Title 14—AERONAUTICS AND SPACE

Chapter I—Federal Aviation Agency

[Regulatory Docket No. 5074]

PART 27—AIRWORTHINESS STANDARDS: NORMAL CATEGORY ROTORCRAFT [NEW]

This amendment adds Part 27 [New] to the Federal Aviation Regulations to replace Part 6 of the Civil Air Regulations, and is a part of the Agency recodification program announced in Draft Release 61-25, published in the FEDERAL REGISTER on November 15, 1961 (26 F.R. 10698).

Part 27 [New] was published as a notice of proposed rule making in the FEDERAL REGISTER on May 23, 1964 (29 F.R. 6822), and given further distribution as Notice No. 64-29.

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

Many of the comments received recommended specific substantive changes to the regulations. Many of these recommendations appear to be meritorious. However, they cannot be adopted as a part of the recodification program, since the purpose of the program is simply to streamline and clarify present regulatory language and delete obsolete or redundant provisions. To attempt substantive changes, other than relaxatory ones that are completely noncontroversial, would delay the project and be contrary to the ground rules specified for it in Draft Release 61-25. However, all comments of this nature will be preserved and considered in any later substantive revision of this part.

Present CAR Part 6 reflects the various writing styles used by those who have worked on it in the past. Consistency in language is vital to consistency in interpretation and fairness in application, especially in technical, complex rules such as this one. The recodification has allowed us to use one style throughout Part 27 [New]. The style changes that have been made do not affect substance.

Part 27 [New] substitutes the word "must" for "shall". This has been done because airworthiness standards are conditions precedent that must be met for the issue of a type certificate. The imperative "shall" would be inappropriate since the failure to meet these standards simply results in a denial of the certificate without further penalty.

The sections in Part 27 [New] have been rearranged and renumbered so that the requirements of this part have the same number as comparable requirements in Parts 23 [New], 25 [New], and 29 [New]. This explains apparent gaps in section numbers in this part, such as that between § 27.79 Limiting height-speed envelope and § 27.141 General. (This gap, for instance, is assigned to the turbine engine performance requirements of Part 25 [New], and includes the normal "growth" gap between subtopics.) Comparative review of specific requirements between airworthiness parts is greatly facilitated by this rearrangement, and has already resulted, for example, in the deletion of §§ 6.202(c), 6.340, 6.380, 6.480, 6.600, 6.602, 6.610, 6.700(a), and 6.744 as surplusage, and in the significant simplification of the Rotorcraft Flight Manual requirements in § 27.1581. Further, this rearrangement allows more efficient review of all parts in the light of comments received on any single part. For example, a comment received on Part 23 [New] has resulted in the deletion of all but the last sentence of the requirement that now appears in § 27.607. As industry becomes acquainted with the new format, the effectiveness of comments received should be greatly magnified.

As was stated in the preamble of the notice of proposed rule making of Part 27, those definitions in present Part 6 (and not now in Part 1 or executed in this part) that are necessary will be recodified with the definitions in other airworthiness parts and added to Part 1 [New]. The detailed disposition of § 6.1 in the distribution table should resolve most definition problems that may arise.

The definitions, abbreviations, and rules of construction in Part 1 [New] of the Federal Aviation Regulations apply to Part 27 [New].

The most significant changes to Part 27 since the notice are listed below. The numbers in parentheses refer to the section numbers in the notice and in former Part 6, respectively.

(1) In § 27.25 (27.23) (6.101), paragraph (a)(2)(iv), the phrase "an occupant weight of" has been added between "seat," and "170 pounds". This was done to make it clear that the weight of the seat itself need not be included in the determination of the subject weight.

(2) In § 27.143 (27.65) (6.121), paragraph (b), subparagraph (2) has been deleted from the section as it appeared in the notice. This effectuates the second paragraph of the preamble in CAR amendment 6-4, effective October 1, 1959, in which it was intended that § 6.121 be revised to replace the requirement for a demonstration of controllability after power failure at only one high speed condition, namely § 6.121(c), with a requirement for controllability after power failure over the range of airspeeds and altitudes for which certification is sought, namely § 6.121(e). Insofar as the intended deletion was not made in the rule at that time and both requirements remained outstanding, the deletion of § 6.121(c) at this time is relaxatory.

(3) The Aerospace Industries Association, Inc. (AIA) suggested that the word "maximum" between "A" and "wind velocity" in § 27.143 (27.65) (6.121) was ambiguous, since in context it could refer either to a performance maximum or to the "maximum" safe wind for operation near the ground in § 27.1587 (27.789) (6.743). Since ultimate performance capability need not be shown under § 27.143, the word "maximum" has been deleted.

(4) In §§ 27.547 and 27.361 (§§ 27.217 (e) and 27.219(e)) (6.250 and 6.251), the word "design" has been deleted since all prescribed loads are design loads.

(5) In § 27.241 (27.31) (6.131), the word "uncontrollable", between "no" and "tendency" has been replaced with the word "dangerous". This was done to harmonize the language with the actual standard against which ground resonance must be judged.

(6) In § 27.301 (27.121) (6.200), the descriptions of limit and ultimate loads have been put back in. It is felt that their utility will be greater in the basic rule than in Part 1 [New].

(7) In § 27.601 (27.251) (6.300), the reference to experience as an element in determining which "hazardous or unreliable" features are covered by the rule has been put back in. This change was made at the request of AIA and is clarifying only.

(8) In § 27.611 (27.261) (6.305), paragraph (a), "periodic inspection" has been replaced with "recurring inspection". This avoids any potential conflict between the intent in the subject section to cover all inspections that occur at regular intervals and the more specific use of the term "periodic inspection" in Parts 43 [New] and 91 [New].

(9) AIA suggested that the language in § 27.775 (27.355) (6.352) be revised to make it clear that (1) materials other than glass may be used in the windows and (2) only glass panes need contain nonsplintering safety glass. This has been done.

(10) Because of an AIA comment to § 27.807 (27.365(a)) (6.357), paragraph (a), the phrase "as prescribed by the Administrator", between "provided" and "where", has been deleted since all requirements in this part are prescribed by the Administrator.

(11) Aero Flow Dynamics, Inc., suggested that the heading and language in § 27.997 (27.471) (6.427) be conformed to that in other airworthiness parts. This has been done.

(12) Section 27.1309 (27.587) (6.606) has been revised to make it clear, as in the original rule, that the general requirement of guarding against hazard in the event of malfunctioning or failure applies to all equipment, systems, and installations, not only to those whose functioning is necessary to show compliance with any regulations in this subchapter.

(13) At the suggestion of AIA, § 27.1505 (27.733(b)) (6.711), paragraph (b), has been reworded to clarify the permissive aspect of this section.

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

In the notice, it was proposed to convert references to "miles" and "miles per hour" to their exact nautical equivalents. Many formulae have been derived under

the existing system. The effect of rounding off to the nearest whole number is unclear in certain cases. Although specifically invited, few comments have been received on this problem. Because of this it is felt that wholesale conversion should be made separately at a later date.

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

In consideration of the foregoing, Chapter I of Title 14 of the Code of Federal Regulations is amended as follows, effective February 1, 1964.

1. By deleting Part 6.

2. By adding a Part 27 [New] reading as hereinafter set forth.

Issued in Washington, D.C. on October 2, 1964.

N. E. HALABY,
Administrator.

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Subpart B—Flight

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AUTHORITY: The provisions of this Part 27 issued under secs. 313(a), 601, 603, 72 Stat. 752, 775; 49 U.S.C. 1354(a), 1421, 1423.

Subpart A—General

§ 27.1 Applicability.

(a) This part prescribes airworthiness standards for the issue of type certificates, and changes to those certificates, for normal category rotorcraft with maximum weights of 6,000 pounds or less.

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

Subpart B—Flight

GENERAL

§ 27.21 Proof of compliance.

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

(1) By tests upon a rotorcraft of the type for which certification is requested, or by calculations based on, and equal in accuracy to, the results of testing; and

(2) By systematic investigation of each required combination of weight and center of gravity if compliance cannot be reasonably inferred from combinations investigated.

(b) The controllability, stability, and trim of the rotorcraft must be shown for each altitude up to the maximum expected in operation.

§ 27.25 Weight limits.

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

(1) Not more than—

(i) The highest weight selected by the applicant;

(ii) The design maximum weight (the highest weight at which compliance with each applicable structural loading condition of this part is shown); or

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

(2) Not less than the sum of—

(i) The empty weight determined under § 27.29;

(ii) The weight of usable fuel appropriate to the intended operation with full payload;

(iii) The weight of full oil capacity; and

(iv) For each seat, an occupant weight of 170 pounds or any lower weight for which certification is requested.

(b) *Minimum weight.* The minimum weight (the lowest weight at which compliance with each applicable requirement of this part is shown) must be established so that it is—

(1) Not more than the sum of—

(i) The empty weight determined under § 27.29;

(ii) The weight of the minimum crew necessary to operate the rotorcraft, assuming for each crewmember a weight no more than 170 pounds, or any lower weight selected by the applicant or included in the loading instructions; and

(iii) The weight of the oil quantity determined under § 27.1011(b); and

(2) Not less than—

(i) The lowest weight selected by the applicant;

(ii) The design minimum weight (the lowest weight at which compliance with each applicable structural loading condition of this part is shown); or

(iii) The lowest weight at which compliance with each applicable flight requirement of this part is shown.

§ 27.27 Center of gravity limits.

The extreme forward and the extreme aft center of gravity must be established for each weight established under § 27.25. Such an extreme may not lie beyond—

(a) The extremes selected by the applicant;

(b) The extremes within which the structure is proven; or

(c) The extremes within which compliance with the applicable flight requirements is shown.

§ 27.29 Empty weight and corresponding center of gravity.

(a) The empty weight and corresponding center of gravity must be determined by weighing the rotorcraft without the crew and payload, but with—

(1) Fixed ballast;
(2) Unusable fuel;
(3) Undrainable oil;
(4) Engine coolant; and
(5) Hydraulic fluid.

(b) The condition of the rotorcraft at the time of determining empty weight must be one that is well defined and can be easily repeated, particularly with respect to the weights of fuel, oil, coolant, and installed equipment.

§ 27.31 Removable ballast.

Removable ballast may be used in showing compliance with the flight requirements of this subpart.

§ 27.33 Main rotor speed and pitch limits.

(a) *Main rotor speed limits.* A range of main rotor speeds must be established that—

(1) With power on, provides adequate margin to accommodate the variations in rotor speed occurring in any appropriate maneuver, and is consistent with the kind of governor or synchronizer used; and

(2) With power off, allows each appropriate autorotative maneuver to be performed throughout the ranges of airspeed and weight for which certification is requested.

(b) *Normal main rotor pitch limits.* There must be means to limit the range of main rotor pitch settings so that—

(1) With power on, and within approved engine limitations, the normal high pitch limit prevents main rotor speeds substantially less than the minimum approved for any flight condition; and

(2) With power off, the low pitch limit provides main rotor speeds within the approved range for autorotative conditions under the most critical combinations of weight and airspeed.

(c) *Emergency high pitch.* A main rotor pitch higher than the normal high pitch limit prescribed in paragraph (b)(1) of this section may be made available for emergency use if the normal high pitch limit cannot be exceeded inadvertently.

PERFORMANCE

§ 27.45 Standard atmosphere and still air.

Compliance with §§ 27.51 through 27.79 must be shown for still air with a standard atmosphere.

§ 27.51 Takeoff.

(a) The takeoff, with takeoff power and r.p.m., and with the extreme forward center of gravity—

(1) May not require exceptional piloting skill or exceptionally favorable conditions; and

(2) Must be made in such a manner that a landing can be made safely at any point along the flight path if an engine fails.

(b) Paragraph (a) of this section must be met throughout the ranges of—

(1) Altitude, from standard sea level conditions to the maximum altitude capability of the rotorcraft, or 7,000 feet, whichever is less; and

(2) Weight, from the maximum weight (at sea level) to each lesser weight selected by the applicant for each altitude covered by subparagraph (1) of this paragraph.

§ 27.65 Climb.

(a) For rotorcraft other than helicopters—

(1) The steady rate of climb, at V_Y, must be determined—

(i) With maximum continuous power on each engine;

(ii) With the landing gear retracted; and

(iii) For the weights, altitudes, and temperatures for which certification is requested; and

(2) The climb gradient, at the rate of climb determined under subparagraph (1) of this paragraph must be at least 1:6 under standard sea level conditions.

(b) For helicopters, V_Y must be determined—

(1) Under standard sea level conditions;

(2) At maximum weight; and

(3) With maximum continuous power on each engine.

§ 27.67 Climb: one engine inoperative.

For multiengine helicopters, the steady rate of climb (or descent), at V_Y (or at the speed for minimum rate of descent), must be determined with—

(a) Maximum weight;

(b) One engine inoperative; and

(c) Maximum continuous power on the other engines.

§ 27.73 Performance at minimum operating speed.

(a) For helicopters—

(1) The hovering ceiling must be determined over the ranges of weight, altitude, and temperature for which certification is requested, with—

(i) Takeoff power;

(ii) The landing gear extended; and

(iii) The helicopter in ground effect at a height consistent with normal takeoff procedures; and

(2) The hovering ceiling determined under subparagraph (1) of this paragraph must be at least—

(i) For reciprocating engine powered helicopters, 4,000 feet at maximum weight with a standard atmosphere; or

(ii) For turbine engine powered helicopters, 2,500 feet pressure altitude at maximum weight at a temperature of standard +40 degrees F.

(b) For rotorcraft other than helicopters, the steady rate of climb at the minimum operating speed must be determined, over the ranges of weight, altitude, and temperature for which certification is requested, with—

(1) Takeoff power; and

(2) The landing gear extended.

§ 27.75 Landing.

(a) The rotorcraft must be able to be landed with no excessive vertical acceleration, no tendency to bounce, nose over, ground loop, porpoise, or water loop, and without exceptional piloting skill or exceptionally favorable conditions, with—

(1) Approach or glide speeds appropriate to the type of rotorcraft and selected by the applicant;

(2) The approach and landing made with—

(i) Power off, for single-engine rotorcraft; and

(ii) One engine inoperative, for multiengine rotorcraft; and

(3) The approach and landing entered from steady autorotation.

(b) Multiengine rotorcraft must be able to be landed safely after complete power failure under normal operating conditions.

§ 27.79 Limiting height—speed envelope.

(a) If there is any combination of height and forward speed (including hover) under which a safe landing cannot be made under the applicable power failure condition in paragraph (b) of this section, a limiting height-speed envelope must be established (including all pertinent information) for that condition, throughout the ranges of—

(1) Altitude, from standard sea level conditions to the maximum altitude capability of the rotorcraft, or 7,000 feet, whichever is less; and

(2) Weight, from the maximum weight (at sea level) to the lesser weights selected by the applicant for each altitude covered by subparagraph (1) of this paragraph.

(b) The applicable power failure conditions are—

(1) For single-engine helicopters, full autorotation;

(2) For multiengine helicopters, one engine inoperative (where engine isolation features ensure continued operation of the remaining engines); and

(3) For other rotorcraft, conditions appropriate to the type.

FLIGHT CHARACTERISTICS

§ 27.141 General.

