H-1P

CIVIL AIR REGULATIONS

# PART 06—ROTORCRAFT AIRWORTHINESS

**Effective May 24, 1946**

**CIVIL AERONAUTICS BOARD**

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## 06.0 GENERAL

**06.00 Scope.** In order to become eligible for type and airworthiness certificates, a rotorcraft shall be shown to comply with the airworthiness requirements set forth in this Part and shall have no characteristics which, according to the findings of the Administrator, renders the rotorcraft unairworthy, provided that:

(a) If any of these requirements become inapplicable to a particular rotorcraft because of increased knowledge of aeronautics or of the development of unforeseen design features, the Administrator shall accept designs shown to provide an equivalent standard of safety.

(b) Requirements of the U. S. Army or Navy, with respect to airworthiness found by the Administrator to provide an equivalent standard of safety, may be accepted in lieu of the requirements set forth in this Part.

Unless otherwise specified, compliance with any amendment to this Part shall be mandatory only for rotorcraft for which application for a type certificate has been received subsequent to the effective date of such amendment.

**06.01 Type certificate.** A type certificate will be issued when the following requirements are met:

**06.011 Data required for NC and NR certification.** The applicant for a type certificate shall submit to the Administrator the following: Such descriptive data, test reports, and computations as are necessary to demonstrate that the rotorcraft complies with the airworthiness requirements. The descriptive data shall be known as the type design and shall consist of drawings and specifications disclosing the configuration of the rotorcraft and all design features covered in the airworthiness requirements as well as sufficient information on dimensions, materials, and processes to define the strength of the structure. The type design shall

describe the rotorcraft in sufficient detail to permit the airworthiness of subsequent rotorcraft of the same type to be determined by comparison with the type design.

**060.11 Inspection and tests for NC and NR certification.** The authorized representatives of the Administrator shall have access to the rotorcraft and may witness or conduct such inspections and tests as are necessary to determine compliance with the airworthiness requirements.

**06.110 Inspection.** Inspections and tests shall include all those found necessary by the Administrator to insure that the airplane conforms with the following:

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

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

(c) All manufacturing processes, construction, and assembly are such that the design strength and safety contemplated by the type design will be realized in service.

**06.0111 Flight tests.** Upon satisfactory completion of all necessary inspection and testing on the ground, and upon receipt from the applicant of a report of flight tests conducted by him, and satisfactory proof of the conformity of the rotorcraft with the type design, such official flight tests as the Administrator finds necessary to prove compliance with this Part shall be conducted.

**06.02 Airworthiness certificates.** Airworthiness certificates are classified as follows:

(a) *NC certificates.* In order to become eligible for an NC certificate the rotorcraft shall be shown to comply with all of the requirements contained in this Part.

(b) *NR certificates.* NR certification is applicable to rotorcraft intended to be operated for restricted purposes not logically encompassed by the requirements of this Part. In order to be eligible for an NR certificate, a rotorcraft must be shown to comply with all of the requirements of this Part which are not rendered inapplicable by the nature of the special purpose involved, and shall be subject to suitable operating restrictions which the Administrator finds will provide a level of safety equivalent to that contemplated for normal purposes by the requirements of this Part.

(c) *NX certificates.* A rotorcraft will become eligible for an NX certificate when the applicant presents satisfactory evidence that the rotorcraft is to be flown for experimental purposes and the Administrator finds that it may, with appropriate restrictions, be operated for that purpose in a manner which does not endanger the general public. Rotorcraft used in racing and exhibition flying may be issued NX certificates under the terms of this section. The applicant shall submit sufficient data such as photographs to identify the rotorcraft satisfactorily and upon inspection of the rotorcraft, any pertinent information found necessary by the Administrator to safeguard the general public.

A rotorcraft manufactured in accordance with a type certificate (see § 06.01) and conforming with the type design will become eligible for an NC airworthiness certificate when, upon inspection of the rotorcraft, the Administrator finds it so to conform and in a condition for safe operation. For each newly manufactured rotorcraft this finding shall include a flight check by the applicant.

For rotorcraft manufactured by holders of a production certificate the issuance of an NC airworthiness certificate shall be dependent upon the provisions of Part 02 of the Civil Air Regulations.

**06.03 Changes.** Changes shall be substantiated to demonstrate compliance of the rotorcraft with the appropriate airworthiness requirements in effect when the particular rotorcraft was certificated as a type unless the applicant chooses to show compliance with the currently effective requirements subject to the approval of the Administrator, or unless the Administrator finds it necessary to require compliance with current airworthiness requirements.

**06.030 Minor Changes.** Minor changes to certificated rotorcraft which obviously do not impair the condition of the airplane for safe operation shall be approved by the authorized representatives of the Administrator prior to the submittal to the Administrator of any required revised drawings.

