)

6.621 ***Generator controls.***

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

(b) A generator reverse current cutout 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.

(Added by Amdt. 6–5, 27 F.R. 2996, Mar. 30, 1962, effective May 3, 1962.)

6.622 ***Electric power system instruments.*** **Means shall be provided to indicate to appropriate crewmembers those electric power system quantities which are essential for the safe operation of the system. For direct current systems, an ammeter which can be switched into each generator feeder shall be acceptable. When only one generator is installed, it shall be acceptable to locate the ammeter in the battery feeder.**

(Part 6, 21 F.R. 10291, Dec. 22, 1956, effective Dec. 20, 1956; as amended by Amdt. 6–5, 27 F.R. 2996, Mar. 30, 1962, effective May 3, 1962.)

[6.623 ***Master switch arrangement.*** **A master switch arrangement shall be provided to permit expeditious disconnection of all electric power sources from the main bus.**

The point of disconnection shall be adjacent to the power sources. Load circuits may be connected in such manner that they remain energized after the master switch is opened if they are protected by circuit protective devices, rated at five amperes or less, located adjacent to the electric power source.]

(Part 6, 21 F.R. 10291, Dec. 22, 1956, effective Dec. 20, 1956; as amended by Amdt. 6-5, 27 F.R. 2996, Mar. 30, 1962, effective May 3, 1962; [Amdt. 6-6, 27 F.R. 12747, Dec. 27, 1962, effective Dec. 18, 1962.])

6.624 *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.

(Part 6, 21 F.R. 10291, Dec. 22, 1956, effective Dec. 20, 1956.)

6.625 *Fuses or circuit breakers.* 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. Not more than one circuit, which is essential to safety in flight, shall be protected by a single protective device. All resettable type circuit protective devices shall be designed so that a manual operation is required to restore service after tripping and so that, when an overload or circuit fault exists, they will open the circuit irrespective of the position of the operating control.

Note: **The aforementioned resettable type circuit protective devices are known commercially as "trip-free"; i.e., 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 trip characteristic.**

(Part 6, 21 F.R. 10291, Dec. 22, 1956, effective Dec. 20, 1956; as amended by Amdt. 6-5, 27 F.R. 2996, Mar. 30, 1962, effective May 3, 1962.)

6.626 *Protective devices installation.* If the ability to reset a circuit breaker or to replace a fuse is essential to safety in flight, such circuit breaker or fuse shall be so located and identified that it can be readily reset or replaced in flight. If fuses are used, one spare of each rating or 50 percent spare fuses of each rating, whichever is the greater, shall be provided.

(Part 6, 21 F.R. 10291, Dec. 22, 1956, effective Dec. 20, 1956; as amended by Amdt. 6-5, 27 F.R. 2996, Mar. 30, 1962, effective May 3, 1962.)

6.627 *Electric cables.* Electric connecting cables shall be of adequate capacity. Cables which would overheat in the event of circuit overload or fault shall be flame-resistant and shall not emit dangerous quantities of toxic fumes.

(Part 6, 21 F.R. 10291, Dec. 22, 1956, effective Dec. 20, 1956; as amended by Amdt. 6-5, 27 F.R. 2996, Mar. 30, 1962, effective May 3, 1962.)

6.628 *Switches.* Switches shall be capable of carrying their rated current. They shall be accessible to the crew and shall be labeled as to operation and the circuit controlled.

(Part 6, 21 F.R. 10291, Dec. 22, 1956, effective Dec. 20, 1956.)

Lights

6.630 *Instrument lights.*

(a) Instrument lights shall provide sufficient illumination to make all instruments, switches, etc., easily readable.

(b) Instrument lights shall be so installed that their direct rays are shielded from the pilot's eyes and so that no objectionable reflections are visible to him.

(Part 6, 21 F.R. 10291, Dec. 22, 1956, effective Dec. 20, 1956.)

6.631 *Landing lights.*

(a) When landing or hovering lights are required, they shall be of an approved type.

(b) Landing lights shall be installed so that there is no objectionable glare visible to the pilot and so that the pilot is not adversely affected by halation.

(c) Landing lights shall be installed in a location where they provide the necessary illumination for night operation including hovering and landing.

(d) A switch for each light shall be provided, except that where multiple lights are installed at one location a single switch for the multiple lights shall be acceptable.

(Part 6, 21 F.R. 10291, Dec. 22, 1956, effective Dec. 20, 1956.)

6.632 *Position light system installation.*

(a) *General.* The provisions of sections 6.632 through 6.635 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 rotorcraft in such a location that, with the rotorcraft 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 of light transmission during normal use.

(Part 6, 21 F.R. 10291, Dec. 22, 1956, effective Dec. 20, 1956; as amended by Amdt. 6–1, 22 F.R. 1274, Mar. 1, 1957, effective Apr. 1, 1957; Amdt. 6–4, 24 F.R. 7072, Sept. 1, 1959, effective Oct. 1, 1959.)

6.633 ***Position light system dihedral angles.*** The forward and rear position lights as installed on the rotorcraft 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 rotorcraft 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 rotorcraft 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.

(Part 6, 21 F.R. 10291, Dec. 22, 1956, effective Dec. 20, 1956.)

6.634 ***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 rotorcraft. 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 6–1. (The horizontal plane is the plane containing the longitudinal axis of the rotorcraft and is perpendicular to the plane of symmetry of the rotorcraft.)

(2) *Intensities above and below horizontal.* The intensities in any vertical plane shall not be less than the appropriate value given in figure 6–2, where I is the minimum intensity prescribed in figure 6–1 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 6–3, 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 6–1 and 6–2 if the overlap intensities in relation to the main beam intensities are such as not to affect adversely signal clarity.

(Part 6, 21 F.R. 10291, Dec. 22, 1956, effective Dec. 20, 1956; as amended by Amdt. 6–5, 27 F.R. 2996, Mar. 30, 1962, effective May 3, 1962.)

Dihedral angle	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 6–1.—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°	0.90 I.
5° to 10°	0.80 I.
10° to 15°	0.70 I.
15° to 20°	0.50 I.
20° to 30°	0.30 I.
30° to 40°	0.10 I.
40° to 90°	[0.05 I.]

Figure 6–2.—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 6–3.—Maximum Intensities in Overlapping Beams of Forward and Rear Position Lights.

6.634–1 *Overlaps between high intensity forward position lights (FAA policies which apply to sec. 6.634 (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 6–3 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.[3]

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

6.635 *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 $x_0=x$.

(Part 6, 21 F.R. 10291, Dec. 22, 1956, effective Dec. 20, 1956.)

6.636 *Riding light.*

(a) When a riding (anchor) light is required for a rotorcraft operated from water, it shall be capable of showing a white light for at least 2 miles at night under clear atmospheric conditions.

(b) Riding lights shall be installed so that they will show a maximum practicable unbroken light when the rotorcraft is moored or drifting on the water. Externally hung lights shall be permitted.

(Part 6, 21 F.R. 10291, Dec. 22, 1956, effective Dec. 20, 1956.)

6.637 *Anticollision light system.* An airplane to be eligible for night operation shall

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

have installed an anticollision light system. Such system shall consist of one or more approved anticollision 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 rotorcraft with due consideration to the physical configuration and flight characteristics of the rotorcraft. In any case, the field of coverage shall extend in all directions within 30° above and 30° below the horizontal plane of the rotorcraft, except that a solid angle or angles of obstructed visibility totaling not more than 0.5 steradians shall be permissible.

(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 rotorcraft's complete anticollision 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 anticollision lights shall be aviation red in accordance with section 6.635 (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 6–4. 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.

(Added by Amdt. 6–1, 22 F.R. 1274, Mar. 1, 1957, effective Apr. 1, 1957; amended by Amdt. 6–5, 27 F.R. 2996, Mar. 30, 1962, effective May 3, 1962.)

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 6–4.—Minimum Effective Intensities for Anticollision Lights.

6.637–1 *Anticollision light standards (FAA policies which apply to sec. 6.637).* The anticollision light standards in section 6.637 apply to rotorcraft for which an application for a type certificate is made on or after April 1, 1957. When anticollision lights are installed on rotorcraft for which an application for a type certificate was made before April 1, 1957, the applicant may conform either to section 6.637 or to the standards listed below:

(a) Anticollision lights (when installed) should be of the rotating beacon type installed on top of the fuselage in such a location that the light will not be detrimental to the 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, 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 6.635.

(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 of not less than 1:75.

(Supp. 14, 22 F. R. 10016, Dec. 13, 1957, effective Jan. 15, 1958.)

Safety Equipment

6.640 *General.* Required safety equipment which the crew is expected to operate at

a time of emergency, such as flares and automatic liferaft releases, shall be readily accessible. (See also sec. 6.738 (e).)

(Part 6, 21 F.R. 10291, Dec. 22, 1956, effective Dec. 20, 1956.)

6.641 *Flares.* When parachute flares are installed, they shall be of an approved type, and their installation shall be in accordance with section 6.642.

(Part 6, 21 F.R. 10291, Dec. 22, 1956, effective Dec. 20, 1956.)

6.642 *Flare installation.*

(a) Parachute flares shall be releasable from the pilot compartment and installed to minimize the [probability] of accidental discharge.

(b) It shall be demonstrated in flight that the flare installation is such that ejection can be accomplished without hazard to the rotorcraft and its occupants.

(c) If recoil loads are involved in the ejection of the flares, the structure of the rotorcraft shall be designed to withstand such loads.

(Part 6, 21 F.R. 10291, Dec. 22, 1956, effective Dec. 20, 1956; as amended by Amdt. 6-5, 27 F.R. 2996, Mar. 30, 1962, effective May 3, 1962.)

6.643 *Safety belts.* Rotorcraft manufactured on or after the effective date of this part (January 15, 1951), shall be equipped with safety belts of an approved type. (See sec. 6.18.) In no case shall the rated strength of the safety belt be less than that corresponding with the ultimate load factors specified, taking due account of the dimensional characteristics of the safety belt installation for the specific seat or berth arrangement. Safety belts shall be attached so that no part of the anchorage will fail at a load lower than that corresponding with the ultimate load factors specified. (See sec. 6.260.)

(Part 6, 21 F.R. 10291, Dec. 22, 1956, effective Dec. 20, 1956.)

6.644 *Emergency flotation and signaling equipment.* When emergency flotation and signaling equipment is required by the operating rules of the regulations in this subchapter such equipment shall comply with the provisions of paragraphs (a) through (c) of this section.

(a) Rafts and life preservers shall be of an approved type and shall be so installed as to be readily available to the crew and passengers.

(b) Rafts released automatically or released by the pilot shall be attached to the rotorcraft by means of lines to keep them alongside the rotorcraft. The strength of the lines shall be such that they will break before submerging the empty raft.

(c) Signaling devices shall be free from hazard in their operation and shall be installed in an accessible location.

(Part 6, 21 F.R. 10291, Dec. 22, 1956, effective Dec. 20, 1956.)

Miscellaneous Equipment

6.650 *Hydraulic systems.*

(a) *Design.* Hydraulic systems and elements shall withstand, without exceeding the yield point, all structural loads which are expected to be imposed in addition to the hydraulic loads.

(b) *Tests.* Hydraulic systems shall be substantiated by proof pressure tests. When proof tested, no part of a hydraulic system shall fail, malfunction, or experience a permanent set. The proof load of any system shall be 1.5 times the maximum operating pressure of that system.

(c) *Accumulators.* Hydraulic accumulators or pressurized reservoirs shall not be installed on the engine side of the firewall, except when they form an integral part of the engine.

(Part 6, 21 F.R. 10291, Dec. 22, 1956, effective Dec. 20, 1956.)

Subpart G—Operating Limitations and Information

General

6.700 *Scope.*

(a) The operating limitations in sections 6.710 through 6.718 shall be established as prescribed in this part.