The rotorcraft must—

(a) Meet the requirements of this section and of §§ 27.143, 27.161, and 27.171 through 27.175—

(1) At the normally expected operating altitudes;

(2) Under any critical loading condition within the range of weights and centers of gravity for which certification is requested;

(3) Under any condition of speed, power, and rotor r.p.m. for which certification is requested; and

(4) Without engine combustion flameout and notwithstanding compressor stall or surge;

(b) Be able to maintain any required flight condition and make a smooth transition from any flight condition to any other flight condition without exceptional piloting skill, alertness, or strength, and without danger of exceeding the limit load factor under any operating condition probable for the type, including sudden powerplant failure; and

(c) Have any additional characteristic required for night or instrument operation, if certification for those kinds of operation is requested.

§ 27.143 Controllability and maneuverability.

(a) The rotorcraft must be safely controllable and maneuverable—

(1) During steady flight; and

(2) During any maneuver appropriate to the type, including—

(i) Takeoff;

(ii) Climb;

(iii) Level flight;

(iv) Turning flight;

(v) Glide;

(vi) Landing (power on and power off); and

(vii) Recovery to power-on flight from a balked autorotative approach.

(b) The margin of cyclic control must allow satisfactory roll and pitch control at V_{NE}, with—

(1) Maximum weight;
(2) Critical center of gravity;
(3) Critical rotor r.p.m.; and
(4) Power on and power off.

(c) A wind velocity of not less than 20 miles per hour must be established in which the rotorcraft can be operated without loss of control on or near the ground in any maneuver appropriate to the type (such as crosswind takeoffs, sideward flight, and rearward flight), with—

(1) Critical weight;
(2) Critical center of gravity; and
(3) Critical rotor r.p.m.

(d) The rotorcraft, after power failure, must be controllable over the range of speeds and altitudes for which certification is requested when the power failure occurs with maximum continuous power and critical weight. No corrective action time delay for any condition following power failure may be less than—

(1) For the cruise condition, one second, or normal pilot reaction time (whichever is greater); and

(2) For any other condition, normal pilot reaction time.

§ 27.161 Trim control.

The trim control—

(a) Must trim any steady longitudinal and lateral control forces to zero in level flight at any appropriate speed; and

(b) May not introduce any undesirable discontinuities in control force gradients.

§ 27.171 Stability: general.

The rotorcraft must be able to be flown, without undue pilot fatigue or strain, in any normal maneuver for a period of time as long as that expected in normal operation. At least three landings and takeoffs must be made during this demonstration.

§ 27.173 Static longitudinal stability.

(a) The longitudinal cyclic control must be designed so that, for the ranges of altitude and rotor r.p.m. for which certification is requested, and with throttle and collective pitch held constant during the maneuvers specified in § 27.175—

(1) A rearward movement of the control is necessary to obtain airspeeds less than the trim speed; and

(2) A forward movement of the control is necessary to obtain airspeeds greater than the trim speed.

(b) The stick position versus speed curve may have a negative slope within the speed ranges specified for each maneuver in § 27.175(a) through (c) if the necessary negative stick travel is not greater than ten percent of the total stick travel.

§ 27.175 Demonstration of static longitudinal stability.

(a) *Climb.* Static longitudinal stability must be shown in the climb condition at speeds from 0.85 V_Y to 1.2 V_Y, with—

(1) Critical weight;
(2) Critical center of gravity;
(3) Maximum continuous power;
(4) The landing gear retracted; and
(5) The rotorcraft trimmed at V_Y.

(b) *Cruise.* Static longitudinal stability must be shown in the cruise condition at speeds from 0.7 V_H or 0.7 V_{NE}, whichever is less, to 1.1 V_H or 1.1 V_{NE}, whichever is less, with—

(1) Critical weight;
(2) Critical center of gravity;
(3) Power for level flight at 0.9 V_H or 0.9 V_{NE}, whichever is less;
(4) The landing gear retracted; and
(5) The rotorcraft trimmed at 0.9 V_H or 0.9 V_{NE}, whichever is less.

(c) *Autorotation.* Static longitudinal stability must be shown in autorotation throughout the speed range for which certification is requested, with—

(1) Critical weight;
(2) Critical center of gravity;
(3) Power off;
(4) The landing gear (i) retracted and (ii) extended; and
(5) The rotorcraft trimmed at the speed for minimum rate of descent.

(d) *Hovering.* For helicopters in the hovering condition—

(1) The longitudinal cyclic control must operate with the sense and direction of motion prescribed in § 27.173; and

(2) The stick position curve must have a stable slope, between the maximum approved rearward speed and a forward speed of 20 miles per hour, with—

(i) Critical weight;
(ii) Critical center of gravity;
(iii) Power required for hovering in still air;
(iv) The landing gear retracted; and
(v) The helicopter trimmed for hovering.

Ground and Water Handling Characteristics

§ 27.231 General.

The rotorcraft must have satisfactory ground and water handling characteristics, including freedom from uncontrollable tendencies in any condition expected in operation.

§ 27.235 Taxiing condition.

The rotorcraft must be designed to withstand the loads that would occur when the rotorcraft is taxied over the roughest ground that may reasonably be expected in normal operation.

§ 27.239 Spray characteristics.

If certification for water operation is requested, no spray characteristics during taxiing, takeoff, or landing may obscure the vision of the pilot or damage the rotors, propellers, or other parts of the rotorcraft.

§ 27.241 Ground resonance.

The rotorcraft may have no dangerous tendency to oscillate on the ground with the rotor turning.

Miscellaneous Flight Requirements

§ 27.251 Vibration.

Each part of the rotorcraft must be free from excessive vibration under each appropriate speed and power condition.

Subpart C—Strength Requirements

GENERAL

§ 27.301 Loads.

(a) Strength requirements are specified in terms of limit loads (the maximum loads to be expected in service) and ultimate loads (limit loads multiplied by prescribed factors of safety). Unless otherwise provided, prescribed loads are limit loads.

(b) Unless otherwise provided, the specified air, ground, and water loads must be placed in equilibrium with inertia forces, considering each item of mass in the rotorcraft. These loads must be distributed to closely approximate or conservatively represent actual conditions.

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

§ 27.303 Factor of safety.

Unless otherwise provided, a factor of safety of 1.5 must be used. This factor applies to external and inertia loads unless its application to the resulting internal stresses is more conservative.

§ 27.305 Strength and deformation.

(a) The structure must be able to support limit loads without detrimental or permanent deformation. At any load up to limit loads, the deformation may not interfere with safe operation.

(b) The structure must be able to support ultimate loads without failure. This must be shown by—

(1) Applying ultimate loads to the structure in a static test for at least three seconds; or

(2) Dynamic tests simulating actual load application.

§ 27.307 Proof of structure.

(a) Compliance with the strength and deformation requirements of this subpart must be shown for each critical loading condition. Structural analysis may be used only if the structure conforms to those for which experience has shown this method to be reliable. In other cases, substantiating load tests must be made.

(b) Proof of compliance with the strength requirements of this subpart must include—

(1) Dynamic and endurance tests of rotors, rotor drives, and rotor controls;

(2) Limit load tests of the control system, including control surfaces;

(3) Operation tests of the control system;

(4) Flight stress measurement tests;

(5) Landing gear drop tests; and

(6) Any additional tests required for new or unusual design features.

§ 27.309 Design limitations.

The following values and limitations must be established to show compliance with the structural requirements of this subpart:

(a) The design maximum weight.

(b) The main rotor r.p.m. ranges, power on and power off.

(c) The maximum forward speeds for each main rotor r.p.m. within the ranges determined under paragraph (b) of this section.

(d) The maximum rearward and sideward flight speeds.

(e) The center of gravity limits corresponding to the limitations determined under paragraphs (b), (c), and (d) of this section.

(f) The rotational speed ratios between each powerplant and each connected rotating component.

(g) The positive and negative limit maneuvering load factors.

FLIGHT LOADS

§ 27.321 General.

(a) For rotorcraft, flight load factors are rotor load factors. The net load factor acting at the center of gravity must be obtained by proper consideration of the balancing loads in each flight condition specified in this part.

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

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

(2) With any practical distribution of disposable load within the operating limitations in the Rotorcraft Fight Manual.

§ 27.337 Limit maneuvering load factor.

The rotorcraft must be designed for—

(a) A positive limit maneuvering load factor of 3.5 and a negative limit maneuvering load factor of 1.0; or

(b) Any lesser positive limit maneuvering load factor not less than 2.0, and lesser negative limit maneuvering load factor not less than 0.5, whose probability of being exceeded is shown by analysis and flight test to be extremely remote.

§ 27.339 Resultant limit maneuvering loads.

The loads resulting from the application of limit maneuvering load factors are assumed to act at the center of each rotor hub and to act in directions, and with distributions of load among the rotors and auxiliary lifting surfaces, so as to represent each critical maneuvering condition, including power-on and power-off flight with the maximum design rotor tip speed ratio. The rotor tip speed ratio is the ratio of the rotorcraft flight velocity component in the plane of the rotor disc to the rotational tip speed of the rotor blades, and is expressed as follows:

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

where—

V = The airspeed along flight path (f.p.s.);

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

Ω = The angular velocity of rotor (radians per second); and

R = The rotor radius (ft.).

§ 27.341 Gust loads.

The rotorcraft must be designed to withstand, at each critical airspeed including hovering, the loads resulting from a vertical gust of 30 feet per second.

§ 27.361 Engine torque.

The limit engine torque may not be less than the mean torque multiplied by a factor of—

(a) 1.25, for turbine engines;

(b) 1.33, for engines with five or more cylinders; and

(c) Two, three, and four, for engines with four, three, and two cylinders, respectively.

CONTROL SURFACE AND SYSTEM LOADS

§ 27.391 General.

Each auxiliary rotor, each fixed or movable stabilizing or control surface, and each system operating any flight control must meet the requirements of §§ 27.395, 27.397, 27.401, 27.403, 27.411, and 27.413.

§ 27.395 Control system.

(a) The part of each control system from the pilot's controls to the control stops must be designed to withstand pilot forces of not less than—

(1) The forces specified in § 27.397; or

(2) If the system prevents the pilot from applying the limit pilot forces to the system, the maximum forces that the system allows the pilot to apply, but not less than 0.60 times the forces specified in § 27.397.

(b) The part of each control system from the control stops to the attachment to the rotor blades (or control areas) must be designed to at least—

(1) Withstand the maximum pilot forces obtainable in normal operation; and

(2) If operational loads may be exceeded through jamming, ground gusts, control inertia, or friction, support, without yielding, 0.60 times the limit pilot forces specified in § 27.397.

§ 27.397 Limit pilot forces.

The limit pilot forces are as follows:

(a) For foot controls, 130 pounds.

(b) For stick controls, 100 pounds fore and aft and 67 pounds laterally.

(c) For wheel controls, 100 pounds fore and aft and a lateral couple of 53D inch-pounds applied at the rim of the control wheel (where D is the wheel diameter in inches).

§ 27.399 Dual control system.

Each dual primary flight control system must be designed to withstand the loads that result when pilot forces of 0.75 times those obtained under § 27.395 are applied—

(a) In opposition; and

(b) In the same direction.

§ 27.401 Auxiliary rotor assemblies.

(a) *Auxiliary rotor assemblies.* Each auxiliary rotor assembly must be tested as prescribed in § 27.923.

(b) *Assemblies with detachable blades.* Each auxiliary rotor assembly with detachable blades must be designed to withstand the centrifugal loads resulting from the maximum design rotor r.p.m.

(c) *Highly stressed metal components.* For each auxiliary rotor with highly

stressed metal components, the vibration stresses must be determined in flight and shown not to exceed safe values for continuous operation.

§ 27.403 Auxiliary rotor attachment structure.

The attachment structure for each auxiliary rotor must be designed to withstand a limit load equal to the maximum loads occurring in the structure in any flight and landing condition.

§ 27.411 Ground clearance: tail rotor guard.

(a) It must be impossible for the tail rotor to contact the landing surface during a normal landing.

(b) If a tail rotor guard is required to show compliance with paragraph (a) of this section—

(1) Suitable design loads must be established for the guard; and

(2) The guard and its supporting structure must be designed to withstand those loads.

§ 27.413 Stabilizing and control surfaces.

(a) Each stabilizing and control surface must be designed so that—

(1) Limit loads are not less than the greater of—

(i) 15 pounds per square foot; or

(ii) The load resulting where C_N equals 0.55 at the maximum design speed; and

(2) The surface can withstand the critical loads resulting from maneuvers and from combined maneuvers and gusts.

(b) Compliance with paragraph (a) of this section must be shown with load distributions that closely simulate actual pressure distribution conditions.

GROUND LOADS

§ 27.471 General.

(a) *Loads and equilibrium.* For limit ground loads—

(1) The limit ground loads obtained in the landing conditions in this part must be considered to be external loads that would occur in the rotorcraft structure if it were acting as a rigid body; and

(2) In each specified landing condition, the external loads must be placed in equilibrium with linear and angular inertia loads in a rational or conservative manner.

(b) *Critical centers of gravity.* The critical centers of gravity within the range for which certification is requested must be selected so that the maximum design loads are obtained in each landing gear element.

§ 27.473 Ground loading conditions and assumptions.

(a) For specified landing conditions, a design maximum weight must be used that is not less than the maximum weight. A rotor lift may be assumed to act through the center of gravity throughout the landing impact. This lift may not exceed—

(1) One-half of the design maximum weight; or

(2) Any greater lift proven to be appropriate by tests or data that are applicable to the particular rotorcraft.

(b) Unless otherwise prescribed, for each specified landing condition, the rotorcraft must be designed for a limit load factor of not less than the limit inertia load factor substantiated under §§ 27.725 and 27.727.

§ 27.475 Tires and shock absorbers.

Unless otherwise prescribed, for each specified landing condition, the tires must be assumed to be in their static position and the shock absorbers to be in their most critical position.

§ 27.477 Landing gear arrangement.

Sections 27.235, 27.479 through 27.485, and 27.493 apply to landing gear with two wheels aft, and one or more wheels forward, of the center of gravity.

§ 27.479 Level landing conditions.

(a) *Attitudes.* Under each of the loading conditions prescribed in paragraph (b) of this section, the rotorcraft is assumed to be in each of the following level landing attitudes:

(1) An attitude in which all wheels contact the ground simultaneously.

(2) An attitude in which the aft wheels contact the ground with the forward wheels just clear of the ground.

(b) *Loading conditions.* The rotorcraft must be designed for the following landing loading conditions:

(1) Vertical loads applied under § 27.471.

(2) The loads resulting from a combination of the loads applied under subparagraph (1) of this paragraph with drag loads at each wheel of not less than 25 percent of the vertical load at that wheel.

(3) If there are two wheels forward, a distribution of the loads applied to those wheels under subparagraphs (1) and (2) of this paragraph in a ratio of 40:60.

(c) *Pitching moments.* Pitching moments are assumed to be restricted by—

(1) In the case of the attitude in paragraph (a) (1) of this section, the forward landing gear; and

(2) In the case of the attitude in paragraph (a) (2) of this section, the angular inertia forces.

§ 27.481 Tail-down landing conditions.

(a) The rotorcraft is assumed to be in the maximum nose-up attitude allowing ground clearance by each part of the rotorcraft.

(b) In this attitude, ground loads are assumed to act perpendicular to the ground.

§ 27.483 One-wheel landing conditions.

For the one-wheel landing condition, the rotorcraft is assumed to be in the level attitude and to contact the ground on one aft wheel. In this attitude—

(a) The vertical load must be the same as that obtained on that side under § 27.479(b) (1); and

(b) The unbalanced external loads must be reacted by rotorcraft inertia.

§ 27.485 Lateral drift landing conditions.

(a) The rotorcraft is assumed to be in the level landing attitude, with—

(1) Side loads combined with one-half of the maximum ground reactions obtained in the level landing conditions of § 27.479(b) (1); and

(2) The loads obtained under subparagraph (1) of this paragraph applied—

(i) At the ground contact point; or

(ii) For full-swiveling gear, at the center of the axle.

