paragraph (a) of this section to the FAA Oversight Office for approval on the following schedule:

(1) For holders of type certificates, no later than 90 days after January 11, 2008.

(2) For holders of supplemental type certificates no later than 180 days after January 11, 2008.

(3) For applicants for changes to type certificates whose application are submitted before January 11, 2008, no later than 180 days after January 11, 2008.

(c) *Compliance Plan Implementation.* Each affected person must implement the compliance plan as approved in compliance with paragraph (a) of this section.

PART 27—AIRWORTHINESS STANDARDS: NORMAL CATEGORY ROTORCRAFT

Subpart A—General

Sec.

Subpart B—Flight

GENERAL

PERFORMANCE

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GENERAL

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AUTHORITY: 49 U.S.C. 106(g), 40113, 44701–44702, 44704.

SOURCE: Docket No. 5074, 29 FR 15695, Nov. 24, 1964, unless otherwise noted.

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 7,000 pounds or less and nine or less passenger seats.

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

(c) Multiengine rotorcraft may be type certified as Category A provided the requirements referenced in appendix C of this part are met.

[Doc. No. 5074, 29 FR 15695, Nov. 24, 1964, as amended by Amdt. 27–33, 61 FR 21906, May 10, 1996; Amdt. 27–37, 64 FR 45094, Aug. 18, 1999]

§ 27.2 Special retroactive requirements.

(a) For each rotorcraft manufactured after September 16, 1992, each applicant must show that each occupant's seat is equipped with a safety belt and shoulder harness that meets the requirements of paragraphs (a), (b), and (c) of this section.

(1) Each occupant's seat must have a combined safety belt and shoulder harness with a single-point release. Each pilot's combined safety belt and shoulder harness must allow each pilot, when seated with safety belt and shoulder harness fastened, to perform all functions necessary for flight operations. There must be a means to secure belts and harnesses, when not in use, to prevent interference with the operation of the rotorcraft and with rapid egress in an emergency.

(2) Each occupant must be protected from serious head injury by a safety belt plus a shoulder harness that will prevent the head from contacting any injurious object.

(3) The safety belt and shoulder harness must meet the static and dynamic strength requirements, if applicable, specified by the rotorcraft type certification basis.

(4) For purposes of this section, the date of manufacture is either—

(i) The date the inspection acceptance records, or equivalent, reflect that the rotorcraft is complete and meets the FAA-Approved Type Design Data; or

(ii) The date the foreign civil airworthiness authority certifies that the rotorcraft is complete and issues an original standard airworthiness certificate, or equivalent, in that country.

(b) For rotorcraft with a certification basis established prior to October 18, 1999—

(1) The maximum passenger seat capacity may be increased to eight or nine provided the applicant shows compliance with all the airworthiness requirements of this part in effect on October 18, 1999.

(2) The maximum weight may be increased to greater than 6,000 pounds provided—

(i) The number of passenger seats is not increased above the maximum number certificated on October 18, 1999, or

(ii) The applicant shows compliance with all of the airworthiness requirements of this part in effect on October 18, 1999.

[Doc. No. 26078, 56 FR 41051, Aug. 16, 1991, as amended by Amdt. 27–37, 64 FR 45094, Aug. 18, 1999]

Subpart B—Flight

GENERAL

§ 27.21 Proof of compliance.

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—

(a) 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

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

[Doc. No. 5074, 29 FR 15695, Nov. 24, 1964, as amended by Amdt. 27–21, 49 FR 44432, Nov. 6, 1984]

§ 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);

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

(iv) The highest weight in which the provisions of § 27.87 or § 27.143(c)(1), or combinations thereof, are demonstrated if the weights and operating conditions (altitude and temperature) prescribed by those requirements cannot be met; and

(2) Not less than the sum of—

(i) The empty weight determined under § 27.29; and

(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; and

(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

(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.

(c) *Total weight with jettisonable external load.* A total weight for the rotorcraft with a jettisonable external load attached that is greater than the maximum weight established under paragraph (a) of this section may be established for any rotorcraft-load combination if—

(1) The rotorcraft-load combination does not include human external cargo,

(2) Structural component approval for external load operations under either § 27.865 or under equivalent operational standards is obtained,

(3) The portion of the total weight that is greater than the maximum weight established under paragraph (a) of this section is made up only of the weight of all or part of the jettisonable external load,

(4) Structural components of the rotorcraft are shown to comply with the applicable structural requirements of this part under the increased loads

and stresses caused by the weight increase over that established under paragraph (a) of this section, and

(5) Operation of the rotorcraft at a total weight greater than the maximum certificated weight established under paragraph (a) of this section is limited by appropriate operating limitations under §27.865(a) and (d) of this part.

(Secs. 313(a), 601, 603, 604, and 605 of the Federal Aviation Act of 1958 (49 U.S.C. 1354(a), 1421, 1423, 1424, and 1425); and sec. 6(c) of the Dept. of Transportation Act (49 U.S.C. 1655(c)))

[Doc. No. 5074, 29 FR 15695, Nov. 29, 1964, as amended by Amdt. 27–11, 41 FR 55468, Dec. 20, 1976; Amdt. 25–42, 43 FR 2324, Jan. 16, 1978; Amdt. 27–36, 64 FR 43019, Aug. 6, 1999; Amdt. 27–44, 73 FR 10998, Feb. 29, 2008; 73 FR 33876, June 16, 2008]

§ 27.27 Center of gravity limits.

The extreme forward and aft centers of gravity and, where critical, the extreme lateral centers 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.

[Amdt. 27–2, 33 FR 962, Jan. 26, 1968]

§ 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; and

(3) Full operating fluids, including—

(i) Oil;

(ii) Hydraulic fluid; and

(iii) Other fluids required for normal operation of roto-craft systems, except water intended for injection in the engines.

(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.

(Secs. 313(a), 601, 603, 604, and 605 of the Federal Aviation Act of 1958 (49 U.S.C. 1354(a), 1421, 1423, 1424, and 1425); and sec. 6(c) of the Dept. of Transportation Act (49 U.S.C. 1655(c)))

[Doc. No. 5074, 29 FR 15695, Nov. 24, 1964, as amended by Amdt. 27–14, 43 FR 2324, Jan. 16, 1978]

§ 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 high pitch limits (power on)*. For rotocraft, except helicopters required to have a main rotor low speed warning under paragraph (e) of this section. It must be shown, with power on and without exceeding approved engine maximum limitations, that main rotor speeds substantially less than the minimum approved main rotor speed will not occur under any sustained flight condition. This must be met by—

(1) Appropriate setting of the main rotor high pitch stop;

(2) Inherent rotorcraft characteristics that make unsafe low main rotor speeds unlikely; or

(3) Adequate means to warn the pilot of unsafe main rotor speeds.

(c) *Normal main rotor low pitch limits (power off)*. It must be shown, with power off, that—

(1) The normal main rotor low pitch limit provides sufficient rotor speed, in any autorotative condition, under the most critical combinations of weight and airspeed; and

(2) It is possible to prevent overspeeding of the rotor without exceptional piloting skill.

(d) *Emergency high pitch*. If the main rotor high pitch stop is set to meet paragraph (b)(1) of this section, and if that stop cannot be exceeded inadvertently, additional pitch may be made available for emergency use.

(e) *Main rotor low speed warning for helicopters*. For each single engine helicopter, and each multiengine helicopter that does not have an approved device that automatically increases power on the operating engines when one engine fails, there must be a main rotor low speed warning which meets the following requirements:

(1) The warning must be furnished to the pilot in all flight conditions, including power-on and power-off flight, when the speed of a main rotor approaches a value that can jeopardize safe flight.

(2) The warning may be furnished either through the inherent aerodynamic qualities of the helicopter or by a device.

(3) The warning must be clear and distinct under all conditons, and must be clearly distinguishable from all other warnings. A visual device that requires the attention of the crew within the cockpit is not acceptable by itself.

(4) If a warning device is used, the device must automatically deactivate and reset when the low-speed condition is corrected. If the device has an audible warning, it must also be equipped with a means for the pilot to manually silence the audible warning before the low-speed condition is corrected.

(Secs. 313(a), 601, 603, 604, and 605 of the Federal Aviation Act of 1958 (49 U.S.C. 1354(a), 1421, 1423, 1424, and 1425); and sec. 6(c) of the Dept. of Transportation Act (49 U.S.C. 1655(c)))

[Doc. No. 5074, 29 FR 15695, Nov. 24, 1964, as amended by Amdt. 27–2, 33 FR 962, Jan. 26, 1968; Amdt. 27–14, 43 FR 2324, Jan. 16, 1978]

PERFORMANCE

§ 27.45 General.

(a) Unless otherwise prescribed, the performance requirements of this subpart must be met for still air and a standard atmosphere.

(b) The performance must correspond to the engine power available under the particular ambient atmospheric conditions, the particular flight condition, and the relative humidity specified in paragraphs (d) or (e) of this section, as appropriate.

(c) The available power must correspond to engine power, not exceeding the approved power, less—

(1) Installation losses; and

(2) The power absorbed by the accessories and services appropriate to the particular ambient atmopheric conditions and the particular flight condition.

(d) For reciprocating engine-powered rotorcraft, the performance, as affected by engine power, must be based on a relative humidity of 80 percent in a standard atmosphere.

(e) For turbine engine-powered rotorcraft, the performance, as affected by engine power, must be based on a relative humidity of—

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

(2) 34 percent, at and above standard temperature plus 50 degrees F. Between these two temperatures, the relative humidity must vary linearly.

(f) For turbine-engine-powered rotorcraft, a means must be provided to permit the pilot to determine prior to takeoff that each engine is capable of developing the power necessary to achieve the applicable rotorcraft performance prescribed in this subpart.

(Secs. 313(a), 601, 603, 604, and 605 of the Federal Aviation Act of 1958 (49 U.S.C. 1354(a), 1421, 1423, 1424, and 1425); and sec. 6(c) of the Dept. of Transportation Act (49 U.S.C. 1655(c)))

[Amdt. 27–14, 43 FR 2324, Jan. 16, 1978, as amended by Amdt. 27–21, 49 FR 44432, Nov. 6, 1984]

§ 27.49 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 paragraph (a)(1) of this section must be at least—

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

(ii) For turbine engine powered helicopters, 2,500 feet pressure altitude at maximum weight at a temperature of standard plus 22 °C (standard plus 40 °F).

(3) The out-of-ground effect hovering performance must be determined over the ranges of weight, altitude, and temperature for which certification is requested, using takeoff power.

(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.

[Amdt. 27–44, 73 FR 10998, Feb. 29, 2008]

§ 27.51 Takeoff.

The takeoff, with takeoff power and r.p.m. at the most critical center of gravity, and with weight from the maximum weight at sea level to the weight for which takeoff certification is requested for each altitude covered by this section—

(a) May not require exceptional piloting skill or exceptionally favorable conditions throughout the ranges of altitude from standard sea level conditions to the maximum altitude for which takeoff and landing certification is requested, and

(b) 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. This must be demonstrated up to the maximum altitude for which takeoff and landing certification is requested or 7,000 feet density altitude, whichever is less.

[Amdt. 27–44, 73 FR 10999, Feb. 29, 2008]

§ 27.65 Climb: all engines operating.

(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 in accordance with paragraph (a)(1) of this section, must be either—

(i) At least 1:10 if the horizontal distance required to take off and climb over a 50-foot obstacle is determined for each weight, altitude, and temperature within the range for which certification is requested; or

(ii) At least 1:6 under standard sea level conditions.

(b) Each helicopter must meet the following requirements:

(1) V_Y must be determined—

(i) For standard sea level conditions;

(ii) At maximum weight; and

(iii) With maximum continuous power on each engine.

(2) The steady rate of climb must be determined—

(i) At the climb speed selected by the applicant at or below V_{NE};

(ii) Within the range from sea level up to the maximum altitude for which certification is requested;

(iii) For the weights and temperatures that correspond to the altitude range set forth in paragraph (b)(2)(ii) of this section and for which certification is requested; and

(iv) With maximum continuous power on each engine.

(Secs. 313(a), 601, 603, 604, and 605 of the Federal Aviation Act of 1958 (49 U.S.C. 1354(a), 1421, 1423, 1424, and 1425); and sec. 6(c) of the Dept. of Transportation Act (49 U.S.C. 1655(c)))

[Doc. No. 5074, 29 FR 15695, Nov. 24, 1964, as amended by Amdt. 27–14, 43 FR 2324, Jan. 16, 1978; Amdt. 27–33, 61 FR 21907, May 10, 1996]

§ 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) The critical engine inoperative and the remaining engines at either—

(1) Maximum continuous power and, for helicopters for which certification for the use of 30-minute OEI power is requested, at 30-minute OEI power; or

(2) Continuous OEI power for helicopters for which certification for the use of continuous OEI power is requested.

(Secs. 313(a), 601, 603, 604, and 605 of the Federal Aviation Act of 1958 (49 U.S.C. 1354(a), 1421, 1423, 1424, and 1425); and sec. 6(c) of the Dept. of Transportation Act (49 U.S.C. 1655(c)))

[Doc. No 5074, 29 FR 15695, Nov. 24, 1964, as amended by Amdt. 27–23, 53 FR 34210, Sept. 2, 1988]

§ 27.71 Autorotation performance.

For single-engine helicopters and multiengine helicopters that do not meet the Category A engine isolation requirements of Part 29 of this chapter, the minimum rate of descent airspeed and the best angle-of-glide airspeed must be determined in autorotation at—

(a) Maximum weight; and

(b) Rotor speed(s) selected by the applicant.

[Amdt. 27–21, 49 FR 44433, Nov. 6, 1984]

§ 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 autorotation 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 entered from steady state autorotation; or

(ii) One-engine inoperative (OEI) for multiengine rotorcraft, with each operating engine within approved operating limitations, and entered from an established OEI approach.

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

[Doc. No. 5074, 29 FR 15695, Nov. 24, 1964, as amended by Amdt. 27–14, 43 FR 2324, Jan. 16, 1978; Amdt. 27–44, 73 FR 10999, Feb. 29, 2008]

§ 27.87 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 7000 feet density altitude, whichever is less; and

(2) Weight, from the maximum weight at sea level to the weight selected by the applicant for each altitude covered by paragraph (a)(1) of this section. For helicopters, the weight at altitudes above sea level may not be less than the maximum weight or the highest weight allowing hovering out-of-ground effect, whichever is lower.

(b) The applicable power failure conditions are—

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

(2) For multiengine helicopters, OEI (where engine isolation features ensure continued operation of the remaining engines), and the remaining engine(s) within approved limits and at the minimum installed specification power available for the most critical combination of approved ambient temperature and pressure altitude resulting in 7000 feet density altitude or the maximum altitude capability of the helicopter, whichever is less, and

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

(Secs. 313(a), 601, 603, 604, Federal Aviation Act of 1958 (49 U.S.C. 1354(a), 1421, 1423, 1424), sec. 6(c), Dept. of Transportation Act (49 U.S.C. 1655(c)))

[Doc. No. 5074, 29 FR 15695, Nov. 24, 1964, as amended by Amdt. 27–14, 43 FR 2324, Jan. 16, 1978; Amdt. 27–21, 49 FR 44433, Nov. 6, 1984; Amdt. 27–44, 73 FR 10999, Feb. 29, 2008]

FLIGHT CHARACTERISTICS

§ 27.141 General.

The rotorcraft must—

(a) Except as specifically required in the applicable section, meet the flight characteristics requirements of this subpart—

(1) At the altitudes and temperatures expected in operation;

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

(3) For power-on operations, under any condition of speed, power, and rotor r.p.m. for which certification is requested; and

(4) For power-off operations, under any condition of speed and rotor r.p.m. for which certification is requested that is attainable with the controls rigged in accordance with the approved rigging instructions and tolerances;

(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—

(1) Sudden failure of one engine, for multiengine rotorcraft meeting Transport Category A engine isolation requirements of part 29 of this chapter;

(2) Sudden, complete power failure for other rotorcraft; and

(3) Sudden, complete control system failures specified in §27.695 of this part; and

(c) Have any additional characteristic required for night or instrument operation, if certification for those kinds of operation is requested. Requirements for helicopter instrument flight are contained in appendix B of this part.

[Doc. No. 5074, 29 FR 15695, Nov. 24, 1964, as amended by Amdt. 27–2, 33 FR 962, Jan. 26, 1968; Amdt. 27–11, 41 FR 55468, Dec. 20, 1976; Amdt. 27–19, 48 FR 4389, Jan. 31, 1983; Amdt. 27–21, 49 FR 44433, Nov. 6, 1984]

§ 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) Autorotation;

(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) Critical weight;

(2) Critical center of gravity;

(3) Critical rotor r.p.m.; and

(4) Power off (except for helicopters demonstrating compliance with paragraph (f) of this section) and power on.

(c) Wind velocities from zero to at least 17 knots, from all azimuths, 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)—

(1) With altitude, from standard sea level conditions to the maximum takeoff and landing altitude capability of the rotorcraft or 7000 feet density altitude, whichever is less; with—

(i) Critical Weight;

(ii) Critical center of gravity;

(iii) Critical rotor r.p.m.;

(2) For takeoff and landing altitudes above 7000 feet density altitude with—

(i) Weight selected by the applicant;

(ii) Critical center of gravity; and

(iii) Critical rotor r.p.m.

(d) Wind velocities from zero to at least 17 knots, from all azimuths, must be established in which the rotorcraft can be operated without loss of control out-of-ground-effect, with—

(1) Weight selected by the applicant;

(2) Critical center of gravity;

(3) Rotor r.p.m. selected by the applicant; and

(4) Altitude, from standard sea level conditions to the maximum takeoff and landing altitude capability of the rotorcraft.

(e) The rotorcraft, after (1) failure of one engine in the case of multiengine rotorcraft that meet Transport Category A engine isolation requirements, or (2) complete engine failure in the case of other rotorcraft, must be controllable over the range of speeds and altitudes for which certification is requested when such 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—

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

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

(f) For helicopters for which a V_{NE} (power-off) is established under § 27.1505(c), compliance must be demonstrated with the following requirements with critical weight, critical center of gravity, and critical rotor r.p.m.:

(1) The helicopter must be safely slowed to V_{NE} (power-off), without exceptional pilot skill, after the last operating engine is made inoperative at power-on V_{NE}.

(2) At a speed of 1.1 V_{NE} (power-off), the margin of cyclic control must allow satisfactory roll and pitch control with power off.

(Secs. 313(a), 601, 603, 604, and 605 of the Federal Aviation Act of 1958 (49 U.S.C. 1354(a), 1421, 1423, 1424, and 1425); and sec. 6(c) of the Dept. of Transportation Act (49 U.S.C. 1655(c)))

[Doc. No. 5074, 29 FR 15695, Nov. 24, 1964, as amended by Amdt. 27–2, 33 FR 963, Jan. 26, 1968; Amdt. 27–14, 43 FR 2325, Jan. 16, 1978; Amdt. 27–21, 49 FR 44433, Nov. 6, 1984; Amdt. 27–44, 73 FR 10999, Feb. 29, 2008]

§ 27.151 Flight controls.

(a) Longitudinal, lateral, directional, and collective controls may not exhibit excessive breakout force, friction, or preload.

(b) Control system forces and free play may not inhibit a smooth, direct rotorcraft response to control system input.

[Amdt. 27–21, 49 FR 44433, Nov. 6, 1984]

§ 27.161 Trim control.

The trim control—

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

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

[Doc. No. 5074, 29 FR 15695, Nov. 24, 1964, as amended by Amdt. 27–21, 49 FR 44433, Nov. 6, 1984]

§ 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 control must be designed so that a rearward movement of the control is necessary to obtain an airspeed less than the trim speed, and a forward movement of the control is necessary to obtain an airspeed more than the trim speed.

(b) Throughout the full range of altitude for which certification is requested, with the throttle and collective pitch held constant during the maneuvers specified in § 27.175(a) through (d), the slope of the control position versus airspeed curve must be positive. However, in limited flight conditions or modes of operation determined by the Administrator to be acceptable, the slope of the control position versus airspeed curve may be neutral or negative if the rotorcraft possesses flight characteristics that allow the pilot to maintain airspeed within ±5 knots of the desired trim airspeed without exceptional piloting skill or alertness.

[Amdt. 27–21, 49 FR 44433, Nov. 6, 1984, as amended by Amdt. 27–44, 73 FR 10999, Feb. 29, 2008]

§ 27.175 Demonstration of static longitudinal stability.

(a) *Climb*. Static longitudinal stability must be shown in the climb condition at speeds from Vy − 10 kt to Vy + 10 kt 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 0.8 V_{NE} − 10 kt to 0.8 V_{NE} + 10 kt or, if V_H is less than 0.8 V_{NE}, from V_H −10 kt to V_H + 10 kt, with—

(1) Critical weight;

(2) Critical center of gravity;

(3) Power for level flight at 0.8 V_{NE} or V_H, whichever is less;

(4) The landing gear retracted; and

(5) The rotorcraft trimmed at 0.8 V_{NE} or V_H, whichever is less.

(c) *V_{NE}.* Static longitudinal stability must be shown at speeds from V_{NE} − 20 kt to V_{NE} with—

(1) Critical weight;

(2) Critical center of gravity;

(3) Power required for level flight at V_{NE} −10 kt or maximum continuous power, whichever is less;

(4) The landing gear retracted; and

(5) The rotorcraft trimmed at V_{NE} − 10 kt.

(d) *Autorotation.* Static longitudinal stability must be shown in autorotation at—

(1) Airspeeds from the minimum rate of descent airspeed − 10 kt to the minimum rate of descent airspeed + 10 kt, with—

(i) Critical weight;

(ii) Critical center of gravity;

(iii) The landing gear extended; and

(iv) The rotorcraft trimmed at the minimum rate of descent airspeed.

(2) Airspeeds from best angle-of-glide airspeed − 10 kt to the best angle-of-glide airspeed + 10 kt, with—

(i) Critical weight;

(ii) Critical center of gravity;

(iii) The landing gear retracted; and

(iv) The rotorcraft trimmed at the best angle-of-glide airspeed.

(Secs. 313(a), 601, 603, 604, and 605 of the Federal Aviation Act of 1958 (49 U.S.C. 1354(a), 1421, 1423, 1424, and 1425); and sec. 6(c) of the Dept. of Transportation Act (49 U.S.C. 1655(c)))

[Doc. No. 5074, 29 FR 15695, Nov. 24, 1964, as amended by Amdt. 27–2, 33 FR 963, Jan. 26, 1968; Amdt. 27–11, 41 FR 55468, Dec. 20, 1976; Amdt. 27–14, 43 FR 2325, Jan. 16, 1978; Amdt. 27–21, 49 FR 44433, Nov. 6, 1984; Amdt. 27–34, 62 FR 46173, Aug. 29, 1997; Amdt. 27–44, 73 FR 10999, Feb. 29, 2008]

§ 27.177 Static directional stability.

(a) The directional controls must operate in such a manner that the sense and direction of motion of the rotorcraft following control displacement are in the direction of the pedal motion with the throttle and collective controls held constant at the trim conditions specified in § 27.175(a), (b), and (c). Sideslip angles must increase with steadily increasing directional control deflection for sideslip angles up to the lesser of—

(1) ±25 degrees from trim at a speed of 15 knots less than the speed for minimum rate of descent varying linearly to ±10 degrees from trim at V_{NE};

(2) The steady state sideslip angles established by § 27.351;

(3) A sideslip angle selected by the applicant, which corresponds to a sideforce of at least 0.1g; or

(4) The sideslip angle attained by maximum directional control input.

(b) Sufficient cues must accompany the sideslip to alert the pilot when the aircraft is approaching the sideslip limits.

(c) During the maneuver specified in paragraph (a) of this section, the sideslip angle versus directional control position curve may have a negative slope within a small range of angles around trim, provided the desired heading can be maintained without exceptional piloting skill or alertness.

[Amdt. 27–44, 73 FR 11000, Feb. 29, 2008]

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 accounting for the environment to which the structure will be exposed in operation. Structural analysis (static or fatigue) may be used only if the structure conforms to those structures 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 test required for new or unusual design features.