(b) The operating limitations, together with any other information concerning the rotorcraft found necessary for safety during operation, shall be included in the Rotorcraft Flight Manual (sec. 6.740), shall be expressed as markings and placards (sec. 6.730), and shall

be made available by such other means as will convey the information to the crewmembers.

(Part 6, 21 F.R. 10291, Dec. 22, 1956, effective Dec. 20, 1956.)

Operating Limitations

6.710 ***Airspeed limitations; general.*** When airspeed limitations are a function of weight, weight distribution, altitude, rotor speed, power, or other factors, the values corresponding with all critical combinations of these values shall be established.

(Part 6, 21 F.R. 10291, Dec. 22, 1956, effective Dec. 20, 1956.)

6.711 ***Never-exceed speed*** V_{NE}.

(a) The never-exceed speed shall be established. It shall not be less than the best rate-of-climb speed with all engines at maximum continuous power, nor greater than either of the following:

(1) $0.9V$ established in accordance with section 6.204, or

(2) 0.9 times the maximum speed demonstrated in accordance with section 6.140.

(b) It shall be permissible to vary the never-exceed speed with altitude and rotor rpm, provided that the ranges of these variables are sufficiently large to allow an operationally practical and safe variation of the never-exceed speeds.

(Part 6, 21 F.R. 10291, Dec. 22, 1956, effective Dec. 20, 1956.)

6.712 ***Operating speed range.*** An operating speed range shall be established for each rotorcraft.

(Part 6, 21 F.R. 10291, Dec. 22, 1956, effective Dec. 20, 1956.)

6.713 ***Rotor speed.*** Rotor limitations shall be established as set forth in paragraphs (a) and (b) of this section. (See also sec. 6.710.)

(a) *Maximum power off (autorotation).* Not to exceed 95 percent of the maximum design determined under section 6.204 (b) or 95 percent of the maximum demonstrated during the type tests (see sec. 6.103 (b)), whichever is lower.

(b) *Minimum.*

(1) *Power off.* Not less than 105 percent of the higher of the following:

(i) The minimum demonstrated during the type tests (see sec. 6.103 (b)), or

(ii) The minimum determined by design substantiation.

(2) *Power on.* Not less than the higher of the following:

(i) The minimum demonstrated during the type tests (see sec. 6.103 (a)), or

(ii) The minimum determined by design substantiation and not higher than a value determined in compliance with section 6.103 (a).

(Part 6, 21 F.R. 10291, Dec. 22, 1956, effective Dec. 20, 1956.)

6.714 ***Powerplant limitations.*** The powerplant limitations set forth in paragraphs (a) through (c) of this section shall be established for the rotorcraft. They shall not exceed the corresponding limits established as a part of the type certification of the engine installed on the rotorcraft.

(a) *Takeoff operation.* The takeoff operation shall be limited by:

(1) The maximum rotational speed, which shall not be greater than the maximum value determined by the rotor design, nor greater than the maximum value demonstrated during type tests,

(2) The maximum permissible manifold pressure,

(3) The time limit upon the use of the corresponding power,

(4) The maximum allowable cylinder head, coolant outlet, or oil temperatures, if applicable when the time limit of subparagraph (3) of this paragraph exceeds two minutes.

(b) *Continuous operation.* The continuous operation shall be limited by:

(1) The maximum rotational speed, which shall not be greater than the maximum value determined by the rotor design, nor greater than the maximum value demonstrated during type tests,

(2) The minimum rotational speed demonstrated in compliance with the rotor speed requirements as prescribed in section 6.713 (b) (2). (See secs. 6.103, 6.710, and 6.711.)

[(c) *Fuel grade or specification designation.* The minimum fuel grade for reciprocating engines or the fuel designation for turbine engines, required for the operation of the

engine within the limitations prescribed in paragraphs (a) and (b) of this section.]

(Part 6, 21 F.R. 10291, Dec. 22, 1956, effective Dec. 20, 1956; as amended by Amdt. 6–5, 27 F.R. 2996, Mar. 30, 1962, effective May 3, 1962.)

6.716 *Rotorcraft weight and center of gravity limitations.* The rotorcraft weight and center of gravity limitations to be established are those required to be determined by sections 6.101 and 6.102.

(Part 6, 21 F.R. 10291, Dec. 22, 1956, effective Dec. 20, 1956.)

6.717 *Minimum flight crew.* The minimum flight crew shall be established by the Administrator as that number of persons which he finds necessary for safety in the operations authorized under section 6.718. This finding shall be based upon the work load imposed upon individual crewmembers with due consideration given to the accessibility and the ease of operation of all necessary controls by the appropriate crewmembers.

(Part 6, 21 F.R. 10291, Dec. 22, 1956, effective Dec. 20, 1956.)

6.718 *Types of operation.* The type of operation to which a rotorcraft is limited shall be established on the basis of flight characteristics and the equipment installed. (See the operating parts of the regulations in this subchapter.)

(Part 6, 21 F.R. 10291, Dec. 22, 1956, effective Dec. 20, 1956.)

6.719 *Maintenance manual.* The applicant shall furnish with each rotorcraft a maintenance manual to contain information which he considers essential for the proper maintenance of the rotorcraft. The maintenance manual shall include recommended limits on service life or retirement periods for major components of the rotorcraft. Such components shall be identified by serial number or by other equivalent means.

(Part 6, 21 F.R. 10291, Dec. 22, 1956, effective Dec. 20, 1956.)

Markings and Placards

6.730 *General.*

(a) The markings and placards specified in sections 6.731 through 6.738 are required for all rotorcraft.

(b) Markings and placards shall be displayed in conspicuous places and shall be such that they cannot be easily erased, disfigured, or obscured.

(c) Additional information, placards, and instrument markings having a direct and important bearing on safe operation of the rotorcraft shall be required when unusual design, operating, or handling characteristics so warrant.

(Part 6, 21 F.R. 10291, Dec. 22, 1956, effective Dec. 20, 1956.)

6.731 *Instrument markings; general.*

(a) When markings are placed on the cover glass of the instrument, provision shall be made to maintain the correct alignment of the glass cover with the face of the dial.

(b) All arcs and lines shall be of sufficient width and so located that they are clearly visible to the pilot.

(Part 6, 21 F.R. 10291, Dec. 22, 1956, effective Dec. 20, 1956.)

6.732 *Airspeed indicator.* Instrument indications shall be in terms of indicated airspeed. The markings set forth in paragraphs (a) through (c) of this section shall be used to indicate to the pilot the maximum and minimum permissible speeds and the normal precautionary operating ranges. (See secs. 6.116, 6.612 (a), 6.710, 6.711, 6.712, and 6.713.)

(a) A red radial line shall be used to indicate the limit beyond which operation is dangerous.

(b) A yellow arc shall be used to indicate the precautionary operating range.

(c) A green arc shall be used to indicate the safe operating range.

(Part 6, 21 F.R. 10291, Dec. 22, 1956, effective Dec. 20, 1956; as amended by Amdt. 6–4, 24 F.R. 7072, Sept. 1, 1959, effective Oct. 1, 1959.)

6.733 *Magnetic direction indicator.* A placard shall be installed on or in close proximity to the magnetic direction indicator which shall comply with the requirements of paragraphs (a) through (c) of this section. (See sec. 6.612 (c).)

(a) The placard shall contain the calibration of the instrument in a level flight attitude with engine(s) operating.

(b) The placard shall state whether the calibration was made with radio receiver(s) on or off.

(c) The calibration readings shall be in terms of magnetic headings in not greater than 45° increments.

(Part 6, 21 F.R. 10291, Dec. 22, 1956, effective Dec. 20, 1956.)

6.734 *Powerplant instruments; general.* All required powerplant instruments shall be marked in accordance with paragraphs (a) through (c) of this section. (See sec. 6.613.)

(a) The maximum and the minimum (if applicable) safe operation limits shall be marked with red radial lines.

(b) The normal operating ranges shall be marked with a green arc not extending beyond the maximum and minimum safe operating limits.

(c) The takeoff and precautionary ranges shall be marked with a yellow arc.

(Part 6, 21 F.R. 10291, Dec. 22, 1956, effective Dec. 20, 1956.)

6.735 *Oil quantity indicator.* Oil quantity indicators shall be marked in sufficient increments to indicate readily and accurately the quantity of oil. (See sec. 6.613 (d).)

(Part 6, 21 F.R. 10291, Dec. 22, 1956, effective Dec. 20, 1956.)

6.736 *Fuel quantity indicator.* When the unusable fuel supply for any tank exceeds 1 gallon or 5 percent of the tank capacity, whichever is greater, a red arc shall be marked on the indicator extending from the calibrated zero reading to the lowest reading obtainable in the level flight attitude. (See secs. 6.421 and 6.613 (b).) A notation in the Rotorcraft Flight Manual shall be made to indicate that the fuel remaining in the tank when the quantity indicator reaches zero is not usable in flight. (See sec. 6.741 (f).)

(Part 6, 21 F.R. 10291, Dec. 22, 1956, effective Dec. 20, 1956; as amended by Amdt. 6-4, 24 F.R. 7072, Sept. 1, 1959, effective Oct. 1, 1959.)

6.737 *Control markings.*

(a) *General.* All cockpit controls including those referred to in paragraphs (b) and (c) of this section shall be plainly marked as to their function and method of operation. (See sec. 6.353.)

(b) *Powerplant fuel controls.* The powerplant fuel controls shall be marked in accordance with subparagraphs (1) through (4) of this paragraph.

(1) Controls for fuel tank selector valves shall be marked to indicate the position corresponding with each tank with all existing crossfeed positions.

(2) When more than one fuel tank is provided, and if safe operation depends upon the use of tanks in a specific sequence, the fuel tank selector controls shall be marked adjacent to or on the control to indicate to the flight personnel the order in which the tanks must be used.

(3) On multiengine rotorcraft, controls for engine valves shall be marked to indicate the position corresponding with each engine.

(4) The capacity of each tank shall be indicated adjacent to or on the fuel tank selector control.

(c) *Accessory and auxiliary controls.* Accessory and auxiliary controls shall be marked in accordance with subparagraphs (1) and (2) of this paragraph.

(1) Where visual indicators are essential to the operation of the rotorcraft (such as a rotor pitch or retractable landing gear indicator), they shall be marked in such a manner that the crewmembers at all times can determine the position of the unit.

(2) Emergency controls shall be colored red and shall be marked to indicate their method of operation.

(Part 6, 21 F.R. 10291, Dec. 22, 1956, effective Dec. 20, 1956.)

6.738 *Miscellaneous markings and placards.*

(a) *Baggage compartments and ballast location.* Each baggage and cargo compartment as well as the ballast location shall bear a placard stating the maximum allowable weight of contents and, if applicable, any other limitation on contents found necessary due to loading requirements. When the maximum permissible weight to be carried in a seat is less than 170 pounds (see sec. 6.101 (b) (4)), a placard shall be permanently attached to the seat structure stating the maximum allowable weight of the occupant to be carried.

(b) *Fuel and oil filler openings.* The information required by subparagraphs (1) and

(2) of this paragraph shall be marked on or adjacent to the appropriate filler cover.

(1) The word "fuel", the minimum permissible fuel [grade or designation] for the engines installed, and the usable fuel tank capacity. (See sec. 6.423 (c).)

(2) The word "oil" and the oil tank capacity. (See sec. 6.441 (e).)

(c) *Emergency exit placards.* Emergency exit placards and operating controls shall be colored red. A placard shall be located adjacent to the controls which clearly indicates the location of the exit and the method of operation. (See sec. 6.357.)

(d) *Operating limitation placard.* A placard shall be provided in clear view of the pilot stating: "This (helicopter, gyrodyne, etc.) must be operated in compliance with the operating limitations specified in the FAA approved Rotorcraft Flight Manual."