(b) The rotorcraft must be designed to withstand, at ground contact—

(1) When only the aft wheels contact the ground, side loads of 0.8 times the vertical reaction acting inward on one side, and 0.6 times the vertical reaction acting outward on the other side, all combined with the vertical loads specified in paragraph (a); and

(2) When all wheels contact the ground simultaneously—

(i) For the aft wheels, the side loads specified in subparagraph (1) of this paragraph; and

(ii) For the forward wheels, a side load of 0.8 times the vertical reaction combined with the vertical load specified in paragraph (a) of this section.

§ 27.493 Braked roll conditions.

Under braked roll conditions with the shock absorbers in their static positions—

(a) The limit vertical load must be based on a load factor of at least—

(1) 1.33, for the attitude specified in § 27.479(a) (1); and

(2) 1.0, for the attitude specified in § 27.479(a) (2); and

(b) The structure must be designed to withstand, at the ground contact point of each wheel with brakes, a drag load at least the lesser of—

(1) The vertical load multiplied by a coefficient of friction of 0.8; and

(2) The maximum value based on limiting brake torque.

§ 27.497 Ground loading conditions: landing gear with tail wheels.

(a) *General.* Rotorcraft with landing gear with two wheels forward, and one wheel aft, of the center of gravity must be designed for loading conditions as prescribed in this section.

(b) *Level landing attitude with only the forward wheels contacting the ground.* In this attitude—

(1) The vertical loads must be applied under §§ 27.471 through 27.475;

(2) The vertical load at each axle must be combined with a drag load at that axle of not less than 25 percent of that vertical load; and

(3) Unbalanced pitching moments are assumed to be resisted by angular inertia forces.

(c) *Level landing attitude with all wheels contacting the ground simultaneously.* In this attitude, the rotorcraft must be designed for landing loading conditions as prescribed in paragraph (b) of this section.

(d) *Maximum nose-up attitude with only the rear wheel contacting the ground.* The attitude for this condition must be the maximum nose-up attitude expected in normal operation, including autorotative landings. In this attitude—

(1) The appropriate ground loads specified in paragraph (b) (1) and (2) of this section must be determined and applied, using a rational method to account for the moment arm between the rear wheel ground reaction and the rotorcraft center of gravity; or

(2) The probability of landing with initial contact on the rear wheel must be shown to be extremely remote.

(e) *Level landing attitude with only one forward wheel contacting the ground.* In this attitude, the rotorcraft must be designed for ground loads as specified in paragraph (b) (1) and (3) of this section.

(f) *Side loads in the level landing attitude.* In the attitudes specified in paragraphs (b) and (c) of this section, the following apply:

(1) The side loads must be combined at each wheel with one-half of the maximum vertical ground reactions obtained for that wheel under paragraphs (b) and (c) of this section. In this condition, the side loads must be—

(i) For the forward wheels, 0.8 times the vertical reaction (on one side) acting inward, and 0.6 times the vertical reaction (on the other side) acting outward; and

(ii) For the rear wheel, 0.8 times the vertical reaction.

(2) The loads specified in subparagraph (1) of this paragraph must be applied—

(i) At the ground contact point with the wheel in the trailing position (for non-full swiveling landing gear or for full swiveling landing gear with a lock, steering device, or shimmy damper to keep the wheel in the trailing position); or

(ii) At the center of the axle (for full swiveling landing gear without a lock, steering device, or shimmy damper).

(g) *Braked roll conditions in the level landing attitude.* In the attitudes specified in paragraphs (b) and (c) of this section, and with the shock absorbers in their static positions, the rotorcraft must be designed for braked roll loads as follows:

(1) The limit vertical load must be based on a limit vertical load factor of not less than—

(i) 1.0, for the attitude specified in paragraph (b) of this section; and

(ii) 1.33, for the attitude specified in paragraph (c) of this section.

(2) For each wheel with brakes, a drag load must be applied, at the ground contact point, of not less than the lesser of—

(i) 0.8 times the vertical load; and

(ii) The maximum based on limiting brake torque.

(h) *Rear wheel turning loads in the static ground attitude.* In the static ground attitude, and with the shock absorbers and tires in their static positions, the rotorcraft must be designed for rear wheel turning loads as follows:

(1) A vertical ground reaction equal to the static load on the rear wheel must be combined with an equal sideload.

(2) The load specified in subparagraph (1) of this paragraph must be applied to the rear landing gear—

(i) Through the axle, if there is a swivel (the rear wheel being assumed to be swiveled 90 degrees to the longitudinal axis of the rotorcraft); or

(ii) At the ground contact point, if there is a lock, steering device or shimmy damper (the rear wheel being assumed to be in the trailing position).

(i) *Taxiing condition.* The rotorcraft and its landing gear must be designed for loads that would occur when the rotorcraft is taxied over the roughest ground that may reasonably be expected in normal operation.

§ 27.501 Ground loading conditions: landing gear with skids.

(a) *General.* Rotorcraft with landing gear with skids must be designed for the loading conditions specified in this section. In showing compliance with this section, the following apply:

(1) The design maximum weight, center of gravity, and load factor must be determined under §§ 27.471 through 27.475.

(2) Structural yielding of elastic spring members under limit loads is acceptable.

(3) Design ultimate loads for elastic spring members need not exceed those obtained in a drop test of the gear with—

(i) A drop height of 1.5 times that specified in § 27.725; and

(ii) An assumed rotor lift of not more than 1.5 times that used in the limit drop tests prescribed in § 27.725.

(4) Compliance with paragraphs (b) through (e) of this section must be shown with—

(i) The gear in its most critically deflected position for the landing condition being considered; and

(ii) The ground reactions rationally distributed along the bottom of the skid tube.

(b) *Vertical reactions in the level landing attitude.* In the level attitude, and with the rotorcraft contacting the ground along the bottom of both skids, the vertical reactions must be applied as prescribed in paragraph (a) of this section.

(c) *Drag reactions in the level landing attitude.* In the level attitude, and with the rotorcraft contacting the ground along the bottom of both skids, the following apply:

(1) The vertical reactions must be combined with horizontal drag reactions of 50 percent of the vertical reaction applied at the ground.

(2) The resultant ground loads must be—

(i) Equal to the vertical load specified in paragraph (b) of this section; and

(ii) Directed through the center of gravity.

(d) *Sideloads in the level landing attitude.* In the level attitude, and with the rotorcraft contacting the ground along the bottom of both skids, the following apply:

(1) The vertical ground reaction must be—

(i) Equal to the vertical loads obtained in the condition specified in paragraph (b) of this section; and

(ii) Divided equally among the skids.

(2) The vertical ground reactions must be combined with a horizontal sideload of 25 percent of their value.

(3) The total sideload must be applied along the length of one skid only.

(4) The unbalanced moments are assumed to be resisted by angular inertia.

(5) The skid gear must be investigated for—

(i) Inward acting sideloads; and

(ii) Outward acting sideloads.

(e) *One-skid landing loads in the level attitude.* In the level attitude, and with the rotorcraft contacting the ground along the bottom of one skid only, the following apply:

(1) The vertical load on the ground contact side must be the same as that obtained on that side in the condition specified in paragraph (b) of this section.

(2) The unbalanced moments are assumed to be resisted by angular inertia.

(f) *Special conditions.* In addition to the conditions specified in paragraphs (b) and (c) of this section, the rotorcraft must be designed for the following ground reactions:

(1) A ground reaction load acting up and aft at an angle of 45 degrees to the longitudinal axis of the rotorcraft. This load must be—

(i) Equal to 1.33 times the maximum weight;

(ii) Distributed symmetrically among the skids;

(iii) Concentrated at the forward end of the straight part of the skid tube; and

(iv) Applied only to the forward end of the skid tube and its attachment to the rotorcraft.

(2) With the rotorcraft in the level landing attitude, a vertical ground reaction load equal to one-half of the vertical load determined under paragraph (b) of this section. This load must be—

(i) Applied only to the skid tube and its attachment to the rotorcraft; and

(ii) Concentrated at a point midway between the skid tube attachments.

§ 27.505 Ski landing conditions.

If certification for ski operation is requested, the rotorcraft, with skis, must be designed to withstand the following loading conditions (where P is the maximum static weight on each ski with the rotorcraft at design maximum weight, and n is the limit load factor determined under § 27.473(b).

(a) Up-load conditions in which—

(1) A vertical load of Pn and a horizontal load of $Pn/4$ are simultaneously applied at the pedestal bearings; and

(2) A vertical load of 1.33 P is applied at the pedestal bearings.

(b) A side-load condition in which a side load of 0.35 Pn is applied at the pedestal bearings in a horizontal plane perpendicular to the centerline of the rotorcraft.

(c) A torque-load condition in which a torque load of 1.33 P (in foot pounds) is applied to the ski about the vertical

axis through the centerline of the pedestal bearings.

WATER LOADS

§ 27.521 Float landing conditions.

If certification for float operation is requested, the rotorcraft, with floats, must be designed to withstand the following loading conditions (where the limit load factor is determined under § 27.473(b) or assumed to be equal to that determined for wheel landing gear):

(a) Up-load conditions in which—

(1) A load is applied so that, with the rotorcraft in the static level attitude, the resultant water reaction passes vertically through the center of gravity; and

(2) The vertical load prescribed in subparagraph (1) of this paragraph is applied simultaneously with an aft component of 0.25 times the vertical component.

(b) A side-load condition in which—

(1) A vertical load of 0.75 times the total vertical load specified in paragraph (a)(1) of this section is divided equally among the floats; and

(2) For each float, the load share determined under subparagraph (1) of this paragraph, combined with a total side load of 0.25 times the total vertical load specified in subparagraph (1) of this paragraph, is applied to that float only.

MAIN COMPONENT REQUIREMENTS

§ 27.547 Main rotor structure.

(a) Each main rotor assembly (including rotor hubs and blades) must be designed as prescribed in this section.

(b) Each hub, blade, blade attachment, and blade control subject to alternating stresses must be designed to withstand repeated loading conditions. In addition—

(1) The stresses of each critical part must be determined in flight in each attitude appropriate to the type of rotorcraft throughout the ranges of limitations prescribed in § 27.309; and

(2) The service life of each critical part must be established on the basis of—

(i) Fatigue tests; or

(ii) Any other acceptable method.

(c) The main rotor structure must be designed to withstand the following loads prescribed in §§ 27.337 through 27.341:

(1) Critical flight loads.

(2) Limit loads occurring under normal conditions of autorotation. For this condition, the rotor r.p.m. must be selected to include the effects of altitude.

(d) The main rotor structure must be designed to withstand loads simulating—

(1) For the rotor blades, hubs, and flapping hinges, the impact force of each blade against its stop during ground operation; and

(2) Any other critical condition expected in normal operation.

(e) The main rotor structure must be designed to withstand the limit torque at any rotational speed, including zero. In addition:

(1) The limit torque need not be greater than the torque defined by a torque limiting device (where provided), and may not be less than the greater of—

(i) The maximum torque likely to be transmitted to the rotor structure in either direction; and

(ii) The limit engine torque specified in § 27.361.

(2) The limit torque must be distributed to the rotor blades in a rational manner.

§ 27.549 Fuselage, landing gear, and rotor pylon structures.

(a) Each fuselage, landing gear, and rotor pylon structure must be designed as prescribed in this section. Resultant rotor forces may be represented as a single force applied at the rotor hub attachment point.

(b) Each structure must be designed to withstand—

(1) The critical loads prescribed in §§ 27.337 through 27.341;

(2) The applicable ground loads prescribed in §§ 27.235, 27.471 through 27.485, 27.493, 27.497, 27.501, 27.505, and 27.521; and

(3) The loads prescribed in § 27.547 (d)(2) and (e).

(c) Auxiliary rotor thrust, and the balancing air and inertia loads occurring under accelerated flight conditions, must be considered.

(d) Each engine mount and adjacent fuselage structure must be designed to withstand the loads occurring under accelerated flight and landing conditions, including engine torque.

(e) For critical parts (parts whose sudden failure would threaten the structural integrity of the rotorcraft), the following apply:

(1) Each part must be designed to withstand any repeated loading condition likely to occur within its established service life.

(2) Stresses must be determined in flight—

(i) For each attitude appropriate to the rotorcraft; and

(ii) For each attitude, throughout the ranges of limitations prescribed in § 27.309.

(3) The service life of each part must be established by—

(i) Fatigue tests; or

(ii) Any other acceptable method.

EMERGENCY LANDING CONDITIONS

§ 27.561 General.

(a) The rotorcraft, although it may be damaged in emergency landing conditions on land or water, must be designed as prescribed in this section to protect the occupants under those conditions.

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

(1) Proper use is made of seats, belts, and other safety design provisions;

(2) The wheels are retracted (where applicable); and

(3) The occupant experiences the following ultimate inertia forces relative to the surrounding structure:

(i) Upward—1.5 *g*.

(ii) Forward—4.0 *g*.

(iii) Sideward—2.0 *g*.

(iv) Downward—4.0 *g*, or any lower force that will not be exceeded when the rotorcraft absorbs the landing loads resulting from impact with an ultimate descent velocity of five f.p.s. at design maximum weight.

(c) The supporting structure must be designed to restrain, under any load up to those specified in paragraph (b)(3) of this section, any item of mass that could injure an occupant if it came loose in a minor crash landing.

Subpart D—Design and Construction

GENERAL

§ 27.601 Design.

(a) The rotorcraft may have no design features or details that experience has shown to be hazardous or unreliable.

(b) The suitability of each questionable design detail and part must be established by tests.

§ 27.603 Materials.

The suitability and durability of materials used in the structure must—

(a) Be established on the basis of experience or tests; and

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

§ 27.605 Fabrication methods.

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

§ 27.607 Self-locking nuts.

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

§ 27.609 Protection of structure.

Each part of the structure must—

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

(1) Weathering;

(2) Corrosion; and

(3) Abrasion; and

(b) Have provisions for ventilation and drainage where necessary to prevent the accumulation of corrosive, flammable, or noxious fluids.

§ 27.611 Inspection provisions.

There must be means to allow the close examination of each part that requires—

(a) Recurring inspection;

(b) Adjustment for proper alignment and functioning; or

(c) Lubrication.

§ 27.613 Material strength properties and design values.

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

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

(c) The strength, detail design, and fabrication of the structure must minimize the probability of disastrous fatigue failure, particularly at points of stress concentration.

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

(1) MIL-HDBK-5, "Metallic Materials and Elements for Flight Vehicle Structure".

(2) MIL-HDBK-17, "Plastics for Flight Vehicles".

(3) ANC-18, "Design of Wood Aircraft Structures".

(4) MIL-HDBK-23, "Composite Construction for Flight Vehicles".

§ 27.619 Special factors.

(a) The special factors prescribed in §§ 27.621 through 27.625 apply to each part of the structure whose strength is—

(1) Uncertain;

(2) Likely to deteriorate in service before normal replacement; or

(3) Subject to appreciable variability due to—

(i) Uncertainties in manufacturing processes; or

(ii) Uncertainties in inspection methods.

(b) For each part to which §§ 27.621 through 27.625 apply, the factor of safety prescribed in § 27.303 must be multiplied by a special factor equal to—

(1) The applicable special factors prescribed in §§ 27.621 through 27.625; or

(2) Any other factor great enough to ensure that the probability of the part being understrength because of the uncertainties specified in paragraph (a) of this section is extremely remote.

§ 27.621 Casting factors.