(Secs. 604, 605, 72 Stat. 778, 49 U.S.C. 1424, 1425)

[Doc. No. 5074, 29 FR 15695, Nov. 24, 1964, as amended by Amdt. 27–3, 33 FR 14105, Sept. 18, 1968; Amdt. 27–26, 55 FR 7999, Mar. 6, 1990]

§ 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) The flight load factor must be assumed to act normal to the longitudinal axis of the rotorcraft, and to be equal in magnitude and opposite in direction to the rotorcraft inertia load factor at the center of gravity.

(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 Flight Manual.

[Doc. No. 5074, 29 FR 15695, Nov. 24, 1964, as amended by Amdt. 27–11, 41 FR 55468, Dec. 20, 1976]

§ 27.337 Limit maneuvering load factor.

The rotorcraft must be designed for—

(a) A limit maneuvering load factor ranging from a positive limit of 3.5 to a negative limit of −1.0; or

(b) Any positive limit maneuvering load factor not less than 2.0 and any negative limit maneuvering load factor of not less than −0.5 for which—

(1) The probability of being exceeded is shown by analysis and flight tests to be extremely remote; and

(2) The selected values are appropriate to each weight condition between the design maximum and design minimum weights.

[Amdt. 27–26, 55 FR 7999, Mar. 6, 1990]

§ 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 at each auxiliary lifting surface, 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);

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

R= The rotor radius (ft).

[Doc. No. 5074, 29 FR 15695, Nov. 24, 1964, as amended by Amdt. 27–11, 41 FR 55469, Dec. 20, 1976]

§ 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.

§ 27.351 Yawing conditions.

(a) Each rotorcraft must be designed for the loads resulting from the maneuvers specified in paragraphs (b) and (c) of this section with—

(1) Unbalanced aerodynamic moments about the center of gravity which the aircraft reacts to in a rational or conservative manner considering the principal masses furnishing the reacting inertia forces; and

(2) Maximum main rotor speed.

(b) To produce the load required in paragraph (a) of this section, in unaccelerated flight with zero yaw, at forward speeds from zero up to 0.6 V_{NE}—

(1) Displace the cockpit directional control suddenly to the maximum deflection limited by the control stops or by the maximum pilot force specified in § 27.397(a);

(2) Attain a resulting sideslip angle or 90°, whichever is less; and

(3) Return the directional control suddenly to neutral.

(c) To produce the load required in paragraph (a) of this section, in unaccelerated flight with zero yaw, at forward speeds from 0.6 V_{NE} up to V_{NE} or V_H, whichever is less—

(1) Displace the cockpit directional control suddenly to the maximum deflection limited by the control stops or by the maximum pilot force specified in § 27.397(a);

(2) Attain a resulting sideslip angle or 15°, whichever is less, at the lesser speed of V_{NE} or V_H;

(3) Vary the sideslip angles of paragraphs (b)(2) and (c)(2) of this section directly with speed; and

(4) Return the directional control suddenly to neutral.

[Amdt. 27–26, 55 FR 7999, Mar. 6, 1990, as amended by Amdt. 27–34, 62 FR 46173, Aug. 29, 1997]

§ 27.361 Engine torque.

(a) For turbine engines, the limit torque may not be less than the highest of—

(1) The mean torque for maximum continuous power multiplied by 1.25;

(2) The torque required by § 27.923;

(3) The torque required by § 27.927; or

(4) The torque imposed by sudden engine stoppage due to malfunction or structural failure (such as compressor jamming).

(b) For reciprocating engines, the limit torque may not be less than the mean torque for maximum continuous power multiplied by—

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

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

[Amdt. 27–23, 53 FR 34210, Sept. 2, 1988]

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, 27.399, 27.411, and 27.427.

[Amdt. 27–26, 55 FR 7999, Mar. 6, 1990, as amended by Amdt. 27–34, 62 FR 46173, Aug. 29, 1997]

§ 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) Each primary control system, including its supporting structure, must be designed as follows:

(1) The system must withstand loads resulting from the limit pilot forces prescribed in § 27.397.

(2) Notwithstanding paragraph (b)(3) of this section, when power-operated actuator controls or power boost controls are used, the system must also withstand the loads resulting from the force output of each normally energized power device, including any single power boost or actuator system failure.

(3) If the system design or the normal operating loads are such that a part of the system cannot react to the limit pilot forces prescribed in § 27.397, that part of the system must be designed to withstand the maximum loads that can be obtained in normal operation. The minimum design loads must, in any case, provide a rugged system for service use, including consideration of fatigue, jamming, ground gusts, control inertia, and friction loads. In the absence of rational analysis, the design loads resulting from 0.60 of the specified limit pilot forces are acceptable minimum design loads.

(4) If operational loads may be exceeded through jamming, ground gusts, control inertia, or friction, the system must withstand the limit pilot forces specified in § 27.397, without yielding.

[Doc. No. 5074, 29 FR 15695, Nov. 24, 1964, as amended by Amdt. 27–26, 55 FR 7999, Mar. 6, 1990]

§ 27.397 Limit pilot forces and torques.

(a) Except as provided in paragraph (b) of this section, the limit pilot forces are as follows:

(1) For foot controls, 130 pounds.

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

(b) For flap, tab, stabilizer, rotor brake, and landing gear operating controls, the follows apply (R=radius in inches):

(1) Crank, wheel, and lever controls, $[1+R]/3 \times 50$ pounds, but not less than 50 pounds nor more than 100 pounds for hand operated controls or 130 pounds for foot operated controls, applied at any angle within 20 degrees of the plane of motion of the control.

(2) Twist controls, 80R inch-pounds.

[Amdt. 27–11, 41 FR 55469, Dec. 20, 1976, as amended by Amdt. 27–40, 66 FR 23538, May 9, 2001]

§ 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.

§ 27.411 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.

§ 27.427 Unsymmetrical loads.

(a) Horizontal tail surfaces and their supporting structure must be designed for unsymmetrical loads arising from yawing and rotor wake effects in combination with the prescribed flight conditions.

(b) To meet the design criteria of paragraph (a) of this section, in the absence of more rational data, both of the following must be met:

(1) One hundred percent of the maximum loading from the symmetrical flight conditions acts on the surface on one side of the plane of symmetry, and no loading acts on the other side.

(2) Fifty percent of the maximum loading from the symmetrical flight conditions acts on the surface on each side of the plane of symmetry but in opposite directions.

(c) For empennage arrangements where the horizontal tail surfaces are supported by the vertical tail surfaces, the vertical tail surfaces and supporting structure must be designed for the combined vertical and horizontal surface loads resulting from each prescribed flight condition, considered separately. The flight conditions must be selected so the maximum design loads are obtained on each surface. In the absence of more rational data, the unsymmetrical horizontal tail surface loading distributions described in this section must be assumed.

[Admt. 27–26, 55 FR 7999, Mar. 6, 1990, as amended by Amdt. 27–27, 55 FR 38966, Sept. 21, 1990]

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 two-thirds of the design maximum weight.

(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.

[Amdt. 27–2, 33 FR 963, Jan. 26, 1968]

§ 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 paragraph (b)(1) of this section 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 paragraphs (b)(1) and (2) of this section in a ratio of 40:60.

(c) *Pitching moments.* Pitching moments are assumed to be resisted 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.

[Doc. No. 5074, 29 FR 15695, Nov. 24, 1964; 29 FR 17885, Dec. 17, 1964]

§ 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 paragraph (a)(1) of this section 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) of this section; and

(2) When all wheels contact the ground simultaneously—

(i) For the aft wheels, the side loads specified in paragraph (b)(1) of this section; 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 paragraphs (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 paragraphs (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 paragraph (f)(1) of this section 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 paragraph (h)(1) of this section 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 equal the vertical load specified in paragraph (b) of this section.

(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 equally between the skids and along the length of the skids.

(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) Distributed equally over 33.3 percent of the length between the skid tube attachments and centrally located midway between the skid tube attachments.

[Doc. No. 5074, 29 FR 15695, Nov. 24, 1964, as amended by Amdt. 27–2, 33 FR 963, Jan. 26, 1968; Amdt. 27–26, 55 FR 8000, Mar. 6, 1990]

§ 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 paragraph (a)(1) of this section 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 paragraph (b)(1) of this section, combined with a total side load of 0.25 times the total vertical load specified in paragraph (b)(1) of this section, 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) [Reserved]

(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.

(Secs. 604, 605, 72 Stat. 778, 49 U.S.C. 1424, 1425)

[Doc. No. 5074, 29 FR 15695, Nov. 24, 1964, as amended by Amdt. 27–3, 33 FR 14105, Sept. 18, 1968]

§ 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.

(Secs. 604, 605, 72 Stat. 778, 49 U.S.C. 1424, 1425)

[Doc. No. 5074, 29 FR 15695, Nov. 24, 1964, as amended by Amdt. 27–3, 33 FR 14105, Sept. 18, 1968]

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 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) Each occupant and each item of mass inside the cabin that could injure an occupant is restrained when subjected to the following ultimate inertial load factors relative to the surrounding structure:

(i) Upward—4g.

(ii) Forward—16g.

(iii) Sideward—8g.

(iv) Downward—20g, after intended displacement of the seat device.

(v) Rearward—1.5g.

(c) The supporting structure must be designed to restrain, under any ultimate inertial load up to those specified in this paragraph, any item of mass above and/or behind the crew and passenger compartment that could injure an occupant if it came loose in an emergency landing. Items of mass to be considered include, but are not limited to, rotors, transmissions, and engines. The items of mass must be restrained for the following ultimate inertial load factors:

(1) Upward—1.5g.

(2) Forward—12g.

(3) Sideward—6g.

(4) Downward—12g.

(5) Rearward—1.5g

(d) Any fuselage structure in the area of internal fuel tanks below the passenger floor level must be designed to resist the following ultimate inertial factors and loads and to protect the fuel tanks from rupture when those loads are applied to that area:

(i) Upward—1.5g.

(ii) Forward—4.0g.

(iii) Sideward—2.0g.

(iv) Downward—4.0g.

[Doc. No. 5074, 29 FR 15695, Nov. 24, 1964, as amended by Amdt. 27–25, 54 FR 47318, Nov. 13, 1989; Amdt. 27–30, 59 FR 50386, Oct. 3, 1994; Amdt. 27–32, 61 FR 10438, Mar. 13, 1996]

§ 27.562 Emergency landing dynamic conditions.

(a) The rotorcraft, although it may be damaged in an emergency crash landing, must be designed to reasonably protect each occupant when—

(1) The occupant properly uses the seats, safety belts, and shoulder harnesses provided in the design; and

(2) The occupant is exposed to the loads resulting from the conditions prescribed in this section.

(b) Each seat type design or other seating device approved for crew or passenger occupancy during takeoff and landing must successfully complete dynamic tests or be demonstrated by rational analysis based on dynamic tests of a similar type seat in accordance with the following criteria. The tests must be conducted with an occupant, simulated by a 170-pound anthropomorphic test dummy (ATD), as defined by 49 CFR 572, subpart B, or its equivalent, sitting in the normal upright position.

(1) A change in downward velocity of not less than 30 feet per second when the seat or other seating device is oriented in its nominal position with respect to the rotorcraft's reference system, the rotorcraft's longitudinal axis is canted upward 60° with respect to the impact velocity vector, and the rotorcraft's lateral axis is perpendicular to a vertical plane containing the impact velocity vector and the rotorcraft's longitudinal axis. Peak floor deceleration must occur in not more than 0.031 seconds after impact and must reach a minimum of 30g's.

(2) A change in forward velocity of not less than 42 feet per second when the seat or other seating device is oriented in its nominal position with respect to the rotorcraft's reference system, the rotorcraft's longitudinal axis is yawed 10° either right or left of the impact velocity vector (whichever would cause the greatest load on the shoulder harness), the rotorcraft's lateral axis is contained in a horizontal plane containing the impact velocity vector, and the rotorcraft's vertical axis is perpendicular to a horizontal plane containing the impact velocity vector. Peak floor deceleration must occur in not more than 0.071 seconds after impact and must reach a minimum of 18.4g's.

(3) Where floor rails or floor or sidewall attachment devices are used to attach the seating devices to the airframe structure for the conditions of this section, the rails or devices must be misaligned with respect to each other by at least 10° vertically (i.e., pitch out of parallel) and by at least a 10° lateral roll, with the directions optional, to account for possible floor warp.

(c) Compliance with the following must be shown:

(1) The seating device system must remain intact although it may experience separation intended as part of its design.

(2) The attachment between the seating device and the airframe structure must remain intact, although the structure may have exceeded its limit load.

(3) The ATD's shoulder harness strap or straps must remain on or in the immediate vicinity of the ATD's shoulder during the impact.

(4) The safety belt must remain on the ATD's pelvis during the impact.

(5) The ATD's head either does not contact any portion of the crew or passenger compartment, or if contact is made, the head impact does not exceed a head injury criteria (HIC) of 1,000 as determined by this equation.

$$\mathrm{HIC} = \left(t_2 - t_1\right)\left[\frac{1}{\left(t_2 - t_1\right)}\int_{t_1}^{t_2} a(t)dt\right]^{2.5}$$

Where: a(t) is the resultant acceleration at the center of gravity of the head form expressed as a multiple of g (the acceleration of gravity) and $t_2 - t_1$ is the time duration, in seconds, of major head impact, not to exceed 0.05 seconds.

(6) Loads in individual upper torso harness straps must not exceed 1,750 pounds. If dual straps are used for retaining the upper torso, the total harness strap loads must not exceed 2,000 pounds.

(7) The maximum compressive load measured between the pelvis and the lumbar column of the ATD must not exceed 1,500 pounds.

(d) An alternate approach that achieves an equivalent or greater level of occupant protection, as required by this section, must be substantiated on a rational basis.

[Amdt. 27–25, 54 FR 47318, Nov. 13, 1989]

§ 27.563 Structural ditching provisions.

If certification with ditching provisions is requested, structural strength for ditching must meet the requirements of this section and § 27.801(e).

(a) *Forward speed landing conditions.* The rotorcraft must initially contact the most critical wave for reasonably probable water conditions at forward velocities from zero up to 30 knots in likely pitch, roll, and yaw attitudes. The rotorcraft limit vertical descent velocity may not be less than 5 feet per second relative to the mean water surface. Rotor lift may be used to act through the center of gravity throughout the landing impact. This lift may not exceed two-thirds of the design maximum weight. A maximum forward velocity of less than 30 knots may be used in design if it can be demonstrated that the forward velocity selected would not be exceeded in a normal one-engine-out touchdown.

(b) *Auxiliary or emergency float conditions*—(1) *Floats fixed or deployed before initial water contact.* In addition to the landing loads in paragraph (a) of this section, each auxiliary or emergency float, of its support and attaching structure in the airframe or fuselage, must be designed for the load developed by a fully immersed float unless it can be shown that full immersion is unlikely. If full immersion is unlikely, the highest likely float buoyancy load must be applied. The highest likely buoyancy load must include consideration of a partially immersed float creating restoring moments to compensate the upsetting moments caused by side wind, unsymmetrical rotorcraft loading, water wave action, rotorcraft inertia, and probable structural damage and leakage considered under § 27.801(d). Maximum roll and pitch angles determined from compliance with § 27.801(d) may be used, if significant, to determine the extent of immersion of each float. If the floats are deployed in flight, appropriate air loads derived from the flight limitations with the floats deployed shall be used in substantiation of the floats and their attachment to the rotorcraft. For this purpose, the design airspeed for limit load is the float deployed airspeed operating limit multiplied by 1.11.

(2) *Floats deployed after initial water contact.* Each float must be designed for full or partial immersion perscribed in paragraph (b)(1) of this section. In addition, each float must be designed for combined vertical and drag loads using a relative limit speed of 20 knots between the rotorcraft and the water. The vertical load may not be less than the highest likely buoyancy load determined under paragraph (b)(1) of this section.

[Amdt. 27–26, 55 FR 8000, Mar. 6, 1990]

FATIGUE EVALUATION

§ 27.571 Fatigue evaluation of flight structure.

(a) *General.* Each portion of the flight structure (the flight structure includes rotors, rotor drive systems between the engines and the rotor hubs, controls, fuselage, landing gear, and their related primary attachments), the failure of which could be catastrophic, must be identified and must be evaluated under paragraph (b), (c), (d), or (e) of this section. The following apply to each fatigue evaluation:

(1) The procedure for the evaluation must be approved.

(2) The locations of probable failure must be determined.

(3) Inflight measurement must be included in determining the following:

(i) Loads or stresses in all critical conditions throughout the range of limitations in § 27.309, except that maneuvering load factors need not exceed the maximum values expected in operation.

(ii) The effect of altitude upon these loads or stresses.

(4) The loading spectra must be as severe as those expected in operation including, but not limited to, external cargo operations, if applicable, and ground-air-ground cycles. The loading spectra must be based on loads or stresses determined under paragraph (a)(3) of this section.

(b) *Fatigue tolerance evaluation.* It must be shown that the fatigue tolerance of the structure ensures that the probability of catastrophic fatigue failure is extremely remote without establishing replacement times, inspection intervals or other procedures under section A27.4 of appendix A.

(c) *Replacement time evaluation.* it must be shown that the probability of catastrophic fatigue failure is extremely remote within a replacement time furnished under section A27.4 of appendix A.

(d) *Fail-safe evaluation.* The following apply to fail-safe evaluation:

(1) It must be shown that all partial failures will become readily detectable under inspection procedures furnished under section A27.4 of appendix A.

(2) The interval between the time when any partial failure becomes readily detectable under paragraph (d)(1) of this section, and the time when any such failure is expected to reduce the remaining strength of the structure to limit or maximum attainable loads (whichever is less), must be determined.

(3) It must be shown that the interval determined under paragraph (d)(2) of this section is long enough, in relation to the inspection intervals and related procedures furnished under section A27.4 of appendix A, to provide a probability of detection great enough to ensure that the probability of catastrophic failure is extremely remote.

(e) *Combination of replacement time and failsafe evaluations.* A component may be evaluated under a combination of paragraphs (c) and (d) of this section. For such component it must be shown that the probability of catastrophic failure is extremely remote with an approved combination of replacement time, inspection intervals, and related procedures furnished under section A27.4 of appendix A.

(Secs. 313(a), 601, 603, 604, and 605, 72 Stat. 752, 775, and 778, (49 U.S.C. 1354(a), 1421, 1423, 1424, and 1425; sec. 6(c), 49 U.S.C. 1655(c)))

[Amdt. 27–3, 33 FR 14106, Sept. 18, 1968, as amended by Amdt. 27–12, 42 FR 15044, Mar. 17, 1977; Amdt. 27–18, 45 FR 60177, Sept. 11 1980; Amdt. 27–26, 55 FR 8000, Mar. 6, 1990]

§ 27.573 Damage Tolerance and Fatigue Evaluation of Composite Rotorcraft Structures.

(a) Each applicant must evaluate the composite rotorcraft structure under the damage tolerance standards of paragraph (d) of this section unless the applicant establishes that a damage tolerance evaluation is impractical within the limits of geometry, inspectability, and good design practice. If an applicant establishes that it is impractical within the limits of geometry, inspectability, and good design practice, the applicant must do a fatigue evaluation in accordance with paragraph (e) of this section.

(b) The methodology used to establish compliance with this section must be submitted to and approved by the Administrator.

(c) Definitions:

(1) *Catastrophic failure* is an event that could prevent continued safe flight and landing.

(2) *Principal Structural Elements (PSEs)* are structural elements that contribute significantly to the carrying of flight or ground loads, the failure of which could result in catastrophic failure of the rotorcraft.

(3) *Threat Assessment* is an assessment that specifies the locations, types, and sizes of damage, considering fatigue, environmental effects, intrinsic and discrete flaws, and impact or other accidental damage (including the discrete source of the accidental damage) that may occur during manufacture or operation.

(d) Damage Tolerance Evaluation:

(1) Each applicant must show that catastrophic failure due to static and fatigue loads, considering the intrinsic or discrete manufacturing defects or accidental damage, is avoided throughout the operational life or prescribed inspection intervals of the rotorcraft by performing damage tolerance evaluations of the strength of composite PSEs and other parts, detail design points, and fabrication techniques. Each applicant must account for the effects of material and process variability along with environmental conditions in the strength and fatigue evaluations. Each applicant must evaluate parts that include PSEs of the airframe, main and tail rotor drive systems, main and tail rotor blades and hubs, rotor controls, fixed and movable control surfaces, engine and transmission mountings, landing gear, other parts, detail design points, and fabrication techniques deemed critical by the FAA. Each damage tolerance evaluation must include:

(i) The identification of all PSEs;

(ii) In-flight and ground measurements for determining the loads or stresses for all PSEs for all critical conditions throughout the range of limits in § 27.309 (including altitude effects), except that maneuvering load factors need not exceed the maximum values expected in service;

(iii) The loading spectra as severe as those expected in service based on loads or stresses determined under paragraph (d)(1)(ii) of this section, including external load operations, if applicable, and other operations including high-torque events;

(iv) A threat assessment for all PSEs that specifies the locations, types, and sizes of damage, considering fatigue, environmental effects, intrinsic and discrete flaws, and impact or other accidental damage (including the discrete source of the accidental damage) that may occur during manufacture or operation; and

(v) An assessment of the residual strength and fatigue characteristics of all PSEs that supports the replacement times and inspection intervals established under paragraph (d)(2) of this section.

(2) Each applicant must establish replacement times, inspections, or other procedures for all PSEs to require the repair or replacement of damaged parts before a catastrophic failure. These replacement times, inspections, or other procedures must be included in the Airworthiness Limitations Section of the Instructions for Continued Airworthiness required by § 27.1529.

(i) Replacement times for PSEs must be determined by tests, or by analysis supported by tests, and must show that the structure is able to withstand the repeated loads of variable magnitude expected in-service. In establishing these replacement times, the following items must be considered:

(A) Damage identified in the threat assessment required by paragraph (d)(1)(iv) of this section;

(B) Maximum acceptable manufacturing defects and in-service damage (*i.e.*, those that do not lower the residual strength below ultimate design loads and those that can be repaired to restore ultimate strength); and

(C) Ultimate load strength capability after applying repeated loads.

(ii) Inspection intervals for PSEs must be established to reveal any damage identified in the threat assessment required by paragraph (d)(1)(iv) of this section that may occur from fatigue or other in-service causes before such damage has grown to the extent that the component cannot sustain the required residual strength capability. In establishing these inspection intervals, the following items must be considered:

(A) The growth rate, including no-growth, of the damage under the repeated loads expected in-service determined by tests or analysis supported by tests;

(B) The required residual strength for the assumed damage established after considering the damage type, inspection interval, detectability of damage, and the techniques adopted for damage detection. The minimum required residual strength is limit load; and

(C) Whether the inspection will detect the damage growth before the minimum residual strength is reached and restored to ultimate load capability, or whether the component will require replacement.

(3) Each applicant must consider the effects of damage on stiffness, dynamic behavior, loads, and functional performance on all PSEs when substantiating the maximum assumed damage size and inspection interval.

(e) Fatigue Evaluation: If an applicant establishes that the damage tolerance evaluation described in paragraph (d) of this section is impractical within the limits of geometry, inspectability, or good design practice, the applicant must do a fatigue evaluation of the particular composite rotorcraft structure and:

(1) Identify all PSEs considered in the fatigue evaluation;

(2) Identify the types of damage for all PSEs considered in the fatigue evaluation;

(3) Establish supplemental procedures to minimize the risk of catastrophic failure associated with the damages identified in paragraph (d) of this section; and

(4) Include these supplemental procedures in the Airworthiness Limitations section of the Instructions for Continued Airworthiness required by § 27.1529.

[76 FR 74663, Dec. 1, 2011]

EFFECTIVE DATE NOTE: By Doc. No. FAA–2009–0660, Amdt. 27–47, 76 FR 74663, Dec. 1, 2011, § 27.573 was added, effective Jan. 30, 2012.

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.

§ 27.602 Critical parts.

(a) *Critical part.* A critical part is a part, the failure of which could have a catastrophic effect upon the rotocraft, and for which critical characteristics have been identified which must be controlled to ensure the required level of integrity.

(b) If the type design includes crtical parts, a critical parts list shall be established. Procedures shall be established to define the critical design characteristics, identify processes that affect those characteristics, and identify the design change and process change controls necessary for showing compliance with the quality assurance requirements of part 21 of this chapter.