(e) *Safety equipment.*

(1) Safety equipment controls which the crew is expected to operate in time of emergency, such as flares, automatic liferaft releases, etc., shall be plainly marked as to their method of operation.

(2) When fire extinguishers and signaling and other life-saving equipment are carried in lockers, compartments, etc., these locations shall be marked accordingly.

[(f) *Tail rotor.* The tail rotor shall be marked so that the rotor disc will be conspicuous under all normal ground conditions.]

(Part 6, 21 F.R. 10291, Dec. 22, 1956, effective Dec. 20, 1956; as amended by Amdt. 6-5, 27 F.R. 2996, Mar. 30, 1962, effective May 3, 1962.)

Rotorcraft Flight Manual

6.740 *General.*

(a) A Rotorcraft Flight Manual shall be furnished with each rotorcraft, except that a Rotorcraft Flight Manual is not required for helicopters certificated under this part; instead, the information prescribed in this part for inclusion in the Rotorcraft Flight Manual shall be made available to the operator by the manufacturer in the form of clearly stated placards, markings, or manuals. If all of the operating limitations are not included in the form of placards and markings on the helicopter then the portion of the manual supplied by the manufacturer containing the operating limitations prescribed in section 6.741 shall be approved and furnished with each helicopter.

(b) The portions of the manual listed in sections 6.741 through 6.744 as are appropriate to the rotorcraft shall be verified and approved and shall be segregated, identified, and clearly distinguished from portions not so approved.

(c) Additional items of information having a direct and important bearing on safe operation shall be required when unusual design, operating, or handling characteristics so warrant.

(Part 6, 21 F.R. 10291, Dec. 22, 1956, effective Dec. 20, 1956.)

6.741 *Operating limitations.* The operating limitations set forth in paragraphs (a) through (g) of this section shall be furnished with each rotorcraft.

(a) *Airspeed and rotor limitations.* Sufficient information shall include the information necessary for the marking of the limitations on or adjacent to the indicators as required. (See sec. 6.732.) In addition, the significance of the limitations and of the color coding used shall be explained.

(b) *Powerplant limitations.* Information shall be included to outline and to explain all powerplant limitations (see sec. 6.714) and to permit marking the instruments as required by sections 6.734 through 6.736.

(c) *Weight and loading distribution.* The rotorcraft weights and center of gravity limits required by sections 6.101 and 6.102 shall be included, together with the items of equipment on which the empty weight is based. Where the variety of possible loading conditions warrants, instructions shall be included to facilitate observance of the limitations.

(d) *Flight crew.* When a flight crew of more than one is required, the number and functions of the minimum flight crew determined in accordance with section 6.717 shall be described.

(e) *Type of operation.* The type(s) of operation(s) shall be listed for which the rotorcraft and its equipment installations have been approved. (See sec. 6.718.)

(f) *Unusable fuel.* If the unusable fuel supply in any tank exceeds one gallon or 5 percent of the tank capacity, whichever is the

greater, warning shall be provided to indicate to the flight personnel that the fuel remaining in the tank when the quantity indicator reads zero cannot be used safely in flight. (See sec. 6.421.)

(Part 6, 21 F.R. 10291, Dec. 22, 1956, effective Dec. 20, 1956; as amended by Amdt. 6-4, 24 F.R. 7072, Sept. 1, 1959, effective Oct. 1, 1959.)

6.742 ***Operating procedures.*** The section of the manual devoted to operating procedures shall contain information concerning normal and emergency procedures and other pertinent information including takeoff and landing procedures and their appropriate airspeeds peculiar to the rotorcraft's operating characteristics which are necessary for safe operation.

(Part 6, 21 F.R. 10291, Dec. 22, 1956, effective Dec. 20, 1956.)

6.743 ***Performance information.*** Information relative to the items of performance set forth in paragraphs (a) through (c) of this section shall be included.

(a) The steady rates of climb and hovering ceilings together with the corresponding airspeeds and other pertinent information, including the calculated effect of altitude and temperature. (See secs. 6.112 and 6.113.)

(b) Maximum wind allowable for safe operation near the ground. (See sec. 6.121 (d).)

(c) Sufficient information to outline the limiting heights and corresponding speeds for safe landing after power failure. (See sec. 6.116.)

(Part 6, 21 F.R. 10291, Dec. 22, 1956, effective Dec. 20, 1956; as amended by Amdt. 6-4, 24 F.R. 7072, Sept. 1, 1959, effective Oct. 1, 1959.)

6.744 ***Marking and placard information.*** (See sec. 6.730.)

(Part 6, 21 F.R. 10291, Dec. 22, 1956, effective Dec. 20, 1956.)

Rotorcraft Identification Data

6.750 ***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 placed in a location where it might be expected to be destroyed or lost in the event of an accident. The identification plate shall contain the identification data required by section 1.50 of this subchapter.

(Part 6, 21 F.R. 10291, Dec. 22, 1956, effective Dec. 20, 1956.)

6.751 ***Identification marks.*** The nationality and registration marks shall be permanently affixed in accordance with section 1.100 of this subchapter.

(Part 6, 21 F.R. 10291, Dec. 22, 1956, effective Dec. 20, 1956.)

Appendix A

Main Rotor Service Life Determination

1. *Introduction.* The fatigue evaluation procedures outlined in this appendix are acceptable to the Federal Aviation Agency for showing compliance with the fatigue evaluation requirements of CAR 6.250. However, the information contained in this appendix is for guidance purposes only and is not mandatory.

(*a*) The rotorcraft is perhaps more directly affected by fatigue than any other type of aircraft. The primary structural elements and systems are subject to vibratory stresses in practically every regime of flight. In addition, being a highly maneuverable aircraft that is capable of forward, rearward, sideward, vertical, and rotational flight, operating limitations due to fatigue are possible in practically all flight situations. For those reasons, it is important that special attention be focused on the fatigue strength evaluation of the essential parts of the rotorcraft.

(*b*) Although a uniform approach to fatigue evaluation is desirable, it is recognized that in such a complex problem, new design features and methods of fabrication, or new approaches and configurations may require variations and deviations from the procedures described herein. Engineering judgment should therefore be exercised for each particular application.

(*c*) There is some question whether a completely rational method exists for the prediction of fatigue life in a built-up structure subject to random loading. Nevertheless, an engineering approach to the subject can be attained through the application of the "Cumulative Damage Hypothesis." This hypothesis asserts that every cycle of stress above an "endurance limit" produces damage proportional to the ratio of cycles run at that stress to the fatigue life at that stress level. Laboratory tests of this hypothesis indicate that it is reasonabe valid when the stress cycles are of random magnitude. That is, stress spectra, in which all high-stress magnitudes are applied consecutively and then all low-stress magnitudes applied, do not obey the hypothesis. Despite the approximation involved in the hypothesis and the lack of an adequate theory connecting the hypothesis with more basic properties of the materials, it attempts to take more factors into account than any other method developed thus far.

(*d*) In any rational determination of the fatigue life of a structure, three basic factors must be known. These factors are:

(1) The stresses associated with the flight maneuvers and operating conditions expected;

(2) The frequency of occurrence of specific loadings expected; and

(3) The fatigue strength characteristics of the structure.

2. *Flight strain measurement program.* It is generally agreed that it is not possible at present to determine analytically the stress levels associated with normal rotorcraft operation and the correlation of occurrence of critical stresses with specific maneuvers or operating conditions. Therefore, the stress levels and occurrence of critical stresses must be determined by a carefully controlled flight strain measurement program.

(*a*) *Instrumentation.* The instrumentation system used in the flight strain measurement program should accurately measure and record the critical strains and test conditions associated with normal operation and specific maneuvers. The location and distribution of the strain gages should be based on a rational evaluation of the critical stress areas. This may be accomplished by a qualitative study by means of brittle coatings (such as stresscoat), by photoelastic methods, or by appropriate analytical means. In any event, the distribution and number of strain gages should define the load spec-

trum adequately for each part essential to the safe operation of the rotorcraft.

(1) The corresponding flight parameters (airspeed, rotor rpm, center of gravity accelerations, etc.) should also be recorded simultaneously by appropriate methods. This is necessary in order to correlate the loads and stresses with the maneuver or operating condition at which they occurred.

(2) The instrumentation system should be adequately calibrated and checked periodically throughout the flight strain measurement program in order to insure consistent results. Sufficient calibration data should be submitted with the fatigue evaluation program to substantiate the results obtained.

(*b*) *Parts to be strain-gaged.* The main rotor blades, rotor hub assembly, controls, tail rotor, and directional control system should be strain-gaged. For rotorcraft of unusual or unique design, special consideration might be necessary to insure that all of the essential parts are evaluated.

(*c*) *Flight regimes and conditions to be investigated.* The flight regimes to be investigated in the flight strain measurement program for power-on and power-off operation are shown in figures I and II. For clarity, the parameters which define these regimes are included in these figures. As noted on figure I, complete coverage at 111 percent V_{NE} should be demonstrated for power-on operation. However, for power-off operation, figure II, complete coverage at 111 percent V_{NE} for maximum and minimum design rpms need not be obtained if points are obtained at V_{NE} at both maximum and minimum design rpm and at 111 percent V_{NE} at both maximum and minimum placarded rpms as indicated in the figure. In addition, if the high speed points are not obtainable at the low rpms, it is acceptable to vary the V_{NE} and 111 percent V_{NE} speed with rotor rpm as shown in the figures.

(1) The determination of flight conditions to be investigated in the flight strain measurement program should be based on the anticipated use of the helicopter and, if available, on past service records for similar designs. In any event, the flight conditions considered appropriate for the design and application should represent those which will occur in actual operation. Suggested flight conditions for single-engine helicopters used in normal operation are shown in table I, which should be used as a guide in making this determination. In the case of multiengine helicopters the flight conditions concerning partial engine-out operation should be considered in addition to complete power-off operation. The flight conditions to be investigated should be submitted, in a form similar to table I, in connection with the flight evaluation program.

(2) The severity and rapidity of control movement used in control reversals, and the extent of blade stall investigated during the flight strain measurement program, should be at least as severe as that which would occur in service. In determining the severity and rapidity of control movement and blade stall, consideration should be given to inadvertent overshoots during training as well as normal service.

(3) All flight conditions considered appropriate for the particular design should be investigated over the complete rpm, airspeed, center of gravity, altitude, and weight ranges in order to determine the most critical stress levels associated with each flight condition. In order to account for data scatter and to determine the stress levels present, a sufficient number of measured strain points should be obtained at each flight condition. In some instances, the critical weight, center of gravity, and altitude ranges for the various maneuvers can be based on past experience with similar designs. This procedure is acceptable where adequate flight tests are performed to substantiate such selections. The combinations of flight parameters that produce the most critical stress levels should be used in the fatigue evaluation.

3. *Frequency of loading.*

(*a*) At best, the determination of the percentage of total operating time associated with each flight maneuver can only be accomplished by a statistical approach and will of necessity be a function of the purpose for which the particular helicopter is intended. Obviously, a helicopter used only for crop dusting would have a different time distribution than one used for mail or passenger service.

the damaging oscillatory stress level is 10,500 psi, the number cycles of damaging stress per hour (n) is 23,200 and the number of cycles to failure (N) from the S–N curve (fig. V) is 3,200,000 cycles. Then by equation (1) the percent of life used per hour at this damaging stress level would be

$$1=\frac{an}{N}=\frac{0.5 \text{ x } 23{,}000}{3{,}200{,}000}=0.00362$$

The summation of the individual percentages of life used per hour for each damaging stress level is shown in column 7. Therefore, by equation (2), the calculated service life of this part would be

$$L_c=\frac{100}{\Sigma 1_i}=\frac{100}{0.15289}=654 \text{ hours}$$

The service life of this part would be, as explained in paragraph (d) of section 4.

$$L=0.75 \text{ x } 654$$
$$L=490 \text{ hours}$$

A summary of the measured stress and percent life used at the various flight conditions should be submitted with the fatigue evaluation program in a form similar to table II.