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

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

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

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

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

(1) Each critical casting must—

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

(ii) Receive 100 percent inspection by visual, radiographic, and magnetic particle (for ferromagnetic materials) or penetrate (for nonferromagnetic materials) inspection methods or approved equivalent inspection methods.

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

(i) The strength requirements of § 27.305 at an ultimate load corresponding to a casting factor of 1.25; and

(ii) The deformation requirements of § 27.305 at a load of 1.15 times the limit load.

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

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

Casting factor	*Inspection*
2.0 or greater	100 percent visual.
Less than 2.0, greater than 1.5.	100 percent visual, and magnetic particle (ferromagnetic materials), penetrant (nonferromagnetic materials), or approved equivalent inspection methods.
1.25 through 1.50.	100 percent visual, and magnetic particle (ferromagnetic materials), penetrant (nonferromagnetic materials), and radiographic or approved equivalent inspection methods.

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

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

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

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

§ 27.623 Bearing factors.

(a) Except as provided in paragraph (b) of this section, each part that has clearance (free fit), and that is subject to pounding or vibration, must have a bearing factor large enough to provide for the effects of normal relative motion.

(b) No bearing factor need be used on a part for which any larger special factor is prescribed.

§ 27.625 Fitting factors.

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

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

(1) The fitting;

(2) The means of attachment; and

(3) The bearing on the joined members.

(b) No fitting factor need be used—

(1) For joints made under approved practices and based on comprehensive test data (such as continuous joints in

metal plating, welded joints, and scarf joints in wood); and

(2) With respect to any bearing surface for which a larger special factor is used.

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

§ 27.629 Flutter.

Each part of the rotorcraft must be free from flutter under each appropriate speed and power condition.

MAIN ROTOR

§ 27.653 Pressure venting and drainage of main rotor blades.

For each main rotor blade—

(a) There must be means for venting the internal pressure of the blade;

(b) Drainage holes must be provided for the blade; and

(c) The blade must be designed to prevent water from becoming trapped in it.

§ 27.659 Mass balance.

The rotors and blades must be mass balanced as necessary to—

(a) Prevent excessive vibration; and

(b) Prevent flutter at any speed up to the maximum forward speed.

§ 27.661 Rotor blade clearance.

There must be enough clearance between the main rotor blades and other parts of the structure to prevent the blades from striking any part of the structure during any operating condition.

CONTROL SYSTEMS

§ 27.671 General.

(a) Each control and control system must operate with the ease, smoothness, and positiveness appropriate to its function.

(b) Each element of each flight control system must be designed, or distinctively and permanently marked, to minimize the probability of any incorrect assembly that could result in the malfunction of the system.

§ 27.675 Stops.

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

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

(1) Wear;

(2) Slackness; or

(3) Takeup adjustments.

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

(d) For each main rotor blade—

(1) The blade must have stops, appropriate to the design, to limit its travel about its hinges; and

(2) There must be means to keep the blade from hitting the droop stops during any operation other than starting and stopping the rotor.

§ 27.679 Control system locks.

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

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

(b) Prevent the lock from engaging in flight.

§ 27.681 Limit load static tests.

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

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

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

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

§ 27.683 Operation tests.

It must be shown by operation tests that, when the controls are operated from the pilot compartment with the control system loaded to correspond with loads specified for the system, the system is free from—

(a) Jamming;

(b) Excessive friction; and

(c) Excessive deflection.

§ 27.685 Control system details.

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

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

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

§ 27.687 Spring devices.

(a) Each control system spring device whose failure could cause flutter or other unsafe characteristics must be reliable.

(b) Compliance with paragraph (a) of this section must be shown by tests simulating service conditions.

§ 27.691 Autorotation control mechanism.

Each main rotor blade pitch control mechanism must allow rapid entry into autorotation after power failure.

§ 27.695 Power boost and power-operated control system.

(a) If a power boost or power-operated control system is used, an alternate system must be immediately available that allows continued safe flight and landing in the event of—

(1) Any single failure in the power portion of the system; or

(2) The failure of all engines.

(b) Each alternate system may be a duplicate power portion or a manually operated mechanical system. The power portion includes the power source (such as hydraulic pumps), and such items as valves, lines, and actuators.

(c) The failure of mechanical parts (such as piston rods and links), and the jamming of power cylinders, must be considered unless they are extremely improbable.

LANDING GEAR

§ 27.723 Shock absorption tests.

The landing inertia load factor and the reserve energy absorption capacity of the landing gear must be substantiated by the tests prescribed in §§ 27.725 and 27.727, respectively. These tests must be conducted on the complete rotorcraft or on units consisting of wheel, tire, and shock absorber in their proper relation.

§ 27.725 Limit drop test.

The limit drop test must be conducted as follows:

(a) The drop height must be—

(1) 13 inches from the lowest point of the landing gear to the ground; or

(2) Any lesser height, not less than eight inches, resulting in a drop contact velocity equal to the greatest probable sinking speed likely to occur at ground contact in normal power-off landings.

(b) If considered, the rotor lift specified in § 27.473(a) must be introduced into the drop test by appropriate energy absorbing devices or by the use of an effective mass.

(c) Each landing gear unit must be tested in the attitude simulating the landing condition that is most critical from the standpoint of the energy to be absorbed by it.

(d) When an effective mass is used in showing compliance with paragraph (b) of this section, the following formula may be used instead of more rational computations:

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

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 moment arm between the main wheel reaction and the rotorcraft center of gravity.

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

$W = W_T$ for tailwheel units (lbs.), 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 that would occur at the tailwheel, assuming that the mass of the rotorcraft acts at the center of gravity and exerts a force of 1g downward with the rotorcraft in the maximum nose-up attitude considered in the nose-up landing conditions.

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 proper inflation pressure) plus the vertical component of the axle travels (inches) relative to the drop mass.

n=limit inertia load factor.
n_j=the load factor developed, during impact, 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).

§ 27.727 Reserve energy absorption drop test.

The reserve energy absorption drop test must be conducted as follows:

(a) The drop height must be 1.5 times that specified in § 27.725(a).

(b) Rotor lift, where considered in a manner similar to that prescribed in § 27.725(b), may not exceed 1.5 times the lift allowed under that paragraph.

(c) The landing gear must withstand this test without collapsing.

§ 27.731 Wheels.

(a) Each landing gear wheel must be approved.

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

(1) Maximum weight; and

(2) Critical center of gravity.

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

§ 27.733 Tires.

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

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

(2) Of the proper rating.

(b) The maximum static load rating of each tire must equal or exceed the static ground reaction obtained at its wheel, assuming—

(1) The design maximum weight; and

(2) The most unfavorable center of gravity.

§ 27.735 Brakes.

A braking device must be installed that is—

(a) Controllable by the pilot;

(b) Usable during power-off landings; and

(c) Adequate to—

(1) Counteract any normal unbalanced torque when starting or stopping the rotor; and

(2) Hold the rotorcraft parked on a 10-degree slope on a dry, smooth pavement.

§ 27.737 Skis.

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

FLOATS AND HULLS

§ 27.751 Main float buoyancy.

(a) For main floats, the buoyancy necessary to support the maximum weight of the rotorcraft in fresh water must be exceeded by—

(1) 50 percent, for single floats; and

(2) 60 percent, for multiple floats.

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

§ 27.753 Main float design.

(a) *Bag floats.* Each bag float must be designed to withstand—

(1) The maximum pressure differential that might be developed at the maximum altitude for which certification with that float is requested; and

(2) The vertical loads prescribed in § 27.521(a), distributed along the length of the bag over three-quarters of its projected area.

(b) *Rigid floats.* Each rigid float must be able to withstand the vertical, horizontal, and side loads prescribed in § 27.521. These loads may be distributed along the length of the float.

§ 27.755 Hulls.

For each rotorcraft, with a hull and auxiliary floats, that is to be approved for both taking off from and landing on water, the hull and auxiliary floats must have enough watertight compartments so that, with any single compartment flooded, the buoyancy of the hull and auxiliary floats (and wheel tires if used) provides a margin of positive stability great enough to minimize the probability of capsizing.

PERSONNEL AND CARGO ACCOMMODATIONS

§ 27.771 Pilot compartment.

For each pilot compartment—

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

(b) If there is provision for a second pilot, the rotorcraft must be controllable with equal safety from either pilot seat; and

(c) The vibration and noise characteristics of cockpit appurtenances may not interfere with safe operation.

§ 27.773 Pilot compartment view.

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

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

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

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

§ 27.775 Windshields and windows.

Nonsplintering safety glass must be used in glass windshields and windows.

§ 27.777 Cockpit controls.

Cockpit controls must be—

(a) Located to provide convenient operation and to prevent confusion and inadvertent operation; and

(b) Located and arranged with respect to the pilots' seats so that there is full and unrestricted movement of each control without interference from the cockpit structure or the pilot's clothing when pilots from 5'2'' to 6'0'' in height are seated.

§ 27.783 Doors.

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

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

§ 27.785 Seats and berths.

(a) The seats and berths, and their supporting structures, must be designed for loads resulting from the specified flight and landing conditions, including the emergency landing conditions of § 27.561.

(b) The reactions from safety belts and harnesses must be considered.

(c) Each pilot seat must be designed for the reactions resulting from the application of the pilot forces prescribed in § 27.397.

(d) The structural analysis and testing of the structures specified in paragraphs (a) through (c) may be simplified—

(1) By assuming that the critical load in each direction, as determined from the prescribed flight, ground, and emergency landing conditions, acts separately; or

(2) By using selected combinations of loads, if the required strength in the specified directions is proven.

§ 27.787 Cargo and baggage compartments.

(a) Each cargo and baggage compartment must be designed for its placarded maximum weight of contents and for the critical load distributions at the appropriate maximum load factors corresponding to the specified flight and ground load conditions, except the emergency landing conditions of § 27.561.

(b) There must be means to prevent the contents of any compartment from becoming a hazard by shifting under the loads specified in paragraph (a) of this section.

(c) There must be means to protect each occupant from injury by the contents of any compartment when the ultimate forward inertia force is $4g$.

§ 27.807 Emergency exits.

(a) *Number and location.* Rotorcraft with closed cabins having a total seating capacity of more than five persons must have at least one emergency exit on the opposite side of the cabin from the main door. Additional exits must be provided where the total seating capacity is more than 15.

(b) *Type and operation.* Each emergency exit prescribed in paragraph (a) of this section must—

(1) Consist of a movable window or panel, or additional external door, providing an unobstructed opening that will admit a 19- by 26-inch ellipse;

(2) Be readily accessible, require no exceptional agility of a person using it, and be located so as to allow ready use, without crowding, in any probable attitudes that may result from a crash;

(3) Have a simple and obvious method of opening and be arranged and marked so as to be readily located and operated, even in darkness; and

(4) Be reasonably protected from jamming by fuselage deformation.

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

§ 27.831 Ventilation.

(a) The ventilating system for the pilot and passenger compartments must be designed to prevent the presence of excessive quantities of fuel fumes and carbon monoxide.

(b) The concentration of carbon monoxide may not exceed one part in 20,000 parts of air during forward flight or hovering in still air. If the concentration exceeds this value under other conditions, there must be suitable operating restrictions.

FIRE PROTECTION

§ 27.853 Compartment interiors.

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

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

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

(c) Each compartment where smoking is to be allowed must have self-contained, removable ash trays, and other compartments must be placarded against smoking.

§ 27.855 Cargo and baggage compartments.

(a) Each cargo and baggage compartment must be constructed of, or lined with, materials that are at least—

(1) Flame resistant, in the case of compartments that are readily accessible to a crewmember in flight; and

(2) Fire resistant, in the case of other compartments.

(b) No compartment may contain any controls, wiring, lines, equipment, or accessories whose damage or failure would affect safe operation, unless those items are protected so that—

(1) They cannot be damaged by the movement of cargo in the compartment; and

(2) Their breakage or failure will not create a fire hazard.

§ 27.859 Heating systems.

(a) *General.* For each heating system that involves the passage of cabin air over, or close to, the exhaust manifold, there must be means to prevent carbon monoxide from entering any cabin or pilot compartment.

(b) *Heat exchangers.* Each heat exchanger must be—

(1) Of suitable materials;

(2) Adequately cooled under all conditions; and

(3) Easily disassembled for inspection.

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

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

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

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

(ii) The combustion airflow or the ventilating airflow becomes inadequate for safe operation.

§ 27.861 Fire protection of structure, controls, and other parts.

Each part of the structure, controls, and the rotor mechanism, and other parts essential to a controlled landing that would be affected by powerplant fires must be protected so that they can perform their essential functions for at least five minutes under any foreseeable powerplant fire condition.

MISCELLANEOUS

§ 27.871 Leveling marks.

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

§ 27.873 Ballast provisions.

Ballast provisions must be designed and constructed to prevent inadvertent shifting of ballast in flight.

Subpart E—Powerplant

GENERAL

§ 27.901 Installation.

(a) For the purpose of this part, the powerplant installation includes each part of the rotorcraft (other than the main and auxiliary rotor structures) that—

(1) Is necessary for propulsion;

(2) Affects the control of the major propulsive units; or

(3) Affects the safety of the major propulsive units between normal inspections or overhauls.

(b) For each powerplant installation—

(1) Each component of the installation must be constructed, arranged, and installed to ensure its continued safe operation between normal inspections or overhauls;

(2) Accessibility must be provided to allow any inspection and maintenance necessary for continued airworthiness; and

(3) Electrical interconnections must be provided to prevent differences of potential between major components of the installation and the rest of the rotorcraft.

§ 27.903 Engines.

(a) *Engine type certification.* Each engine must be type certificated under Part 33 [New].

(b) *Engine cooling fan blade protection.* If an engine cooling fan is installed, there must be means to protect the rotorcraft and allow a safe landing if a fan blade fails. This must be shown by showing that—

(1) The fan blades are contained in case of failure;

(2) Each fan is located so that a failure will not jeopardize safety; or

(3) Each fan blade can withstand an ultimate load of 1.5 times the centrifugal force resulting from engine r.p.m. limited by either—

(i) The terminal engine r.p.m. under uncontrolled conditions; or

(ii) An overspeed limiting device.

§ 27.907 Engine vibration.

(a) Each engine must be installed to prevent the harmful vibration of any part of the engine or rotorcraft.

(b) The addition of the rotor and the rotor drive system to the engine may not subject the principal rotating parts of the engine to excessive vibration stresses. This must be shown by a vibration investigation.

(c) No part of the rotor drive system may be subjected to excessive vibration stresses.

ROTOR DRIVE SYSTEM

§ 27.917 Design.

(a) Each rotor drive system must incorporate a unit for each engine to automatically disengage that engine from the main and auxiliary rotors if that engine fails.

(b) Each rotor drive system must be arranged so that each rotor necessary for control in autorotation will continue to be driven by the main rotors after disengagement of the engine from the main and auxiliary rotors.

(c) If a torque limiting device is used in the rotor drive system, it must be located so as to allow continued control of the rotorcraft when the device is operating.

§ 27.921 Rotor brake.

If there is a means to control the rotation of the rotor drive system independently of the engine, any limitations on the use of that means must be specified, and the control for that means must be guarded to prevent inadvertent operation.

§ 27.923 Rotor drive system and control mechanism tests.

(a) Each part tested as prescribed in this section must be in a serviceable condition at the end of the tests.

(b) Each rotor drive system and control mechanism must be tested for not less than 100 hours. The test must be conducted on the rotorcraft, and the power must be absorbed by the rotors to be installed, except that other ground or flight test facilities with other appropriate methods of power absorption may be used if the conditions of support and vibration closely simulate the conditions that would exist during a test on the rotorcraft.