[Doc. No. 29311, 64 FR 46232, Aug. 24, 1999]

§ 27.603 Materials.

The suitability and durability of materials used for parts, the failure of which could adversely affect safety, must—

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

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

(c) Take into account the effects of environmental conditions, such as temperature and humidity, expected in service.

(Secs. 313(a), 601, 603, 604, Federal Aviation Act of 1958 (49 U.S.C. 1354(a), 1421, 1423, 1424); and sec. 6(c) of the Dept. of Transportation Act (49 U.S.C. 1655(c)))

[Doc. No. 5074, 29 FR 15695, Nov. 24, 1964, as amended by Amdt. 27–11, 41 FR 55469, Dec. 20, 1976; Amdt. 27–16, 43 FR 50599, Oct. 30, 1978]

§ 27.605 Fabrication methods.

(a) 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.

(b) Each new aircraft fabrication method must be substantiated by a test program.

(Secs. 313(a), 601, 603, 604, and 605 of the Federal Aviation Act of 1958 (49 U.S.C. 1354(a), 1421, 1423, 1424 and 1425); sec. 6(c) of the Dept. of Transportation Act (49 U.S.C. 1655(c)))

[Doc. No. 5074, 29 FR 15695, Nov. 24, 1964, as amended by Amdt. 27–16, 43 FR 50599, Oct. 30, 1978]

§ 27.607 Fasteners.

(a) Each removable bolt, screw, nut, pin, or other fastener whose loss could jeopardize the safe operation of the rotorcraft must incorporate two separate locking devices. The fastener and its locking devices may not be adversely affected by the environmental conditions associated with the particular installation.

(b) No self-locking nut may be used on any bolt subject to rotation in operation unless a nonfriction locking device is used in addition to the self-locking device.

[Amdt. 27–4, 33 FR 14533, Sept. 27, 1968]

§ 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.

§ 27.610 Lightning and static electricity protection.

(a) The rotorcraft must be protected against catastrophic effects from lightning.

(b) For metallic components, compliance with paragraph (a) of this section may be shown by—

(1) Electrically bonding the components properly to the airframe; or

(2) Designing the components so that a strike will not endanger the rotorcraft.

(c) For nonmetallic components, compliance with paragraph (a) of this section may be shown by—

(1) Designing the components to minimize the effect of a strike; or

(2) Incorporating acceptable means of diverting the resulting electrical current so as not to endanger the rotorcraft.

(d) The electrical bonding and protection against lightning and static electricity must—

(1) Minimize the accumulation of electrostatic charge;

(2) Minimize the risk of electric shock to crew, passengers, and service and maintenance personnel using normal precautions;

(3) Provide an electrical return path, under both normal and fault conditions, on rotorcraft having grounded electrical systems; and

(4) Reduce to an acceptable level the effects of static electricity on the functioning of essential electrical and electronic equipment.

[Amdt. 27–21, 49 FR 44433, Nov. 6, 1984, as amended by Amdt. 27–37, 64 FR 45094, Aug. 18, 1999; Amdt. 27–46, 76 FR 33135, June 8, 2011]

§ 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 to minimize the probability of structural failure due to material variability. Except as provided in paragraphs (d) and (e) of this section, compliance with this paragraph must be shown by selecting design values that assure material strength with the following probability—

(1) Where applied loads are eventually distributed through a single member within an assembly, the failure of which would result in loss of structural integrity of the component, 99 percent probability with 95 percent confidence; and

(2) For redundant structure, those in which the failure of individual elements would result in applied loads being safely distributed to other load-carrying members, 90 percent probability with 95 percent confidence.

(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) Design values may be those contained in the following publications (available from the Naval Publications and Forms Center, 5801 Tabor Avenue, Philadelphia, Pennsylvania 19120) or other values approved by the Administrator:

(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''.

(e) Other design values may be used if a selection of the material is made in which a specimen of each individual item is tested before use and it is determined that the actual strength properties of that particular item will equal or exceed those used in design.

(Secs. 313(a), 601, 603, 604, Federal Aviation Act of 1958 (49 U.S.C. 1354(a), 1421, 1423, 1424), sec. 6(c), Dept. of Transportation Act (49 U.S.C. 1655(c)))

[Doc. No. 5074, 29 FR 15695, Nov. 24, 1964, as amended by Amdt. 27–16, 43 FR 50599, Oct. 30, 1978; Amdt. 27–26, 55 FR 8000, Mar. 6, 1990]

§ 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 penetrant (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 paragraphs (d)(2) and (3) of this section, 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 paragraph (d)(1) of this section 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 paragraph (d)(1) of this section for casting factors of ''1.25 through 1.50'' and tested under paragraph (c)(2) of this section.

[Doc. No. 5074, 29 FR 15695, Nov. 24, 1964, as amended by Amdt. 27–34, 62 FR 46173, Aug. 29, 1997]

§ 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.

(d) Each seat, berth, litter, safety belt, and harness attachment to the structure must be shown by analysis, tests, or both, to be able to withstand the inertia forces prescribed in § 27.561(b)(3) multiplied by a fitting factor of 1.33.

[Doc. No. 5074, 29 FR 15695, Nov. 24, 1964, as amended by Amdt. 27–35, 63 FR 43285, Aug. 12, 1998]

§ 27.629 Flutter.

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

[Doc. No. 5074, 29 FR 15695, Nov. 24, 1964, as amended by Amdt. 27–26, 55 FR 8000, Mar. 6, 1990]

ROTORS

§ 27.653 Pressure venting and drainage of rotor blades.

(a) For each rotor blade—

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

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

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

(b) Paragraphs (a)(1) and (2) of this section does not apply to sealed rotor blades capable of withstanding the maximum pressure differentials expected in service.

[Amdt. 27–2, 33 FR 963, Jan. 26, 1968]

§ 27.659 Mass balance.

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

(1) Prevent excessive vibration; and

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

(b) The structural integrity of the mass balance installation must be substantiated.

[Amdt. 27–2, 33 FR 963, Jan. 26, 1968]

§ 27.661 Rotor blade clearance.

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

[Amdt. 27–2, 33 FR 963, Jan. 26, 1968]

§ 27.663 Ground resonance prevention means.

(a) The reliability of the means for preventing ground resonance must be shown either by analysis and tests, or reliable service experience, or by showing through analysis or tests that malfunction or failure of a single means will not cause ground resonance.

(b) The probable range of variations, during service, of the damping action of the ground resonance prevention means must be established and must be investigated during the test required by § 27.241.

[Amdt. 27–2, 33 FR 963, Jan. 26, 1968, as amended by Amdt. 27–26, 55 FR 8000, Mar. 6, 1990]

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.

§ 27.672 Stability augmentation, automatic, and power-operated systems.

If the functioning of stability augmentation or other automatic or power-operated systems is necessary to show compliance with the flight characteristics requirements of this part, such systems must comply with § 27.671 of this part and the following:

(a) A warning which is clearly distinguishable to the pilot under expected flight conditions without requiring the pilot's attention must be provided for any failure in the stability augmentation system or in any other automatic or power-operated system which could result in an unsafe condition if the pilot is unaware of the failure. Warning systems must not activate the control systems.

(b) The design of the stability augmentation system or of any other automatic or power-operated system must allow initial counteraction of failures without requiring exceptional pilot skill or strength by overriding the failure by movement of the flight controls in the normal sense and deactivating the failed system.

(c) It must be shown that after any single failure of the stability augmentation system or any other automatic or power-operated system—

(1) The rotorcraft is safely controllable when the failure or malfunction occurs at any speed or altitude within the approved operating limitations;

(2) The controllability and maneuverability requirements of this part are met within a practical operational flight envelope (for example, speed, altitude, normal acceleration, and rotorcraft configurations) which is described in the Rotorcraft Flight Manual; and

(3) The trim and stability characteristics are not impaired below a level needed to permit continued safe flight and landing.

[Amdt. 27–21, 49 FR 44433, Nov. 6, 1984; 49 FR 47594, Dec. 6, 1984]

§ 27.673 Primary flight control.

Primary flight controls are those used by the pilot for immediate control of pitch, roll, yaw, and vertical motion of the rotorcraft.

[Amdt. 27–21, 49 FR 44434, Nov. 6, 1984]

§ 27.674 Interconnected controls.

Each primary flight control system must provide for safe flight and landing and operate independently after a malfunction, failure, or jam of any auxiliary interconnected control.

[Amdt. 27–26, 55 FR 8001, Mar. 6, 1990]

§ 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) Stops that are appropriate to the blade design must be provided to limit travel of the blade about its hinge points; 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.

(Secs. 313(a), 601, 603, 604, Federal Aviation Act of 1958 (49 U.S.C. 1354(a), 1421, 1423, 1424), sec. 6(c), Dept. of Transportation Act (49 U.S.C. 1655(c)))

[Doc. No. 5074, 29 FR 15695, Nov. 24, 1964, as amended by Amdt. 27–16, 43 FR 50599, Oct. 30, 1978]

§ 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, loose objects or the freezing of moisture.

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

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

(d) Cable systems must be designed as follows:

(1) Cables, cable fittings, turnbuckles, splices, and pulleys must be of an acceptable kind.

(2) The design of the cable systems must prevent any hazardous change in cable tension throughout the range of travel under any operating conditions and temperature variations.

(3) No cable smaller than three thirty-seconds of an inch diameter may be used in any primary control system.

(4) Pulley kinds and sizes must correspond to the cables with which they are used. The pulley cable combinations and strength values which must be used are specified in Military Handbook MIL-HDBK-5C, Vol. 1 & Vol. 2, Metallic Materials and Elements for Flight Vehicle Structures, (Sept. 15, 1976, as amended through December 15, 1978). This incorporation by reference was approved by the Director of the Federal Register in accordance with 5 U.S.C. section 552(a) and 1 CFR part 51. Copies may be obtained from the Naval Publications and Forms Center, 5801 Tabor Avenue, Philadelphia, Pennsylvania, 19120. Copies may be inspected at the FAA, Rotorcraft Standards Staff, 4400 Blue Mount Road, Fort Worth, Texas, or at the National Archives and Records Administration (NARA). For information on the availability of this material at NARA, call 202–741–6030, or go to: *http://www.archives.gov/federal_register/code_of_federal_regulations/ibr_locations.html.*

(5) Pulleys must have close fitting guards to prevent the cables from being displaced or fouled.

(6) Pulleys must lie close enough to the plane passing through the cable to prevent the cable from rubbing against the pulley flange.

(7) No fairlead may cause a change in cable direction of more than 3°.

(8) No clevis pin subject to load or motion and retained only by cotter pins may be used in the control system.

(9) Turnbuckles attached to parts having angular motion must be installed to prevent binding throughout the range of travel.

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

(e) Control system joints subject to angular motion must incorporate the following special factors with respect to the ultimate bearing strength of the softest material used as a bearing:

(1) 3.33 for push-pull systems other than ball and roller bearing systems.

(2) 2.0 for cable systems.

(f) For control system joints, the manufacturer's static, non-Brinell rating of ball and roller bearings must not be exceeded.

[Doc. No. 5074, 29 FR 15695, Nov. 24, 1964, as amended by Amdt. 27–11, 41 FR 55469, Dec. 20, 1976; Amdt. 27–26, 55 FR 8001, Mar. 6, 1990; 69 FR 18803, Apr. 9, 2004]

§ 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:

$$W_e = W \times \frac{h + (1 - \mathrm{L})d}{h + d}; \quad \text{and}$$

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

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 1.0*g* downward and 0.25*g* 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 1*g* downward with the rotorcraft in the maximum nose-up attitude considered in the nose-up landing conditions.

h=specified free drop height (inches).

L=ration 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. Collapse of the landing gear occurs when a member of the nose, tail, or main gear will not support the rotorcraft in the proper attitude or allows the rotorcraft structure, other than the landing gear and external accessories, to impact the landing surface.

[Doc. No. 5074, 29 FR 15695, Nov. 24, 1964, as amended by Amdt. 27–26, 55 FR 8001, Mar. 6, 1990]

§ 27.729 Retracting mechanism.

For rotorcraft with retractable landing gear, the following apply:

(a) *Loads.* The landing gear, retracting mechansim, wheel-well doors, and supporting structure must be designed for—

(1) The loads occurring in any maneuvering condition with the gear retracted;

(2) The combined friction, inertia, and air loads occurring during retraction and extension at any airspeed up to the design maximum landing gear operating speed; and

(3) The flight loads, including those in yawed flight, occurring with the gear extended at any airspeed up to the design maximum landing gear extended speed.

(b) *Landing gear lock.* A positive means must be provided to keep the gear extended.

(c) *Emergency operation.* When other than manual power is used to operate the gear, emergency means must be provided for extending the gear in the event of—

(1) Any reasonably probable failure in the normal retraction system; or

(2) The failure of any single source of hydraulic, electric, or equivalent energy.

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

(e) *Position indicator.* There must be a means to indicate to the pilot when the gear is secured in the extreme positions.

(f) *Control.* The location and operation of the retraction control must meet the requirements of §§ 27.777 and 27.779.

(g) *Landing gear warning.* An aural or equally effective landing gear warning device must be provided that functions continuously when the rotorcraft is in a normal landing mode and the landing gear is not fully extended and locked. A manual shutoff capability must be provided for the warning device and the warning system must automatically reset when the rotorcraft is no longer in the landing mode.

[Amdt. 27–21, 49 FR 44434, Nov. 6, 1984]

§ 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.

(c) Each tire installed on a retractable landing gear system must, at the maximum size of the tire type expected in service, have a clearance to surrounding structure and systems that is adequate to prevent contact between the tire and any part of the structure or systems.

[Doc. No. 5074, 29 FR 15695, Nov. 24, 1964, as amended by Amdt. 27–11, 41 FR 55469, Dec. 20, 1976]

§ 27.735 Brakes.

For rotorcraft with wheel-type landing gear, 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.

[Doc. No. 5074, 29 FR 15695, Nov. 24, 1964, as amended by Amdt. 27–21, 49 FR 44434, Nov. 6, 1984]

§ 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 enough water-tight compartments so that, with any single main float compartment flooded, the main floats will provide a margin of positive stability great enough to minimize the probability of capsizing.

[Doc. No. 5074, 29 FR 15695, Nov. 24, 1964, as amended by Amdt. 27–2, 33 FR 963, Jan. 26, 1968]

§ 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.

Windshields and windows must be made of material that will not break into dangerous fragments.

[Amdt. 27–27, 55 FR 38966, Sept. 21, 1990]

§ 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.

§ 27.779 Motion and effect of cockpit controls.

Cockpit controls must be designed so that they operate in accordance with the following movements and actuation:

(a) Flight controls, including the collective pitch control, must operate with a sense of motion which corresponds to the effect on the rotorcraft.

(b) Twist-grip engine power controls must be designed so that, for lefthand operation, the motion of the pilot's hand is clockwise to increase power when the hand is viewed from the edge containing the index finger. Other engine power controls, excluding the collective control, must operate with a forward motion to increase power.

(c) Normal landing gear controls must operate downward to extend the landing gear.

[Amdt. 27–21, 49 FR 44434, Nov. 6, 1984]

§ 27.783 Doors.

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

(b) Each external door must be located where persons using it will not be endangered by the rotors, propellers, engine intakes, and exhausts when appropriate operating procedures are used. If opening procedures are required, they must be marked inside, on or adjacent to the door opening device.

[Doc. No. 5074, 29 FR 15695, Nov. 24, 1964, as amended by Amdt. 27–26, 55 FR 8001, Mar. 6, 1990]

§ 27.785 Seats, berths, litters, safety belts, and harnesses.

(a) Each seat, safety belt, harness, and adjacent part of the rotorcraft at each station designated for occupancy during takeoff and landing must be free of potentially injurious objects, sharp edges, protuberances, and hard surfaces and must be designed so that a person making proper use of these facilities will not suffer serious injury in an emergency landing as a result of the static inertial load factors specified in § 27.561(b) and dynamic conditions specified in § 27.562.

(b) Each occupant must be protected from serious head injury by a safety belt plus a shoulder harness that will prevent the head from contacting any injurious object except as provided for in § 27.562(c)(5). A shoulder harness (upper torso restraint), in combination with the safety belt, constitutes a torso restraint system as described in TSO-C114.

(c) Each occupant's seat must have a combined safety belt and shoulder harness with a single-point release. Each pilot's combined safety belt and shoulder harness must allow each pilot when seated with safety belt and shoulder harness fastened to perform all functions necessary for flight operations. There must be a means to secure belts and harnesses, when not in use, to prevent interference with the operation of the rotorcraft and with rapid egress in an emergency.

(d) If seat backs do not have a firm handhold, there must be hand grips or rails along each aisle to enable the occupants to steady themselves while using the aisle in moderately rough air.

(e) Each projecting object that could injure persons seated or moving about in the rotorcraft in normal flight must be padded.

(f) Each seat and its supporting structure must be designed for an occupant weight of at least 170 pounds considering the maximum load factors, inertial forces, and reactions between occupant, seat, and safety belt or harness corresponding with the applicable flight and ground load conditions, including the emergency landing conditions of § 27.561(b). In addition—

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

(2) The inertial forces prescribed in § 27.561(b) must be multiplied by a factor of 1.33 in determining the strength of the attachment of—

(i) Each seat to the structure; and

(ii) Each safety belt or harness to the seat or structure.

(g) When the safety belt and shoulder harness are combined, the rated strength of the safety belt and shoulder harness may not be less than that corresponding to the inertial forces specified in § 27.561(b), considering the occupant weight of at least 170 pounds, considering the dimensional characteristics of the restraint system installation, and using a distribution of at least a 60-percent load to the safety belt and at least a 40-percent load to the shoulder harness. If the safety belt is capable of being used without the shoulder harness, the inertial forces specified must be met by the safety belt alone.

(h) When a headrest is used, the headrest and its supporting structure must be designed to resist the inertia forces specified in § 27.561, with a 1.33 fitting factor and a head weight of at least 13 pounds.

(i) Each seating device system includes the device such as the seat, the cushions, the occupant restraint system, and attachment devices.

(j) Each seating device system may use design features such as crushing or separation of certain parts of the seats to reduce occupant loads for the emergency landing dynamic conditions of § 27.562; otherwise, the system must remain intact and must not interfere with rapid evacuation of the rotorcraft.

(k) For the purposes of this section, a litter is defined as a device designed to carry a nonambulatory person, primarily in a recumbent position, into and on the rotorcraft. Each berth or litter must be designed to withstand the load reaction of an occupant weight of at least 170 pounds when the occupant is subjected to the forward inertial factors specified in § 27.561(b). A berth or litter installed within 15° or less of the longitudinal axis of the rotorcraft must be provided with a padded end-board, cloth diaphram, or equivalent means that can withstand the forward load reaction. A berth or litter oriented greater than 15° with the longitudinal axis of the rotorcraft must be equipped with appropriate restraints, such as straps or safety belts, to withstand the forward load reaction. In addition—

(1) The berth or litter must have a restraint system and must not have corners or other protuberances likely to cause serious injury to a person occupying it during emergency landing conditions; and

(2) The berth or litter attachment and the occupant restraint system attachments to the structure must be designed to withstand the critical loads resulting from flight and ground load conditions and from the conditions prescribed in § 27.561(b). The fitting factor required by § 27.625(d) shall be applied.

[Amdt. 27–21, 49 FR 44434, Nov. 6, 1984, as amended by Amdt. 27–25, 54 FR 47319, Nov. 13, 1989; Amdt. 27–35, 63 FR 43285, Aug. 12, 1998]

§ 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) Under the emergency landing conditions of § 27.561, cargo and baggage compartments must—

(1) Be positioned so that if the contents break loose they are unlikely to

cause injury to the occupants or restrict any of the escape facilities provided for use after an emergency landing; or

(2) Have sufficient strength to withstand the conditions specified in § 27.561 including the means of restraint, and their attachments, required by paragraph (b) of this section. Sufficient strength must be provided for the maximum authorized weight of cargo and baggage at the critical loading distribution.

(d) If cargo compartment lamps are installed, each lamp must be installed so as to prevent contact between lamp bulb and cargo.

[Doc. No. 5074, 29 FR 15695, Nov. 24, 1964, as amended by Amdt. 27–11, 41 FR 55469, Dec. 20, 1976; Amdt. 27–27, 55 FR 38966, Sept. 21, 1990]

§ 27.801 Ditching.

(a) If certification with ditching provisions is requested, the rotorcraft must meet the requirements of this section and §§ 27.807(d), 27.1411 and 27.1415.

(b) Each practicable design measure, compatible with the general characteristics of the rotorcraft, must be taken to minimize the probability that in an emergency landing on water, the behavior of the rotorcraft would cause immediate injury to the occupants or would make it impossible for them to escape.

(c) The probable behavior of the rotorcraft in a water landing must be investigated by model tests or by comparison with rotorcraft of similar configuration for which the ditching characteristics are known. Scoops, flaps, projections, and any other factor likely to affect the hydrodynamic characteristics of the rotorcraft must be considered.

(d) It must be shown that, under reasonably probable water conditions, the flotation time and trim of the rotorcraft will allow the occupants to leave the rotorcraft and enter the life rafts required by § 27.1415. If compliance with this provision is shown by buoyancy and trim computations, appropriate allowances must be made for probable structural damage and leakage. If the rotorcraft has fuel tanks (with fuel jettisoning provisions) that can reasonably be expected to withstand a ditching without leakage, the jettisonable volume of fuel may be considered as buoyancy volume.

(e) Unless the effects of the collapse of external doors and windows are accounted for in the investigation of the probable behavior of the rotorcraft in a water landing (as prescribed in paragraphs (c) and (d) of this section), the external doors and windows must be designed to withstand the probable maximum local pressures.

[Amdt. 27–11, 41 FR 55469, Dec. 20, 1976]

§ 27.805 Flight crew emergency exits.

(a) For rotorcraft with passenger emergency exits that are not convenient to the flight crew, there must be flight crew emergency exits, on both sides of the rotorcraft or as a top hatch in the flight crew area.

(b) Each flight crew emergency exit must be of sufficient size and must be located so as to allow rapid evacuation of the flight crew. This must be shown by test.

(c) Each flight crew emergency exit must not be obstructed by water or flotation devices after an emergency landing on water. This must be shown by test, demonstration, or analysis.

[Doc. No. 29247, 64 FR 45094, Aug. 18, 1999]

§ 27.807 Emergency exits.

(a) *Number and location.* (1) There must be at least one emergency exit on each side of the cabin readily accessible to each passenger. One of these exits must be usable in any probable attitude that may result from a crash;

(2) Doors intended for normal use may also serve as emergency exits, provided that they meet the requirements of this section; and

(3) If emergency flotation devices are installed, there must be an emergency exit accessible to each passenger on each side of the cabin that is shown by test, demonstration, or analysis to;

(i) Be above the waterline; and

(ii) Open without interference from flotation devices, whether stowed or deployed.

(b) *Type and operation.* Each emergency exit prescribed by 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) Have simple and obvious methods of opening, from the inside and from the outside, which do not require exceptional effort;

(3) Be arranged and marked so as to be readily located and opened 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.

(d) *Ditching emergency exits for passengers*. If certification with ditching provisions is requested, the markings required by paragraph (b)(3) of this section must be designed to remain visible if the rotorcraft is capsized and the cabin is submerged.

[Doc. No. 29247, 64 FR 45094, Aug. 18, 1999]

§ 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.

§ 27.833 Heaters.

Each combustion heater must be approved.

[Amdt. 27–23, 53 FR 34210, Sept. 2, 1988]

Fire Protection

§ 27.853 Compartment interiors.

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

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

(b) [Reserved]

(c) If smoking is to be prohibited, there must be a placard so stating, and if smoking is to be allowed—

(1) There must be an adequate number of self-contained, removable ashtrays; and

(2) Where the crew compartment is separated from the passenger compartment, there must be at least one illuminated sign (using either letters or symbols) notifying all passengers when smoking is prohibited. Signs which notify when smoking is prohibited must—

(i) When illuminated, be legible to each passenger seated in the passenger cabin under all probable lighting conditions; and

(ii) Be so constructed that the crew can turn the illumination on and off.