TABLE I

Percent occurrence

I GROUND CONDITIONS		1.5
(a) Rapid increase of rpm on ground to quickly engage clutch	0.5	
(b) Taxiing with full cyclic control	.5	
(c) Jump takeoff	.5	
II HOVERING		2.0
(a) Steady hovering	.5	
(b) Lateral reversal	.5	
(c) Longitudinal reversal	.5	
(d) Rudder reversal	.5	
III FORWARD FLIGHT—POWER ON		87.5
(a) Level flight—20% V_{NE}	1.0	
(b) Level flight—40% V_{NE}	3.0	
(c) Level flight—60% V_{NE}	18.0	
(d) Level flight—80% V_{NE}	25.0	
(e) Maximum level flight (but not greater than V_{NE})	15.0	
(f) V_{NE}	3.0	
(g) 111% V_{NE}	.5	
(h) Right turns—30, 60, 90% V_{NE}	3.0	
(i) Left turns—30, 60, 90% V_{NE}	3.0	
(j) Climb (Takeoff power)	2.0	
(k) Climb (Max. continuous power)	4.0	
(l) Change to autorotation from power-on flight—30, 60, 90% V_{NE}	1.5	
(m) Partial power descent (including condition of zero flow through rotor)	2.0	
(n) Cyclic and collective pull-ups from level flight	1.0	
(o) Lateral reversals at V_H	.5	
(p) Longitudinal reversals at V_H	.5	
(q) Rudder reversals at V_H	.5	
(r) Landing approach	3.0	
(s) Sideward flight	.5	
(t) Rearward flight	.5	
IV AUTOROTATION—POWER OFF		9.0
(a) Steady forward flight	2.0	
(b) Rapid power recovery from autorotational flight	.5	
(c) Right turns—30, 60, 90% V_{NE}	1.0	
(d) Left turns—30, 60, 90% V_{NE}	1.0	
(e) Lateral reversals	.5	
(f) Longitudinal reversals	.5	
(g) Rudder reversals	.5	
(h) Cyclic and collective pull-ups	1.0	
(i) Landings (including flares)	2.0	
	100.00	100.0

TABLE II

DETERMINATION OF SERVICE LIFE

(Sample calculation)

1	2	3	4	5	6	7
Flight condition	Percent occurrence	Critical steady stress	Critical oscillatory stress	Cycles oscillatory stress	Cycles to failure	Percent of life used per hour
Table–I	Table–I				Figure V	
I (a)	0. 5	Level A	1900	23, 200 Cycles/Hr.	----------	--------
(b)	. 5		2100		----------	--------
(c)	. 5		2300		----------	--------
II (a)	. 5		2600		----------	--------
(b)	. 5		9600		5, 000, 000	0. 00232
(c)	. 5		10500		3, 200, 000	. 00362
(d)	. 5		3400		----------	--------
III (a)	1. 0		6500		----------	--------
(b)	3. 0		5100		----------	--------
(c)	18. 0		7700		----------	--------
(d)	25. 0		8100		----------	--------
(e)	15. 0		8380		16, 000, 000	. 02175
(f)	3. 0		8900		8, 400, 000	. 00829
(g)	. 5		9100		7, 400, 000	. 00157
(h)	3. 0		11200		2, 400, 000	. 02900
(i)	3. 0		11400		2, 250, 000	. 03093
(j)	2. 0		10900		2, 700, 000	. 01719
(k)	4. 0		9900		4, 100, 000	. 02263
(l)	1. 5		7800		----------	--------
(m)	2. 0		6700		----------	--------
(n)	1. 0		9700		4, 800, 000	. 00483
(o)	. 5		7800		----------	--------
(p)	. 5		7900		----------	--------
(q)	. 5		7300		----------	--------
(r)	3. 0		6700		----------	--------
(s)	. 5		6700		----------	--------
(t)	. 5		7900		----------	--------
IV (a)	2. 0		7100		----------	--------
(b)	. 5		9700		4, 800, 000	. 00242
(c)	1. 0		9300		6, 300, 000	. 00368
(d)	1. 0		9900		4, 100, 000	. 00566
(e)	. 5		6800		----------	--------
(f)	. 5		6100		----------	--------
(g)	. 5		5900		----------	--------
(h)	1. 0		7600		----------	--------
(i)	2. 0		7900		----------	--------
Totals	100. 0					. 15289

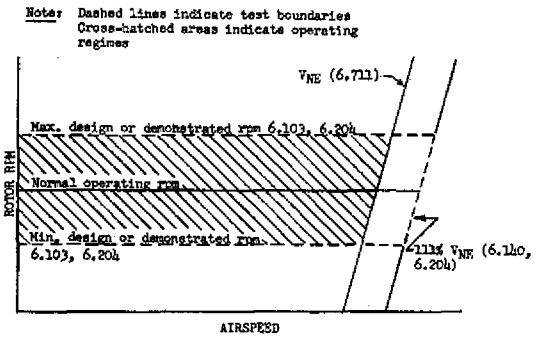

Figure I. Power on—Rotor R.P.M. Airspeed Envelope.

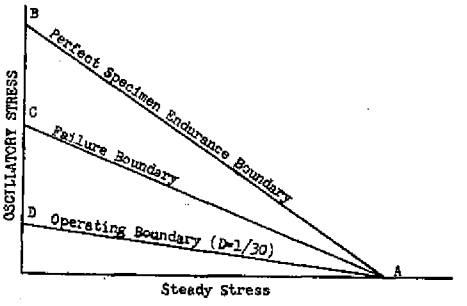

Figure III.

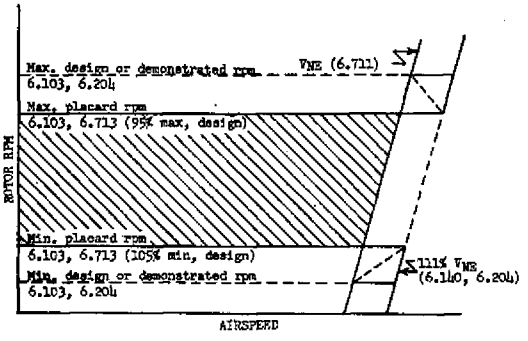

Figure II. Power off—Rotor R.P.M. Airspeed Envelope.

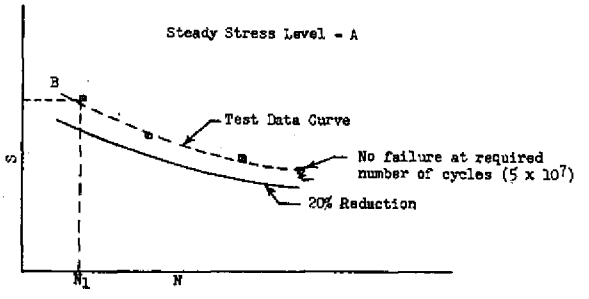

Figure IV.

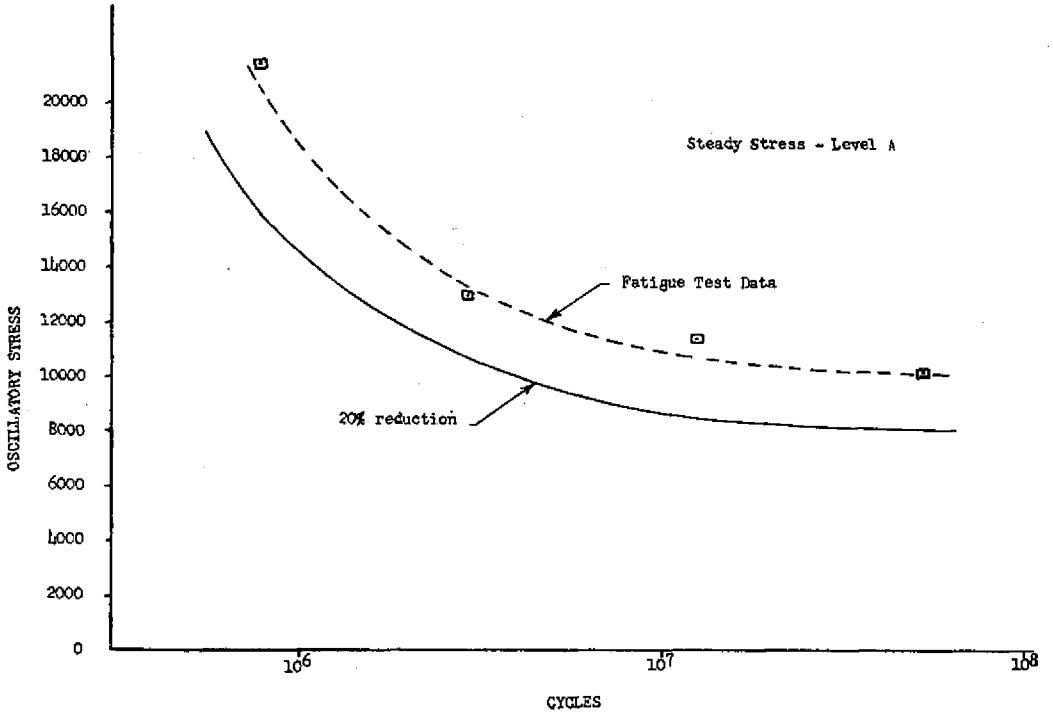

Figure V.

(Published in 27 F.R. 12400, Dec. 14, 1962, effective Dec. 14, 1962.)

Appendix B

Special Civil Air Regulations Which Affect Part 6

SPECIAL CIVIL AIR REGULATION NO. SR–392C

Effective: Feb. 3, 1962
Adopted: Jan. 30, 1962
Published: Feb. 3, 1962
(27 F.R. 1008)

Facilitation of Experiments With Exterior Lighting Systems

Special Civil Air Regulation No. SR–392B, adopted on February 25, 1957, permits experimentation with exterior lighting systems, which do not comply with the standards prescribed in the Civil Air Regulations, on aircraft with standard airworthiness certificates. Several conditions are imposed to insure that the number of aircraft engaged in the experiments is reasonably limited; that the experimental exterior lights are in fact installed for bonafide experimentation; and that the results of such experimentation become generally available. This special regulation expires on February 25, 1962.

In a notice of proposed rule making contained in Draft Release No. 61–27 and published in the Federal Register, December 23, 1961 (26 F.R. 12294), the Agency gave notice that it has under consideration the termination of SR–392B and requested comments from interested persons concerning this matter. In response to such request, the Agency has received numerous reports, arguments and other evidence. However, the volume of the comments received is such that there is not sufficient time remaining to review and evaluate such comments prior to the termination of SR–392B. Therefore, in order to afford the Agency the opportunity to fully consider all the relevant matter presented and to take whatever additional rule making action that may be indicated, it is necessary to extend the termination date of SR–392B to June 25, 1962.

Since this regulation continues in effect the provisions of the previous regulation and imposes no additional burden upon any person, compliance with the notice and public procedure provisions of the Administrative Procedure Act is unnecessary and good cause exists for making this regulation effective on less than 30 days' notice.