(c) A 60-hour part of the test prescribed in paragraph (b) of this section must be run at not less than the maximum continuous engine power and r.p.m. In this test, the main rotor must

be set in the position that will give maximum longitudinal cyclic pitch change to simulate forward flight. The auxiliary rotor controls must be in the position for normal operation under the conditions of the test.

(d) A 30-hour part of the test prescribed in paragraph (b) of this section must be run at not less than 90 percent of maximum continuous engine r.p.m. and 75 percent of maximum continuous engine power. The main and auxiliary rotor controls must be in the position for normal operation under the conditions of the test.

(e) A 10-hour part of the test prescribed in paragraph (b) of this section must be run at not less than takeoff engine power and r.p.m. The main and auxiliary rotor controls must be in the normal position for vertical ascent.

(f) The parts of the test prescribed in paragraphs (c) and (d) of this section must be conducted in intervals of not less than 30 minutes and may be accomplished either on the ground or in flight. The part of the test prescribed in paragraph (e) of this section must be conducted in intervals of not less than five minutes.

(g) At intervals of not more than five hours during the tests prescribed in paragraphs (c), (d), and (e) of this section, the engine must be stopped rapidly enough to allow the engine and rotor drive to be automatically disengaged from the rotors.

(h) Under the operating conditions specified in paragraph (c) of this section, 500 complete cycles of lateral control, 500 complete cycles of longitudinal control of the main rotors, and 500 complete cycles of control of each auxiliary rotor must be accomplished. A "complete cycle" involves movement of the controls from the neutral position, through both extreme positions, and back to the neutral position, except that control movements need not produce loads or flapping motions exceeding the maximum loads or motions encountered in flight. The cycling may be accomplished during the testing prescribed in paragraph (c) of this section.

§ 27.927 Additional tests.

Any additional dynamic, endurance, and operational tests, and vibratory investigations necessary to determine that the rotor drive mechanism is safe, must be performed.

§ 27.931 Shafting critical speed.

(a) The critical speeds of any shafting must be determined by demonstration, except that analytical methods may be used if reliable methods of analysis are available for the particular design.

(b) If any critical speed lies within, or close to, the operating ranges for idling, power on, and autorotative conditions, the stresses occurring at that speed must be within safe limits. This must be shown by tests.

(c) If analytical methods are used and show that no critical speed lies within the permissible operating ranges, the margins between the calculated critical speeds and the limits of the allowable operating ranges must be adequate to allow for possible variations between the computed and actual values.

§ 27.935 Shafting joints.

Each universal joint, slip joint, and other shafting joints whose lubrication is necessary for operation must have provision for lubrication.

FUEL SYSTEM

§ 27.951 General.

(a) Each fuel system must be constructed and arranged to ensure a flow of fuel at a rate and pressure established for proper engine functioning under any likely operating condition, including the maneuvers for which certification is requested.

(b) Each fuel system must be arranged so that—

(1) No fuel pump can draw fuel from more than one tank at a time; or

(2) There are means to prevent introducing air into the system.

§ 27.953 Fuel system independence.

(a) Each fuel system for multiengine rotorcraft must allow fuel to be supplied to each engine through a system independent of those parts of each system supplying fuel to other engines. However, separate fuel tanks need not be provided for each engine.

(b) If a single fuel tank is used on a multiengine rotorcraft, the following must be provided:

(1) Independent tank outlets for each engine, each incorporating a shutoff valve at the tank. This shutoff valve may also serve as the firewall shutoff valve required by § 27.995 if the line between the valve and the engine compartment does not contain a hazardous amount of fuel that can drain into the engine compartment.

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

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

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

§ 27.955 Fuel flow.

(a) Each fuel system must provide at least 100 percent of the fuel flow required under the intended operating conditions and maneuvers. This must be shown as follows:

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

(2) The quantity of fuel in the tank may not exceed that established as the unusable fuel supply for that tank under § 27.959 plus that necessary to show compliance with this section.

(3) Each main pump must be used that is necessary for each operating condition and attitude for which compliance with this section is shown, and the appropriate emergency pump must be substituted for each main pump so used.

(b) If an engine can feed from more than one fuel tank, the fuel system must feed promptly when fuel becomes low in one tank and another tank is selected.

§ 27.959 Unusable fuel supply.

The unusable fuel supply for each tank must be established as not less than the quantity at which the first evidence of malfunction occurs under the most adverse fuel feed condition occurring under any intended operations and flight maneuvers involving that tank.

§ 27.961 Fuel system hot weather operation.

Each suction lift fuel system and other fuel systems conducive to vapor formation must be free from vapor lock when using fuel at a temperature of 110 degrees F. under critical operating conditions. This must be shown by test.

§ 27.963 Fuel tanks: general.

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

(b) Each fuel tank of 10 gallons or greater capacity must have internal baffles, or must have external support to resist surging.

(c) Each fuel tank must be separated from the engine compartment by a firewall. At least one-half inch of clear airspace must be provided between the tank and the firewall.

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

§ 27.965 Fuel tank internal pressure.

Each fuel tank must be able to withstand, without leakage, an internal pressure equal to the pressure developed during the maximum limit acceleration with that tank full, but not less than—

(a) 3.5 p.s.i., for conventional tanks; or

(b) 2.0 p.s.i., for bladder tanks.

§ 27.969 Fuel tank expansion space.

Each fuel tank must have an expansion space of not less than two percent of the tank capacity. It must be impossible to fill the fuel tank expansion space inadvertently with the rotorcraft in the normal ground attitude.

§ 27.971 Fuel tank sump.

Each fuel tank must have a sump and drain at the point in the tank that is lowest with the rotorcraft in the normal ground attitude. The main fuel supply may not be drawn from the bottom of the sump.

§ 27.973 Fuel tank filler connection.

Each fuel tank filler connection must prevent the entrance of fuel into any part of the rotorcraft other than the tank.

§ 27.975 Fuel tank vents.

Each fuel tank must be vented from the top part of the expansion space so that venting is effective under all normal flight conditions. Each vent must minimize the probability of stoppage by dirt or ice.

§ 27.977 Fuel tank outlet.

There must be a large-mesh finger strainer for the fuel tank outlet.

FUEL SYSTEM COMPONENTS

§ 27.991 Fuel pumps.

(a) *Main pumps.* Each fuel pump required for proper engine operation, or required to meet the fuel system requirements of this subpart (other than those in paragraph (b) of this section), is a main pump. For each main pump, there must be means to allow the bypass of each positive displacement fuel pump other than a fuel injection pump (a pump that supplies the proper flow and pressure for fuel injection when the injection is not accomplished in a carburetor) approved as part of an engine.

(b) *Emergency pumps.* There must be emergency pumps to feed the engines immediately after the failure of any main pump (other than fuel injection pump approved as part of the engine). Each emergency pump must be actuated automatically or operated continuously so that enough fuel pressure will be maintained to prevent engine stoppage.

§ 27.993 Fuel system lines and fittings.

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

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

(c) Flexible hose must be approved.

(d) Each fuel line and fitting must have a large enough inside diameter so that the fuel flow, at the minimum pressure for proper carburetor operation, is not less than—

(1) For gravity feed systems, 1.5 times the normal flow required at takeoff power; and

(2) For pump systems, 1.25 times the normal flow required at takeoff power.

(e) Compliance with the applicable flow requirements must be shown by test.

§ 27.995 Fuel valves.

(a) There must be a positive, quick-acting valve to shut off fuel to each engine individually.

(b) The control for this valve must be within easy reach of appropriate crewmembers.

(c) Where there is more than one source of fuel supply there must be means for independent feeding from each source.

(d) No shutoff valve may be on the engine side of any firewall.

§ 27.997 Fuel strainer or filter.

(a) There must be a fuel strainer or filter between the fuel tank outlet and the fuel metering device of the engine (or engine-driven fuel pump, if one is provided). In addition—

(1) Each strainer or filter must have a sediment trap and drain;

(2) Each strainer or filter must be accessible; and

(3) Each screen or filter element must be easily removable for cleaning.

(b) For turbine engines—

(1) There must be means to automatically maintain the fuel flow when the strainer or filter is clogged by ice; or

(2) There must be means in the fuel system to prevent the accumulation of ice on the strainer or filter.

§ 27.999 Fuel system drains.

(a) There must be at least one accessible drain at the lowest point in each fuel system to completely drain the system with the rotorcraft in its normal attitude on level ground.

(b) Each drain required by paragraph (a) of this section must—

(1) Discharge clear of the entire rotorcraft; and

(2) Have a safety lock to prevent accidental opening.

OIL SYSTEM

§ 27.1011 General.

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

(b) The usable oil capacity of each system may 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, plus a suitable margin to ensure adequate circulation and cooling. Instead of a rational analysis of endurance and consumption, a usable oil capacity of one gallon for each 40 gallons of usable fuel may be used.

(c) The oil cooling provisions for each engine must be able to maintain the oil inlet temperature to that engine at or below the maximum established value. This must be shown by flight tests.

§ 27.1013 Oil tanks.

Each oil tank must be designed and installed so that—

(a) It can withstand, without failure, each vibration, inertia, fluid, and structural load expected in operation;

(b) It can withstand, without leakage, an internal pressure of five p.s.i.;

(c) It has an expansion space of not less than the greater of—

(1) 10 percent of the tank capacity; or

(2) 0.5 gallon;

(d) It is impossible to fill the tank expansion space inadvertently with the rotorcraft in the normal ground attitude;

(e) Adequate venting is provided; and

(f) There are means in the filler opening to prevent oil overflow from entering the oil tank compartment.

§ 27.1017 Oil lines and fittings.

(a) Each oil line must be supported to prevent excessive vibration.

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

(c) Flexible hose must be approved.

(d) Each oil line must have an inside diameter of not less than the inside diameter of the engine inlet or outlet. No line may have splices between connections.

§ 27.1019 Oil strainer or filter.

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

§ 27.1021 Oil system drains.

(a) There must be at least one accessible drain at the lowest point in the oil system to drain the system completely with the rotorcraft in its normal position on level ground.

(b) Each drain must discharge clear of the entire rotorcraft and have safety locks to prevent accidental opening.

COOLING

§ 27.1041 General.

(a) Each powerplant cooling system must be able to maintain the temperatures of powerplant components and engine fluids within the limits established for those components and fluids under any critical surface (ground or water) and flight operating conditions.

(b) Compliance with paragraph (a) of this section must be shown in tests conducted under the conditions prescribed in that paragraph.

§ 27.1043 Cooling tests.

(a) *General.* For the tests prescribed in § 27.104(b), the following apply:

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

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

(3) For reciprocating engines, the fuel used during the cooling tests must be of the minimum grade approved for the engines, and the mixture settings must be those normally used in the flight stages for which the cooling tests are conducted.

(4) The test procedures must be as prescribed in § 27.1045.

(b) *Maximum anticipated air temperature.* For cooling tests, the maximum anticipated temperature (hot-day condition) is 100 degrees F. at sea level, decreasing from this value at the rate of 3.6 degrees F. per thousand feet of altitude above sea level up to the altitude at which a temperature of −69.7 degrees F. is reached, above which altitude the temperature is constant at −69.7 degrees F.

(c) *Correction factor (except cylinder barrels).* The temperatures of engine fluids and powerplant components (except cylinder barrels) for which temperature limits are established must be corrected by adding to them the difference between the maximum anticipated air temperature and the temperature of the ambient air at the time of the first occurrence of the maximum component or fluid temperatures recorded during the cooling test.

(d) *Correction factor for cylinder barrel temperatures.* Cylinder barrel temperatures must be corrected by adding to them 0.7 times the difference between the maximum anticipated air temperature and the temperature of the ambient air at the time of the first occurrence of the maximum cylinder barrel temperature recorded during the cooling test.

§ 27.1045 Cooling test procedures.

(a) *General.* For each stage of flight, the cooling tests must be conducted with the rotorcraft—

(1) In the configuration most critical for cooling; and

(2) Under the conditions most critical for cooling.

(b) *Temperature stabilization.* For the purpose of the cooling tests, a temperature is "stabilized" when its rate of change is less than two degrees F. per minute. The following component and engine fluid temperature stabilization rules apply:

(1) For each rotorcraft, and for each stage of flight—

(i) The temperatures must be stabilized under the conditions from which entry is made into the stage of flight being investigated; or

(ii) If the entry condition normally does not allow temperatures to stabilize, operation through the full entry condition must be conducted before entry into the stage of flight being investigated in order to allow the temperatures to attain their natural levels at the time of entry.

(2) For each helicopter during the takeoff stage of flight, the climb at takeoff power must be preceded by a period of hover during which the temperatures are stabilized.

(c) *Duration of test.* For each stage of flight the tests must be continued until—

(1) The temperatures stabilize;

(2) That stage of flight is completed; or

(3) An operating limitation is reached.

INDUCTION SYSTEM

§ 27.1091 Air induction.

(a) The air induction system for each engine must supply the air required by that engine under the operating conditions and maneuvers for which certification is requested.

(b) Each cold air induction system opening must be outside the cowling if backfire flames can emerge.

(c) If fuel can accumulate in any air induction system, that system must have drains that discharge fuel—

(1) Clear of the rotorcraft; and

(2) Out of the path of exhaust flames.

(d) Operation of turbine engines from idle power and r.p.m. to the power and r.p.m. necessary for lift-off may not result in pebble ingestion into the induction air inlet with the rotorcraft on a pebble bed at least 1½ inches deep, consisting of pebbles that—

(1) Can pass through one-half inch mesh screening but not through one-eighth inch mesh screening; and

(2) Are spread over an area that extends horizontally five feet beyond the tips of the main rotors.

§ 27.1093 Induction system icing protection.

(a) *Reciprocating engines.* Each reciprocating engine air induction system must have means to prevent and eliminate icing. Unless this is done by other means, it must be shown that, in air free of visible moisture at a temperature of 30 degrees F., and with the engines at 75 percent of maximum continuous power—

(1) Each rotorcraft with sea level engines using conventional venturi carburetors has a preheater that can provide a heat rise of 90 degrees F.;

(2) Each rotorcraft with sea level engines using carburetors tending to prevent icing has a sheltered alternate source of air, and that the preheat supplied to the alternate air intake is not less than that provided by the engine cooling air downstream of the cylinders;

(3) Each rotorcraft with altitude engines using conventional venturi carburetors has a preheater capable of providing a heat rise of 120 degrees F.; and

(4) Each rotorcraft with altitude engines using carburetors tending to prevent icing has a preheater that can provide a heat rise of—

(i) 100 degrees F.; or

(ii) If a fluid deicing system is used, at least 40 degrees F.

(b) *Turbine engines.* Each turbine engine must be able to operate throughout its flight power range, without adverse effect on engine operation or serious loss of power or thrust, under the icing conditions specified in Appendix C of Part 25 of this chapter.

EXHAUST SYSTEM

§ 27.1121 General.

For each exhaust system—

(a) There must be means for thermal expansion of manifolds and pipes;

(b) There must be means to prevent local hot spots;

(c) Exhaust gases must discharge clear of the engine air intake, fuel system components, and drains;

(d) No exhaust pipe may be adjacent to, or under, any carburetor or fuel system part that is not protected against leakage;

(e) Exhaust gases may not impair pilot vision at night due to glare; and

(f) If significant traps exist, each turbine engine exhaust system must have drains discharging clear of the rotorcraft, in any normal ground and flight attitudes, to prevent fuel accumulation after the failure of an attempted engine start.