[Amdt. 27–17, 45 FR 7755, Feb. 4, 1980, as amended by Amdt. 27–37, 64 FR 45095, Aug. 18, 1999]

§ 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 heater fire protection*. Except for heaters which incorporate designs to prevent hazards in the event of fuel leakage in the heater fuel system, fire within the ventilating air passage, or any other heater malfunction, each heater zone must incorporate the fire protection features of the applicable requirements of §§ 27.1183, 27.1185, 27.1189, 27.1191, and be provided with—

(1) Approved, quick-acting fire detectors in numbers and locations ensuring prompt detection of fire in the heater region.

(2) Fire extinguisher systems that provide at least one adequate discharge to all areas of the heater region.

(3) Complete drainage of each part of each zone to minimize the hazards resulting from failure or malfunction of any component containing flammable fluids. The drainage means must be—

(i) Effective under conditions expected to prevail when drainage is needed; and

(ii) Arranged so that no discharged fluid will cause an additional fire hazard.

(4) Ventilation, arranged so that no discharged vapors will cause an additional fire hazard.

(d) *Ventilating air ducts.* Each ventilating air duct passing through any heater region must be fireproof.

(1) Unless isolation is provided by fireproof valves or by equally effective means, the ventilating air duct downstream of each heater must be fireproof for a distance great enough to ensure that any fire originating in the heater can be contained in the duct.

(2) Each part of any ventilating duct passing through any region having a flammable fluid system must be so constructed or isolated from that system that the malfunctioning of any component of that system cannot introduce flammable fluids or vapors into the ventilating airstream.

(e) *Combustion air ducts.* Each combustion air duct must be fireproof for a distance great enough to prevent damage from backfiring or reverse flame propagation.

(1) No combustion air duct may connect with the ventilating airstream unless flames from backfires or reverse burning cannot enter the ventilating airstream under any operating condition, including reverse flow or malfunction of the heater or its associated components.

(2) No combustion air duct may restrict the prompt relief of any backfire that, if so restricted, could cause heater failure.

(f) *Heater control: General.* There must be means to prevent the hazardous accumulation of water or ice on or in any heater control component, control system tubing, or safety control.

(g) *Heater safety controls.* For each combustion heater, safety control means must be provided as follows:

(1) 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 the ignition and fuel supply of that heater at a point remote from that heater when any of the following occurs:

(i) The heat exchanger temperature exceeds safe limits.

(ii) The ventilating air temperature exceeds safe limits.

(iii) The combustion airflow becomes inadequate for safe operation.

(iv) The ventilating airflow becomes inadequate for safe operation.

(2) The means of complying with paragraph (g)(1) of this section for any individual heater must—

(i) Be independent of components serving any other heater, the heat output of which is essential for safe operation; and

(ii) Keep the heater off until restarted by the crew.

(3) There must be means to warn the crew when any heater, the heat output of which is essential for safe operation, has been shut off by the automatic means prescribed in paragraph (g)(1) of this section.

(h) *Air intakes.* Each combustion and ventilating air intake must be located so that no flammable fluids or vapors can enter the heater system—

(1) During normal operation; or

(2) As a result of the malfunction of any other component.

(i) *Heater exhaust.* Each heater exhaust system must meet the requirements of §§ 27.1121 and 27.1123.

(1) Each exhaust shroud must be sealed so that no flammable fluids or hazardous quantities of vapors can reach the exhaust system through joints.

(2) No exhaust system may restrict the prompt relief of any backfire that, if so restricted, could cause heater failure.

(j) *Heater fuel systems*. Each heater fuel system must meet the powerplant fuel system requirements affecting safe heater operation. Each heater fuel system component in the ventilating airstream must be protected by shrouds so that no leakage from those components can enter the ventilating airstream.

(k) *Drains*. There must be means for safe drainage of any fuel that might accumulate in the combustion chamber or the heat exchanger.

(1) Each part of any drain that operates at high temperatures must be protected in the same manner as heater exhausts.

(2) Each drain must be protected against hazardous ice accumulation under any operating condition.

[Doc. No. 5074, 29 FR 15695, Nov. 24, 1964, as amended by Amdt. 27–23, 53 FR 34211, Sept. 2, 1988]

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

Each part of the structure, controls, rotor mechanism, and other parts essential to a controlled landing that would be affected by powerplant fires must be fireproof or protected so they can perform their essential functions for at least 5 minutes under any foreseeable powerplant fire conditions.

[Amdt. 27–26, 55 FR 8001, Mar. 6, 1990]

§ 27.863 Flammable fluid fire protection.

(a) In each area where flammable fluids or vapors might escape by leakage of a fluid system, there must be means to minimize the probability of ignition of the fluids and vapors, and the resultant hazards if ignition does occur.

(b) Compliance with paragraph (a) of this section must be shown by analysis or tests, and the following factors must be considered:

(1) Possible sources and paths of fluid leakage, and means of detecting leakage.

(2) Flammability characteristics of fluids, including effects of any combustible or absorbing materials.

(3) Possible ignition sources, including electrical faults, overheating of equipment, and malfunctioning of protective devices.

(4) Means available for controlling or extinguishing a fire, such as stopping flow of fluids, shutting down equipment, fireproof containment, or use of extinguishing agents.

(5) Ability of rotorcraft components that are critical to safety of flight to withstand fire and heat.

(c) If action by the flight crew is required to prevent or counteract a fluid fire (e.g. equipment shutdown or actuation of a fire extinguisher) quick acting means must be provided to alert the crew.

(d) Each area where flammable fluids or vapors might escape by leakage of a fluid system must be identified and defined.

(Secs. 313(a), 601, 603, 604, Federal Aviation Act of 1958 (49 U.S.C. 1354(a), 1421, 1423, 1424), sec. 6(c), Dept. of Transportation Act (49 U.S.C. 1655(c)))

[Amdt. 27–16, 43 FR 50599, Oct. 30, 1978]

External Loads

§ 27.865 External loads.

(a) It must be shown by analysis, test, or both, that the rotorcraft external load attaching means for rotorcraft-load combinations to be used for nonhuman external cargo applications can withstand a limit static load equal to 2.5, or some lower load factor approved under §§ 27.337 through 27.341, multiplied by the maximum external load for which authorization is requested. It must be shown by analysis, test, or both that the rotorcraft external load attaching means and corresponding personnel carrying device system for rotorcraft-load combinations to be used for human external cargo applications can withstand a limit static load equal to 3.5 or some lower load factor, not less than 2.5, approved under §§ 27.337 through 27.341, multiplied by the maximum external load for which authorization is requested. The load for any rotorcraft-load combination class, for any external cargo type, must be applied in the vertical direction. For jettisonable external loads of any applicable external cargo type, the load must also be applied in any direction making the maximum angle with the vertical that can be achieved in service but not less than

30°. However, the 30° angle may be reduced to a lesser angle if—

(1) An operating limitation is established limiting external load operations to such angles for which compliance with this paragraph has been shown; or

(2) It is shown that the lesser angle can not be exceeded in service.

(b) The external load attaching means, for jettisonable rotorcraft-load combinations, must include a quick-release system to enable the pilot to release the external load quickly during flight. The quick-release system must consist of a primary quick release subsystem and a backup quick release subsystem that are isolated from one another. The quick-release system, and the means by which it is controlled, must comply with the following:

(1) A control for the primary quick release subsystem must be installed either on one of the pilot's primary controls or in an equivalently accessible location and must be designed and located so that it may be operated by either the pilot or a crewmember without hazardously limiting the ability to control the rotorcraft during an emergency situation.

(2) A control for the backup quick release subsystem, readily accessible to either the pilot or another crewmember, must be provided.

(3) Both the primary and backup quick release subsystems must—

(i) Be reliable, durable, and function properly with all external loads up to and including the maximum external limit load for which authorization is requested.

(ii) Be protected against electromagnetic interference (EMI) from external and internal sources and against lightning to prevent inadvertent load release.

(A) The minimum level of protection required for jettisonable rotorcraft-load combinations used for nonhuman external cargo is a radio frequency field strength of 20 volts per meter.

(B) The minimum level of protection required for jettisonable rotorcraft-load combinations used for human external cargo is a radio frequency field strength of 200 volts per meter.

(iii) Be protected against any failure that could be induced by a failure mode of any other electrical or mechanical rotorcraft system.

(c) For rotorcraft-load combinations to be used for human external cargo applications, the rotorcraft must—

(1) For jettisonable external loads, have a quick-release system that meets the requirements of paragraph (b) of this section and that—

(i) Provides a dual actuation device for the primary quick release subsystem, and

(ii) Provides a separate dual actuation device for the backup quick release subsystem;

(2) Have a reliable, approved personnel carrying device system that has the structural capability and personnel safety features essential for external occupant safety;

(3) Have placards and markings at all appropriate locations that clearly state the essential system operating instructions and, for the personnel carrying device system, the ingress and egress instructions;

(4) Have equipment to allow direct intercommunication among required crewmembers and external occupants; and

(5) Have the appropriate limitations and procedures incorporated in the flight manual for conducting human external cargo operations.

(d) The critically configured jettisonable external loads must be shown by a combination of analysis, ground tests, and flight tests to be both transportable and releasable throughout the approved operational envelope without hazard to the rotorcraft during normal flight conditions. In addition, these external loads must be shown to be releasable without hazard to the rotorcraft during emergency flight conditions.

(e) A placard or marking must be installed next to the external-load attaching means clearly stating any operational limitations and the maximum authorized external load as demonstrated under § 27.25 and this section.

(f) The fatigue evaluation of § 27.571 of this part does not apply to rotorcraft-load combinations to be used for nonhuman external cargo except for the failure of critical structural elements that would result in a hazard to the rotorcraft. For rotorcraft-load combinations to be used for human external cargo, the fatigue evaluation of §27.571 of this part applies to the entire quick release and personnel carrying device structural systems and their attachments.

[Amdt. 27–11, 41 FR 55469, Dec. 20, 1976; as amended by Amdt. 27–26, 55 FR 8001, Mar. 6, 1990; Amdt. 27–36, 64 FR 43019, Aug. 6, 1999]

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 for the range of temperature and altitude for which approval is requested;

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

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

(4) Axial and radial expansion of turbine engines may not affect the safety of the installation; and

(5) Design precautions must be taken to minimize the possibility of incorrect assembly of components and equipment essential to safe operation of the rotorcraft, except where operation with the incorrect assembly can be shown to be extremely improbable.

(c) The installation must comply with—

(1) The installation instructions provided under §33.5 of this chapter; and

(2) The applicable provisions of this subpart.

(Secs. 313(a), 601, and 603, 72 Stat. 752, 775, 49 U.S.C. 1354(a), 1421, and 1423; sec. 6(c), 49 U.S.C. 1655(c))

[Doc. No. 5074, 29 FR 15695, Nov. 24, 1964, as amended by Amdt. 27–2, 33 FR 963, Jan. 26, 1968; Amdt. 27–12, 42 FR 15044, Mar. 17, 1977; Amdt. 27–23, 53 FR 34211, Sept. 2, 1988]

§ 27.903 Engines.

(a) *Engine type certification.* Each engine must have an approved type certificate. Reciprocating engines for use in helicopters must be qualified in accordance with §33.49(d) of this chapter or be otherwise approved for the intended usage.

(b) *Engine or drive system cooling fan blade protection.* (1) If an engine or rotor drive system cooling fan is installed, there must be a means to protect the rotorcraft and allow a safe landing if a fan blade fails. This must be shown by showing that—

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

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

(iii) Each fan blade can withstand an ultimate load of 1.5 times the centrifugal force resulting from operation limited by the following:

(A) For fans driven directly by the engine—

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

(*2*) An overspeed limiting device.

(B) For fans driven by the rotor drive system, the maximum rotor drive system rotational speed to be expected in service, including transients.

(2) Unless a fatigue evaluation under §27.571 is conducted, it must be shown that cooling fan blades are not operating at resonant conditions within the operating limits of the rotorcraft.

(c) *Turbine engine installation.* For turbine engine installations, the powerplant systems associated with engine control devices, systems, and instrumentation must be designed to give reasonable assurance that those engine operating limitations that adversely affect turbine rotor structural integrity will not be exceeded in service.

(d) *Restart capability:* A means to restart any engine in flight must be provided.

(1) Except for the in-flight shutdown of all engines, engine restart capability must be demonstrated throughout a flight envelope for the rotorcraft.

(2) Following the in-flight shutdown of all engines, in-flight engine restart capability must be provided.

[Doc. No. 5074, 29 FR 15695, Nov. 24, 1964, as amended by Amdt. 27–11, 41 FR 55469, Dec. 20, 1976; Amdt. 27–23, 53 FR 34211, Sept. 2, 1988; Amdt. 27–44, 73 FR 11000, Feb. 29, 2008]

§ 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.

(d) The rotor drive system includes any part necessary to transmit power from the engines to the rotor hubs. This includes gear boxes, shafting, universal joints, couplings, rotor brake assemblies, clutches, supporting bearings for shafting, any attendant accessory pads or drives, and any cooling fans that are a part of, attached to, or mounted on the rotor drive system.

[Doc. No. 5074, 29 FR 15695, Nov. 24, 1964, as amended by Amdt. 27–11, 41 FR 55469, Dec. 20, 1976]

§ 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. No intervening disassembly which might affect test results may be conducted.

(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 torque must be absorbed by the rotors to be installed, except that other ground or flight test facilities with other appropriate methods of torque 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 maximum continuous torque and the maximum speed for use with maximum continuous torque. In this test, the main rotor controls 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 or, for rotorcraft for which the use of either 30-minute OEI power or continuous OEI power is requested, a 25-hour part of the test prescribed in paragraph (b) of this section must be run at not less than 75 percent of maximum continuous torque and the minimum speed for use with 75 percent of maximum continuous torque. 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 torque and the maximum speed for use with takeoff torque. The main and auxiliary rotor controls must be in the normal position for vertical ascent.

(1) For multiengine rotorcraft for which the use of 2½ minute OEI power is requested, 12 runs during the 10-hour test must be conducted as follows:

(i) Each run must consist of at least one period of 2½ minutes with takeoff torque and the maximum speed for use with takeoff torque on all engines.

(ii) Each run must consist of at least one period for each engine in sequence, during which that engine simulates a power failure and the remaining engines are run at 2½ minute OEI torque and the maximum speed for use with 2½ minute OEI torque for 2½ minutes.

(2) For multiengine turbine-powered rotorcraft for which the use of 30-second and 2-minute OEI power is requested, 10 runs must be conducted as follows:

(i) Immediately following a takeoff run of at least 5 minutes, each power source must simulate a failure, in turn, and apply the maximum torque and the maximum speed for use with 30-second OEI power to the remaining affected drive system power inputs for not less than 30 seconds, followed by application of the maximum torque and the maximum speed for use with 2-minute OEI power for not less than 2 minutes. At least one run sequence must be conducted from a simulated "flight idle" condition. When conducted on a bench test, the test sequence must be conducted following stabilization at takeoff power.

(ii) For the purpose of this paragraph, an affected power input includes all parts of the rotor drive system which can be adversely affected by the application of higher or asymmetric torque and speed prescribed by the test.

(iii) This test may be conducted on a representative bench test facility when engine limitations either preclude repeated use of this power or would result in premature engine removal during the test. The loads, the vibration frequency, and the methods of application to the affected rotor drive system components must be representative of rotorcraft conditions. Test components must be those used to show compliance with the remainder of this section.

(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.

(i) At least 200 start-up clutch engagements must be accomplished—

(1) So that the shaft on the driven side of the clutch is accelerated; and

(2) Using a speed and method selected by the applicant.

(j) For multiengine rotorcraft for which the use of 30-minute OEI power is requested, five runs must be made at 30-minute OEI torque and the maximum speed for use with 30-minute OEI torque, in which each engine, in sequence, is made inoperative and the remaining engine(s) is run for a 30-minute period.

(k) For multiengine rotorcraft for which the use of continuous OEI power is requested, five runs must be made at continuous OEI torque and the maximum speed for use with continuous OEI torque, in which each engine, in sequence, is made inoperative and the remaining engine(s) is run for a 1-hour period.

(Secs. 313(a), 601, and 603, 72 Stat. 752, 775, 49 U.S.C. 1354(a), 1421, and 1423; sec. 6(c), 49 U.S.C. 1655(c))

[Doc. No. 5074, 29 FR 15695, Nov. 24, 1964, as amended by Amdt. 27–2, 33 FR 963, Jan. 26, 1968; Amdt. 27–12, 42 FR 15044, Mar. 17, 1977; Amdt. 27–23, 53 FR 34212, Sept. 2, 1988; Amdt. 27–29, 59 FR 47767, Sept. 16, 1994]

§ 27.927 Additional tests.

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

(b) If turbine engine torque output to the transmission can exceed the highest engine or transmission torque rating limit, and that output is not directly controlled by the pilot under normal operating conditions (such as where the primary engine power control is accomplished through the flight control), the following test must be made:

(1) Under conditions associated with all engines operating, make 200 applications, for 10 seconds each, or torque that is at least equal to the lesser of—

(i) The maximum torque used in meeting § 27.923 plus 10 percent; or

(ii) The maximum attainable torque output of the engines, assuming that torque limiting devices, if any, function properly.

(2) For multiengine rotorcraft under conditions associated with each engine, in turn, becoming inoperative, apply to the remaining transmission torque inputs the maximum torque attainable under probable operating conditions, assuming that torque limiting devices, if any, function properly. Each transmission input must be tested at this maximum torque for at least 15 minutes.

(3) The tests prescribed in this paragraph must be conducted on the rotorcraft at the maximum rotational speed intended for the power condition of the test and the torque must be absorbed by the rotors to be installed, except that other ground or flight test facilities with other appropriate methods of torque 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) It must be shown by tests that the rotor drive system is capable of operating under autorotative conditions for 15 minutes after the loss of pressure in the rotor drive primary oil system.

(Secs. 313(a), 601, and 603, 72 Stat. 752, 775, 49 U.S.C. 1354(a), 1421, and 1423; sec. 6(c), 49 U.S.C. 1655(c))

[Amdt. 27–2, 33 FR 963, Jan. 26, 1968, as amended by Amdt. 27–12, 42 FR 15045, Mar. 17, 1977; Amdt. 27–23, 53 FR 34212, Sept. 2, 1988]

§ 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.

§ 27.939 Turbine engine operating characteristics.

(a) Turbine engine operating characteristics must be investigated in flight to determine that no adverse characteristics (such as stall, surge, or flameout) are present, to a hazardous degree, during normal and emergency operation within the range of operating limitations of the rotorcraft and of the engine.

(b) The turbine engine air inlet system may not, as a result of airflow distortion during normal operation, cause vibration harmful to the engine.

(c) For governor-controlled engines, it must be shown that there exists no hazardous torsional instability of the drive system associated with critical combinations of power, rotational speed, and control displacement.

[Amdt. 27–1, 32 FR 6914, May 5, 1967, as amended by Amdt. 27–11, 41 FR 55469, Dec. 20, 1976]

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.

(c) Each fuel system for a turbine engine must be capable of sustained operation throughout its flow and pressure range with fuel initially saturated with water at 80 °F. and having 0.75cc of free water per gallon added and cooled to the most critical condition for icing likely to be encountered in operation.

[Doc. No. 5074, 29 FR 15695, Nov. 24, 1964, as amended by Amdt. 27–9, 39 FR 35461, Oct. 1, 1974]

§ 27.952 Fuel system crash resistance.

Unless other means acceptable to the Administrator are employed to minimize the hazard of fuel fires to occupants following an otherwise survivable impact (crash landing), the fuel systems must incorporate the design features of this section. These systems must be shown to be capable of sustaining the static and dynamic deceleration loads of this section, considered as ultimate loads acting alone, measured at the system component's center of gravity, without structural damage to system components, fuel tanks, or their attachments that would leak fuel to an ignition source.

(a) *Drop test requirements.* Each tank, or the most critical tank, must be drop-tested as follows:

(1) The drop height must be at least 50 feet.

(2) The drop impact surface must be nondeforming.

(3) The tank must be filled with water to 80 percent of the normal, full capacity.

(4) The tank must be enclosed in a surrounding structure representative of the installation unless it can be established that the surrounding structure is free of projections or other design features likely to contribute to rupture of the tank.

(5) The tank must drop freely and impact in a horizontal position ±10°.

(6) After the drop test, there must be no leakage.

(b) *Fuel tank load factors.* Except for fuel tanks located so that tank rupture with fuel release to either significant ignition sources, such as engines, heaters, and auxiliary power units, or occupants is extremely remote, each fuel tank must be designed and installed to retain its contents under the following ultimate inertial load factors, acting alone.

(1) For fuel tanks in the cabin:

(i) Upward—4g.

(ii) Forward—16g.

(iii) Sideward—8g.

(iv) Downward—20g.

(2) For fuel tanks located above or behind the crew or passenger compartment that, if loosened, could injure an occupant in an emergency landing:

(i) Upward—1.5g.

(ii) Forward—8g.

(iii) Sideward—2g.

(iv) Downward—4g.

(3) For fuel tanks in other areas:

(i) Upward—1.5g.

(ii) Forward—4g.

(iii) Sideward—2g.

(iv) Downward—4g.

(c) *Fuel line self-sealing breakaway couplings.* Self-sealing breakaway couplings must be installed unless hazardous relative motion of fuel system components to each other or to local rotorcraft structure is demonstrated to be extremely improbable or unless other means are provided. The couplings or equivalent devices must be installed at all fuel tank-to-fuel line connections, tank-to-tank interconnects, and at other points in the fuel system where local structural deformation could lead to the release of fuel.

(1) The design and construction of self-sealing breakaway couplings must incorporate the following design features:

(i) The load necessary to separate a breakaway coupling must be between 25 to 50 percent of the minimum ultimate failure load (ultimate strength) of the weakest component in the fluid-carrying line. The separation load must in no case be less than 300 pounds, regardless of the size of the fluid line.

(ii) A breakaway coupling must separate whenever its ultimate load (as defined in paragraph (c)(1)(i) of this section) is applied in the failure modes most likely to occur.

(iii) All breakaway couplings must incorporate design provisions to visually ascertain that the coupling is locked together (leak-free) and is open during normal installation and service.

(iv) All breakaway couplings must incorporate design provisions to prevent uncoupling or unintended closing due to operational shocks, vibrations, or accelerations.

(v) No breakaway coupling design may allow the release of fuel once the coupling has performed its intended function.

(2) All individual breakaway couplings, coupling fuel feed systems, or equivalent means must be designed, tested, installed, and maintained so that inadvertent fuel shutoff in flight is improbable in accordance with § 27.955(a) and must comply with the fatigue evaluation requirements of § 27.571 without leaking.

(3) Alternate, equivalent means to the use of breakaway couplings must not create a survivable impact-induced load on the fuel line to which it is installed greater than 25 to 50 percent of the ultimate load (strength) of the weakest component in the line and must comply with the fatigue requirements of § 27.571 without leaking.

(d) *Frangible or deformable structural attachments.* Unless hazardous relative motion of fuel tanks and fuel system components to local rotorcraft structure is demonstrated to be extremely improbable in an otherwise survivable impact, frangible or locally deformable attachments of fuel tanks and fuel system components to local rotorcraft structure must be used. The attachment of fuel tanks and fuel system components to local rotorcraft structure, whether frangible or locally deformable, must be designed such that its separation or relative local deformation will occur without rupture or local tear-out of the fuel tank or fuel system components that will cause fuel leakage. The ultimate strength of frangible or deformable attachments must be as follows:

(1) The load required to separate a frangible attachment from its support structure, or deform a locally deformable attachment relative to its support structure, must be between 25 and 50 percent of the minimum ultimate load (ultimate strength) of the weakest component in the attached system. In no case may the load be less than 300 pounds.

(2) A frangible or locally deformable attachment must separate or locally deform as intended whenever its ultimate load (as defined in paragraph (d)(1) of this section) is applied in the modes most likely to occur.

(3) All frangible or locally deformable attachments must comply with the fatigue requirements of § 27.571.

(e) *Separation of fuel and ignition sources.* To provide maximum crash resistance, fuel must be located as far as practicable from all occupiable areas and from all potential ignition sources.

(f) *Other basic mechanical design criteria.* Fuel tanks, fuel lines, electrical wires, and electrical devices must be designed, constructed, and installed, as far as practicable, to be crash resistant.