In consideration of the foregoing, the following Special Civil Air Regulation is adopted to become effective on February 3, 1962:

Contrary provisions of the Civil Air Regulations notwithstanding, experimental exterior lighting equipment which does not comply with the relevant specifications contained in the Civil Air Regulations may, subject to the approval of the Administrator, be installed and used on aircraft for the purpose of experimentation intended to improve exterior lighting for a period not to exceed 6 months: *Provided,* That

(1) The Administrator may grant approval for additional periods if he finds that the experiments can be reasonably expected to contribute to improvements in exterior lighting;

(2) Not more than 15 aircraft possessing a U.S. certificate of airworthiness may have installed at any one time experimental exterior lighting equipment of one basic type;

(3) The Administrator shall prescribe such conditions and limitations as may be necessary to insure safety and avoid confusion in air navigation;

(4) The person engaged in the operation of the aircraft shall disclose publicly the deviations of the exterior lighting from the relevant specifications contained in the Civil Air Regulations at times and in a manner prescribed by the Administrator; and

(5) Upon application for approval to conduct experimentation with exterior lighting, the applicant shall advise the Administrator of the specific purpose of the experiments to be conducted; and, at the conclusion of the approved period of experimentation, he shall advise the Administrator of the detailed results thereof.

This regulation supersedes Special Civil Air Regulation No. SR–392B and shall terminate June 25, 1962, unless sooner superseded or rescinded.

SPECIAL CIVIL AIR REGULATION NO. SR-392D

Effective: June 25, 1962
Adopted: June 22, 1962
Published: June 26, 1962
(27 F.R. 5979)

Display of Experimental Exterior Lighting Systems Approved for Use on Aircraft

Special Civil Air Regulation No. SR-392B, adopted on February 25, 1957, and superseded by SR-392C on February 3, 1962, permitted experimentation with exterior lighting systems that did not comply with the standards prescribed in the Civil Air Regulations on aircraft with standard airworthiness certificates. Several conditions were imposed to insure that the number of aircraft engaged in the experiments was reasonably limited; that the experimental exterior lights were in fact installed for bona fide experimentation; and that the results of such experimentation became generally available.

In a notice of proposed rule making contained in Draft Release No. 61-27 and published in the Federal Register, December 23, 1961 (26 F.R. 12294), the Agency gave notice that it had under consideration the termination of SR-392B, which was then in effect, and requested comments from interested persons. However, the nature of the comments received was such that there was not sufficient time remaining, before the February 25, 1962, termination date specified in SR-392B, for their proper review and evaluation. To provide the time needed; the Agency adopted SR-392C which superseded SR-392B without revision other than extension of the termination date from February 25, 1962, to June 25, 1962.

On April 3, 1962, the Agency convened a public conference (previously announced by a notice of conference dated February 12, 1962) to give persons interested in SR-392C an opportunity to supplement their written comments with oral presentations, to make additional evidence available, and to participate in direct discussions with government-industry technical people in the aircraft lighting field.

From a study of all comments made on the issue, those who support the need for an extension of SR-392C contend essentially as follows: (1) Experimental lighting systems now operating under SR-392C are more effective than the system prescribed in the Civil Air Regulations; (2) much money and time has been invested in the experiments, which would be wasted if SR-392C were terminated; (3) extension would continue grass-roots cooperation between experienced FAA inspectors and inventors, and stimulate inventive initiatives; (4) unrestrictive field testing would insure reliability of new lighting equipment by exposing it to actual service conditions; (5) a new lighting concept cannot attract financing, or interest manufacturing management, unless its sales potential is established by flight demonstrations to prospective customers; and (6) there is no satisfactory alternative to extension of SR-392C.

After more than 10 years of experimentation under the provisions of SR-392C and predecessor special regulations, the evidence supporting the conten-

tion that various experimental lighting systems surpass the standard system now prescribed in the Civil Air Regulations remains inconclusive. For the most part, reports submitted by experimenters contain subjective evaluations of proposed systems without the use of experimental controls to insure a valid basis for comparison. Tests and studies conducted by the Navy Department and by the Agency's National Aviation Facilities Experimental Center have not corroborated the advantages claimed by private experimenters for their respective systems.

The experiments were no doubt expensive and time-consuming, but the persons who undertook them did so voluntarily and with no assurance of success. In any case, the costs incurred in such experiments do not justify the indefinitely prolonged display of experimental lighting systems, since these systems necessarily introduce some degree of ambiguity and confusion in night operations.

Termination of SR–392C would not prevent further lighting experimentation since such experiments could still be performed under the terms of an experimental airworthiness certificate. There appears to be no reason why cooperation between FAA inspectors and inventors would necessarily diminish if further lighting experiments were conducted only on that basis.

The point that unrestricted field testing insures reliability of experimental lighting equipment is largely irrelevant since the objective of SR–392C was to facilitate experiments with new lighting concepts rather than to achieve component reliability. Component technology is not in question; and, in any case, there is no evidence that unusual problems exist. Further, reliability can be attained to a large extent by laboratory tests in a simulated environment, a practice which has worked satisfactorily in the past.

It may be true that the privileges granted by SR–392C (as opposed to the generally more restrictive terms of experimental airworthiness certificates) make it easier to finance new lighting concepts, but similar privileges are not granted to those who experiment with aircraft in other ways. This preference for one class of experimenters over all other classes has not been justified in terms of safety improvements achieved to date.

Reasonable alternatives to SR–392C are, in fact, open to experimenters. Experiments may be conducted under the terms of an experimental airworthiness certificate; and the Agency's well-equipped experimental facilities, with trained personnel, are now available for cooperative evaluation of new lighting concepts developed by inventors.

For these reasons, the Agency concludes that the arguments offered in support of an extension of SR–392C are not persuasive; and SR–392C will not be continued in effect beyond June 25, 1962. However, the Agency believes that a reasonable transition period of not less than one year should be established. This would permit 6 months for completion of experiments begun before June 25, 1962, the maximum period of experimentation permitted under SR–392C without special permission, and would allow not less than an additional 6 months for airplane modifications that may be necessitated by the termination of experimentation hereunder.

The various experiments which were conducted under the provisions of SR–392C and predecessor special regulations, although inconclusive, have, nevertheless, helped to crystallize the Agency's position on the need for revisions of the currently effective exterior lighting regulations. Therefore, a proposed rule concerning these requirements is under study by the Agency. If rule making action is initiated as a result of this study, it may ultimately affect some of the details of the lighting systems now required to be installed on aircraft. Moreover, if such rule making action is initiated it may not be completed before December 25, 1962. In such case, a requirement to accomplish the necessary modifications within one year after the termination of SR–392C, i.e., by June 25, 1963, may not provide the operator with a period of 6 months in which to accomplish the modifications, if any, required by the regulation.

In order to permit an adequate transition period for the accomplishment of any necessary modifications, this regulation permits the current experimental lighting systems to be used until June 25, 1963, or 6 months after completion of the proposed rule making action in regard to exterior lighting systems, whichever date is later. If, however, the Agency finds at the conclusion of its studies that rule making action will not be adopted an appropriate notice thereof will be issued and published in the Federal Register. In such case this regulation also permits the experimental lighting systems to be used until June 25, 1963, or 6 months after such notice is published in the Federal Register, whichever date is later.

In consideration of the foregoing, the following Special Civil Air Regulation is adopted to become effective on June 25, 1962:

Contrary provisions of the Civil Air Regulations notwithstanding, experimental exterior lighting systems which do not comply with the Civil Air Regulations, and which were installed for the purposes of experimentation on aircraft with standard airworthiness certificates under the provisions of SR–392B or SR–392C, may be displayed until:

(1) 6 months after the date of publication in the Federal Register of either

(i) revised standards adopted by the Agency for exterior lighting systems, or

(ii) a notice that rule making action to revise such standards will not be adopted by the Agency; or

(2) June 25, 1963, if later than that specified in paragraph (1).

This Special Civil Air Regulation shall remain in effect until superseded or rescinded.

SPECIAL CIVIL AIR REGULATION NO. SR-425C

Effective: June 6, 1961
Adopted: May 31, 1961
Published: June 6, 1961
(26 F.R. 4990)

Provisional Certification and Operation of Aircraft

Special Civil Air Regulation No. SR-425A was adopted on July 22, 1958, to provide for provisional certification of turbine-powered transport category airplanes in order to permit certain air carriers and manufacturers to conduct crew training, service testing, and simulated air carrier operations prior to introduction of the airplanes into commercial service. The objective of this regulation was to provide a means whereby the air carriers and manufacturers could obtain as much experience as possible with turbine-powered airplanes which, although safe for flight, had not been approved for the issuance of a type certificate.

Special Civil Air Regulation No. SR-425B, which superseded SR-425A, was adopted on April 7, 1960, to extend the application of the regulation to: (1) piston-engine transport category aircraft, including rotorcraft; and (2) personal and executive type aircraft, including rotorcraft, irrespective of powerplant type. In addition, this regulation permitted operations such as sales demonstrations and market surveys with aircraft having a provisional type and airworthiness certificate.

To accomplish this, SR-425B provided for, among other things, the issuance of two classes of provisional type and airworthiness certificates. Class I provisional and airworthiness certificates could be issued for all types of aircraft for operation by the aircraft manufacturer. Class II provisional type and airworthiness certificates could be issued only for transport category aircraft, but these aircraft could be operated by either the aircraft manufacturer or a certificated air carrier. In general, the requirements for the issuance of Class I provisional certificates were less stringent, and the operating limitations less confining, than those for the issuance of Class II provisional certificates.

Under the provisions of SR-425B, however, eligibility to apply for Class I provisional certificates was limited to aircraft manufacturers. A recommendation that this eligibility be extended to include engine manufacturers had been evaluated by the Agency prior to the adoption of SR-425B, but rule making action on such extension was deferred until additional experience with provisional certification could be acquired.

Experience accumulated since the adoption of SR-425B has indicated that it would be practicable for engine manufacturers, who have altered a type certificated aircraft by installing type certificated engines of their own manufacture in place of the original engines, to show compliance with the currently effective requirements for issuance of Class I provisional type and provisional airworthiness certificates; and that compliance with these requirements will insure safe operation of provisionally certificated aircraft by such engine manufacturers. Further, the Agency

believes that operations conducted by engine manufacturers under the terms of Class I provisional certificates, for the purpose of sales demonstrations, market surveys, and other similar activities related to the sale of their engines, would contribute to the promotion and development of civil aeronautics in the United States.

SR–425B is therefore being superseded by SR–425C to permit certain engine manufacturers to apply for Class I provisional type and provisional airworthiness certificates if they have applied for the issuance of a supplemental type certificate.

Since this is a superseding regulation which relieves restrictions and imposes no additional burden on any person, notice and public procedures hereon are unnecessary, and this regulation may be made effective on less than 30 days' notice.

In consideration of the foregoing, the following Special Civil Air Regulation is adopted to become effective June 6, 1961:

GENERAL

1. *Applicability.* Contrary provisions of the Civil Air Regulations notwithstanding, provisional type and airworthiness certificates, amendments to provisional type certificates, and provisional amendments to type certificates, will be issued as prescribed in this regulation to a manufacturer or an air carrier. As used in this regulation, a manufacturer shall mean only a manufacturer who is a citizen of the United States; and the term air carrier shall not include an air taxi operator.

2. *Eligibility.*

(a) A manufacturer of aircraft manufactured by him within the United States may apply for Class I or Class II provisional type and provisional airworthiness certificates, for amendments to provisional type certificates held by him, and for provisional amendments to type certificates held by him.

(b) An air carrier holding an air carrier operating certificate authorizing him to conduct operations under Parts 40, 41, 42, or 46 of the Civil Air Regulations may apply for Class II provisional airworthiness certificates for transport category aircraft which meet the conditions of either subparagraphs (1) or (2) of this paragraph.

(1) The aircraft has a currently valid Class II provisional type certificate or an amendment thereto;

(2) The aircraft has a currently valid provisional amendment to a type certificate which was preceded by a corresponding Class II provisional type certificate.

(c) An engine manufacturer who has altered a type certificated aircraft by installing different type certificated engines, manufactured by him within the United States, in place of the original engines, may apply for Class I provisional type and provisional airworthiness certificates for such aircraft, and for amendments to Class I provisional type certificates held by him, if the basic aircraft, before alteration was type certificated in the normal, utility, acrobatic, or transport category.