POWERPLANT CONTROLS AND ACCESSORIES

§ 27.1141 Powerplant controls: general.

(a) Powerplant controls must be located and arranged under § 27.777 and marked under § 27.1555.

(b) Each flexible powerplant control must be approved.

§ 27.1143 Throttle controls.

(a) There must be a separate throttle control for each engine.

(b) Throttle controls must be grouped and arranged to allow—

(1) Separate control of each engine; and

(2) Simultaneous control of all engines.

(c) Each throttle control must provide a positive and immediately responsive means of controlling its engine.

§ 27.1145 Ignition switches.

(a) There must be means to quickly shut off all ignition by the grouping of switches or by a master ignition control.

(b) Each master ignition control must have a guard to prevent its inadvertent operation.

§ 27.1147 Mixture controls.

If there are mixture controls, each engine must have a separate control and the controls must be arranged to allow—

(a) Separate control of each engine; and

(b) Simultaneous control of all engines.

§ 27.1163 Powerplant accessories.

Each engine-mounted accessory must—

(a) Be approved for mounting on the engine involved; and

(b) Use the provisions on the engine for mounting.

POWERPLANT FIRE PROTECTION

§ 27.1183 Lines and fittings.

(a) Except as provided in paragraph (b) of this section, each line and fitting carrying flammable fluids in any area subject to engine fire conditions must meet the following:

(1) The line and fitting must be at least fire resistant.

(2) Flexible hose assemblies (hose and end fittings) must be approved.

(3) The line and fitting must be located or shielded to prevent fluid leakage on surfaces hot enough to ignite the fluid.

(b) Paragraph (a) does not apply to—

(1) Lines and fittings forming an integral part of an engine; and

(2) Vent and drain lines, and their fittings, whose failure will not result in, or add to, a fire hazard.

(c) Each flammable fluid drain and vent must discharge clear of the induction system air inlet.

§ 27.1185 Flammable fluids.

(a) Each fuel tank must be isolated from the engines by a firewall or shroud.

(b) For rotorcraft with engines of more than 900 cu. in. displacement—

(1) Each flammable fluid tank must be isolated under paragraph (a) of this section; or

(2) The fluid in the tank, the design of the system, the materials used in the tank, the shutoff means, and all connections, lines, and controls must provide a degree of safety equal to that resulting from isolation under paragraph (a) of this section.

(c) There must be at least one-half inch of clear airspace between each tank and each firewall or shroud isolating that tank, unless equivalent means are used to prevent heat transfer from each engine compartment to the flammable fluid.

§ 27.1187 Ventilation.

Each compartment containing any part of the powerplant installation must have provision for ventilation.

§ 27.1189 Shutoff means.

(a) There must be means to shut off each line carrying flammable fluids into the engine compartment, except—

(1) Lines forming an integral part of an engine; and

(2) Engine oil system lines in powerplant installations using engines of less than 500 cu. in. displacement.

(b) There must be means to guard against inadvertent operation of each shutoff, and to make it possible for the crew to reopen it in flight after it has been closed.

(c) Each shutoff valve and its controls must be on the remote side of the firewall from the engine if they cannot function under any fire condition likely to result from an engine fire.

§ 27.1191 Firewall.

(a) Each engine must be isolated by a firewall, shroud, or equivalent means, from personnel compartments, structures, controls, rotor mechanisms, and other parts that are—

(1) Essential to a controlled landing; and

(2) Not protected under § 27.861.

(b) Each auxiliary power unit and combustion heater, and any other combustion equipment to be used in flight, must be isolated from the rest of the rotorcraft by firewalls, shrouds, or equivalent means.

(c) In meeting paragraphs (a) and (b) of this section, account must be taken of the probable path of a fire as affected by the airflow in normal flight and in autorotation.

(d) Each firewall and shroud must be constructed so that no hazardous quantity of air, fluids, or flame can pass from any engine compartment to other parts of the rotorcraft.

(e) Each opening in the firewall or shroud must be sealed with close-fitting, fireproof grommets, bushings, or firewall fittings.

(f) Each firewall and shroud must be fireproof and protected against corrosion.

§ 27.1193 Cowling and engine compartment covering.

(a) Each cowling and engine compartment covering must be constructed and supported so that it can resist the vibration, inertia, and air loads to which it may be subjected in operation.

(b) There must be means for rapid and complete drainage of each part of the cowling or engine compartment in the normal ground and flight attitudes.

(c) No drain may discharge where it might cause a fire hazard.

(d) Each cowling and engine compartment covering must be at least fire resistant.

(e) Each part of the cowling or engine compartment covering subject to high temperatures due to its nearness to exhaust system parts or exhaust gas impingement must be fireproof.

Subpart F—Equipment

GENERAL

§ 27.1301 Function and installation.

Each item of installed equipment must—

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

(b) Be labeled as to its identification, function, or operating limitations, or any applicable combination of these factors;

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

(d) Function properly when installed.

§ 27.1303 Flight and navigation instruments.

The following are the required flight and navigation instruments:

(a) An airspeed indicator.

(b) An altimeter.

(c) A magnetic direction indicator.

§ 27.1305 Powerplant instruments.

The following are the required powerplant instruments:

(a) A carburetor air temperature indicator, for each engine having a preheater that can provide a heat rise in excess of 60° F.

(b) A cylinder head temperature indicator, for each—

(1) Air cooled engine;

(2) Rotorcraft with cooling shutters; and

(3) Rotorcraft for which compliance with § 27.1043 is shown in any condition other than the most critical flight condition with respect to cooling.

(c) A fuel pressure indicator, for each pump-fed engine.

(d) A fuel quantity indicator, for each fuel tank.

(e) A manifold pressure indicator, for each altitude engine.

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

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

(h) An oil pressure indicator for each engine.

(i) An oil quantity indicator for each oil tank.

(j) An oil temperature indicator for each engine.

(k) At least one tachometer to indicate the r.p.m. of each engine and, as applicable—

(1) The r.p.m. of the single main rotor;

(2) The common r.p.m. of any main rotors whose speeds cannot vary appreciably with respect to each other; or

(3) The r.p.m. of each main rotor whose speed can vary appreciably with respect to that of another main rotor.

(l) If an engine can be supplied with fuel from more than one tank, a warning device to indicate, for each tank, when a five-minute usable fuel supply remains when the rotorcraft is in the most adverse fuel feed condition for that tank, regardless of whether that condition can be sustained for the five minutes.

(m) Means to indicate to the pilot when each emergency pump is in operation.

(n) A gas temperature indicator for each turbine engine.

(o) Means to enable the pilot to determine the torque of each turboshaft engine, if a torque limitation is established for that engine under § 27.1521(e).

§ 27.1307 Miscellaneous equipment.

The following is the required miscellaneous equipment:

(a) An approved seat for each occupant.

(b) An approved safety belt for each occupant.

(c) A master switch arrangement.

(d) An adequate source of electrical energy, where electrical energy is necessary for operation of the rotorcraft.

(e) Electrical protective devices.

§ 27.1309 Equipment, systems, and installations.

(a) *Functioning and reliability.* The equipment, systems, and installations whose functioning is required by this subchapter must be designed and installed to ensure that they perform their intended functions under any foreseeable operating condition.

(b) *Hazards.* All equipment, systems, and installations must be designed

to prevent hazards to the rotorcraft if they malfunction or fail.

INSTRUMENTS: INSTALLATION

§ 27.1321 Arrangement and visibility.

(a) Each flight, navigation, and powerplant instrument for use by any pilot must be easily visible to him.

(b) For each multiengine rotorcraft, identical powerplant instruments must be located so as to prevent confusion as to which engine each instrument relates.

(c) Instrument panel vibration may not damage, or impair the readability or accuracy of, any instrument.

§ 27.1323 Airspeed indicating system.

(a) The airspeed indicating system must be calibrated in flight at forward speeds of 10 m.p.h. and over.

(b) At each forward speed above 80 percent of the climbout speed, the airspeed indicator must indicate true airspeed, at sea level with a standard atmosphere, to within an allowable installation error of not more than the greater of—

(1) ±3 percent of the calibrated airspeed; or

(2) Five m.p.h.

§ 27.1325 Static air vent system.

Each instrument with static air case connections must be vented so that the influence of rotorcraft speed, the opening and closing of windows, airflow variation, and moisture or other foreign matter does not seriously affect its accuracy.

§ 27.1327 Magnetic direction indicator.

(a) Each magnetic direction indicator must be installed so that its accuracy is not excessively affected by the rotorcraft's vibration or magnetic fields.

(b) The compensated installation may not have a deviation, in level flight, greater than 10° on any heading.

§ 27.1337 Powerplant instruments.

(a) *Instrument lines.* Each powerplant instrument line must meet the requirements of §§ 27.961 and 27.993. Each line carrying flammable fluids or gases under pressure must have restricting orifices or equivalent safety devices at the source of pressure to prevent the escape of excessive fluid or gas if the line fails.

(b) *Fuel quantity indicator.* Each fuel quantity indicator must be installed to clearly indicate to the flight crew the quantity of fuel in each tank in flight. In addition—

(1) Each fuel quantity indicator must be calibrated to read "zero" during level flight when the quantity of fuel remaining in the tank is equal to the unusable fuel supply determined under § 27.959;

(2) 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, at least one fuel quantity indicator must be installed; and

(3) Each exposed sight gauge used as a fuel quantity indicator must be protected against damage.

(c) *Fuel flowmeter system.* If a fuel flowmeter system is installed, each metering component must have a means for bypassing the fuel supply if malfunction of that component severely restricts fuel flow.

(d) *Oil quantity indicator.* There must be means to indicate the quantity of oil in each tank—

(1) On the ground (including during the filling of each tank); and

(2) In flight, if there is an oil transfer system or reserve oil supply system.

ELECTRICAL SYSTEMS AND EQUIPMENT

§ 27.1351 General.

(a) *Electrical system capacity.* Electrical equipment must be adequate for its intended use. In addition—

(1) Electric power sources, their transmission cables, and their associated control and protective devices must be able to furnish the required power at the proper voltage to each load circuit essential for safe operation; and

(2) Compliance with subparagraph (1) of this paragraph must be shown by an electrical load analysis, or by electrical measurements that take into account the electrical loads applied to the electrical system, in probable combinations and for probable durations.

(b) *Function.* For each electrical system, the following apply:

(1) Each system, when installed, must be—

(i) Free from hazards in itself, in its method of operation, and in its effects on other parts of the rotorcraft; and

(ii) Protected from fuel, oil, water, other detrimental substances, and mechanical damage.

(2) Electric power sources must function properly when connected in combination or independently.

(3) No failure or malfunction of any source may impair the ability of any remaining source to supply load circuits essential for safe operation.

(4) Each electric power source control must allow the independent operation of each source.

(c) *Generating system.* There must be at least one generator if the system supplies power to load circuits essential for safe operation. In addition—

(1) Each generator must be able to deliver its continuous rated power;

(2) Generator voltage control equipment must be able to dependably regulate each generator output within rated limits; and

(3) Each generator must have a reverse current cutout designed to disconnect the generator from the battery and from the other generators when enough reverse current exists to damage that generator.

(d) *Instruments.* There must be means to indicate to appropriate crewmembers the electric power system quantities essential for safe operation of the system. In addition—

(1) For direct current systems, an ammeter that can be switched into each generator feeder may be used; and

(2) If there is only one generator, the ammeter may be in the battery feeder.

§ 27.1353 Storage battery design and installation.

(a) Each storage battery must be designed and installed as prescribed in this section.

(b) Safe cell temperatures and pressures must be maintained during any probable charging and discharging condition. No uncontrolled increase in cell temperature may result when the battery is recharged (after previous complete discharge)—

(1) At maximum regulated voltage;

(2) During a flight of maximum duration; and

(3) Under the most adverse cooling condition likely to occur in service.

(c) Compliance with paragraph (b) of this section must be shown by test unless experience with similar batteries and installations has shown that maintaining safe cell temperatures and pressures presents no problem.

(d) No explosive or toxic gases emitted by any battery in normal operation, or as the result of any probable malfunction in the charging system or battery installation, may accumulate in hazardous quantities within the rotorcraft.

(e) No corrosive fluids or gases that may escape from the battery may damage surrounding structures or adjacent essential equipment.

§ 27.1357 Circuit protective devices.

(a) Protective devices, such as fuses or circuit breakers, must be installed in each electrical circuit other than—

(1) The main circuits of starter motors; and

(2) Circuits in which no hazard is presented by their omission.

(b) No protective device may protect more than one circuit essential to flight safety.

(c) Each resettable circuit protective device ("trip free" device in which the tripping mechanism cannot be overridden by the operating control) must be designed so that—

(1) A manual operation is required to restore service after tripping; and

(2) If an overload or circuit fault exists, the device will open the circuit regardless of the position of the operating control.

(d) If the ability to reset a circuit breaker or replace a fuse is essential to safety in flight, that circuit breaker or fuse must be located and identified so that it can be readily reset or replaced in flight.

(e) If fuses are used, there must be one spare of each rating, or 50 percent spare fuses of each rating, whichever is greater.

§ 27.1361 Master switch.

(a) There must be a master switch arrangement to allow ready disconnection of each electric power source from the main bus. The point of disconnection must be adjacent to the sources controlled by the switch.

(b) Load circuits may be connected so that they remain energized after the switch is opened, if they are protected by

circuit protective devices, rated at five amperes or less, adjacent to the electric power source.

(c) The master switch or its controls must be installed so that the switch is easily discernible and accessible to a crewmember in flight.

§ 27.1365 Electric cables.

(a) Each electric connecting cable must be of adequate capacity.

(b) Each cable that would overheat in the event of circuit overload or fault must be at least flame resistant and may not emit dangerous quantities of toxic fumes.

§ 27.1367 Switches.

Each switch must be—

(a) Able to carry its rated current;

(b) Accessible to the crew; and

(c) Labeled as to operation and the circuit controlled.

LIGHTS

§ 27.1381 Instrument lights.

The instrument lights must—

(a) Make each instrument, switch, and other devices for which they are provided easily readable; and

(b) Be installed so that—

(1) Their direct rays are shielded from the pilot's eyes; and

(2) No objectionable reflections are visible to the pilot.

§ 27.1383 Landing lights.

(a) Each required landing or hovering light must be approved.

(b) Each landing light must be installed so that—

(1) No objectionable glare is visible to the pilot;

(2) The pilot is not adversely affected by halation; and

(3) It provides enough light for night operation, including hovering and landing.

(c) At least one separate switch must be provided, as applicable—

(1) For each separately installed landing light; and

(2) For each group of landing lights installed at a common location.

§ 27.1385 Position light system installation.

(a) *General.* Each part of each position light system must meet the applicable requirements of this section, and each system as a whole must meet the requirements of §§ 27.1387 through 27.1397.

(b) *Forward position lights.* Forward position lights must consist of a red and a green light spaced laterally as far apart as practicable and installed forward on the rotorcraft so that, with the rotorcraft in the normal flying position, the red light is on the left side and the green light is on the right side. Each light must be approved.

(c) *Rear position light.* The rear position light must be a white light mounted as far aft as practicable, and must be approved.

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

(e) *Light covers and color filters.* Each light cover or color filter must be at least flame resistant and may not change color or shape or lose any appreciable light transmission during normal use.

§ 27.1387 Position light system dihedral angles.

(a) Each forward and rear position light must, as installed, show unbroken light within the dihedral angles described in this section.

(b) Dihedral angle *L* (left) is formed by two intersecting vertical planes, the first parallel to the longitudinal axis of the rotorcraft, and the other at 110 degrees to the left of the first, as viewed when looking forward along the longitudinal axis.