(g) *Rigid or semirigid fuel tanks.* Rigid or semirigid fuel tank or bladder walls must be impact and tear resistant.

[Doc. No. 26352, 59 FR 50386, Oct. 3, 1994]

§ 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.

§ 27.954 Fuel system lightning protection.

The fuel system must be designed and arranged to prevent the ignition of fuel vapor within the system by—

(a) Direct lightning strikes to areas having a high probability of stroke attachment;

(b) Swept lightning strokes to areas where swept strokes are highly probable; or

(c) Corona and streamering at fuel vent outlets.

[Amdt. 27–23, 53 FR 34212, Sept. 2, 1988]

§ 27.955 Fuel flow.

(a) *General.* The fuel system for each engine must be shown to provide the engine with at least 100 percent of the fuel required under each operating and maneuvering condition to be approved for the rotorcraft including, as applicable, the fuel required to operate the engine(s) under the test conditions required by § 27.927. Unless equivalent methods are used, compliance must be shown by test during which the following provisions are met except that combinations of conditions which are shown to be improbable need not be considered.

(1) The fuel pressure, corrected for critical accelerations, must be within the limits specified by the engine type certificate data sheet.

(2) The fuel level in the tank may not exceed that established as the unusable fuel supply for that tank under § 27.959, plus the minimum additional fuel necessary to conduct the test.

(3) The fuel head between the tank outlet and the engine inlet must be critical with respect to rotorcraft flight attitudes.

(4) The critical fuel pump (for pump-fed systems) is installed to produce (by actual or simulated failure) the critical restriction to fuel flow to be expected from pump failure.

(5) Critical values of engine rotation speed, electrical power, or other sources of fuel pump motive power must be applied.

(6) Critical values of fuel properties which adversely affect fuel flow must be applied.

(7) The fuel filter required by § 27.997 must be blocked to the degree necessary to simulate the accumulation of fuel contamination required to activate the indicator required by § 27.1305(q).

(b) *Fuel transfer systems.* If normal operation of the fuel system requires fuel to be transferred to an engine feed tank, the transfer must occur automatically via a system which has been shown to maintain the fuel level in the engine feed tank within acceptable limits during flight or surface operation of the rotorcraft.

(c) *Multiple fuel tanks.* If an engine can be supplied with fuel from more than one tank, the fuel systems must, in addition to having appropriate manual switching capability, be designed to prevent interruption of fuel flow to that engine, without attention by the flightcrew, when any tank supplying fuel to that engine is depleted of usable fuel during normal operation, and any other tank that normally supplies fuel to the engine alone contains usable fuel.

[Amdt. 27–23, 53 FR 34212, Sept. 2, 1988]

§ 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 with features conducive to vapor formation must be shown by test to operate satisfactorily (within certification limits) when using fuel at a temperature of 110 °F under critical operating conditions including, if applicable, the engine operating conditions defined by § 27.927 (b)(1) and (b)(2).

[Amdt. 27–23, 53 FR 34212, Sept. 2, 1988]

§ 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.

(e) The maximum exposed surface temperature of any component in the fuel tank must be less, by a safe margin as determined by the Administrator, than the lowest expected autoignition temperature of the fuel or fuel vapor in the tank. Compliance with this requirement must be shown under all operating conditions and under all failure or malfunction conditions of all components inside the tank.

(f) Each fuel tank installed in personnel compartments must be isolated by fume-proof and fuel-proof enclosures that are drained and vented to the exterior of the rotorcraft. The design and construction of the enclosures must provide necessary protection for the tank, must be crash resistant during a survivable impact in accordance with § 27.952, and must be adequate to withstand loads and abrasions to be expected in personnel compartments.

(g) Each flexible fuel tank bladder or liner must be approved or shown to be suitable for the particular application and must be puncture resistant. Puncture resistance must be shown by meeting the TSO-C80, paragraph 16.0, requirements using a minimum puncture force of 370 pounds.

(h) Each integral fuel tank must have provisions for inspection and repair of its interior.

[Doc. No. 5074, 29 FR 15695, Nov. 24, 1964, as amended by Amdt. 27–23, 53 FR 34213, Sept. 2, 1988; Amdt. 27–30, 59 FR 50387, Oct. 3, 1994]

§ 27.965 Fuel tank tests.

(a) Each fuel tank must be able to withstand the applicable pressure tests in this section without failure or leakage. If practicable, test pressures may be applied in a manner simulating the pressure distribution in service.

(b) Each conventional metal tank, nonmetallic tank with walls that are not supported by the rotorcraft structure, and integral tank must be subjected to a pressure of 3.5 p.s.i. unless the pressure developed during maximum limit acceleration or emergency deceleration with a full tank exceeds this value, in which case a hydrostatic head, or equivalent test, must be applied to duplicate the acceleration loads as far as possible. However, the pressure need not exceed 3.5 p.s.i. on surfaces not exposed to the acceleration loading.

(c) Each nonmetallic tank with walls supported by the rotorcraft structure must be subjected to the following tests:

(1) A pressure test of at least 2.0 p.s.i. This test may be conducted on the tank alone in conjunction with the test specified in paragraph (c)(2) of this section.

(2) A pressure test, with the tank mounted in the rotorcraft structure, equal to the load developed by the reaction of the contents, with the tank

full, during maximum limit acceleration or emergency deceleration. However, the pressure need not exceed 2.0 p.s.i. on surfaces not exposed to the acceleration loading.

(d) Each tank with large unsupported or unstiffened flat areas, or with other features whose failure or deformation could cause leakage, must be subjected to the following test or its equivalent:

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

(2) The tank assembly must be vibrated for 25 hours while two-thirds full of any suitable fluid. The amplitude of vibration may not be less than one thirty-second of an inch, unless otherwise substantiated.

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

(i) If no frequency of vibration resulting from any r.p.m. within the normal operating range of engine or rotor system speeds is critical, the test frequency of vibration, in number of cycles per minute must, unless a frequency based on a more rational calculation is used, be the number obtained by averaging the maximum and minimum power-on engine speeds (r.p.m.) for reciprocating engine powered rotorcraft or 2,000 c.p.m. for turbine engine powered rotorcraft.

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

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

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

(5) During the test, the tank assembly must be rocked at the rate of 16 to 20 complete cycles per minute through an angle of 15 degrees on both sides of the horizontal (30 degrees total), about the most critical axis, for 25 hours. If motion about more than one axis is likely to be critical, the tank must be rocked about each critical axis for 12½ hours.

(Secs. 313(a), 601, and 603, 72 Stat. 752, 775, 49 U.S.C. 1354(a), 1421, and 1423; sec. 6(c), 49 U.S.C. 1655(c))

[Amdt. 27–12, 42 FR 15045, Mar. 17, 1977]

§ 27.967 Fuel tank installation.

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

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

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

(3) If flexible tank liners are used, they must be supported so that it is not necessary for them to withstand fluid loads; and

(4) Each interior surface of tank compartments must be smooth and free of projections that could cause wear of the liner unless—

(i) There are means for protection of the liner at those points; or

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

(b) Any spaces adjacent to tank surfaces must be adequately ventilated to avoid accumulation of fuel or fumes in those spaces due to minor leakage. If the tank is in a sealed compartment, ventilation may be limited to drain holes that prevent clogging and excessive pressure resulting from altitude changes. If flexible tank liners are installed, the venting arrangement for the spaces between the liner and its container must maintain the proper relationship to tank vent pressures for any expected flight condition.

(c) The location of each tank must meet the requirements of § 27.1185 (a) and (c).

(d) No rotorcraft skin immediately adjacent to a major air outlet from the engine compartment may act as the wall of the integral tank.

[Doc. No. 26352, 59 FR 50387, Oct. 3, 1994]

§ 27.969 Fuel tank expansion space.

Each fuel tank or each group of fuel tanks with interconnected vent systems must have an expansion space of not less than 2 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.

[Amdt. 27–23, 53 FR 34213, Sept. 2, 1988]

§ 27.971 Fuel tank sump.

(a) Each fuel tank must have a drainable sump with an effective capacity in any ground attitude to be expected in service of 0.25 percent of the tank capacity or 1/16 gallon, whichever is greater, unless—

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

(2) Each fuel tank drain is located so that in any ground attitude to be expected in service, water will drain from all parts of the tank to the sediment bowl or chamber.

(b) Each sump, sediment bowl, and sediment chamber drain required by this section must comply with the drain provisions of § 27.999(b).

[Amdt. 27–23, 53 FR 34213, Sept. 2, 1988]

§ 27.973 Fuel tank filler connection.

(a) Each fuel tank filler connection must prevent the entrance of fuel into any part of the rotorcraft other than the tank itself during normal operations and must be crash resistant during a survivable impact in accordance with § 27.952(c). In addition—

(1) Each filler must be marked as prescribed in § 27.1557(c)(1);

(2) Each recessed filler connection that can retain any appreciable quantity of fuel must have a drain that discharges clear of the entire rotorcraft; and

(3) Each filler cap must provide a fuel-tight seal under the fluid pressure expected in normal operation and in a survivable impact.

(b) Each filler cap or filler cap cover must warn when the cap is not fully locked or seated on the filler connection.

[Doc. No. 26352, 59 FR 50387, Oct. 3, 1994]

§ 27.975 Fuel tank vents.

(a) 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.

(b) The venting system must be designed to minimize spillage of fuel through the vents to an ignition source in the event of a rollover during landing, ground operation, or a survivable impact.

[Doc. No. 5074, 29 FR 15695, Nov. 24, 1964, as amended by Amdt. 27–23, 53 FR 34213, Sept. 2, 1988; Amdt. 27–30, 59 FR 50387, Oct. 3, 1994; Amdt. 27–35, 63 FR 43285, Aug. 12, 1998]

§ 27.977 Fuel tank outlet.

(a) There must be a fuel stainer for the fuel tank outlet or for the booster pump. This strainer must—

(1) For reciprocating engine powered rotorcraft, have 8 to 16 meshes per inch; and

(2) For turbine engine powered rotorcraft, prevent the passage of any object that could restrict fuel flow or damage any fuel system component.

(b) The clear area of each fuel tank outlet strainer must be at least five times the area of the outlet line.

(c) The diameter of each strainer must be at least that of the fuel tank outlet.

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

[Amdt. 27–11, 41 FR 55470, Dec. 20, 1976]

FUEL SYSTEM COMPONENTS

§ 27.991 Fuel pumps.

Compliance with § 27.955 may not be jeopardized by failure of—

(a) Any one pump except pumps that are approved and installed as parts of a type certificated engine; or

(b) Any component required for pump operation except, for engine driven pumps, the engine served by that pump.

[Amdt. 27–23, 53 FR 34213, Sept. 2, 1988]

§ 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 flexible connection in fuel lines that may be under pressure or subjected to axial loading must use flexible hose assemblies.

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

[Doc. No. 5074, 29 FR 15695, Nov. 24, 1964, as amended by Amdt. 27–2, 33 FR 964, Jan. 26, 1968]

§ 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.

There must be a fuel strainer or filter between the fuel tank outlet and the inlet of the first fuel system component which is susceptible to fuel contamination, including but not limited to the fuel metering device or an engine positive displacement pump, whichever is nearer the fuel tank outlet. This fuel strainer or filter must—

(a) Be accessible for draining and cleaning and must incorporate a screen or element which is easily removable;

(b) Have a sediment trap and drain except that it need not have a drain if the strainer or filter is easily removable for drain purposes;

(c) Be mounted so that its weight is not supported by the connecting lines or by the inlet or outlet connections of the strainer or filter itself, unless adequate strength margins under all loading conditions are provided in the lines and connections; and

(d) Provide a means to remove from the fuel any contaminant which would jeopardize the flow of fuel through rotorcraft or engine fuel system components required for proper rotorcraft fuel system or engine fuel system operation.

[Amdt. 27–9, 39 FR 35461, Oct. 1, 1974, as amended by Amdt. 27–20, 49 FR 6849, Feb. 23, 1984; Amdt. 27–23, 53 FR 34213, Sept. 2, 1988]

§ 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 any ground attitude to be expected in service.

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

(1) Discharge clear of all parts of the rotorcraft;

(2) Have manual or automatic means to assure positive closure in the off position; and

(3) Have a drain valve—

(i) That is readily accessible and which can be easily opened and closed; and

(ii) That is either located or protected to prevent fuel spillage in the event of a landing with landing gear retracted.

[Doc. No. 574, 29 FR 15695, Nov. 24, 1964, as amended by Amdt. 27–11, 41 FR 55470, Dec. 20, 1976; Amdt. 27–23, 53 FR 34213, Sept. 2, 1988]

OIL SYSTEM

§ 27.1011 Engines: 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.

[Doc. No. 5074, 29 FR 15695, Nov. 24, 1964, as amended by Amdt. 27–23, 53 FR 34213, Sept. 2, 1988]

§ 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) [Reserved]

(c) Where used with a reciprocating engine, it has an expansion space of not less than the greater of 10 percent of the tank capacity or 0.5 gallon, and where used with a turbine engine, it has an expansion space of not less than 10 percent of the tank capacity.

(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.

[Doc. No. 5074, 29 FR 15695, Nov. 24, 1964, as amended by Amdt. 27–9, 39 FR 35461, Oct. 1, 1974]

§ 27.1015 Oil tank tests.

Each oil tank must be designed and installed so that it can withstand, without leakage, an internal pressure of 5 p.s.i., except that each pressurized oil tank used with a turbine engine must be designed and installed so that it can withstand, without leakage, an internal pressure of 5 p.s.i., plus the maximum operating pressure of the tank.

[Amdt. 27–9, 39 FR 35462, Oct. 1, 1974]

§ 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.

(a) Each turbine engine installation must incorporate an oil strainer or filter through which all of the engine oil flows and which meets the following requirements:

(1) Each oil strainer or filter that has a bypass 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 completely blocked.

(2) The oil strainer or filter must have the capacity (with respect to operating limitations established for the engine) to ensure that engine oil system functioning is not impaired when the oil is contaminated to a degree (with respect to particle size and density) that is greater than that established for the engine under Part 33 of this chapter.

(3) The oil strainer or filter, unless it is installed at an oil tank outlet, must incorporate a means to indicate contamination before it reaches the capacity established in accordance with paragraph (a)(2) of this section.

(4) The bypass of a strainer or filter must be constructed and installed so that the release of collected contaminants is minimized by appropriate location of the bypass to ensure that collected contaminants are not in the bypass flow path.

(5) An oil strainer or filter that has no bypass, except one that is installed at an oil tank outlet, must have a means to connect it to the warning system required in § 27.1305(r).

(b) Each oil strainer or filter in a powerplant installation using reciprocating engines 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.

[Amdt. 27–9, 39 FR 35462, Oct. 1, 1974, as amended by Amdt. 27–20, 49 FR 6849, Feb. 23, 1984; Amdt. 27–23, 53 FR 34213, Sept. 2, 1988]

§ 27.1021 Oil system drains.

A drain (or drains) must be provided to allow safe drainage of the oil system. Each drain must—

(a) Be accessible; and

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

[Amdt. 27–20, 49 FR 6849, Feb. 23, 1984]

§ 27.1027 Transmissions and gearboxes: General.

(a) The lubrication system for components of the rotor drive system that require continuous lubrication must be sufficiently independent of the lubrication systems of the engine(s) to ensure lubrication during autorotation.

(b) Pressure lubrication systems for transmissions and gearboxes must comply with the engine oil system requirements of §§ 27.1013 (except paragraph (c)), 27.1015, 27.1017, 27.1021, and 27.1337(d).

(c) Each pressure lubrication system must have an oil strainer or filter through which all of the lubricant flows and must—

(1) Be designed to remove from the lubricant any contaminant which may damage transmission and drive system components or impede the flow of lubricant to a hazardous degree;

(2) Be equipped with a means to indicate collection of contaminants on the filter or strainer at or before opening of the bypass required by paragraph (c)(3) of this section; and

(3) Be equipped with a bypass constructed and installed so that—

(i) The lubricant will flow at the normal rate through the rest of the system with the strainer or filter completely blocked; and

(ii) The release of collected contaminants is minimized by appropriate location of the bypass to ensure that collected contaminants are not in the bypass flowpath.

(d) For each lubricant tank or sump outlet supplying lubrication to rotor drive systems and rotor drive system components, a screen must be provided to prevent entrance into the lubrication system of any object that might obstruct the flow of lubricant from the outlet to the filter required by paragraph (c) of this section. The requirements of paragraph (c) do not apply to screens installed at lubricant tank or sump outlets.

(e) Splash-type lubrication systems for rotor drive system gearboxes must comply with §§ 27.1021 and 27.1337(d).

[Amdt. 27–23, 53 FR 34213, Sept. 2, 1988, as amended by Amdt. 27–37, 64 FR 45095, Aug. 18, 1999]

COOLING

§ 27.1041 General.

(a) Each powerplant cooling system must be able to maintain the temperatures of powerplant components within the limits established for these components under critical surface (ground or water) and flight operating conditions for which certification is required and after normal shutdown. Powerplant components to be considered include but may not be limited to engines, rotor drive system components, auxiliary power units, and the cooling or lubricating fluids used with these components.

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

[Doc. No. 5074, 29 FR 15695, Nov. 24, 1964, as amended by Amdt. 27–23, 53 FR 34213, Sept. 2, 1988]

§ 27.1043 Cooling tests.

(a) *General.* For the tests prescribed in § 27.1041(b), the following apply:

(1) If the tests are conducted under conditions deviating from the maximum ambient atmospheric 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 paragraph (a)(1) of this section 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 ambient atmospheric temperature.* A maximum ambient atmospheric temperature corresponding to sea level conditions of at least 100 degrees F. must be established. The assumed temperature lapse rate is 3.6 degrees F. per thousand feet of altitude above sea level until a temperature of −69.7 degrees F. is reached, above which altitude the temperature is considered constant at −69.7 degrees F. However, for winterization installations, the applicant may select a maximum ambient atmospheric temperature corresponding to sea level conditions of less than 100 degrees F.

(c) *Correction factor (except cylinder barrels).* Unless a more rational correction applies, temperatures of engine fluids and power-plant components (except cylinder barrels) for which temperature limits are established, must be corrected by adding to them the difference between the maximum ambient atmospheric temperature and the temperature of the ambient air at the time of the first occurrence of the maximum component or fluid temperature 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 ambient atmospheric 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.

(Secs. 313(a), 601, 603, 604, and 605 of the Federal Aviation Act of 1958 (49 U.S.C. 1354(a), 1421, 1423, 1424, and 1425); and sec. 6(c) of the Dept. of Transportation Act (49 U.S.C. 1655(c)))

[Doc. No. 5074, 29 FR 15695, Nov. 24, 1964, as amended by Amdt. 27–11, 41 FR 55470, Dec. 20, 1976; Amdt. 27–14, 43 FR 2325, Jan. 16, 1978]

§ 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 or 5 minutes after the occurrence of the highest temperature recorded, as appropriate to the test condition;

(2) That stage of flight is completed; or

(3) An operating limitation is reached.

[Doc. No. 5074, 29 FR 15695, Nov. 24, 1964, as amended by Amdt. 27–23, 53 FR 34214, Sept. 2, 1988]

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) For turbine engine powered rotorcraft—

(1) There must be means to prevent hazardous quantities of fuel leakage or overflow from drains, vents, or other

components of flammable fluid systems from entering the engine intake system; and

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

[Doc. No. 5074, 29 FR 15695, Nov. 24, 1964, as amended by Amdt. 27–2, 33 FR 964, Jan. 26, 1968; Amdt. 27–23, 53 FR 34214, Sept. 2, 1988]

§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 engine.* (1) It must be shown that each turbine engine and its air inlet system can operate throughout the flight power range of the engine (including idling)—

(i) Without accumulating ice on engine or inlet system components that would adversely affect engine operation or cause a serious loss of power under the icing conditions specified in appendix C of Part 29 of this chapter; and

(ii) In snow, both falling and blowing, without adverse effect on engine operation, within the limitations established for the rotorcraft.

(2) Each turbine engine must idle for 30 minutes on the ground, with the air bleed available for engine icing protection at its critical condition, without adverse effect, in an atmosphere that is at a temperature between 15° and 30 °F (between −9° and −1 °C) and has a liquid water content not less than 0.3 gram per cubic meter in the form of drops having a mean effective diameter not less than 20 microns, followed by momentary operation at takeoff power or thrust. During the 30 minutes of idle operation, the engine may be run up periodically to a moderate power or thrust setting in a manner acceptable to the Administrator.

(c) *Supercharged reciprocating engines.* For each engine having superchargers to pressurize the air before it enters the carburetor, the heat rise in the air caused by that supercharging at any altitude may be utilized in determining compliance with paragraph (a) of this section if the heat rise utilized is that which will be available, automatically, for the applicable altitude and operating condition because of supercharging.

(Secs. 313(a), 601, and 603, 72 Stat. 752, 775, 49 U.S.C. 1354(a), 1421, and 1423; sec. 6(c), 49 U.S.C. 1655(c))

[Doc. No. 5074, 29 FR 15695, Nov. 24, 1964, as amended by Amdt. 27–11, 41 FR 55470, Dec. 20, 1976; Amdt. 27–12, 42 FR 15045, Mar. 17, 1977; Amdt. 27–20, 49 FR 6849, Feb. 23, 1984; Amdt. 27–23, 53 FR 34214, Sept. 2, 1988]

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) Each exhaust system part with a surface hot enough to ignite flammable fluids or vapors must be located or shielded so that leakage from any system carrying flammable fluids or vapors will not result in a fire caused by impingement of the fluids or vapors on any part of the exhaust system including shields for the exhaust system;

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

(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;

(g) Each exhaust heat exchanger must incorporate means to prevent blockage of the exhaust port after any internal heat exchanger failure.

(Secs. 313(a), 601, and 603, 72 Stat. 752, 775, 49 U.S.C. 1354(a), 1421, and 1423; sec. 6(c), 49 U.S.C. 1655(c))

[Doc. No. 5074, 29 FR 15695, Nov. 24, 1964 as amended by Amdt. 27–12, 42 FR 15045, Mar. 17, 1977]

§ 27.1123 Exhaust piping.

(a) Exhaust piping must be heat and corrosion resistant, and must have provisions to prevent failure due to expansion by operating temperatures.

(b) Exhaust piping must be supported to withstand any vibration and inertia loads to which it would be subjected in operations.

(c) Exhaust piping connected to components between which relative motion could exist must have provisions for flexibility.

[Amdt. 27–11, 41 FR 55470, Dec. 20, 1976]

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.

(c) Each control must be able to maintain any set position without—

(1) Constant attention; or

(2) Tendency to creep due to control loads or vibration.

(d) Controls of powerplant valves required for safety must have—

(1) For manual valves, positive stops or in the case of fuel valves suitable index provisions, in the open and closed position; and

(2) For power-assisted valves, a means to indicate to the flight crew when the valve—

(i) Is in the fully open or fully closed position; or

(ii) Is moving between the fully open and fully closed position.

(e) For turbine engine powered rotorcraft, no single failure or malfunction, or probable combination thereof, in any powerplant control system may cause the failure of any powerplant function necessary for safety.

(Secs. 313(a), 601, and 603, 72 Stat. 752, 775, 49 U.S.C. 1354(a), 1421, and 1423; sec. 6(c), 49 U.S.C. 1655(c))

[Doc. No. 5074, 29 FR 15695, Nov. 24, 1964, as amended by Amdt. 27–12, 42 FR 15045, Mar. 17, 1977; Amdt. 27–23, 53 FR 34214, Sept. 2, 1988; Amdt. 27–33, 61 FR 21907, May 10, 1996]

§ 27.1143 Engine controls.

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

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

(1) Separate control of each engine; and

(2) Simultaneous control of all engines.

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

(d) If a power control incorporates a fuel shutoff feature, the control must have a means to prevent the inadvertent movement of the control into the shutoff position. The means must—

(1) Have a positive lock or stop at the idle position; and

(2) Require a separate and distinct operation to place the control in the shutoff position.

(e) For rotorcraft to be certificated for a 30-second OEI power rating, a means must be provided to automatically activate and control the 30-second OEI power and prevent any engine from exceeding the installed engine limits associated with the 30-second OEI power rating approved for the rotorcraft.