3. *Application.*

(a) *General.* Applications for provisional type and airworthiness certificates, for amendments to provisional type certificates, and for

provisional amendments to type certificates, shall be submitted to the Chief, Flight Standards Division, FAA, of the Regional Office in which the manufacturer or air carrier is located and shall be accompanied by the pertinent information specified in this regulation.

4. *Duration.* Unless sooner surrendered, superseded, revoked, or otherwise terminated, certificates and amendments thereto, shall have periods of duration in accordance with paragraphs (a) through (f) of this section.

(a) A Class I provisional type certificate shall remain in effect for 24 months after the date of its issuance or until the date of issuance of the corresponding type or supplemental type certificate, whichever occurs first.

(b) A Class I provisional type certificate shall expire immediately upon issuance of a Class II provisional type certificate for aircraft of the same type design.

(c) A Class II provisional type certificate shall remain in effect for 6 months after the date of its issuance or 60 days after the date of issuance of the corresponding type certificate, whichever occurs first.

(d) An amendment to a Class I or a Class II provisional type certificate shall remain in effect for the duration of the corresponding provisional type certificate.

(e) A provisional amendment to a type certificate shall remain in effect for 6 months after its approval or until the amendment to the type certificate is approved, whichever occurs first.

(f) Provisional airworthiness certificates shall remain in effect for the duration of the corresponding provisional type certificate, amendment to a provisional type certificate, or a provisional amendment to the type certificate.

5. *Transferability of certificates.* Certificates issued pursuant to this regulation are not transferable except that a Class II provisional airworthiness certificate may be transferred to an air carrier eligible to apply for such certificate under section 2 of this regulation.

6. *Display of certificates and markings.* A provisional airworthiness certificate shall be prominently displayed in the aircraft for which it is issued. The words "Provisional Airworthiness" shall be painted in letters not less than 2 inches high on the exterior of such aircraft adjacent to each entrance to the cabin and cockpit of the aircraft.

REQUIREMENTS FOR ISSUANCE

7. *Class I provisional type certificates.* A Class I provisional type certificate and amendments thereto will be issued for a particular type design when the eligible aircraft or engine manufacturer shows compliance with the provisions of paragraphs (a) through (f) of this section, and an authorized representative of the Administrator finds, on the basis of information submitted to him by the manufacturer in compliance with the provisions of this section and of other relevant information, that there is no feature, characteristic, or condition which would render the aircraft unsafe when operated in accordance with the limitations established in paragraph (d) of this section and in section 13 of this regulation.

(a) The manufacturer has applied for the issuance of a type or supplemental type certificate for the aircraft.

(b) The manufacturer certifies that the aircraft has met the provisions of subparagraphs (1) through (3) of this paragraph.

(1) The aircraft has been designed and constructed in accordance with the airworthiness requirements applicable to the issuance of the type or supplemental type certificate for the aircraft;

(2) The aircraft substantially complies with the applicable flight characteristics requirements for the type or supplemental type certificate;

(3) The aircraft can be operated safely under the appropriate operating limitations specified in this regulation.

(c) The manufacturer has submitted a report showing that the aircraft had been flown in all maneuvers necessary to show compliance with the flight requirements for the issuance of the type or supplemental type certificate and to establish that the aircraft can be operated safely in accordance with the limitations specified in this regulation.

(d) The manufacturer has established limitations with respect to weights, speeds, flight maneuvers, loading, operation of controls and equipment, and all other relevant factors. The limitations shall include all the limitations required for the issuance of a type or supplemental type certificate for the aircraft: *Provided,* That, where such limitations have not been established, appropriate restrictions on the operation of the aircraft shall be established.

(e) The manufacturer has established an inspection and maintenance program for the continued airworthiness of the aircraft.

(f) A prototype aircraft has been flown by the manufacturer for at least 50 hours pursuant to the authority of an experimental certificate issued under Part 1 of the Civil Air Regulations or under the auspices of a United States military service: *Provided,* That the number of flight hours may be reduced by the authorized representative of the Administrator in the case of an amendment to a provisional type certificate.

8. *Class I provisional airworthiness certificates.* Except as provided in section 12 of this regulation, a Class I provisional airworthiness certificate will be issued for an aircraft, for which a Class I provisional type certificate is in effect, when the eligible aircraft or engine manufacturer shows compliance with the provisions of paragraphs (a) through (d) of this section, and an authorized representative of the Administrator finds that there is no feature, characteristic, or condition of the aircraft which would render the aircraft unsafe when operated in accordance with the limitations established in sections 7(d) and 13 of this regulation.

(a) The manufacturer is the holder of the provisional type certificate for the aircraft.

(b) The manufacturer submits a statement that the aircraft conforms to the type design corresponding with the provisional type certificate and has been found by him to be in safe operating condition under the applicable limitations.

(c) The aircraft has been flown at least 5 hours by the manufacturer.

(d) The aircraft has been supplied with a provisional aircraft flight manual or other document and appropriate placards containing the limitations required by sections 7(d) and 13 of this regulation.

9. *Class II provisional type certificates.* A Class II provisional type certificate and amendments thereto will be issued for a particular transport category type design when the manufacturer of the aircraft shows compliance with the provisions of paragraphs (a) through (h) of this section, and an authorized representative of the Administrator finds, on the basis of information submitted to him by the manufacturer in compliance with the provisions of this section and of other relevant information, that there is no feature, characteristic, or condition which would render the aircraft unsafe when operated in accordance with the limitations established in paragraph (f) of this section and in sections 13 and 14 of this regulation.

(a) The manufacturer has applied for the issuance of a transport category type certificate for the aircraft.

(b) The manufacturer holds a type certificate and a currently effective production certificate for at least one other aircraft in the same transport category as the subject aircraft.

(c) The Agency's official flight test program with respect to the issuance of a type certificate for the aircraft is in progress.

(d) The manufacturer certifies that the aircraft has met the provisions of subparagraphs (1) through (3) of this paragraph.

(1) The aircraft has been designed and constructed in accordance with the airworthiness requirements applicable to the issuance of the type certificate for the aircraft;

(2) The aircraft substantially complies with the applicable flight characteristics requirements for the type certificate;

(3) The aircraft can be operated safely under the appropriate operating limitations specified in this regulation.

(e) The manufacturer has submitted a report showing that the aircraft had been flown in all maneuvers necessary to show compliance with the flight requirements for the issuance of the type certificate and to establish that the aircraft can be operated safely in accordance with the limitations specified in this regulation.

(f) The manufacturer has prepared a provisional aircraft flight manual which includes limitations with respect to weights, speeds, flight maneuvers, loading, operation of controls and equipment, and all other relevant factors. The limitations shall include all the limitations required for the issuance of a type certificate for the aircraft: *Provided,* That, where such limitations have not been established, the provisional flight manual shall contain appropriate restrictions on the operation of the aircraft.

(g) The manufacturer has established an inspection and maintenance program for the continued airworthiness of the aircraft.

(h) A prototype aircraft has been flown by the manufacturer for at least 100 hours pursuant to the authority of either an experimental certificate issued under Part 1 of the Civil Air Regulations or a Class I provisional airworthiness certificate: *Provided,* That the number of flight hours may be reduced by the authorized representative of the Administrator in the case of an amendment to a provisional type certificate.

10. *Class II provisional airworthiness certificates.* Except as provided in section 12 of this regulation, a Class II provisional airworthiness certificate will be issued for an aircraft, for which a Class II provisional type certificate is in effect, when the applicant shows compliance with the provisions of paragraphs (a) through (e) of this section, and an authorized representative of the Administrator finds that there is no feature, characteristic, or condition of the aircraft which would render the aircraft unsafe when operated in accordance with the limitations established in sections 9(f), 13, and 14 of this regulation.

(a) The applicant submits evidence that a Class II provisional type certificate for the aircraft has been issued to the manufacturer.

(b) The applicant submits a statement by the manufacturer that the aircraft has been manufactured under a quality control system adequate to insure that the aircraft conforms to the type design corresponding with the provisional type certificate.

(c) The applicant submits a statement that the aircraft has been found by him to be in a safe operating condition under the applicable limitations.

(d) The applicant submits a statement that the aircraft has been flown at least 5 hours by the manufacturer.

(e) The aircraft has been supplied with a provisional aircraft flight manual containing the limitations required by sections 9(f), 13, and 14 of this regulation.

11. *Provisional amendments to type certificate.* A provisional amendment to a type certificate will be approved when the manufacturer of the type certificated aircraft shows compliance with the provisions of paragraphs (a) through (g) of this section, and an authorized representative of the Administrator finds, on the basis of information submitted to him by the manufacturer in compliance with the provisions of this section and of other relevant information, that there is no feature, characteristic, or condition which would render the aircraft unsafe when operated in accordance with the limitations established in paragraph (e) of this section, and section 13 and, if applicable, section 14 of this regulation.

(a) The manufacturer has applied for an amendment to the type certificate.

(b) The Agency's official flight test program with respect to the amendment of the type certificate is in progress.

(c) The manufacturer certifies that the aircraft has met the provisions of subparagraphs (1) through (3) of this paragraph.

(1) The modification involved in the amendment to the type certificate has been designed and constructed in accordance with the airworthiness requirements applicable to the issuance of the type certificate for the aircraft;

(2) The aircraft substantially complies with the applicable flight characteristics requirements for the type certificate;

(3) The aircraft can be operated safely under the appropriate operating limitations specified in this regulation.

(d) The manufacturer has submitted a report showing that the aircraft incorporating the modifications involved had been flown in all maneuvers necessary to show compliance with the flight require-

ments applicable to these modifications and to establish that the aircraft can be operated safely in accordance with the limitations specified in this regulation.

(e) The manufacturer has established, in a provisional aircraft flight manual or other document and appropriate placards, limitations with respect to weights, speeds, flight maneuvers, loading, operation of controls and equipment, and all other relevant factors. The limitations shall include all the limitations required for the issuance of a type certificate for the aircraft: *Provided,* That, where such limitations have not been established, appropriate restrictions on the operation of the aircraft shall be established.

(f) The manufacturer has established an inspection and maintenance program for the continued airworthiness of the aircraft.

(g) An aircraft modified in accordance with the corresponding amendment to the type certificate has been flown by the manufacturer for the number of hours found necessary by the authorized representative of the Administrator, such flights having been conducted pursuant to the authority of an experimental certificate issued under Part 1 of the Civil Air Regulations.

12. *Provisional airworthiness certificates corresponding with provisional amendment to type certificate.* A Class I or a Class II provisional airworthiness certificate, as specified in section 2 of this regulation, will be issued for an aircraft, for which a provisional amendment to the type certificate has been issued, when the applicant shows compliance with the provisions of paragraphs (a) through (e) of this section, and an authorized representative of the Administrator finds that there is no feature, characteristic, or condition of the aircraft, as modified in accordance with the provisionally amended type certificate, which would render the aircraft unsafe when operated in accordance with the limitations established in sections 11(e) and 13 and, if applicable, section 14 of this regulation.

(a) The applicant submits evidence that approval has been obtained for the relevant provisional amendment to the type certificate for the aircraft.

(b) The applicant submits evidence that the modification to the aircraft was accomplished under a quality control system adequate to insure that the modification conforms to the provisionally amended type certificate.

(c) The applicant submits a statement that the aircraft has been found by him to be in a safe operating condition under the applicable limitations.

(d) The applicant submits a statement that the aircraft has been flown at least 5 hours by the manufacturer.

(e) The aircraft has been supplied with a provisional aircraft flight manual or other document and appropriate placards containing the limitations required by sections 11(e) and 13 and, if applicable, section 14 of this regulation.