(c) Dihedral angle *R* (right) is formed by two intersecting vertical planes, the first parallel to the longitudinal axis of the rotorcraft, and the other at 110 degrees to the right of the first, as viewed when looking forward along the longitudinal axis.

(d) Dihedral angle *A* (aft) is formed by two intersecting vertical planes making angles of 70 degrees to the right and to the left, respectively, to a vertical plane passing through the longitudinal axis, as viewed when looking aft along the longitudinal axis.

§ 27.1389 Position light distribution and intensities.

(a) *General.* The intensities prescribed in this section must be provided by new equipment with light covers and color filters in place. Intensities must be determined with the light source operating at a steady value equal to the average luminous output of the source at the normal operating voltage of the rotorcraft. The light distribution and intensity of each position light must meet the requirements of paragraph (b) of this section.

(b) *Forward and rear position lights.* The light distribution and intensities of forward and rear position lights must be expressed in terms of minimum intensities in the horizontal plane, minimum intensities in any vertical plane, and maximum intensities in overlapping beams, within dihedral angles *L*, *R*, and *A*, and must meet the following requirements:

(1) *Intensities in the horizontal plane.* Each intensity in the horizontal plane (the plane containing the longitudinal axis of the rotorcraft and perpendicular to the plane of symmetry of the rotorcraft) must equal or exceed the values in § 27.1391.

(2) *Intensities in any vertical plane.* Each intensity in any vertical plane (the plane perpendicular to the horizontal plane) must equal or exceed the appropriate value in § 27.1393, where *I* is the minimum intensity prescribed in § 27.1391 for the corresponding angles in the horizontal plane.

(3) *Intensities in overlaps between adjacent signals.* No intensity in any overlap between adjacent signals may exceed the values in § 27.1395, except that higher intensities in overlaps may be used with main beam intensities substantially greater than the minima specified in §§ 27.1391 and 27.1393, if the overlap intensities in relation to the main beam intensities do not adversely affect signal clarity. When the peak intensity of the forward position lights is greater than 100 candles, the maximum overlap intensities between them may exceed the values in § 27.1395 if the overlap intensity in Area A is not more than 10 percent of peak position light intensity and the overlap intensity in Area B is not more than 2.5 percent of peak position light intensity.

§ 27.1391 Minimum intensities in the horizontal plane of forward and rear position lights.

Each position light intensity must equal or exceed the applicable values in the following table:

Dihedral angle (light included)	Angle from right or left of longitudinal axis, measured from dead ahead	Intensity (candles)
L and *R* (forward red and green).	0° to 10°	40
	10° to 20°	30
	20° to 110°	5
A (rear white)	110° to 180°	20

§ 27.1393 Minimum intensities in any vertical plane of forward and rear position lights.

Each position light intensity must equal or exceed the applicable values in the following table:

Angle above or below the horizontal plane:	*Intensity*
0°	1.00 *I*.
0° to 5°	0.90 *I*.
5° to 10°	0.80 *I*.
10° to 15°	0.70 *I*.
15° to 20°	0.50 *I*.
20° to 30°	0.30 *I*.
30° to 40°	0.10 *I*.
40° to 90°	0.05 *I*.

§ 27.1395 Maximum intensities in overlapping beams of forward and rear position lights.

No position light intensity may exceed the applicable values in the following table, except as provided in § 27.1389 (b) (3).

Overlaps	Maximum intensity	
	Area A (candles)	Area B (candles)
Green in dihedral angle *L*	10	1
Red in dihedral angle *R*	10	1
Green in dihedral angle *A*	5	1
Red in dihedral angle *A*	5	1
Rear white in dihedral angle *L*	5	1
Rear white in dihedral angle *R*	5	1

Where—

(a) Area A includes all directions in the adjacent dihedral angle that pass through the light source and intersect the common boundary plane at more than 10 degrees but less than 20 degrees; and

(b) Area B includes all directions in the adjacent dihedral angle that pass through the light source and intersect the common boundary plane at more than 20 degrees.

§ 27.1397 Color specifications.

Each position light color must have the applicable International Commission on Illumination chromaticity coordinates as follows:

(a) *Aviation red*—

"y" is not greater than 0.335; and
"z" is not greater than 0.002.

(b) *Aviation green*—

"x" is not greater than $0.440-0.320y$;
"x" is not greater than $y-0.170$; and
"y" is not less than $0.390-0.170x$.

(c) *Aviation white*—

"x" is not less than 0.350;
"x" is not greater than 0.540; and
"$y-y_0$" is not numerically greater than 0.01, "y_0" being the y coordinate of the Planckian radiator for which $x_0=x$.

§ 27.1399 Riding light.

(a) Each riding light required for water operation must be installed so that it can—

(1) Show a white light for at least two miles at night under clear atmospheric conditions; and

(2) Show a maximum practicable unbroken light with the rotorcraft on the water.

(b) Externally hung lights may be used.

§ 27.1401 Anticollision light system.

(a) *General.* If certification for night operation is requested, the rotorcraft must have an anticollision light system that—

(1) Consists of one or more approved anticollision lights located so that their emitted light will not impair the crew's vision or detract from the conspicuity of the position lights; and

(2) Meets the requirements of paragraphs (b) through (f) of this section.

(b) *Field of coverage.* The system must consist of enough lights to illuminate the vital areas around the rotorcraft, considering the physical configuration and flight characteristics of the rotorcraft. The field of coverage must extend in each direction within at least 30 degrees above and 30 degrees below the horizontal plane of the rotorcraft, except that there may be solid angles of obstructed visibility totaling not more than 0.5 steradians.

(c) *Flashing characteristics.* The arrangement of the system, that is, the number of light sources, beam width, speed of rotation, and other characteristics, must give an effective flash frequency of not less than 40, nor more than 100, cycles per minute. The effective flash frequency is the frequency at which the rotorcraft's complete anticollision light system is observed from a distance, and applies to each sector of light including any overlaps that exist when the system consists of more than one light source. In overlaps, flash frequencies may exceed 100, but not 180, cycles per minute.

(d) *Color.* Each anticollision light must be aviation red and must meet the requirements of § 27.1397(a).

(e) *Light intensity.* The minimum light intensities in any vertical plane, measured with the red filter and expressed in terms of "effective" intensities, must meet the requirements of paragraph (f) of this section. The following relation must be assumed:

$$I_e=\frac{\int_{t_1}^{t_2} I(t)\,dt}{0.2+(t_2-t_1)};$$

where:

I_e = effective intensity (candles).
$I(t)$ = instantaneous intensity as a function of time.
t_2-t_1 = flash time interval (seconds).

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

(f) *Minimum effective intensities for anticollision lights.* Each anticollision light effective intensity must equal or exceed the applicable values in the following table.

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

SAFETY EQUIPMENT

§ 27.1411 General.

Required safety equipment to be used by the crew in an emergency, such as flares and automatic liferaft releases, must be readily accessible.

§ 27.1413 Safety belts.

(a) The rated strength of safety belts may not be less than that corresponding with the ultimate load factors specified in § 27.561(b), considering the dimensional characteristics of the belt installation for the specific seat or berth arrangement.

(b) Each belt must be attached so that no part of its anchorage can fail at a load lower than that corresponding with the ultimate load factors specified in § 27.561(b).

§ 27.1415 Ditching equipment.

(a) Emergency flotation and signaling equipment required by any operating rule in this chapter must meet the requirements of this section.

(b) Each raft and each life preserver must be approved and must be installed so that it is readily available to the crew and passengers.

(c) Each raft released automatically or by the pilot must be attached to the rotorcraft by a line to keep it alongside the rotorcraft. This line must be weak enough to break before submerging the empty raft to which it is attached.

(d) Each signaling device must be free from hazard in its operation and must be installed in an accessible location.

§ 27.1435 Hydraulic systems.

(a) *Design.* Each hydraulic system and its elements must withstand, without yielding, any structural loads expected in addition to hydraulic loads.

(b) *Tests.* Each system must be substantiated by proof pressure tests. When proof tested, no part of any system may fail, malfunction, or experience a permanent set. The proof load of each system must be at least 1.5 times the maximum operating pressure of that system.

(c) *Accumulators.* No hydraulic accumulator or pressurized reservoir may be installed on the engine side of any firewall unless it is an integral part of an engine.

Subpart G—Operating Limitations and Information

§ 27.1501 General.

Each operating limitation specified in §§ 27.1503 through 27.1525 and other information necessary for safe operation, must be—

(a) Included in the Rotorcraft Flight Manual;

(b) Expressed in markings and placards; and

(c) Made available by any other means that will convey the information to the crewmembers.

OPERATING LIMITATIONS

§ 27.1503 Airspeed limitations: general.

(a) An operating speed range must be established.

(b) When airspeed limitations are a function of weight, weight distribution, altitude, rotor speed, power, or other factors, airspeed limitations corresponding with the critical combinations of these factors must be established.

§ 27.1505 Never-exceed speed.

(a) The never-exceed speed V_{NE} must be established so that it is—

(1) Not less than V_Y with the engines at maximum continuous power; and

(2) Not more than the lesser of—

(i) 0.9V established under § 27.309; and

(ii) 0.9 times the maximum speed shown under §§ 27.251 and 27.629.

(b) V_{NE} may vary with altitude and rotor r.p.m., if the ranges of these variables are large enough to allow an operationally practical and safe variation of V_{NE}.

§ 27.1509 Rotor speed.

(a) *Maximum power off (autorotation).* The maximum power-off rotor speed must be established so that it does not exceed 95 percent of the lesser of—

(1) The maximum design r.p.m. determined under § 27.309(b); and

(2) The maximum r.p.m. shown during the type tests.

(b) *Minimum power off.* The minimum power-off rotor speed must be established so that it is not less than 105 percent of the greater of—

(1) The minimum shown during the type tests; and

(2) The minimum determined by design substantiation.

(c) *Minimum power on.* The minimum power-on rotor speed must be established so that it is—

(1) Not less than the greater of—

(i) The minimum shown during the type tests; and

(ii) The minimum determined by design substantiation; and

(2) Not more than a value determined under § 27.33(a)(1) and (b)(1).

§ 27.1519 Weight and center of gravity.

The weight and center of gravity limitations determined under §§ 27.25 and 27.27, respectively, must be established as operating limitations.

§ 27.1521 Powerplant limitations.

(a) *General.* The powerplant limitations prescribed in this section must be established so that they do not exceed the corresponding limits for which the engines are type certificated.

(b) *Takeoff operation.* The powerplant takeoff operation must be limited by—

(1) The maximum rotational speed, which may not be greater than—

(i) The maximum value determined by the rotor design; or

(ii) The maximum value shown during the type tests;

(2) The maximum allowable manifold pressure (for reciprocating engines);

(3) The time limit for the use of the power corresponding to the limitations established in subparagraphs (1) and (2) of this paragraph;

(4) If the time limit in subparagraph (3) of this paragraph exceeds two minutes, the maximum allowable cylinder head, coolant outlet, or oil temperatures;

(5) The gas temperature limits for turbine engines over the range of operating and atmospheric conditions for which certification is requested.

(c) *Continuous operation.* The continuous operation must be limited by—

(1) The maximum rotational speed, which may not be greater than—

(i) The maximum value determined by the rotor design; or

(ii) The maximum value shown during the type tests;

(2) The minimum rotational speed shown under the rotor speed requirements in § 27.1509(c); and

(3) The gas temperature limits for turbine engines over the range of operating and atmospheric conditions for which certification is requested.

(d) *Fuel grade or designation.* The minimum fuel grade (for reciprocating engines), or fuel designation (for turbine engines), must be established so that it is not less than that required for the operation of the engines within the limitations in paragraphs (b) and (c) of this section.

(e) *Turboshaft engine torque.* For rotorcraft with main rotors driven by turboshaft engines, and that do not have a torque limiting device in the transmission system, the following apply:

(1) A limit engine torque must be established if the maximum torque that the engine can exert is greater than—

(i) The torque that the rotor drive system is designed to transmit; or

(ii) The torque that the main rotor assembly is designed to withstand in showing compliance with § 27.547(e).

(2) The limit engine torque established under subparagraph (1) of this paragraph may not exceed either torque specified in subdivision (1) (i) or (ii) of this paragraph.

§ 27.1523 Minimum flight crew.

The minimum flight crew must be established so that it is sufficient for safe operation, considering—

(a) The workload on individual crewmembers;

(b) The accessibility and ease of operation of necessary controls by the appropriate crewmember; and

(c) The kinds of operation authorized under § 27.1525.

§ 27.1525 Kinds of operation.

The kinds of operation to which the rotorcraft is limited are established by the flight characteristics and installed equipment.

§ 27.1529 Maintenance manual.

Each rotorcraft must have a maintenance manual containing any information that the applicant considers essential for proper maintenance, including recommended limits on service life or retirement periods for major components. These components must be identified by serial number or equivalent means.

MARKINGS AND PLACARDS

§ 27.1541 General.

(a) The rotorcraft must contain—

(1) The markings and placards specified in §§ 27.1545 through 27.1565, and

(2) Any additional information, instrument markings, and placards required for the safe operation of rotorcraft with unusual design, operating or handling characteristics.

(b) Each marking and placard prescribed in paragraph (a) of this section—

(1) Must be displayed in a conspicuous place; and

(2) May not be easily erased, disfigured, or obscured.

§ 27.1543 Instrument markings: general.

For each instrument—

(a) When markings are on the cover glass of the instrument, there must be means to maintain the correct alignment of the glass cover with the face of the dial; and

(b) Each arc and line must be wide enough, and located, to be clearly visible to the pilot.

§ 27.1545 Airspeed indicator.

(a) Each airspeed indicator must be marked to show indicated airspeed.

(b) The following markings must be made:

(1) For the limit beyond which operation is dangerous, a red radial line.

(2) For the caution range, a yellow arc.

(3) For the safe operating range, a green arc.

§ 27.1547 Magnetic direction indicator.

(a) A placard meeting the requirements of this section must be installed on or near the magnetic direction indicator.

(b) The placard must show the calibration of the instrument in level flight with the engines operating.

(c) The placard must state whether the calibration was made with radio receivers on or off.

(d) Each calibration reading must be in terms of magnetic heading in not more than 45 degree increments.

§ 27.1549 Powerplant instruments.

For each required powerplant instrument—

(a) Each maximum and, if applicable, minimum safe operating limit must be marked with a red radial line;

(b) Each normal operating range must be marked with a green arc not extending beyond the maximum and minimum safe operating limits; and

(c) Each takeoff and precautionary range must be marked with a yellow arc.

§ 27.1551 Oil quantity indicator.

Each oil quantity indicator must be marked with enough increments to indicate readily and accurately the quantity of oil.

§ 27.1553 Fuel quantity indicator.

If the unusable fuel supply for any tank exceeds one gallon, or five percent of the tank capacity, whichever is greater, a red arc must be marked on its indicator extending from the calibrated zero reading to the lowest reading obtainable in level flight.

§ 27.1555 Control markings.

(a) Each cockpit control must be plainly marked as to its function and method of operation.

(b) For powerplant fuel controls—

(1) Each fuel tank selector control must be marked to indicate the position corresponding to each tank and to each existing cross feed position;

(2) If safe operation requires the use of any tanks in a specific sequence, that sequence must be marked on, or adjacent to, the selector for those tanks; and

(3) Each valve control for any engine of a multiengine rotorcraft must be marked to indicate the position corresponding to each engine controlled.

(c) The capacity of each tank must be marked on, or near each selector controlling that tank.