[Doc. No. 5074, 29 FR 15695, Nov. 24, 1964, as amended by Amdt. 27–11, 41 FR 55470, Dec. 20, 1976; Amdt. 27–23, 53 FR 34214, Sept. 2, 1988; Amdt. 27–29, 59 FR 47767, Sept. 16, 1994]

§ 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 group of ignition switches, except ignition switches for turbine engines for which continuous ignition is not required, and each master ignition control must have a means to prevent its inadvertent operation.

(Secs. 313(a), 601, and 603, 72 Stat. 752, 775, 49 U.S.C. 1354(a), 1421, and 1423; sec. 6(c), 49 U.S.C. 1655(c))

[Doc. No. 5074, 29 FR 15695, Nov. 24, 1964, as amended by Amdt. 27–12, 42 FR 15045, Mar. 17, 1977]

§ 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.

§ 27.1151 Rotor brake controls.

(a) It must be impossible to apply the rotor brake inadvertently in flight.

(b) There must be means to warn the crew if the rotor brake has not been completely released before takeoff.

[Doc. No. 28008, 61 FR 21907, May 10, 1996]

§ 27.1163 Powerplant accessories.

(a) Each engine-mounted accessory must—

(1) Be approved for mounting on the engine involved;

(2) Use the provisions on the engine for mounting; and

(3) Be sealed in such a way as to prevent contamination of the engine oil system and the accessory system.

(b) Unless other means are provided, torque limiting means must be provided for accessory drives located on any component of the transmission and rotor drive system to prevent damage to these components from excessive accessory load.

[Amdt. 27–2, 33 FR 964, Jan. 26, 1968, as amended by Amdt. 27–20, 49 FR 6849, Feb. 23, 1984; Amdt. 27–23, 53 FR 34214, Sept. 2, 1988]

POWERPLANT FIRE PROTECTION

§ 27.1183 Lines, fittings, and components.

(a) Except as provided in paragraph (b) of this section, each line, fitting, and other component carrying flammable fluid in any area subject to engine fire conditions must be fire resistant, except that flammable fluid tanks and supports which are part of and attached to the engine must be fireproof or be enclosed by a fireproof shield unless damage by fire to any non-fireproof part will not cause leakage or spillage of flammable fluid. Components must be shielded or located so as to safeguard against the ignition of leaking flammable fluid. An integral oil sump of less than 25-quart capacity on a reciprocating engine need not be fireproof nor be enclosed by a fireproof shield.

(b) Paragraph (a) does not apply to—

(1) Lines, fittings, and components which are already approved as part of a type certificated 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.

[Doc. No. 5074, 29 FR 15695, Nov. 24, 1964, as amended by Amdt. 27–1, 32 FR 6914, May 5, 1967; Amdt. 27–9, 39 FR 35462, Oct. 1, 1974; Amdt. 27–20, 49 FR 6849, Feb. 23, 1984]

§ 27.1185 Flammable fluids.

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

(b) Each tank or reservoir, other than a fuel tank, that is part of a system containing flammable fluids or gases must be isolated from the engine by a firewall or shroud, unless the design of the system, the materials used in the tank and its supports, the shutoff means, and the connections, lines and controls provide a degree of safety equal to that which would exist if the tank or reservoir were isolated from the engines.

(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.

(d) Absorbent materials close to flammable fluid system components that might leak must be covered or treated to prevent the absorption of hazardous quantities of fluids.

[Doc. No. 5074, 29 FR 15695, Nov. 24, 1964, as amended by Amdt. 27–2, 33 FR 964, Jan. 26, 1968; Amdt. 27–11, 41 FR 55470, Dec. 20, 1976; Amdt. 27–37, 64 FR 45095, Aug. 18, 1999]

§ 27.1187 Ventilation and drainage.

Each compartment containing any part of the powerplant installation must have provision for ventilation and drainage of flammable fluids. The drainage means must be—

(a) Effective under conditions expected to prevail when drainage is needed, and

(b) Arranged so that no discharged fluid will cause an additional fire hazard.

[Doc. No. 29247, 64 FR 45095, Aug. 18, 1999]

§ 27.1189 Shutoff means.

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

(1) Lines, fittings, and components forming an intergral part of an engine;

(2) For oil systems for which all components of the system, including oil tanks, are fireproof or located in areas not subject to engine fire conditions; and

(3) For reciprocating engine installations only, engine oil system lines in installation 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 control must be designed, located, and protected to function properly under any condition likely to result from an engine fire.

[Doc. No. 5074, 29 FR 15695, Nov. 24, 1964, as amended by Amdt. 27–2, 33 FR 964, Jan. 26, 1968; Amdt. 27–20, 49 FR 6850, Feb. 23, 1984; Amdt. 27–23, 53 FR 34214, Sept. 2, 1988]

§ 27.1191 Firewalls.

(a) Each engine, including the combustor, turbine, and tailpipe sections of turbine engines 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.

[Doc. No. 5074, 29 FR 15695, Nov. 24, 1964, as amended by Amdt. 27–2, 22 FR 964, Jan. 26, 1968]

§ 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.

(f) A means of retaining each openable or readily removable panel, cowling, or engine or rotor drive system covering must be provided to preclude hazardous damage to rotors or critical control components in the event of structural or mechanical failure of the normal retention means, unless such failure is extremely improbable.

[Doc. No. 5074, 29 FR 15695, Nov. 24, 1964, as amended by Amdt. 27–23, 53 FR 34214, Sept. 2, 1988]

§ 27.1194 Other surfaces.

All surfaces aft of, and near, powerplant compartments, other than tail surfaces not subject to heat, flames, or sparks emanating from a powerplant compartment, must be at least fire resistant.

[Amdt. 27–2, 33 FR 964, Jan. 26, 1968]

§ 27.1195 Fire detector systems.

Each turbine engine powered rotorcraft must have approved quick-acting fire detectors in numbers and locations insuring prompt detection of fire in the engine compartment which cannot be readily observed in flight by the pilot in the cockpit.

[Amdt. 27–5, 36 FR 5493, Mar. 24, 1971]

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) A low fuel warning device for each fuel tank which feeds an engine. This device must—

(1) Provide a warning to the flightcrew when approximately 10 minutes of usable fuel remains in the tank; and

(2) Be independent of the normal fuel quantity indicating system.

(m) Means to indicate to the flightcrew the failure of any fuel pump installed to show compliance with § 27.955.

(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).

(p) For each turbine engine, an indicator to indicate the functioning of the powerplant ice protection system.

(q) An indicator for the fuel filter required by § 27.997 to indicate the occurrence of contamination of the filter at the degree established by the applicant in compliance with § 27.955.

(r) For each turbine engine, a warning means for the oil strainer or filter required by § 27.1019, if it has no bypass, to warn the pilot of the occurrence of contamination of the strainer or filter before it reaches the capacity established in accordance with § 27.1019(a)(2).

(s) An indicator to indicate the functioning of any selectable or controllable heater used to prevent ice clogging of fuel system components.

(t) For rotorcraft for which a 30-second/2-minute OEI power rating is requested, a means must be provided to alert the pilot when the engine is at the 30-second and the 2-minute OEI power levels, when the event begins, and when the time interval expires.

(u) For each turbine engine utilizing 30-second/2-minute OEI power, a device or system must be provided for use by ground personnel which—

(1) Automatically records each usage and duration of power at the 30-second and 2-minute OEI levels;

(2) Permits retrieval of the recorded data;

(3) Can be reset only by ground maintenance personnel; and

(4) Has a means to verify proper operation of the system or device.

(v) Warning or caution devices to signal to the flight crew when ferromagnetic particles are detected by the chip detector required by § 27.1337(e).

[Doc. No. 5074, 29 FR 15695, Nov. 24, 1964, as amended by Amdt. 27–9, 39 FR 35462, Oct. 1, 1974; Amdt. 27–23, 53 FR 34214, Sept. 2, 1988; Amdt. 27–29, 59 FR 47767, Sept. 16, 1994; Amdt. 27–37, 64 FR 45095, Aug. 18, 1999; 64 FR 47563, Aug. 31, 1999]

§ 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) 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) The equipment, systems, and installations of a multiengine rotorcraft must be designed to prevent hazards to the rotorcraft in the event of a probable malfunction or failure.

(c) The equipment, systems, and installations of single-engine rotorcraft must be designed to minimize hazards to the rotorcraft in the event of a probable malfunction or failure.

[Doc. No. 5074, 29 FR 15695, Nov. 24, 1964, as amended by Amdt. 27–21, 49 FR 44435, Nov. 6, 1984; Amdt. 27–46, 76 FR 33135, June 8, 2011]

§ 27.1316 Electrical and electronic system lightning protection.

(a) Each electrical and electronic system that performs a function, for which failure would prevent the continued safe flight and landing of the rotorcraft, must be designed and installed so that—

(1) The function is not adversely affected during and after the time the rotorcraft is exposed to lightning; and

(2) The system automatically recovers normal operation of that function

in a timely manner after the rotorcraft is exposed to lightning.

(b) For rotorcraft approved for instrument flight rules operation, each electrical and electronic system that performs a function, for which failure would reduce the capability of the rotorcraft or the ability of the flightcrew to respond to an adverse operating condition, must be designed and installed so that the function recovers normal operation in a timely manner after the rotorcraft is exposed to lightning.

[Doc. No. FAA–2010–0224, Amdt. 27–46, 76 FR 33135, June 8, 2011]

§ 27.1317 High-intensity Radiated Fields (HIRF) Protection.

(a) Except as provided in paragraph (d) of this section, each electrical and electronic system that performs a function whose failure would prevent the continued safe flight and landing of the rotorcraft must be designed and installed so that—

(1) The function is not adversely affected during and after the time the rotorcraft is exposed to HIRF environment I, as described in appendix D to this part;

(2) The system automatically recovers normal operation of that function, in a timely manner, after the rotorcraft is exposed to HIRF environment I, as described in appendix D to this part, unless this conflicts with other operational or functional requirements of that system;

(3) The system is not adversely affected during and after the time the rotorcraft is exposed to HIRF environment II, as described in appendix D to this part; and

(4) Each function required during operation under visual flight rules is not adversely affected during and after the time the rotorcraft is exposed to HIRF environment III, as described in appendix D to this part.

(b) Each electrical and electronic system that performs a function whose failure would significantly reduce the capability of the rotorcraft or the ability of the flightcrew to respond to an adverse operating condition must be designed and installed so the system is not adversely affected when the equipment providing these functions is exposed to equipment HIRF test level 1 or 2, as described in appendix D to this part.

(c) Each electrical and electronic system that performs a function whose failure would reduce the capability of the rotorcraft or the ability of the flightcrew to respond to an adverse operating condition, must be designed and installed so the system is not adversely affected when the equipment providing these functions is exposed to equipment HIRF test level 3, as described in appendix D to this part.

(d) Before December 1, 2012, an electrical or electronic system that performs a function whose failure would prevent the continued safe flight and landing of a rotorcraft may be designed and installed without meeting the provisions of paragraph (a) provided—

(1) The system has previously been shown to comply with special conditions for HIRF, prescribed under § 21.16, issued before December 1, 2007;

(2) The HIRF immunity characteristics of the system have not changed since compliance with the special conditions was demonstrated; and

(3) The data used to demonstrate compliance with the special conditions is provided.

[Doc. No. FAA–2006–23657, 72 FR 44026, Aug. 6, 2007]

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.

(d) If a visual indicator is provided to indicate malfunction of an instrument, it must be effective under all probable cockpit lighting conditions.

(Secs. 313(a), 601, 603, 604, and 605 of the Federal Aviation Act of 1958 (49 U.S.C. 1354(a), 1421, 1423, 1424, and 1425); and sec. 6(c) of the Dept. of Transportation Act (49 U.S.C. 1655(c)))

[Doc. No. 5074, 29 FR 15695, Nov. 24, 1964; 29 FR 17885, Dec. 17, 1964, as amended by Amdt. 27–13, 42 FR 36971, July 18, 1977]

§ 27.1322 Warning, caution, and advisory lights.

If warning, caution or advisory lights are installed in the cockpit, they must, unless otherwise approved by the Administrator, be—

(a) Red, for warning lights (lights indicating a hazard which may require immediate corrective action):

(b) Amber, for caution lights (lights indicating the possible need for future corrective action);

(c) Green, for safe operation lights; and

(d) Any other color, including white, for lights not described in paragraphs (a) through (c) of this section, provided the color differs sufficiently from the colors prescribed in paragraphs (a) through (c) of this section to avoid possible confusion.

[Amdt. 27–11, 41 FR 55470, Dec. 20, 1976]

§ 27.1323 Airspeed indicating system.

(a) Each airspeed indicating instrument must be calibrated to indicate true airspeed (at sea level with a standard atmosphere) with a minimum practicable instrument calibration error when the corresponding pitot and static pressures are applied.

(b) The airspeed indicating system must be calibrated in flight at forward speeds of 20 knots and over.

(c) 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 knots.

(Secs. 313(a), 601, 603, 604, and 605 of the Federal Aviation Act of 1958 (49 U.S.C. 1354(a), 1421, 1423, 1424, and 1425); and sec. 6(c) of the Dept. of Transportation Act (49 U.S.C. 1655(c)))

[Doc. No. 5074, 29 FR 15695, Nov. 24, 1964, as amended by Amdt. 27–13, 42 FR 36972, July 18, 1977]

§ 27.1325 Static pressure systems.

(a) 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.

(b) Each static pressure port must be designed and located in such manner that the correlation between air pressure in the static pressure system and true ambient atmospheric static pressure is not altered when the rotorcraft encounters icing conditions. An anti-icing means or an alternate source of static pressure may be used in showing compliance with this requirement. If the reading of the altimeter, when on the alternate static pressure system, differs from the reading of the altimeter when on the primary static system by more than 50 feet, a correction card must be provided for the alternate static system.

(c) Except as provided in paragraph (d) of this section, if the static pressure system incorporates both a primary and an alternate static pressure source, the means for selecting one or the other source must be designed so that—

(1) When either source is selected, the other is blocked off; and

(2) Both sources cannot be blocked off simultaneously.

(d) For unpressurized rotorcraft, paragraph (c)(1) of this section does not apply if it can be demonstrated that the static pressure system calibration, when either static pressure source is selected is not changed by the other static pressure source being open or blocked.

(Secs. 313(a), 601, 603, 604, and 605 of the Federal Aviation Act of 1958 (49 U.S.C. 1354(a), 1421, 1423, 1424, and 1425); and sec. 6(c) of the Dept. of Transportation Act (49 U.S.C. 1655(c)))

[Doc. No. 5074, 29 FR 15695, Nov. 24, 1964, as amended by Amdt. 27–13, 42 FR 36972, July 18, 1977]

§ 27.1327 Magnetic direction indicator.

(a) Except as provided in paragraph (b) of this section—

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

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

(b) A magnetic nonstabilized direction indicator may deviate more than 10 degrees due to the operation of electrically powered systems such as electrically heated windshields if either a magnetic stabilized direction indicator, which does not have a deviation in level flight greater than 10 degrees on any heading, or a gyroscopic direction indicator, is installed. Deviations of a magnetic nonstabilized direction indicator of more than 10 degrees must be placarded in accordance with § 27.1547(e).

(Secs. 313(a), 601, 603, 604, and 605 of the Federal Aviation Act of 1958 (49 U.S.C. 1354(a), 1421, 1423, 1424, and 1425); and sec. 6(c) of the Dept. of Transportation Act (49 U.S.C. 1655(c)))

[Amdt. 27–13, 42 FR 36972, July 18, 1977]

§ 27.1329 Automatic pilot system.

(a) Each automatic pilot system must be designed so that the automatic pilot can—

(1) Be sufficiently overpowered by one pilot to allow control of the rotorcraft; and

(2) Be readily and positively disengaged by each pilot to prevent it from interfering with control of the rotorcraft.

(b) Unless there is automatic synchronization, each system must have a means to readily indicate to the pilot the alignment of the actuating device in relation to the control system it operates.

(c) Each manually operated control for the system's operation must be readily accessible to the pilots.

(d) The system must be designed and adjusted so that, within the range of adjustment available to the pilot, it cannot produce hazardous loads on the rotorcraft or create hazardous deviations in the flight path under any flight condition appropriate to its use, either during normal operation or in the event of a malfunction, assuming that corrective action begins within a reasonable period of time.

(e) If the automatic pilot integrates signals from auxiliary controls or furnishes signals for operation of other equipment, there must be positive interlocks and sequencing of engagement to prevent improper operation.

(f) If the automatic pilot system can be coupled to airborne navigation equipment, means must be provided to indicate to the pilots the current mode of operation. Selector switch position is not acceptable as a means of indication.

[Amdt. 27–21, 49 FR 44435, Nov. 6, 1984, as amended by Amdt. 27–35, 63 FR 43285, Aug. 12, 1998]

§ 27.1335 Flight director systems.

If a flight director system is installed, means must be provided to indicate to the flight crew its current mode of operation. Selector switch position is not acceptable as a means of indication.

(Secs. 313(a), 601, 603, 604, and 605 of the Federal Aviation Act of 1958 (49 U.S.C. 1354(a), 1421, 1423, 1424, and 1425); and sec. 6(c) of the Dept. of Transportation Act (49 U.S.C. 1655(c)))

[Amdt. 27–13, 42 FR 36972, July 18, 1977]

§ 27.1337 Powerplant instruments.

(a) *Instruments and instrument lines.* (1) Each powerplant instrument line must meet the requirements of §§ 27.961 and 27.993.

(2) Each line carrying flammable fluids under pressure must—

(i) Have restricting orifices or other safety devices at the source of pressure to prevent the escape of excessive fluid if the line fails; and

(ii) Be installed and located so that the escape of fluids would not create a hazard.

(3) Each powerplant instrument that utilizes flammable fluids must be installed and located so that the escape of fluid would not create a hazard.

(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.

(e) Rotor drive system transmissions and gearboxes utilizing ferromagnetic materials must be equipped with chip detectors designed to indicate the presence of ferromagnetic particles resulting from damage or excessive wear. Chip detectors must—

(1) Be designed to provide a signal to the device required by § 27.1305(v) and be provided with a means to allow crewmembers to check, in flight, the function of each detector electrical circuit and signal.

(2) [Reserved]

(Secs. 313(a), 601, and 603, 72 Stat. 752, 775, 49 U.S.C. 1354(a), 1421, and 1423; sec. 6(c) 49 U.S.C. 1655(c))

[Doc. No. 5074, 29 FR 15695, Nov. 24, 1964, as amended by Amdt. 27–12, 42 FR 15046, Mar. 17, 1977; Amdt. 27–23, 53 FR 34214, Sept. 2, 1988; Amdt. 27–37, 64 FR 45095, Aug. 18, 1999]

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 paragraph (a)(1) of this section 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;

(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; and

(4) Each generator must have an overvoltage control designed and installed to prevent damage to the electrical system, or to equipment supplied by the electrical system, that could result if that generator were to develop an overvoltage condition.

(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.

(e) *External power*. If provisions are made for connecting external power to the rotorcraft, and that external power can be electrically connected to equipment other than that used for engine starting, means must be provided to ensure that no external power supply having a reverse polarity, or a reverse phase sequence, can supply power to the rotorcraft's electrical system.

(Secs. 313(a), 601, 603, 604, and 605 of the Federal Aviation Act of 1958 (49 U.S.C. 1354(a), 1421, 1423, 1424, and 1425); and sec. 6(c) of the Dept. of Transportation Act (49 U.S.C. 1655(c)))

[Doc. No. 5074, 29 FR 15695, Nov. 24, 1964, as amended by Amdt. 27–11, 41 FR 55470, Dec. 20, 1976; Amdt. 27–13, 42 FR 36972, July 18, 1977]

§ 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 or power;

(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.

(f) Each nickel cadmium battery installation capable of being used to start an engine or auxiliary power unit must have provisions to prevent any hazardous effect on structure or essential systems that may be caused by the maximum amount of heat the battery can generate during a short circuit of the battery or of its individual cells.

(g) Nickel cadmium battery installations capable of being used to start an engine or auxiliary power unit must have—

(1) A system to control the charging rate of the battery automatically so as to prevent battery overheating;

(2) A battery temperature sensing and over-temperature warning system with a means for disconnecting the battery from its charging source in the event of an over-temperature condition; or

(3) A battery failure sensing and warning system with a means for disconnecting the battery from its charging source in the event of battery failure.

(Secs. 313(a), 601, 603, 604, and 605 of the Federal Aviation Act of 1958 (49 U.S.C. 1354(a), 1421, 1423, 1424, and 1425); and sec. 6(c) of the Dept. of Transportation Act (49 U.S.C. 1655(c)))

[Doc. No. 5074, 29 FR 15695, Nov. 24, 1964, as amended by Amdt. 27–13, 42 FR 36972, July 18, 1977; Amdt. 27–14, 43 FR 2325, Jan. 16, 1978]

§ 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) A protective device for a circuit essential to flight safety may not be used to protect any other circuit.

(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 trippling; 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.

(Secs. 313(a), 601, 603, 604, and 605 of the Federal Aviation Act of 1958 (49 U.S.C. 1354(a), 1421, 1423, 1424, and 1425); and sec. 6(c) of the Dept. of Transportation Act (49 U.S.C. 1655(c)))

[Doc. No. 5074, 29 FR 15695, Nov. 24, 1964; 29 FR 17885, Dec. 17, 1964, as amended by Amdt. 27–13, 42 FR 36972, July 18, 1977]

§ 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.

(c) Insulation on electrical wire and cable installed in the rotorcraft must be self-extinguishing when tested in accordance with appendix F, part I(a)(3), of part 25 of this chapter.

[Doc. No. 5074, 29 FR 15695, Nov. 24, 1964, as amended by Amdt. 27–35, 63 FR 43285, Aug. 12, 1998]

§ 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) Except as provided in paragraph (e) of this section, 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.

(e) If the rear position light, when mounted as far aft as practicable in accordance with § 25.1385(c), cannot show unbroken light within dihedral angle A (as defined in paragraph (d) of this section), a solid angle or angles of obstructed visibility totaling not more than 0.04 steradians is allowable within that dihedral angle, if such solid angle is within a cone whose apex is at the rear position light and whose elements make an angle of 30° with a vertical line passing through the rear position light.

(49 U.S.C. 1655(c))

[Doc. No. 5074, 29 FR 15695, Nov. 24, 1964, as amended by Amdt. 27–7, 36 FR 21278, Nov. 5, 1971]

§ 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).	10° 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, *I*
0°	1.00
0° to 5°	0.90
5° to 10°	0.80
10° to 15°	0.70
15° to 20°	0.50
20° to 30°	0.30
30° to 40°	0.10
40° to 90°	0.05

§ 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 0.300 and not greater than 0.540;
y is not less than $x - 0.040$'' or $y_c - 0.010$, whichever is the smaller; and
y is not greater than $x + 0.020$ nor $0.636 - 0.400x$;
Where y_c is the y coordinate of the Planckian radiator for the value of x considered.

[Doc. No. 5074, 29 FR 15695, Nov. 24, 1964, as amended by Amdt. 27–6, 36 FR 12972, July 10, 1971]

§ 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 nautical 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.

[Doc. No. 5074, 29 FR 15695, Nov. 24, 1964, as amended by Amdt. 27–2, 33 FR 964, Jan. 26, 1968]

§ 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 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 applicable requirements of § 27.1397.

(e) *Light intensity.* The minimum light intensities in any vertical plane, measured with the red filter (if used) 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 light.* 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°	150
5° to 10°	90
10° to 20°	30
20° to 30°	15

[Doc. No. 5074, 29 FR 15695, Nov. 24, 1964, as amended by Amdt. 27–6, 36 FR 12972, July 10, 1971; Amdt. 27–10, 41 FR 5290, Feb. 5, 1976]

SAFETY EQUIPMENT

§ 27.1411 General.

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

(b) Stowage provisions for required safety equipment must be furnished and must—

(1) Be arranged so that the equipment is directly accessible and its location is obvious; and

(2) Protect the safety equipment from damage caused by being subjected to the inertia loads specified in § 27.561.

[Doc. No. 5074, 29 FR 15695, Nov. 24, 1964, as amended by Amdt. 27–11, 41 FR 55470, Dec. 20, 1976]

§ 27.1413 Safety belts.