OPERATING LIMITATIONS

13. *Operation of provisionally certificated aircraft.* An aircraft for which a provisional airworthiness certificate has been issued shall

be operated only by a person eligible to apply for a provisional airworthiness certificate in accordance with section 2 of this regulation. Operations shall be in compliance with paragraphs (a) through (j) of this section.

(a) The aircraft shall not be operated in air transportation unless so authorized in a particular case by the Director, Bureau of Flight Standards.

(b) Operations shall be restricted to the United States, its Territories and possessions.

(c) The aircraft shall be limited to the types of operations listed in subparagraphs (1) through (7) of this paragraph.

(1) Flights conducted by the aircraft or engine manufacturer in direct conjunction with the type or supplemental type certification of the aircraft;

(2) Training of flight crews, including simulated air carrier operations;

(3) Demonstration flights conducted by the manufacturer for prospective purchasers;

(4) Market surveys by the manufacturer;

(5) Flight checking of instruments, accessories, and equipment, the functioning of which does not adversely affect the basic airworthiness of the aircraft;

(6) Service testing of the aircraft;

(7) Such additional operations as may be specifically authorized by the authorized representative of the Administrator.

(d) All operations shall be conducted within the prescribed limitations displayed in the aircraft or set forth in the provisional aircraft flight manual or other document containing the limitations for the safe operation of the aircraft: *Provided,* That operations conducted in direct conjunction with the type or supplemental type certification of the aircraft shall be subject to the experimental aircraft limitations of section 1.74 of Part 1 of the Civil Air Regulations, and all "flight tests" as defined in section 60.60 of the Civil Air Regulations shall be conducted in accordance with the requirements of section 60.24 of that part.

(e) The operator shall establish procedures for the use and guidance of flight and ground personnel in the conduct of operations under this section. Specific procedures shall be established for operations from and into airports where the runways require takeoffs or approaches over populated areas. All procedures shall be approved by an authorized representative of the Administrator. All operations shall be conducted in accordance with such approved procedures.

(f) The operator shall insure that each flight crewmember is properly certificated and possesses adequate knowledge of, and familiarity with, the aircraft and the procedures to be used by him.

(g) The aircraft shall be maintained in accordance with applicable Civil Air Regulations, with the inspection and maintenance program established in accordance with this regulation, and with any special inspections and maintenance conditions prescribed by an authorized representative of the Administrator.

(h) No aircraft shall be operated under authority of a provisional airworthiness certificate if the manufacturer or the authorized

representative of the Administrator determines that a change in design, construction, or operation is necessary to insure safe operation, until such change is made and approved by the authorized representative of the Administrator. Section 1.24 of Part 1 of the Civil Air Regulations shall be applicable to operations under this section.

(i) Only those persons who have a bona fide interest in the operations permitted under this section or who are specifically authorized by both the manufacturer and the authorized representative of the Administrator may be carried in provisionally certificated aircraft: *Provided,* That they have been advised by the operator of the provisional certification status of the aircraft.

(j) The authorized representative of the Administrator may prescribe such additional limitations or procedures as he finds necessary. This shall include limitations on the number of persons who may be carried aboard the aircraft.

14. *Additional limitations to operations by air carriers.* In addition to the limitations in section 13 of this regulation, operations by air carriers shall be subject to the provisions of paragraphs (a) through (d) of this section.

(a) In addition to crewmembers, the aircraft may carry only those persons who are listed in section 40.356(c) of Part 40 of the Civil Air Regulations or who are specifically authorized by both the air carrier and the authorized representative of the Administrator.

(b) The air carrier shall maintain current records for each flight crewmember. These records shall include such information as is necessary to show that each flight crewmember is properly trained and qualified to perform his assigned duties.

(c) The appropriate instructor, supervisor, or check airman shall certify to the proficiency of each flight crewmember and such certification shall become a part of the flight crewmember's record.

(d) A log of all flights conducted under this regulation, and accurate and complete records of inspections made and maintenance accomplished, shall be kept by the air carrier and made available to the manufacturer and to an authorized representative of the Administrator.

15. *Other operations.* The Director, Bureau of Flight Standards, may credit toward the aircraft proving test requirements of the applicable air carrier regulations such operations conducted pursuant to this special regulation as he finds have met the applicable aircraft proving test requirements: *Provided,* That he also finds that there is no significant difference between the provisionally certificated aircraft and the aircraft for which application is made for operation pursuant to an air carrier operating certificate.

CERTIFICATES ISSUED UNDER SR-425A AND SR-425B

16. *Duration.* Currently valid provisional type and airworthiness certificates issued in accordance with Special Civil Air Regulations Nos. SR-425A and SR-425B shall remain in effect for the durations and under the conditions prescribed in those regulations.

This special regulation supersedes Special Civil Air Regulation No. SR-425B and shall terminate on June 30, 1963, unless sooner superseded, rescinded, or otherwise terminated.

Addendum

Preambles of Amendments to Civil Air Regulations Part 6

NOTE

Part 6 of the Civil Air Regulations was last revised by the Civil Aeronautics Board with an effective date of December 20, 1956. This was not a general revision of the part, but only a reprint to incorporate outstanding amendments. This revision was published in the Federal Register on December 22, 1956 (21 F.R. 10291).

Amendment 6-1

Position and Anticollision Light Requirements

Adopted: Feb. 25, 1957
Effective: Apr. 1, 1957
Published: Mar. 1, 1957
(22 F.R. 1274)

The currently effective provisions of Part 6 of the Civil Air Regulations prescribe certain installational requirements for an exterior lighting system consisting of the three conventional position lights. Experience with the use of anticollision lights on large airplanes has shown that a significant increase in the conspicuity of aircraft can be attained with such lights during night operations. Although such lights are not required on small rotorcraft by the currently effective provisions of the operating parts of the Civil Air Regulations, many owners and operators of such rotorcraft have elected to install anticollision lights. In the approval of such installations, the Administrator had made applicable the requirements in section 4b.637 of Part 4b of the Civil Air Regulations in view of the fact that there were no specifications in this part.

Recent studies, with respect to the use of anticollision lights on all types of aircraft, have indicated the need for broadening the specification in section 4b.637 to permit the use of newly developed lights. As a result of these studies, new specifications for anticollision lights were developed and are being added to Part 6 by this amendment. These specifications are the same as those being incorporated by a concurrent amendment into Part 7 of the Civil Air Regulations. No differentiation is made between the standards in Part 6 and Part 7 in view of the Board's belief that equal conspicuity should be required for all future aircraft.

The continuing increase in air traffic density and the advent of airplanes capable of appreciably higher speeds than heretofore attained emphasize the need for increased conspicuity for newly designed small airplanes. Therefore, concurrently with this amendment, Part 43 of the Civil Air Regulations is being amended to require the use of anticollision lights on all small rotorcraft for which application for type certification is made on or after the effective date of this amendment. Such lights will be required to comply with the anticollision light specifications included in this amendment. These specifications will afford coverage of all vital areas around the rotorcraft with due consideration to the physical configuration and flight characteristics of the rotorcraft.

It is not anticipated that this amendment will affect the basis of approval used in the past by the Administrator with respect to the installation of anticollision lights on small rotorcraft for which the application for type certification was made prior to the effective date of this amendment. Anticollision lights which cannot comply with the aforementioned policy of the Administrator may be installed on such older rotorcraft on a voluntary basis if compliance can be shown with the new specifications in this amendment.

Another change being made by this amendment is the deletion of the specifications for the position light system flasher. This deletion is made in view of the belief that when position lights are used with anti collision lights, steady lights provide important direction and attitude information whereas flashing lights contribute very little to increased conspiracy or to information on direction and attitude.

It is considered that these new requirements set forth necessary and sufficient conditions for anticollision light systems to provide a reasonable level of safety. However, since these requirements entail more conditions than have been required in the past, experience with them on individual rotorcraft might indicate the need for future revisions, particularly with respect to light intensities and coverage. Further, as current research and development programs progress, the question of color of the light might need re-evaluation. The Board will consider any necessary changes as might be indicated by future developments.

Interested persons have been afforded an opportunity to participate in the making of this amendment (21 F.R. 3388), and due consideration has been given to all relevant matter presented.

Amendment revised section 6.632 and added new section 6.637 and Figure 6-4.

Amendment 6–2

Miscellaneous Amendments Resulting From the 1956 Annual Airworthiness Review	Adopted: July 8, 1957 Effective: Aug. 12, 1957 Published: July 16, 1957 (22 F.R. 5568)

There are contained herein amendments stemming from the 1956 Annual Airworthiness Review.

The currently effective provisions governing the design loading conditions for landing gears are applicable principally to landing gears having two wheels aft and one or two wheels forward. In view of the development of tail-wheel and skid type gears, it is necessary to incorporate into the regulations appropriate design criteria which are specifically applicable to such gears. These criteria are set forth in new section 6.246 for tail-wheel gears and in new section 6.247 for skid gears.

There are also included herein several changes of a minor nature.

Interested persons have been afforded an opportunity to participate in the making of this amendment (21 F.R. 9217), and due consideration has been given to all relevant matter presented.

Amendment revised sections 6.237(a), 6.383(c), 6.425(e), and 6.441(c), and added new sections 6.246 and 6.247.

Amendment 6–3

Miscellaneous Amendments Resulting From the 1957 Annual Airworthiness Review	Adopted: Apr. 15, 1958 Effective: May 17, 1958 Published: Apr. 19, 1958 (23 F.R. 2592)

There are contained herein amendments with respect to issues stemming from the 1957 Annual Airworthiness Review.

The nonsubstantive changes deal with the definitions of standard atmosphere, takeoff power or thrust, maximum continuous power or thrust, and gas temperature. These changes are being made to maintain consistency in the definitions throughout the Civil Air Regulations.

The only substantive change being made deals with protection from fan blade failures. A recent accident involving engine overspeed and fan disintegration prompts the Board to amend section 6.401 to require protection from fan blade failures.

Interested persons have been afforded an opportunity to participate in the making of this amendment (22 F.R. 9116), and due consideration has been given to all relevant matter presented.

Amendment revised sections 6.1 (c) and (g), and 6.401.

Amendment 6–4

Miscellaneous Amendments Resulting From the 1958 Annual Airworthiness Review

Adopted: Aug. 24, 1959
Effective: Oct. 1, 1959
Published: Sept. 1, 1959
(24 F.R. 7072)

There are contained herein amendments as a result of the 1958 Annual Airworthiness Review.

In the flight requirements, a revision to section 6.121 replaces the current requirement for a demonstration of controllability after power failure at only one high speed condition with a requirement for controllability after power failure over the range of airspeeds and altitudes for which certification is sought. A revision to section 6.123, while still requiring satisfactory controllability, permits a slight negative slope of the stick position versus speed curve over the speed ranges prescribed.

A number of changes are being made with respect to the structural provisions. The requirement for ground vibration tests previously set forth in section 6.203 is being deleted. This action is based upon the conclusion that if any major component has a natural frequency which would be significantly excited by some operating parameter, such a condition would be revealed in the course of other flight and ground tests. Section 6.235, having to do with the braked roll condition, is being amended to indicate that where rotor lift is present a load factor of 1.0 is acceptable in place of 1.33. In order to standardize the test procedure used in the shock absorption tests of section 6.237, this section is being changed to specify the attitude of the landing gear during drop tests. Another change to the structural provisions is being made to section 6.247, covering skid gear ground loading conditions. This amendment permits, when applicable, the use of more than limit rotor lift in the conduct of the ultimate drop test.

Several changes are being made to the sections dealing with control system design. One, to section 6.320, adds a requirement aimed at minimizing the possibility of incorrect assembly of the elements of the flight control system. In addition, a new section 6.328 is being included to provide minimum safety standards for power-operated control systems.