(d) For accessory, auxiliary, and emergency controls—

(1) Each essential visual position indicator, such as those showing rotor pitch or landing gear position, must be marked so that each crewmember can determine at any time the position of the unit to which it relates; and

(2) Each emergency control must be red and must be marked as to method of operation.

§ 27.1557 Miscellaneous markings and placards.

(a) *Baggage and cargo compartments, and ballast location.* Each baggage and cargo compartment, and each ballast location must have a placard stating any limitations on contents, including weight, that are necessary under the loading requirements.

(b) *Seats.* If the maximum allowable weight to be carried in a seat is less than 170 pounds, a placard stating the lesser weight must be permanently attached to the seat structure.

(c) *Fuel and oil filler openings.* The following must be marked on, or near, each appropriate filler cover:

(1) The word "fuel", the minimum fuel grade or designation for the engines, and the usable fuel tank capacity.

(2) The word "oil" and the oil tank capacity.

(d) *Emergency exit placards.* Each placard and operating control for each emergency exit must be red. A placard must be near each emergency exit control and must clearly indicate the location of that exit and its method of operation.

§ 27.1559 Operating limitations placard.

There must be a placard 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."

§ 27.1561 Safety equipment.

(a) Each safety equipment control to be operated by the crew in emergency, such as controls for automatic liferaft releases, must be plainly marked as to its method of operation.

(b) Each location, such as a locker or compartment, that carries any fire extinguishing, signaling, or other life saving equipment, must be so marked.

§ 27.1565 Tail rotor.

Each tail rotor must be marked so that its disc is conspicuous under normal ground conditions.

ROTORCRAFT FLIGHT MANUAL

§ 27.1581 General.

(a) *Furnishing information.* The applicable information in §§ 27.1583 through 27.1589 must be furnished—

(1) For each rotorcraft other than a helicopter, in a Rotorcraft Flight Manual; and

(2) For each helicopter, in a Rotorcraft Flight Manual or in any combination of manuals, markings, and placards.

(b) *Approval and segregation of information.* Each part of the Rotorcraft Flight Manual containing information prescribed in §§ 27.1583 through 27.1589 must be approved, segregated, identified, and clearly distinguished from each unapproved part of that manual.

(c) *Additional information.* Any information not specified in §§ 27.1583 through 27.1589 that is required for safe operation because of unusual design, operating, or handling characteristics, must be furnished.

§ 27.1583 Operating limitations.

(a) *Airspeed and rotor limitations.* Information necessary for the marking of airspeed and rotor limitations on, or near, their respective indicators must be furnished. The significance of each limitation and of the color coding must be explained.

(b) *Powerplant limitations.* Information must be furnished to explain the powerplant limitations, and to allow marking the instruments under §§ 27.1549 through 27.1553.

(c) *Weight and loading distribution.* The weight and center of gravity limits required by §§ 27.25 and 27.27, respectively, must be furnished, together with the items included in the empty weight in § 27.29(a). If the variety of possible loading conditions warrants, instructions must be included to allow ready 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 under § 27.1523 must be furnished.

(e) *Kinds of operation.* Each kind of operation for which the rotorcraft and its equipment installations are approved must be listed.

(f) *Unusable fuel.* If the unusable fuel in any tank exceeds one gallon, or five percent of tank capacity, whichever is greater, there must be means to warn the flight personnel that the fuel remaining in that tank when the quantity indicator reads "zero" cannot be used safely in flight.

§ 27.1585 Operating procedures.

Parts of the manual containing operating procedures must have information concerning any normal and emergency procedures, and other information necessary for safe operation, including takeoff and landing procedures and associated airspeeds.

§ 27.1587 Peformance information.

(a) The rotorcraft must be furnished with—

(1) Enough information to determine the limiting height-speed envelope; and

(2) Information relative to—

(i) The hovering ceilings and the steady rates of climb and descent, as affected by any pertinent factors such as airspeed, temperature, and altitude; and

(ii) The maximum safe wind for operation near the ground.

(b) The Rotorcraft Flight Manual (if provided) must contain—

(1) In its performance information section any pertinent information concerning the takeoff weights and altitudes used in compliance with § 27.51; and

(2) In its operating procedures section—

(i) Any pertinent information concerning the takeoff procedure, including the kind of takeoff surface used in the tests and each appropriate climbout speed; and

(ii) Any pertinent landing procedures, including the kind of landing surface used in the tests and appropriate approach and glide airspeeds.

§ 27.1589 Loading information.

There must be loading instructions for each possible loading condition between the maximum and minimum weights determined under § 27.25 that can result in a center of gravity beyond any extreme prescribed in § 27.27, assuming any probable occupant weights.

DISTRIBUTION TABLE

Former section	Revised section
6.0 (1st sentence)	27.1.
6.0 (less 1st sentence)	Surplusage.
6.1(a)(1)	Part 1 [New].
6.1(a)(2)	Surplusage.
6.1(a) (less (1) and (2))	Part 1 [New].
6.1(b)	Part 1 [New].
6.1(c)(1)	Part 1 [New].
6.1(c)(2)	Surplusage.
6.1(c)(3)	Part 1 [New].
6.1(c)(4)	Part 1 [New].
6.1(c) less (1) through (4)	Surplusage.
6.1(d)(1)-(d)(2)	Executed.
6.1(d)(3)	Surplusage.
6.1(d)(4)-(d)(5)	Executed
6.1(d) (less (1)-(5))	Surplusage.
6.1(e)(1) (less symbol "IAS").	Part 1 [New].
Symbol "IAS"	To be transferred to Part 1 [New].
6.1(e)(2)	Part 1 [New].
6.1(e)(3) (less symbol "EAS").	Part 1 [New].
Symbol "EAS"	To be transferred to Part 1 [New].
6.1(e)(4) (less symbol "TAS").	Part 1 [New].
Symbol "TAS"	To be transferred to Part 1 [New].
6.1(e) (less (1)-(4))	To be transferred to Part 1 [New].
6.1(f) (1) and (2)	Executed.
6.1(f)(3)	Surplusage.
6.1(f)(4)	To be transferred to Part 1 [New].
6.1(f) (5) and (6)	Surplusage.
6.1(f) (less (1)-(6))	Executed.
6.1(g) (1)-(3)	Part 1 [New].
6.1(g)(4)	Surplusage.
6.1(g)(5)	Part 1 [New].
6.1(g) (less (1)-(5))	To be transferred to Part 1 [New].
6.1(h)(1)	Surplusage.
6.1(h) (2) and (3)	Part 1 [New].
6.1(h) (4) and (5)	Surplusage.
6.1(h) (less (1)-(5))	27.339.
6.1(i) (1)-(4)	Part 1 [New].
6.1 (less (a)-(h) and (i)(1)-(i)(4)).	Part 1 [New].
6.10-6.19	To be transferred to proposed Part 21 [New].
6.100 (a)-(c)	27.21.
6.100 (less (a)-(c))	To be transferred to proposed Part 21 [New].
6.101	27.25.
6.102(a)	27.27.
6.102 (less (a))	27.1589.
6.103	27.33.
6.104	27.29.
6.105	27.31.
6.110	27.45.
6.111(d)	27.1587.
6.111 (less (d))	27.51.
6.112 (a) and (b)	27.65.
6.112 (less (a) and (b))	27.67.
6.113	27.73.
6.114 (2d sentence)	27.1587.
6.114 (less 2d sentence)	27.75.
6.114-1	Not a rule.
6.115	27.75.
6.116	27.79.
6.120	27.141.
6.121 (less (c))	27.143.
6.121(c)	Out of date.
6.122	27.161.
6.123 (less (b))	27.171.
6.123(b) (less (1)-(4))	27.173.
6.123(b) (1)-(4)	27.175.
6.130	27.231.
6.131	27.241.
6.132	27.239.
6.140 (vibration aspect)	27.251.
6.140 (less vibration aspect)	27.629.
6.200(b)	27.303.
6.200 (less (b))	27.301.
6.201	27.305.
6.202 (less (c))	27.307.
6.202(c)	Surplusage.
6.203	27.307.
6.203-1	Not a rule.
6.204	27.309.
6.210	27.321.
6.211	27.321.
6.212 (last sentence)	27.339.
6.212 (less last sentence)	27.337.
6.213	27.341.
6.220	27.391.
6.221	27.401.
6.221-1	Not a rule.
6.222	27.403.
6.223	27.411.
6.224	27.413.
6.225(a) (1), (2), and (3)	27.397.
6.225 (less (a) (1), (2), and (3)).	27.395.
6.226	27.399.
6.230 (a) and (b)	27.471.
6.230 (c) and (d)	27.473.
6.230(e)	27.475.
6.230 (less (a)-(e))	27.477.
6.231	27.479.
6.231-1	Not a rule.
6.232	27.481.
6.233	27.483.
6.234	27.485.
6.235	27.493.
6.236	27.235.
6.237 (introductory paragraph).	27.723.
6.237(a)	27.725.
6.237 (less introductory paragraph and (a)).	27.727.
6.240	27.505.
6.245	27.521.
6.246	27.497.
6.247	27.501.
6.250	27.547.
6.250-1	Not a rule.
6.251(c) (2d-4th sentences)	27.361.
6.251 (less (c) (2d-4th sentences)).	27.549.
6.260	27.561.
6.300	27.601.
6.301	27.603.
6.302	27.605.
6.303	27.607.
6.304	27.609.
6.305	27.611.
6.306	27.613.
6.307(a)	27.619.
6.307(b)	27.621.
6.307(c)	27.623.
6.307 (less (a)-(c))	27.625.
6.310	27.653.
6.311	27.675.
6.312	27.659.
6.313	27.661.
6.320	27.671.
6.321	27.675.
6.322	27.679.
6.323	27.681.
6.324	27.683.
6.325	27.685.
6.326	27.687.
6.327	27.691.
6.328	27.695.
6.335	27.731.
6.336	27.735.
6.337	27.733.
6.338	27.737.
6.340	Surplusage.
6.341 (a) and (b)	27.751.
6.341 (less (a) and (b))	27.755.
6.342	27.753.
6.350	27.771.
6.351	27.773.
6.352	27.775.
6.353	27.777.
6.354	27.783.
6.355	27.785.
6.355-1 (less 1st sentence)	27.785.
6.355-1 (1st sentence)	Surplusage.
6.356	27.787.
6.357	27.807.
6.358	27.831.
6.380	Surplusage.
6.381	27.853.
6.382	27.855.
6.383	27.859.
6.384	27.861.
6.390	27.871.
6.391	27.873.
6.400	27.901.
6.400-1	27.901.
6.401 (less (c))	27.903.
6.401(c)	27.141.
6.402	27.907.
6.410	27.917.
6.411	27.921.
6.412	27.923.
6.413	27.927.
6.414	27.931.
6.415	27.935.
6.418	27.951.
6.419	27.953.
6.420	27.955.
6.421	27.959.
6.422	27.963.
6.423(a)	27.969.
6.423(b)	27.971.
6.423(c)	27.973.
6.423(d)	27.975.
6.423 (less (a)-(d))	27.977.
6.424 (less 2d and 3d sentences of note following (a)).	27.991.
2d and 3d sentences of note following § 6.424(a).	Not a rule.
6.425(e)	27.961.
6.425 (less (e))	27.993.
6.426	27.995.
6.427	27.997.
6.428	27.999.
6.429	27.1337.
6.440	27.1011.
6.441	27.1013.
6.442	27.1017.
6.443	27.1021.
6.444	27.1337.
6.447	27.1019.
6.450	27.1041.
6.451 (1st sentence)	27.1041.
6.451 (less 1st sentence)	27.1043.
6.452	27.1045.
6.460	27.1091.
6.461	27.1091.
6.461-1	Not a rule.
6.462	27.1093.
6.463	27.1121.
6.470	27.1141.
6.471	27.1143.
6.472	27.1145.
6.473	27.1147.
6.474	27.1163.
6.480	Surplusage.
Note following § 6.480	Not a rule.

Former section	Revised section
6.481	27.1187.
6.482	27.1189.
6.483	27.1191.
6.484	27.1193.
6.485	27.1183.
6.486	27.1185.
6.600	Surplusage.
6.601	27.1301.
6.602	Surplusage.
6.603	27.1303.
6.604	27.1305.
6.605	27.1307.
6.606	27.1309.
6.610	Surplusage.
6.611	27.1321.
6.612 (less (b) and (c))	27.1323.
6.612(b)	27.1325.
6.612(c) (less last sentence)	27.1327.
6.612(c) (last sentence)	Surplusage.
6.613	27.1337.
6.617	27.1351.
6.618	27.1351.
6.619	27.1353.
6.620	27.1351.
6.621	27.1351.
6.622	27.1351.
6.623	27.1361.
6.624	27.1361.
6.625 (less last sentence of note following).	27.1357.
Last sentence of note following § 6.625.	Not a rule.
6.626	27.1357.
6.627	27.1365.
6.628	27.1367.
6.630	27.1381.
6.631	27.1383.
6.632 (less note following (a)).	27.1385.
Note following § 6.632(a)	Not a rule.
6.633	27.1387.
6.634	27.1389.
6.634–1 (less footnote 2)	27.1389.
Footnote 2 of § 6.634–1	Not a rule.
Figure 6–1	27.1391.
Figure 6–2	27.1393.
Figure 6–3 and note following	27.1395.
6.635	27.1397.
6.636	27.1399.
6.637	27.1401.
Figure 6–4	27.1401.
6.637–1	Obsolete.
6.640	27.1411.
6.643	27.1413.
6.644	27.1415.
6.650	27.1435.
6.700(a)	Surplusage.
6.700 (less (a))	27.1501.
6.710	27.1503.
6.711	27.1505.
6.712	27.1503.
6.713	27.1509.
6.714	27.1521.
6.716	27.1519.
6.717	27.1523.
6.718	27.1525.
6.719	27.1529.
6.730	27.1541.
6.731	27.1543.
6.732	27.1545.
6.733	27.1547.
6.734	27.1549.
6.735	27.1551.
6.736 (less last sentence)	27.1553.
Last sentence of § 6.736	Surplusage.
6.737	27.1555.
6.738(a)–(c)	27.1557.
6.738(d)	27.1559.
6.738(e)	27.1561.
6.738 (less (a)–(e))	27.1565.
6.740	27.1581.
6.741	27.1583.
6.742	27.1585.
6.743	27.1587.
6.744	Surplusage.
6.750–6.751	To be transferred to Part 45 [New].
Appendix A	Not a rule.
Appendix B:	
SR 392C	Expired.
SR 392D	Expired.
SR 425C	To be transferred to proposed Part 21 [New].

[F.R. Doc. 64–12026; Filed, Nov. 23, 1964; 8:50 a.m.]

Title 14—AERONAUTICS AND SPACE

Chapter I—Federal Aviation Agency

[Regulatory Docket No. 5074]

PART 27—AIRWORTHINESS STANDARDS: NORMAL CATEGORY ROTORCRAFT [NEW]

Correction

In Federal Register Document 64-12026, published at page 15694 in the issue dated Tuesday, November 24, 1964, the effective date, appearing in the fourth from last paragraph preceding signature, should read "effective February 1, 1965".

Title 14—AERONAUTICS AND SPACE

Chapter I—Federal Aviation Agency

[Regulatory Docket No. 5074]

PART 27—AIRWORTHINESS STANDARDS: NORMAL CATEGORY ROTORCRAFT [NEW]

Correction

In Federal Register Document 64-12026, published at page 15694 in the issue of November 24, 1964, the word "restricted", appearing in the second line of § 27.479(c), should read "resisted".