Each safety belt must be equipped with a metal to metal latching device.

(Secs. 313, 314, and 601 through 610 of the Federal Aviation Act of 1958 (49 U.S.C. 1354, 1355, and 1421 through 1430) and sec. 6(c), Dept. of Transportation Act (49 U.S.C. 1655(c)))

[Doc. No. 5074, 29 FR 15695, Nov. 24, 1964, as amended by Amdt. 27–15, 43 FR 46233, Oct. 5, 1978; Amdt. 27–21, 49 FR 44435, Nov. 6, 1984]

§ 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. The storage provisions for life preservers must accommodate one life preserver for each occupant for which certification for ditching is requested.

(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.

[Doc. No. 5074, 29 FR 15695, Nov. 24, 1964, as amended by Amdt. 27–11, 41 FR 55470, Dec. 20, 1976]

§ 27.1419 Ice protection.

(a) To obtain certification for flight into icing conditions, compliance with this section must be shown.

(b) It must be demonstrated that the rotorcraft can be safely operated in the continuous maximum and intermittent maximum icing conditions determined under appendix C of part 29 of this chapter within the rotorcraft altitude envelope. An analysis must be performed to establish, on the basis of the rotorcraft's operational needs, the adequacy of the ice protection system for the various components of the rotorcraft.

(c) In addition to the analysis and physical evaluation prescribed in paragraph (b) of this section, the effectiveness of the ice protection system and its components must be shown by flight tests of the rotorcraft or its components in measured natural atmospheric icing conditions and by one or more of the following tests as found necessary to determine the adequacy of the ice protection system:

(1) Laboratory dry air or simulated icing tests, or a combination of both, of the components or models of the components.

(2) Flight dry air tests of the ice protection system as a whole, or its individual components.

(3) Flight tests of the rotorcraft or its components in measured simulated icing conditions.

(d) The ice protection provisions of this section are considered to be applicable primarily to the airframe. Powerplant installation requirements are contained in subpart E of this part.

(e) A means must be indentified or provided for determining the formation of ice on critical parts of the rotorcraft. Unless otherwise restricted, the means must be available for nighttime as well as daytime operation. The rotorcraft flight manual must describe the means of determining ice formation and must contain information necessary for safe operation of the rotorcraft in icing conditions.

[Amdt. 27–19, 48 FR 4389, Jan. 31, 1983]

§ 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.

§ 27.1457 Cockpit voice recorders.

(a) Each cockpit voice recorder required by the operating rules of this chapter must be approved, and must be installed so that it will record the following:

(1) Voice communications transmitted from or received in the rotorcraft by radio.

(2) Voice communications of flight crewmembers on the flight deck.

(3) Voice communications of flight crewmembers on the flight deck, using the rotorcraft's interphone system.

(4) Voice or audio signals identifying navigation or approach aids introduced into a headset or speaker.

(5) Voice communications of flight crewmembers using the passenger loudspeaker system, if there is such a system, and if the fourth channel is available in accordance with the requirements of paragraph (c)(4)(ii) of this section.

(6) If datalink communication equipment is installed, all datalink communications, using an approved data message set. Datalink messages must be recorded as the output signal from the communications unit that translates the signal into usable data.

(b) The recording requirements of paragraph (a)(2) of this section may be met:

(1) By installing a cockpit-mounted area microphone located in the best position for recording voice communications originating at the first and second pilot stations and voice communications of other crewmembers on the flight deck when directed to those stations; or

(2) By installing a continually energized or voice-actuated lip microphone at the first and second pilot stations.

The microphone specified in this paragraph must be so located and, if necessary, the preamplifiers and filters of the recorder must be adjusted or supplemented so that the recorded communications are intelligible when recorded under flight cockpit noise conditions and played back. The level of intelligibility must be approved by the Administrator. Repeated aural or visual playback of the record may be used in evaluating intelligibility.

(c) Each cockpit voice recorder must be installed so that the part of the communication or audio signals specified in paragraph (a) of this section obtained from each of the following sources is recorded on a separate channel:

(1) For the first channel, from each microphone, headset, or speaker used at the first pilot station.

(2) For the second channel, from each microphone, headset, or speaker used at the second pilot station.

(3) For the third channel, from the cockpit-mounted area microphone, or the continually energized or voice-actuated lip microphone at the first and second pilot stations.

(4) For the fourth channel, from:

(i) Each microphone, headset, or speaker used at the stations for the third and fourth crewmembers; or

(ii) If the stations specified in paragraph (c)(4)(i) of this section are not required or if the signal at such a station is picked up by another channel, each microphone on the flight deck that is used with the passenger loudspeaker system if its signals are not picked up by another channel.

(iii) Each microphone on the flight deck that is used with the rotorcraft's loudspeaker system if its signals are not picked up by another channel.

(d) Each cockpit voice recorder must be installed so that:

(1)(i) It receives its electrical power from the bus that provides the maximum reliability for operation of the cockpit voice recorder without jeopardizing service to essential or emergency loads.

(ii) It remains powered for as long as possible without jeopardizing emergency operation of the rotorcraft.

(2) There is an automatic means to simultaneously stop the recorder and prevent each erasure feature from functioning, within 10 minutes after crash impact;

(3) There is an aural or visual means for preflight checking of the recorder for proper operation;

(4) Whether the cockpit voice recorder and digital flight data recorder are installed in separate boxes or in a combination unit, no single electrical failure external to the recorder may disable both the cockpit voice recorder and the digital flight data recorder; and

(5) It has an independent power source—

(i) That provides 10 ± 1 minutes of electrical power to operate both the cockpit voice recorder and cockpit-mounted area microphone;

(ii) That is located as close as practicable to the cockpit voice recorder; and

(iii) To which the cockpit voice recorder and cockpit-mounted area microphone are switched automatically in the event that all other power to the cockpit voice recorder is interrupted either by normal shutdown or by any other loss of power to the electrical power bus.

(e) The record container must be located and mounted to minimize the probability of rupture of the container as a result of crash impact and consequent heat damage to the record from fire.

(f) If the cockpit voice recorder has a bulk erasure device, the installation must be designed to minimize the probability of inadvertent operation and actuation of the device during crash impact.

(g) Each recorder container must be either bright orange or bright yellow.

(h) When both a cockpit voice recorder and a flight data recorder are required by the operating rules, one combination unit may be installed, provided that all other requirements of this section and the requirements for flight data recorders under this part are met.

[Amdt. 27–22, 53 FR 26144, July 11, 1988, as amended by Amdt. 27–43, 73 FR 12563, Mar. 7, 2008; 74 FR 32800, July 9, 2009; Amdt. 27–45, 75 FR 17045, Apr. 5, 2010]

§ 27.1459 Flight data recorders.

(a) Each flight recorder required by the operating rules of Subchapter G of this chapter must be installed so that:

(1) It is supplied with airspeed, altitude, and directional data obtained from sources that meet the accuracy requirements of §§ 27.1323, 27.1325, and 27.1327 of this part, as applicable;

(2) The vertical acceleration sensor is rigidly attached, and located longitudinally within the approved center of gravity limits of the rotorcraft;

(3)(i) It receives its electrical power from the bus that provides the maximum reliability for operation of the flight data recorder without jeopardizing service to essential or emergency loads.

(ii) It remains powered for as long as possible without jeopardizing emergency operation of the rotorcraft.

(4) There is an aural or visual means for preflight checking of the recorder for proper recording of data in the storage medium;

(5) Except for recorders powered solely by the engine-driven electrical generator system, there is an automatic means to simultaneously stop a recorder that has a data erasure feature and prevent each erasure feature from functioning, within 10 minutes after any crash impact; and

(6) Whether the cockpit voice recorder and digital flight data recorder are installed in separate boxes or in a combination unit, no single electrical failure external to the recorder may disable both the cockpit voice recorder and the digital flight data recorder.

(b) Each nonejectable recorder container must be located and mounted so as to minimize the probability of container rupture resulting from crash impact and subsequent damage to the record from fire.

(c) A correlation must be established between the flight recorder readings of airspeed, altitude, and heading and the corresponding readings (taking into account correction factors) of the first pilot's instruments. This correlation must cover the airspeed range over which the aircraft is to be operated, the range of altitude to which the aircraft is limited, and 360 degrees of heading. Correlation may be established on the ground as appropriate.

(d) Each recorder container must:

(1) Be either bright orange or bright yellow;

(2) Have a reflective tape affixed to its external surface to facilitate its location under water; and

(3) Have an underwater locating device, when required by the operating rules of this chapter, on or adjacent to the container which is secured in such a manner that they are not likely to be separated during crash impact.

(e) When both a cockpit voice recorder and a flight data recorder are required by the operating rules, one combination unit may be installed, provided that all other requirements of this section and the requirements for cockpit voice recorders under this part are met.

[Amdt. 27–22, 53 FR 26144, July 11, 1988, as amended by Amdt. 27–43, 73 FR 12564, Mar. 7, 2008; 74 FR 32800, July 9, 2009; Amdt. 27–45, 75 FR 17045, Apr. 5, 2010]

§ 27.1461 Equipment containing high energy rotors.

(a) Equipment containing high energy rotors must meet paragraph (b), (c), or (d) of this section.

(b) High energy rotors contained in equipment must be able to withstand damage caused by malfunctions, vibration, abnormal speeds, and abnormal temperatures. In addition—

(1) Auxiliary rotor cases must be able to contain damage caused by the failure of high energy rotor blades; and

(2) Equipment control devices, systems, and instrumentation must reasonably ensure that no operating limitations affecting the integrity of high energy rotors will be exceeded in service.

(c) It must be shown by test that equipment containing high energy rotors can contain any failure of a high energy rotor that occurs at the highest speed obtainable with the normal speed control devices inoperative.

(d) Equipment containing high energy rotors must be located where rotor failure will neither endanger the occupants nor adversely affect continued safe flight.

[Amdt. 27–2, 33 FR 964, Jan. 26, 1968]

Subpart G—Operating Limitations and Information

§ 27.1501 General.

(a) Each operating limitation specified in §§ 27.1503 through 27.1525 and other limitations and information necessary for safe operation must be established.

(b) The operating limitations and other information necessary for safe operation must be made available to the crewmembers as prescribed in §§ 27.1541 through 27.1589.

(Secs. 313(a), 601, 603, 604, and 605 of the Federal Aviation Act of 1958 (49 U.S.C. 1354(a), 1421, 1423, 1424, and 1425); and sec. 6(c) of the Dept. of Transportation Act (49 U.S.C. 1655(c)))

[Amdt. 27–14, 43 FR 2325, Jan. 16, 1978]

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 40 knots (CAS); and

(2) Not more than the lesser of—

(i) 0.9 times the maximum forward speeds established under § 27.309;

(ii) 0.9 times the maximum speed shown under §§ 27.251 and 27.629; or

(iii) 0.9 times the maximum speed substantiated for advancing blade tip mach number effects.

(b) V_{NE} may vary with altitude, r.p.m., temperature, and weight, if—

(1) No more than two of these variables (or no more than two instruments integrating more than one of these variables) are used at one time; and

(2) The ranges of these variables (or of the indications on instruments integrating more than one of these variables) are large enough to allow an operationally practical and safe variation of $V_{NE.}$

(c) For helicopters, a stabilized power-off V_{NE} denoted as V_{NE} (power-off) may be established at a speed less than V_{NE} established pursuant to paragraph (a) of this section, if the following conditions are met:

(1) V_{NE} (power-off) is not less than a speed midway between the power-on V_{NE} and the speed used in meeting the requirements of—

(i) § 27.65(b) for single engine helicopters; and

(ii) § 27.67 for multiengine helicopters.

(2) V_{NE} (power-off) is—

(i) A constant airspeed;

(ii) A constant amount less than power-on V_{NE}; or

(iii) A constant airspeed for a portion of the altitude range for which certification is requested, and a constant amount less than power-on V_{NE} for the remainder of the altitude range.

(Secs. 313(a), 601, 603, 604, and 605 of the Federal Aviation Act of 1958 (49 U.S.C. 1354(a), 1421, 1423, 1424, and 1425); and sec. 6(c) of the Dept. of Transportation Act (49 U.S.C. 1655(c)))

[Amdt. 27–2, 33 FR 964, Jan. 26, 1968, and Amdt. 27–14, 43 FR 2325, Jan. 16, 1978; Amdt. 27–21, 49 FR 44435, Nov. 6, 1984]

§ 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.

[Amdt. 27–2, 33 FR 965, Jan. 26, 1968, as amended by Amdt. 27–21, 49 FR 44435, Nov. 6, 1984]

§ 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 paragraphs (b)(1) and (2) of this section;

(4) If the time limit in paragraph (b)(3) of this section 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 paragraph (e)(1) of this section may not exceed either torque specified in paragraph (e)(1)(i) or (ii) of this section.

(f) *Ambient temperature.* For turbine engines, ambient temperature limitations (including limitations for winterization installations, if applicable) must be established as the maximum ambient atmospheric temperature at which compliance with the cooling provisions of §§ 27.1041 through 27.1045 is shown.

(g) *Two and one-half-minute OEI power operation.* Unless otherwise authorized, the use of 2½-minute OEI power must be limited to engine failure operation of multiengine, turbine-powered rotorcraft for not longer than 2½ minutes after failure of an engine. The use of 2½-minute OEI power must also 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 demonstrated during the type tests;

(2) The maximum allowable gas temperature; and

(3) The maximum allowable torque.

(h) *Thirty-minute OEI power operation.* Unless otherwise authorized, the use of 30-minute OEI power must be limited to multiengine, turbine-powered rotorcraft for not longer than 30 minutes after failure of an engine. The use of 30-minute OEI power must also 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 demonstrated during the type tests;

(2) The maximum allowable gas temperature; and

(3) The maximum allowable torque.

(i) *Continuous OEI power operation.* Unless otherwise authorized, the use of continuous OEI power must be limited to multiengine, turbine-powered rotorcraft for continued flight after failure of an engine. The use of continuous OEI power must also 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 demonstrated during the type tests;

(2) The maximum allowable gas temperature; and

(3) The maximum allowable torque.

(j) *Rated 30-second OEI power operation.* Rated 30-second OEI power is permitted only on multiengine, turbine-powered rotorcraft, also certificated for the use of rated 2-minute OEI power, and can only be used for continued operation of the remaining engine(s) after a failure or precautionary shutdown of an engine. It must be shown that following application of 30-second OEI power, any damage will be readily detectable by the applicable inspections and other related procedures furnished in accordance with Section A27.4 of appendix A of this part and Section A33.4 of appendix A of part 33. The use of 30-second OEI power must be limited to not more than 30 seconds for any period in which that power is used, and 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 demonstrated during the type tests;

(2) The maximum allowable gas temperature; and

(3) The maximum allowable torque.

(k) *Rated 2-minute OEI power operation.* Rated 2-minute OEI power is permitted only on multiengine, turbine-powered rotorcraft, also certificated for the use of rated 30-second OEI power, and can only be used for continued operation of the remaining engine(s) after a failure or precautionary shutdown of an engine. It must be shown that following application of 2-minute OEI power, any damage will be readily detectable by the applicable inspections and other related procedures furnished in accordance with Section A27.4 of appendix A of this part and Section A33.4 of appendix A of part 33.

The use of 2-minute OEI power must be limited to not more than 2 minutes for any period in which that power is used, and 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 demonstrated during the type tests;

(2) The maximum allowable gas temperature; and

(3) The maximum allowable torque.

(Secs. 313(a), 601, 603, 604, and 605 of the Federal Aviation Act of 1958 (49 U.S.C. 1354(a), 1421, 1423, 1424, and 1425); and sec. 6(c) of the Dept. of Transportation Act (49 U.S.C. 1655(c)))

[Doc. No. 5074, 29 FR 15695, Nov. 24, 1964, as amended by Amdt. 27–14, 43 FR 2325, Jan. 16, 1978; Amdt. 27–23, 53 FR 34214, Sept. 2, 1988; Amdt. 27–29, 59 FR 47767, Sept. 16, 1994]

§ 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 operations.

The kinds of operations (such as VFR, IFR, day, night, or icing) for which the rotorcraft is approved are established by demonstrated compliance with the applicable certification requirements and by the installed equipment.

[Amdt. 27–21, 49 FR 44435, Nov. 6, 1984]

§ 27.1527 Maximum operating altitude.

The maximum altitude up to which operation is allowed, as limited by flight, structural, powerplant, functional, or equipment characteristics, must be established.

(Secs. 313(a), 601, 603, 604, and 605 of the Federal Aviation Act of 1958 (49 U.S.C. 1354(a), 1421, 1423, 1424, and 1425); and sec. 6(c) of the Dept. of Transportation Act (49 U.S.C. 1655(c)))

[Amdt. 27–14, 43 FR 2325, Jan. 16, 1978]

§ 27.1529 Instructions for Continued Airworthiness.

The applicant must prepare Instructions for Continued Airworthiness in accordance with appendix A to this part that are acceptable to the Administrator. The instructions may be incomplete at type certification if a program exists to ensure their completion prior to delivery of the first rotorcraft or issuance of a standard certificate of airworthiness, whichever occurs later.

[Amdt. 27–18, 45 FR 60177, Sept. 11, 1980]

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 as specified in paragraph (b) of this section, with the marks located at the corresponding indicated airspeeds.

(b) The following markings must be made:

(1) A red radial line—

(i) For rotocraft other than helicopters, at V_{NE}; and

(ii) For helicopters at V_{NE} (power-on).

(2) A red cross-hatched radial line at V_{NE} (power-off) for helicopters, if V_{NE} (power-off) is less than V_{NE} (power-on).

(3) For the caution range, a yellow arc.

(4) For the safe operating range, a green arc.

(Secs. 313(a), 601, 603, 604, and 605 of the Federal Aviation Act of 1958 (49 U.S.C. 1354(a), 1421, 1423, 1424, and 1425); and sec. 6(c) of the Dept. of Transportation Act (49 U.S.C. 1655(c)))

[Doc. No. 5074, 29 FR 15695, Nov. 24, 1964, as amended by Amdt. 27–14, 43 FR 2325, Jan. 16, 1978; 43 FR 3900, Jan. 30, 1978; Amdt. 27–16, 43 FR 50599, Oct. 30, 1978]

§ 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.

(e) If a magnetic nonstabilized direction indicator can have a deviation of more than 10 degrees caused by the operation of electrical equipment, the placard must state which electrical loads, or combination of loads, would cause a deviation of more than 10 degrees when turned on.

(Secs. 313(a), 601, 603, 604, and 605 of the Federal Aviation Act of 1958 (49 U.S.C. 1354(a), 1421, 1423, 1424, and 1425); and sec. 6(c) of the Dept. of Transportation Act (49 U.S.C. 1655(c)))

[Doc. No. 5074, 29 FR 15695, Nov. 24, 1964, as amended by Amdt. 27–13, 42 FR 36972, July 18, 1977]

§ 27.1549 Powerplant instruments.

For each required powerplant instrument, as appropriate to the type of instrument—

(a) Each maximum and, if applicable, minimum safe operating limit must be marked with a red radial or a red line;

(b) Each normal operating range must be marked with a green arc or green line, not extending beyond the maximum and minimum safe limits;

(c) Each takeoff and precautionary range must be marked with a yellow arc or yellow line;

(d) Each engine or propeller range that is restricted because of excessive vibration stresses must be marked with red arcs or red lines; and

(e) Each OEI limit or approved operating range must be marked to be clearly differentiated from the markings of paragraphs (a) through (d) of this section except that no marking is normally required for the 30-second OEI limit.

[Amdt. 27–11, 41 FR 55470, Dec. 20, 1976, as amended by Amdt. 27–23, 53 FR 34215, Sept. 2, 1988; Amdt. 27–29, 59 FR 47768, Sept. 16, 1994]

§ 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, other than primary flight controls or control whose function is obvious, 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) Usable fuel capacity must be marked as follows:

(1) For fuel systems having no selector controls, the usable fuel capacity of the system must be indicated at the fuel quantity indicator.

(2) For fuel systems having selector controls, the usable fuel capacity available at each selector control position must be indicated near the selector control.

(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.

(e) For rotorcraft incorporating retractable landing gear, the maximum landing gear operating speed must be displayed in clear view of the pilot.

[Doc. No. 5074, 29 FR 15695, Nov. 24, 1964, as amended by Amdt. 27–11, 41 FR 55470, Dec. 20, 1976; Amdt. 27–21, 49 FR 44435, Nov. 6, 1984]

§ 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 apply:

(1) Fuel filler openings must be marked at or near the filler cover with—

(i) The word "fuel";

(ii) For reciprocating engine powered rotorcraft, the minimum fuel grade;

(iii) For turbine engine powered rotorcraft, the permissible fuel designations; and

(iv) For pressure fueling systems, the maximum permissible fueling supply pressure and the maximum permissible defueling pressure.

(2) Oil filler openings must be marked at or near the filler cover with the word "oil".

(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.

[Doc. No. 5074, 29 FR 15695, Nov. 24, 1964, as amended by Amdt. 27–11, 41 FR 55471, Dec. 20, 1976]

§ 27.1559 Limitations placard.

There must be a placard in clear view of the pilot that specifies the kinds of operations (such as VFR, IFR, day, night, or icing) for which the rotorcraft is approved.

[Amdt. 27–21, 49 FR 44435, Nov. 6, 1984]

§ 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 daylight ground conditions.

[Amdt. 27–2, 33 FR 965, Jan. 26, 1968]

Rotorcraft Flight Manual and Approved Manual Material

§ 27.1581 General.

(a) *Furnishing information.* A Rotorcraft Flight Manual must be furnished with each rotorcraft, and it must contain the following:

(1) Information required by §§ 27.1583 through 27.1589.

(2) Other information that is necessary for safe operation because of design, operating, or handling characteristics.

(b) *Approved information.* Each part of the manual listed in §§ 27.1583 through 27.1589, that is appropriate to the rotorcraft, must be furnished, verified, and approved, and must be segregated, identified, and clearly distinguished from each unapproved part of that manual.

(c) [Reserved]

(d) *Table of contents.* Each Rotorcraft Flight Manual must include a table of contents if the complexity of the manual indicates a need for it.

(Secs. 313(a), 601, 603, 604, and 605 of the Federal Aviation Act of 1958 (49 U.S.C. 1354(a), 1421, 1423, 1424, and 1425); and sec. 6(c) of the Dept. of Transportation Act (49 U.S.C. 1655(c)))

[Amdt. 27–14, 43 FR 2325, Jan. 16, 1978]

§ 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.* The following information must be furnished:

(1) Limitations required by § 27.1521.

(2) Explanation of the limitations, when appropriate.

(3) Information necessary for marking the instruments required by §§ 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. 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) [Reserved]

(g) *Altitude.* The altitude established under § 27.1527 and an explanation of the limiting factors must be furnished.

(Secs. 313(a), 601, 603, 604, and 605 of the Federal Aviation Act of 1958 (49 U.S.C. 1354(a), 1421, 1423, 1424, and 1425); and sec. 6(c) of the Dept. of Transportation Act (49 U.S.C. 1655(c)))

[Doc. No. 5074, 29 FR 15695, Nov. 24, 1964, as amended by Amdt. 27–2, 33 FR 965, Jan. 26, 1968; Amdt. 27–14, 43 FR 2325, Jan. 16, 1978; Amdt. 27–16, 43 FR 50599, Oct. 30, 1978]

§ 27.1585 Operating procedures.

(a) 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. The manual must contain any pertinent information including—

(1) The kind of takeoff surface used in the tests and each appropriate climbout speed; and

(2) The kind of landing surface used in the tests and appropriate approach and glide airspeeds.

(b) For multiengine rotorcraft, information identifying each operating condition in which the fuel system independence prescribed in § 27.953 is necessary for safety must be furnished, together with instructions for placing the fuel system in a configuration used to show compliance with that section.

(c) For helicopters for which a V_{NE} (power-off) is established under § 27.1505(c), information must be furnished to explain the V_{NE} (power-off) and the procedures for reducing airspeed to not more than the V_{NE} (power-off) following failure of all engines.

(d) For each rotorcraft showing compliance with § 27.1353 (g)(2) or (g)(3), the operating procedures for disconnecting the battery from its charging source must be furnished.