In the subpart dealing with powerplant installations, section 6.420 is being revised to include requirements for multiengine rotorcraft which employ a common fuel tank. Section 6.424 is being amended to provide for automatically activated or continuously operating emergency fuel pumps. This change is intended to assure that in the event of failure of the main fuel pump, fuel would continue to be supplied to the engine without requiring action by the pilot. Sections 6.445 and 6.446 are being deleted inasmuch as the requirements of these sections are now covered in section 6.604. By the amendment to section 6.485, the use of rigid fuel lines is permitted regardless of whether or not the line is under pressure, provided there is no other requirement for flexibility.

Section 6.604, covering powerplant instruments, is being revised to no longer require oil temperature indicators for all gearboxes but to require an oil temperature warning device for main rotor drive gearboxes. A new section 6.606 is being added to indicate the general requirements for reliability of equipment and systems. Since it is difficult to maintain low speeds during climbout and because the pilot's attention is not likely to be concentrated on the airspeed indicator during the takeoff maneuver much before climbout speed is reached, section 6.612 is being revised to make the requirement for airspeed indicator accuracy at low speeds more realistic. Section 6.621 is being amended to cover new types of storage batteries as well as the conventional lead-acid type.

In the subpart dealing with operating limitations and information, the limiting height-speed diagram for safe landing after power failure has been transferred from operating limitations to operating information by deleting section 6.715 and section 6.741(f) and by inserting the text of the latter in section 6.743. The flight test requirements to establish the diagram are being inserted as a new section 6.116. Through these changes, the height-speed diagram will no longer be a limitation under the type certificate, but may be applied as a limitation in particular types of operations under the operating rules.

In addition, there are included other changes which are of a clarifying or editorial nature.

Interested persons have been afforded an opportunity to participate in the making of this amendment (24 F.R. 128), and due consideration has been given to all relevant matter presented.

Amendment made the following changes;

(1) Amended sections 6.1 (c) and (e), 6.110, 6.111, 6.123(b), 6.140, 6.203, 6.235, 6.237(a), 6.246(f), 6.247(a), 6.320, 6.420, 6.421, 6.424, 6.480, 6.485, 6.604, 6.612(a), 6.621, 6.632(e), 6.732, 6.736, 6.741, and 6.743;

(2) Deleted sections 6.445, 6.446, 6.613 (e), (f), (g), and (h), and 6.715; and

(3) Added sections 6.116, 6.121(e), 6.328, and 6.606.

Amendment 6–5

Miscellaneous Amendments Resulting From the First Federal Aviation Agency Airworthiness Review	Adopted: Mar. 27, 1962 Effective: May 3, 1962 Published: Mar. 30, 1962 (27 F.R. 2996)

As a result of the First Federal Aviation Agency Airworthiness Review, the Agency published a notice of proposed rule making affecting several parts of the Civil Air Regulations. This notice was published in the Federal Register (26 F.R. 5130) and circulated as Civil Air Regulations Draft Release No. 61–12 dated June 8, 1961. There are contained herein amendments to Part 6 of the Civil Air Regulations which stem from this First FAA Airworthiness Review.

Interested persons have been afforded an opportunity to express their comments in regard to the proposal and, in some cases, the proposal has been modified in accordance with such comments. The more significant amendments being adopted by the Agency are discussed herein.

Two changes are being made which affect control systems. Section 6.225 now requires manual control systems to comply with the provisions of that section. Because the word "manual" has erroneously been construed to limit the applicability of this section, it is being amended to make certain that it applies to all control systems. The other change stems from the fact that Part 6 does not now cover the design of dual primary flight control systems. To insure that future dual control systems will be designed to withstand more than single pilot effort, a new section 6.226 is being adopted.

Several changes to the structural provisions relating to parts subjected to alternating stresses, casting factors, and hull and float design are being made. The current regulations require fatigue evaluation of the rotor structure but not of the essential fuselage and rotor pylon structure. Service experience has shown a need for fatigue evaluation of these other structural parts. Therefore, section 6.251 is being amended to require an evaluation of fuselage and rotor pylon structure, the failure of which would threaten the structural integrity of the rotorcraft. The present requirements on factors of safety and inspections for structural castings specify a special factor of 2.0 for visual inspection only, and a factor of 1.25 when radiographic inspection and strength tests of 3 sample castings are employed. Section 6.307 is being amended to provide a series of casting factors and corresponding test and inspection requirements which reflect current methods and practices. In addition, a minor revision in the format of this section has been made from that which was proposed and the rule now provides for alternative methods of compliance with the requirements therein. It was proposed in Draft Release 61–12 to add a new section 6.343 setting forth minimum design standards for hull and float design of "sea and amphibian type rotorcraft." To avoid having the requirement affect all amphibian rotorcraft, i.e., even those which have an extremely limited capability as an amphibian, the proposal has been confined in applicability only to those rotorcraft which are to be approved for both taking off from and alighting on water. The requirement is being set forth in a new paragraph (c) under section 6.341 rather

than as a new section 6.343 because it is concerned with buoyancy. This change necessitates the inclusion of the word "hulls" in section 6.340.

The regulations covering Part 6 fuel systems are not in the same form and do not use terminology similar to that used in other airworthiness parts. To eliminate this inconsistency, new sections 6.418 and 6.419 are being adopted, and changes are being made to sections 6.420, 6.421, and 6.424.

Section 6.420 presently requires that, insofar as practicable, the entire fuel supply can be utilized under certain conditions. Such a requirement is unnecessary, even when practicable, because a rotorcraft will continue to be airworthy so long as usable fuel can be used regardless of the quantity of unusable fuel. Therefore, this provision is being deleted in favor of the objective requirement being added in section 6.418, which covers fuel system construction and arrangement to insure a satisfactory fuel flow.

Currently effective section 6.421 defines unusable fuel supply as that quantity at which the first evidence of malfunctioning occurs. This definition is unnecessarily restrictive and is not essential to safety since a rotorcraft is no less airworthy if an unusable fuel supply is selected as a quantity which is in excess of that which would produce a malfunction. Accordingly, the definition of unusable fuel supply is being revised to make it not less than the quantity at which the first evidence of malfunction occurs, the same as in other airworthiness parts.

As a result of comment received on Draft Release 61–12, specific requirements for demonstrations or tests are being deleted from sections 6.420 and 6.421. Adequate authority for any ground or flight tests which might be required continues to rest in presently effective sections 6.15 and 6.16. The provisions of paragraph (b) of section 6.421 as proposed are being transferred to a new paragraph (c) under section 6.420 as an editorial change, since the provision for fuel feed belongs more appropriately in the fuel flow section than in the unusable fuel supply section. In addition, the requirements for a low fuel quantity warning indicator presently in section 6.420(a), and a means to indicate when the emergency fuel system is in operation presently in section 6.424, are being transferred to section 6.604 which lists required items of equipment. In addition the powerplant operating limitation dealing with fuel is being brought up to date by including reference to turbine engine fuel in section 6.714.

Presently effective Part 6 contains no requirement pertaining to the bypass of engine oil around a filter element when the element becomes clogged. Although installation of a filter is not required, it is necessary to provide for the bypass of a clogged filter, if a filter is installed, to insure continued normal functioning of the rest of the oil system. Accordingly, a new section 6.447 is being adopted to provide for bypass capability, consistent with the same requirement now appearing in all the other airworthiness parts.

Revisions to the regulations concerning electrical systems and equipment are being made involving sections 6.617 through 6.627. These changes are being made in recognition of the substantial growth in capacity, complexity, and significance to safety of electrical systems on rotorcraft. In particular, new section 6.618 dealing with electric power sources is being added. Revisions are being made to sections 6.623, 6.626, and 6.627 concerned with master switch arrangement, protective devices, and electric cables, respectively. In conjunction with these changes, sections 6.623–1, 6.625–1, 6.625–2, and 6.627–1 are being deleted because the material in these sections is being included or is already contained, in other sections.

Two changes are being made to the lighting requirements. Figure 6–2 now specifies that position light intensity for angles 40° to 90° above or below the horizontal be at least 2 candles. Because this results in an irrational discontinuity when related to the other data in figure 6–2, figure 6–2 is being amended to require an intensity of 0.05 I for these angles.

The current anticollision light requirements in section 6.637(a) permit 0.03 steradians blockage. In view of recent qualitative studies, it has been determined that such a limitation might be unduly restrictive. Therefore, section 6.637(a) is being amended to permit 0.5 steradians of obstruction.

Part 6 currently does not require the tail rotor to be marked. Because there have been a number of accidents attributable to persons walking into tail rotors, section 6.738(f) is being added to require that tail rotors be marked conspicuously.

Miscellaneous changes of an editorial or clarifying nature are being made to sections 6.11, 6.203, 6.237, 6.251, 6.306, 6.605, 6.642, and 6.738. Among the miscellaneous amendments there is one to expressly exclude from the provisions of section 6.11(b) consideration

of provisional type certificates. While it was proposed that this be accomplished by a note, it now appears that it is more appropriate to include such a provision within section 6.11(b) rather than as a note thereto.

Interested persons have been afforded an opportunity to participate in the making of this amendment, and due consideration has been given to all relevant matter presented.

Amendment made the following changes;

(1) Amended sections 6.11(b), 6.203(d), 6.225, 6.237(a), 6.251, 6.306(c), 6.307(b), 6.340, 6.341, 6.420, 6.421, 6.424, 6.605(d) 6.620, 6.622, 6.623, 6.625, 6.626, 6.627, 6.637(a), 6.642(a), 6.714(c), and 6.738(b)(1), and Figure 6–2;

(2) Deleted sections 6.623–1, 6.625–1, 6.625–2, and 6.627–1;

(3) Redesignated section 6.621 as section 6.619 and added a new section 6.621; and

(4) Added sections 6.226, 6.418, 6.447, 6.604 (l) and (m), 6.617, 6.618, and 6.738(f).

Amendment 6–6

Master Switch Requirements

Adopted: Dec. 18, 1962
Effective: Dec. 18, 1962
Published: Dec. 27, 1962
(27 F.R. 12747)

The currently effective provisions of section 6.623 require that a master switch arrangement be provided to permit expeditious disconnection of all electric power sources from all load circuits and that the point of disconnection be adjacent to the power source. An identical provision is set forth in section 3.688 of Part 3 for airplanes in the normal, utility, and acrobatic categories.

In a separate rule making action, initiated in response to a petition by interested persons, the provisions of section 3.688 have been amended to permit connection of load circuits in such manner that they remain energized after the master switch is opened if such circuits are protected by circuit protective devices, rated at five amperes or less, located adjacent to the electric power source. This amendment of section 3.688 was based on the determination by the Agency that load circuits wired directly to electric power sources through low-rated protective devices are not only less costly and more reliable than switch-relay circuits designed to comply with the previously effective rule, but are no more likely to ignite fuel in a crash. Further, tests witnessed by Agency representatives, coupled with the satisfactory safety record established by aircraft which were fitted with auxiliary circuits wired around the master switch, indicate that electrical ignition of fuel during a crash is less probable than previously believed.

Since the master switch provisions are needed for Part 6 rotorcraft for the same reasons they are needed for Part 3 airplanes, a similar amendment to Part 6 is considered to be appropriate. Accordingly, section 6.623 is being amended to permit connection of load circuits in such manner that they remain energized after the master switch is opened if such circuits are protected by circuit protective devices, rated at five amperes or less, located adjacent to the electric power source.

Since this regulation provides relief from the provisions of the previous regulation, and imposes no additional burden upon any persons, compliance with the notice and public procedure provisions of the Administrative Procedure Act is unnecessary, and good cause exists for making this regulation effective immediately.

Amendment revised section 6.623.

U.S. GOVERNMENT PRINTING OFFICE : 1963 O—674099