(e) If the unusable fuel supply in any tank exceeds five percent of the tank capacity, or one gallon, whichever is greater, information must be furnished which indicates that when the fuel quantity indicator reads ''zero'' in level flight, any fuel remaining in the fuel tank cannot be used safely in flight.

(f) Information on the total quantity of usable fuel for each fuel tank must be furnished.

(g) The airspeeds and rotor speeds for minimum rate of descent and best glide angle as prescribed in § 27.71 must be provided.

(Secs. 313(a), 601, 603, 604, and 605 of the Federal Aviation Act of 1958 (49 U.S.C. 1354(a), 1421, 1423, 1424, and 1425); and sec. 6(c) of the Dept. of Transportation Act (49 U.S.C. 1655(c)))

[Amdt. 27–1, 32 FR 6914, May 5, 1967, as amended by Amdt. 27–14, 43 FR 2326, Jan. 16, 1978; Amdt. 27–16, 43 FR 50599, Oct. 30, 1978; Amdt. 27–21, 49 FR 44435, Nov. 6, 1984]

§ 27.1587 Performance information.

(a) The Rotorcraft Flight Manual must contain the following information, determined in accordance with §§ 27.49 through 27.87 and 27.143(c) and (d):

(1) Enough information to determine the limiting height-speed envelope.

(2) Information relative to—

(i) The steady rates of climb and descent, in-ground effect and out-of-ground effect hovering ceilings, together with the corresponding airspeeds and other pertinent information including the calculated effects of altitude and temperatures;

(ii) The maximum weight for each altitude and temperature condition at which the rotorcraft can safely hover in-ground effect and out-of-ground effect in winds of not less than 17 knots from all azimuths. These data must be clearly referenced to the appropriate hover charts. In addition, if there are other combinations of weight, altitude and temperature for which performance information is provided and at which the rotorcraft cannot land and take off safely with the maximum wind value, those portions of the operating envelope and the appropriate safe wind conditions must be stated in the Rotorcraft Flight Manual;

(iii) For reciprocating engine-powered rotorcraft, the maximum atmospheric temperature at which compliance with the cooling provisions of §§ 27.1041 through 27.1045 is shown; and

(iv) Glide distance as a function of altitude when autorotating at the speeds and conditions for minimum rate of descent and best glide as determined in § 27.71.

(b) The Rotorcraft Flight Manual 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) The horizontal takeoff distance determined in accordance with § 27.65(a)(2)(i).

(Secs. 313(a), 601, 603, 604, and 605 of the Federal Aviation Act of 1958 (49 U.S.C. 1354(a), 1421, 1423, 1424, and 1425); and sec. 6(c) of the Dept. of Transportation Act (49 U.S.C. 1655(c)))

[Doc. No. 5074, 29 FR 15695, Nov. 24, 1964, as amended by Amdt. 27–14, 43 FR 2326, Jan. 16, 1978; Amdt. 27–21, 49 FR 44435, Nov. 6, 1984; Amdt. 27–44, 73 FR 11000, Feb. 29, 2008; 73 FR 33876, June 16, 2008]

§ 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.

APPENDIX A TO PART 27—INSTRUCTIONS FOR CONTINUED AIRWORTHINESS

A27.1 *General.*

(a) This appendix specifies requirements for the preparation of Instructions for Continued Airworthiness as required by § 27.1529.

(b) The Instructions for Continued Airworthiness for each rotorcraft must include the Instructions for Continued Airworthiness for each engine and rotor (hereinafter designated 'products'), for each appliance required by this chapter, and any required information relating to the interface of those appliances and products with the rotorcraft. If Instructions for Continued Airworthiness are not supplied by the manufacturer of an appliance or product installed in the rotorcraft, the Instructions for Continued Airworthiness for the rotorcraft must include the information essential to the continued airworthiness of the rotorcraft.

(c) The applicant must submit to the FAA a program to show how changes to the Instructions for Continued Airworthiness made by the applicant or by the manufacturers of products and appliances installed in the rotorcraft will be distributed.

A27.2 *Format.*

(a) The Instructions for Continued Airworthiness must be in the form of a manual or manuals as appropriate for the quantity of data to be provided.

(b) The format of the manual or manuals must provide for a practical arrangement.

A27.3 *Content.*

The contents of the manual or manuals must be prepared in the English language.

The Instructions for Continued Airworthiness must contain the following manuals or sections, as appropriate, and information:

(a) *Rotorcraft maintenance manual or section.* (1) Introduction information that includes an explanation of the rotorcraft's features and data to the extent necessary for maintenance or preventive maintenance.

(2) A description of the rotorcraft and its systems and installations including its engines, rotors, and appliances.

(3) Basic control and operation information describing how the rotorcraft components and systems are controlled and how they operate, including any special procedures and limitations that apply.

(4) Servicing information that covers details regarding servicing points, capacities of tanks, reservoirs, types of fluids to be used, pressures applicable to the various systems, location of access panels for inspection and servicing, locations of lubrication points, the lubricants to be used, equipment required for servicing, tow instructions and limitations, mooring, jacking, and leveling information.

(b) *Maintenance instructions.* (1) Scheduling information for each part of the rotorcraft and its engines, auxiliary power units, rotors, accessories, instruments and equipment that provides the recommended periods at which they should be cleaned, inspected, adjusted, tested, and lubricated, and the degree of inspection, the applicable wear tolerances, and work recommended at these periods. However, the applicant may refer to an accessory, instrument, or equipment manufacturer as the source of this information if the applicant shows the item has an exceptionally high degree of complexity requiring specialized maintenance techniques, test equipment, or expertise. The recommended overhaul periods and necessary cross references to the Airworthiness Limitations section of the manual must also be included. In addition, the applicant must include an inspection program that includes the frequency and extent of the inspections necessary to provide for the continued airworthiness of the rotorcraft.

(2) Troubleshooting information describing problem malfunctions, how to recognize those malfunctions, and the remedial action for those malfunctions.

(3) Information describing the order and method of removing and replacing products and parts with any necessary precautions to be taken.

(4) Other general procedural instructions including procedures for system testing during ground running, symmetry checks, weighing and determining the center of gravity, lifting and shoring, and storage limitations.

(c) Diagrams of structural access plates and information needed to gain access for inspections when access plates are not provided.

(d) Details for the application of special inspection techniques including radiographic and ultrasonic testing where such processes are specified.

(e) Information needed to apply protective treatments to the structure after inspection.

(f) All data relative to structural fasteners such as identification, discarded recommendations, and torque values.

(g) A list of special tools needed.

A27.4 *Airworthiness Limitations section.*

The Instructions for Continued Airworthiness must contain a section, titled Airworthiness Limitations that is segregated and clearly distinguishable from the rest of the document. This section must set forth each mandatory replacement time, structural inspection interval, and related structural inspection procedure approved under §27.571. If the Instructions for Continued Airworthiness consist of multiple documents, the section required by this paragraph must be included in the principal manual. This section must contain a legible statement in a prominent location that reads: ''The Airworthiness Limitations section is FAA approved and specifies inspections and other maintenance required under §§43.16 and 91.403 of the Federal Aviation Regulations unless an alternative program has been FAA approved.''

[Amdt. 27–18, 45 FR 60177, Sept. 11, 1980, as amended by Amdt. 27–24, 54 FR 34329, Aug. 18, 1989]

EFFECTIVE DATE NOTE: By Amdt. 27–47, 76 FR 74663, Dec. 1, 2011, the second sentence of section A.27.4 of appendix A to part 27 was amended by removing the phrase ''approved under §27.571'' and adding the phrase ''required for type certification'' in its place, effective Jan. 30, 2012.

APPENDIX B TO PART 27—AIRWORTHINESS CRITERIA FOR HELICOPTER INSTRUMENT FLIGHT

I. *General.* A normal category helicopter may not be type certificated for operation under the instrument flight rules (IFR) of this chapter unless it meets the design and installation requirements contained in this appendix.

II. *Definitions.* (a) V_{YI} means instrument climb speed, utilized instead of V_Y for compliance with the climb requirements for instrument flight.

(b) V_{NEI} means instrument flight never exceed speed, utilized instead of V_{NE} for compliance with maximum limit speed requirements for instrument flight.

(c) V_{MINI} means instrument flight minimum speed, utilized in complying with minimum limit speed requirements for instrument flight.

III. *Trim.* It must be possible to trim the cyclic, collective, and directional control forces to zero at all approved IFR airspeeds, power settings, and configurations appropriate to the type.

IV. *Static longitudinal stability.* (a) *General.* The helicopter must possess positive static longitudinal control force stability at critical combinations of weight and center of gravity at the conditions specified in paragraph IV (b) or (c) of this appendix, as appropriate. The stick force must vary with speed so that any substantial speed change results in a stick force clearly perceptible to the pilot. For single-pilot approval, the airspeed must return to within 10 percent of the trim speed when the control force is slowly released for each trim condition specified in paragraph IV(b) of the this appendix.

(b) *For single-pilot approval:*

(1) *Climb.* Stability must be shown in climb throughout the speed range 20 knots either side of trim with—

(i) The helicopter trimmed at V_{YI};

(ii) Landing gear retracted (if retractable); and

(iii) Power required for limit climb rate (at least 1,000 fpm) at V_{YI} or maximum continuous power, whichever is less.

(2) *Cruise.* Stability must be shown throughout the speed range from 0.7 to 1.1 V_H or V_{NEI}, whichever is lower, not to exceed ±20 knots from trim with—

(i) The helicopter trimmed and power adjusted for level flight at 0.9 V_H or 0.9 V_{NEI}, whichever is lower; and

(ii) Landing gear retracted (if retractable).

(3) *Slow cruise.* Stability must be shown throughout the speed range from 0.9 V_{MINI} to 1.3 V_{MINI} or 20 knots above trim speed, whichever is greater, with—

(i) the helicopter trimmed and power adjusted for level flight at 1.1 V_{MINI}; and

(ii) Landing gear retracted (if retractable).

(4) *Descent.* Stability must be shown throughout the speed range 20 knots either side of trim with—

(i) The helicopter trimmed at 0.8 V_H or 0.8 V_{NEI} (or 0.8 V_{LE} for the landing gear extended case), whichever is lower;

(ii) Power required for 1,000 fpm descent at trim speed; and

(iii) Landing gear extended and retracted, if applicable.

(5) *Approach.* Stability must be shown throughout the speed range from 0.7 times the minimum recommended approach speed to 20 knots above the maximum recommended approach speed with—

(i) The helicopter trimmed at the recommended approach speed or speeds;

(ii) Landing gear extended and retracted, if applicable; and

(iii) Power required to maintain a 3° glide path and power required to maintain the steepest approach gradient for which approval is requested.

(c) Helicopters approved for a minimum crew of two pilots must comply with the provisions of paragraphs IV(b)(2) and IV(b)(5) of this appendix.

V. *Static Lateral Directional Stability.* (a) Static directional stability must be positive throughout the approved ranges of airspeed, power, and vertical speed. In straight and steady sideslips up to ±10° from trim, directional control position must increase without discontinuity with the angle of sideslip, except for a small range of sideslip angles around trim. At greater angles up to the maximum sideslip angle appropriate to the type, increased directional control position must produce an increased angle of sideslip. It must be possible to maintain balanced flight without exceptional pilot skill or alertness.

(b) During sideslips up to ±10° from trim throughout the approved ranges of airspeed, power, and vertical speed, there must be no negative dihedral stability perceptible to the pilot through lateral control motion or force. Longitudinal cyclic movement with sideslip must not be excessive.

VI. *Dynamic stability.* (a) For single-pilot approval—

(1) Any oscillation having a period of less than 5 seconds must damp to ½ amplitude in not more than one cycle.

(2) Any oscillation having a period of 5 seconds or more but less than 10 seconds must damp to ½ amplitude in not more than two cycles.

(3) Any oscillation having a period of 10 seconds or more but less than 20 seconds must be damped.

(4) Any oscillation having a period of 20 seconds or more may not achieve double amplitude in less than 20 seconds.

(5) Any aperiodic response may not achieve double amplitude in less than 6 seconds.

(b) For helicopters approved with a minimum crew of two pilots—

(1) Any oscillation having a period of less than 5 seconds must damp to ½ amplitude in not more than two cycles.

(2) Any oscillation having a period of 5 seconds or more but less than 10 seconds must be damped.

(3) Any oscillation having a period of 10 seconds or more may not achieve double amplitude in less than 10 seconds.

VII. *Stability Augmentation System (SAS).*

(a) If a SAS is used, the reliability of the SAS must be related to the effects of its failure. Any SAS failure condition that would prevent continued safe flight and landing must be extremely improbable. It must be shown that, for any failure condition of the SAS that is not shown to be extremely improbable—

(1) The helicopter is safely controllable when the failure or malfunction occurs at any speed or altitude within the approved IFR operating limitations; and

(2) The overall flight characteristics of the helicopter allow for prolonged instrument flight without undue pilot effort. Additional unrelated probable failures affecting the control system must be considered. In addition—

(i) The controllability and maneuverability requirements in Subpart B of this part must be met throughout a practical flight envelope;

(ii) The flight control, trim, and dynamic stability characteristics must not be impaired below a level needed to allow continued safe flight and landing; and

(iii) The static longitudinal and static directional stability requirements of Subpart B must be met throughout a practical flight envelope.

(b) The SAS must be designed so that it cannot create a hazardous deviation in flight path or produce hazardous loads on the helicopter during normal operation or in the event of malfunction or failure, assuming corrective action begins within an appropriate period of time. Where multiple systems are installed, subsequent malfunction conditions must be considered in sequence unless their occurrence is shown to be improbable.

VIII. *Equipment, systems, and installation*. The basic equipment and installation must comply with §§29.1303, 29.1431, and 29.1433 through Amendment 29–14, with the following exceptions and additions:

(a) *Flight and Navigation Instruments*. (1) A magnetic gyro-stablized direction indicator instead of a gyroscopic direction indicator required by §29.1303(h); and

(2) A standby attitude indicator which meets the requirements of §§29.1303(g)(1) through (7) instead of a rate-of-turn indicator required by §29.1303(g). For two-pilot configurations, one pilot's primary indicator may be designated for this purpose. If standby batteries are provided, they may be charged from the aircraft electrical system if adequate isolation is incorporated.

(b) *Miscellaneous requirements*. (1) Instrument systems and other systems essential for IFR flight that could be adversely affected by icing must be adequately protected when exposed to the continuous and intermittent maximum icing conditions defined in appendix C of Part 29 of this chapter, whether or not the rotorcraft is certificated for operation in icing conditions.

(2) There must be means in the generating system to automatically de-energize and disconnect from the main bus any power source developing hazardous overvoltage.

(3) Each required flight instrument using a power supply (electric, vacuum, etc.) must have a visual means integral with the instrument to indicate the adequacy of the power being supplied.

(4) When multiple systems performing like functions are required, each system must be grouped, routed, and spaced so that physical separation between systems is provided to ensure that a single malfunction will not adversely affect more than one system.

(5) For systems that operate the required flight instruments at each pilot's station—

(i) Only the required flight instruments for the first pilot may be connected to that operating system;

(ii) Additional instruments, systems, or equipment may not be connected to an operating system for a second pilot unless provisions are made to ensure the continued normal functioning of the required instruments in the event of any malfunction of the additional instruments, systems, or equipment which is not shown to be extremely improbable;

(iii) The equipment, systems, and installations must be designed so that one display of the information essential to the safety of flight which is provided by the instruments will remain available to a pilot, without additional crewmember action, after any single failure or combination of failures that is not shown to be extremely improbable; and

(iv) For single-pilot configurations, instruments which require a static source must be provided with a means of selecting an alternate source and that source must be calibrated.

IX. *Rotorcraft Flight Manual*. A Rotorcraft Flight Manual or Rotorcraft Flight Manual IFR Supplement must be provided and must contain—

(a) *Limitations*. The approved IFR flight envelope, the IFR flightcrew composition, the revised kinds of operation, and the steepest IFR precision approach gradient for which the helicopter is approved;

(b) *Procedures*. Required information for proper operation of IFR systems and the recommended procedures in the event of stability augmentation or electrical system failures; and

(c) *Performance*. If V_{YI} differs from V_Y, climb performance at V_{YI} and with maximum continuous power throughout the ranges of weight, altitude, and temperature for which approval is requested.

X. Electrical and electronic system lightning protection. For regulations concerning lightning protection for electrical and electronic systems, see §27.1316.

[Amdt. 27–19, 48 FR 4389, Jan. 31, 1983, as amended by Amdt. 27–44, 73 FR 11000, Feb. 29, 2008; Amdt. 27–46, 76 FR 33135, June 8, 2011]

APPENDIX C TO PART 27—CRITERIA FOR CATEGORY A

C27.1 General.

A small multiengine rotorcraft may not be type certificated for Category A operation unless it meets the design installation and performance requirements contained in this appendix in addition to the requirements of this part.

C27.2 Applicable part 29 sections. The following sections of part 29 of this chapter must be met in addition to the requirements of this part:

29.45(a) and (b)(2)—General.
29.49(a)—Performance at minimum operating speed.
29.51—Takeoff data: General.
29.53—Takeoff: Category A.
29.55—Takeoff decision point: Category A.
29.59—Takeoff Path: Category A.
29.60—Elevated heliport takeoff path: Category A.
29.61—Takeoff distance: Category A.
29.62—Rejected takeoff: Category A.
29.64—Climb: General.
29.65(a)—Climb: AEO.
29.67(a)—Climb: OEI.
29.75—Landing: General.
29.77—Landing decision point: Category A.
29.79—Landing: Category A.
29.81—Landing distance (Ground level sites): Category A.
29.85—Balked landing: Category A.
29.87(a)—Height-velocity envelope.
29.547(a) and (b)—Main and tail rotor structure.
29.861(a)—Fire protection of structure, controls, and other parts.
29.901(c)—Powerplant: Installation.
29.903(b) (c) and (e)—Engines.
29.908(a)—Cooling fans.
29.917(b) and (c)(1)—Rotor drive system: Design.
29.927(c)(1)—Additional tests.
29.953(a)—Fuel system independence.
29.1027(a)—Transmission and gearboxes: General.
29.1045(a)(1), (b), (c), (d), and (f)—Climb cooling test procedures.
29.1047(a)—Takeoff cooling test procedures.
29.1181(a)—Designated fire zones: Regions included.
29.1187(e)—Drainage and ventilation of fire zones.
29.1189(c)—Shutoff means.
29.1191(a)(1)—Firewalls.
29.1193(e)—Cowling and engine compartment covering.
29.1195(a) and (d)—Fire extinguishing systems (one shot).
29.1197—Fire extinguishing agents.
29.1199—Extinguishing agent containers.
29.1201—Fire extinguishing system materials.
29.1305(a) (6) and (b)—Powerplant instruments.
29.1309(b)(2) (i) and (d)—Equipment, systems, and installations.
29.1323(c)(1)—Airspeed indicating system.
29.1331(b)—Instruments using a power supply.
29.1351(d)(2)—Electrical systems and equipment: General (operation without normal electrical power).
29.1587(a)—Performance information.

NOTE: In complying with the paragraphs listed in paragraph C27.2 above, relevant material in the AC ''Certification of Transport Category Rotorcraft'' should be used.

[Doc. No. 28008, 61 FR 21907, May 10, 1996]

APPENDIX D TO PART 27—HIRF ENVIRONMENTS AND EQUIPMENT HIRF TEST LEVELS

This appendix specifies the HIRF environments and equipment HIRF test levels for electrical and electronic systems under §27.1317. The field strength values for the HIRF environments and laboratory equipment HIRF test levels are expressed in root-mean-square units measured during the peak of the modulation cycle.

(a) HIRF environment I is specified in the following table:

TABLE I.—HIRF ENVIRONMENT I

Frequency	Field strength (volts/meter)	
	Peak	Average
10 kHz–2 MHz	50	50
2 MHz–30 MHz	100	100
30 MHz–100 MHz	50	50
100 MHz–400 MHz	100	100
400 MHz–700 MHz	700	50
700 MHz–1 GHz	700	100
1 GHz–2 GHz	2,000	200
2 GHz–6 GHz	3,000	200
6 GHz–8 GHz	1,000	200
8 GHz–12 GHz	3,000	300
12 GHz–18 GHz	2,000	200
18 GHz–40 GHz	600	200

In this table, the higher field strength applies at the frequency band edges.

(b) HIRF environment II is specified in the following table:

TABLE II.—HIRF ENVIRONMENT II

Frequency	Field strength (volts/meter)	
	Peak	Average
10 kHz–500 kHz	20	20
500 kHz–2 MHz	30	30
2 MHz–30 MHz	100	100
30 MHz–100 MHz	10	10
100 MHz–200 MHz	30	10
200 MHz–400 MHz	10	10
400 MHz–1 GHz	700	40
1 GHz–2 GHz	1,300	160
2 GHz–4 GHz	3,000	120
4 GHz–6 GHz	3,000	160
6 GHz–8 GHz	400	170
8 GHz–12 GHz	1,230	230
12 GHz–18 GHz	730	190
18 GHz–40 GHz	600	150

In this table, the higher field strength applies at the frequency band edges.

(c) HIRF environment III is specified in the following table:

TABLE III.—HIRF ENVIRONMENT III

Frequency	Field strength (volts/meter)	
	Peak	Average
10 kHz–100 kHz	150	150
100 kHz–400 MHz	200	200
400 MHz–700 MHz	730	200
700 MHz–1 GHz	1,400	240
1 GHz–2 GHz	5,000	250
2 GHz–4 GHz	6,000	490
4 GHz–6 GHz	7,200	400
6 GHz–8 GHz	1,100	170
8 GHz–12 GHz	5,000	330
12 GHz–18 GHz	2,000	330
18 GHz–40 GHz	1,000	420

In this table, the higher field strength applies at the frequency band edges.

(d) *Equipment HIRF Test Level 1.*

(1) From 10 kilohertz (kHz) to 400 megahertz (MHz), use conducted susceptibility tests with continuous wave (CW) and 1 kHz square wave modulation with 90 percent depth or greater. The conducted susceptibility current must start at a minimum of 0.6 milliamperes (mA) at 10 kHz, increasing 20 decibels (dB) per frequency decade to a minimum of 30 mA at 500 kHz.

(2) From 500 kHz to 40 MHz, the conducted susceptibility current must be at least 30 mA.

(3) From 40 MHz to 400 MHz, use conducted susceptibility tests, starting at a minimum of 30 mA at 40 MHz, decreasing 20 dB per frequency decade to a minimum of 3 mA at 400 MHz.

(4) From 100 MHz to 400 MHz, use radiated susceptibility tests at a minimum of 20 volts per meter (V/m) peak with CW and 1 kHz square wave modulation with 90 percent depth or greater.

(5) From 400 MHz to 8 gigahertz (GHz), use radiated susceptibility tests at a minimum of 150 V/m peak with pulse modulation of 4 percent duty cycle with a 1 kHz pulse repetition frequency. This signal must be switched on and off at a rate of 1 Hz with a duty cycle of 50 percent.

(e) *Equipment HIRF Test Level 2.* Equipment HIRF test level 2 is HIRF environment II in table II of this appendix reduced by acceptable aircraft transfer function and attenuation curves. Testing must cover the frequency band of 10 kHz to 8 GHz.

(f) *Equipment HIRF Test Level 3.* (1) From 10 kHz to 400 MHz, use conducted susceptibility tests, starting at a minimum of 0.15 mA at 10 kHz, increasing 20 dB per frequency decade to a minimum of 7.5 mA at 500 kHz.

(2) From 500 kHz to 40 MHz, use conducted susceptibility tests at a minimum of 7.5 mA.

(3) From 40 MHz to 400 MHz, use conducted susceptibility tests, starting at a minimum of 7.5 mA at 40 MHz, decreasing 20 dB per frequency decade to a minimum of 0.75 mA at 400 MHz.

(4) From 100 MHz to 8 GHz, use radiated susceptibility tests at a minimum of 5 V/m.

[Doc. No. FAA–2006–23657, 72 FR 44027, Aug. 6, 2007]

PART 29—AIRWORTHINESS STANDARDS: TRANSPORT CATEGORY ROTORCRAFT

Subpart A—General

Subpart B—Flight

GENERAL

PERFORMANCE

FLIGHT CHARACTERISTICS