**06.031 Major Changes.** A major change is any change not covered by minor changes as defined in § 06.030.

**06.032 Service Experience Changes.** When the Administrator finds that service experience indicates the need for design changes, the applicant shall submit for the approval of the Administrator engineering data describing and substantiating the necessary changes. The Administrator may in such cases withhold issuance of airworthiness certificates for additional rotorcraft of the type involved until satisfactory corrective measures have been taken. Upon approval by the Administrator these changes shall be considered as a part of the type design, and descriptive data covering these changes shall be furnished by the applicant to all rotorcraft owners concerned. In the case of rotorcraft approved as a type under the terms of earlier airworthiness requirements, the Administrator may require that a rotorcraft submitted for an original airworthiness certificate comply with such portions of the currently effective airworthiness requirements as may be necessary for safety.

**06.04 Definitions.** The following definitions apply to the terms as used in this Part.

**06.0400 Rotorcraft.** Any aircraft deriving its principal lift from one or more rotors.

**06.0401 Helicopter.** A rotorcraft which depends entirely for its support and motion in the air upon the lift generated by one or more power-driven rotors.

**06.0402 Gyroplane.** A rotorcraft which depends principally for its support upon the lift generated by one or more rotors which are not power driven, except for initial starting, and which are caused to rotate by the action of the air when the rotorcraft is in motion.

**06.0403 Main rotor(s).** The main system(s) of rotating airfoils providing sustentation for the rotorcraft.

**06.0404 Antitorque rotor.** An auxiliary rotor which serves to counteract the effect of the main rotor torque on the rotorcraft.

**06.0405 Control rotor.** An auxiliary rotor, other than an antitorque rotor, which serves as a device by means of which the rotorcraft can be controlled in flight.

**06.0406 Plane of rotor disc.** A reference plane at right angles to the mechanical axis of rotation of the rotor.

**06.0407 Tip speed ratio.** The ratio of the rotorplane flight velocity component in the plane of the rotor disc to the rotational tip speed of the rotor blades.

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

V=airspeed of the rotorcraft along flight path, (feet per second)
$\alpha$=angle between flight path and plane of rotor disc
$\Omega$=angular velocity of rotor, (radians per second)
R=rotor radius, (feet)

**06.0408 Load factor, n.** The ratio of any specific load on the rotorcraft to the rotorcraft design weight. When the load in question represents the net external load acting on the aircraft in a given direction, n represents the acceleration in that direction.

**06.0409 Limit load.** A load which it is assumed, or known, may be experienced but not exceeded in operation. From a design standpoint it is a load which the structure is capable of supporting without detrimental permanent deformations.

**06.0410 Factor of safety.** A factor by which limit loads are multiplied to obtain ultimate loads.

**06.0411 Ultimate load.** A load which the structure is capable of carrying without failure. (Equal to the limit load multiplied by the factor of safety.)

**06.0412 Primary structure.** Those portions of the aircraft the failure of which would seriously endanger the safety of the aircraft.

**06.0413 Fittings.** Fittings are defined as parts such as end terminals used to connect one structural member to another (see Table 06–1).

## 06.1 FLIGHT REQUIREMENTS

**06.10 General.** All rotorcraft shall have such general performance and flight characteristics as to provide reasonable safety during the execution of any maneuver appropriate to, or necessary for, the aircraft and during steady flight at any weight, center of gravity position, speed, and power within the ranges for which the aircraft is certificated. Compliance with all performance requirements shall be demonstrated by suitable flight tests conducted by the applicant and witnessed by a representative of the Administrator of Civil Aeronautics or, at his discretion, conducted by that representative.

**06.11 Landing.** It shall be possible to make a safe landing with all power off.

**06.12 Ground handling.** The rotorcraft shall demonstrate satisfactory ground resonance characteristics.

## 06.2 STRENGTH CRITERIA

**06.20 General.** The primary structure shall be capable of supporting the ultimate loads without failure and shall be capable of supporting the limit loads for a period of at least one minute without detrimental permanent deformations.

**06.200 Ultimate loads.** Ultimate loads are those obtained by multiplying the limit loads by the required factor of safety. The factor of safety shall be 1.5, except in cases where an additional (multiplying) factor of safety is specified. In such cases the final factor of safety shall be equal to 1.5 times the additional factor of safety.

**06.201 Additional (multiplying) factors of safety.** The additional factors of safety specified in Table 06–1 shall be used where applicable. When more than one additional factor is indicated only the largest need be used.

**06.202 Proof of structure.** Structural analyses, load tests, flight tests, dynamic tests, or combinations thereof, shall be made for the purpose of providing proof of compliance with the strength criteria.

**06.2020 Structural tests.** The following structural tests are required and shall be conducted in such manner as to substantiate clearly compliance with the strength criteria:

(a) dynamic and endurance tests of rotors and rotor drives, including controls, (see § 06.420),
(b) control surface and system tests (limit load and operation tests),
(c) vibration surveys, (see §§ 06.22 and 06.240),
(d) landing gear drop tests (see § 06.2130),
(e) such additional tests as may be found necessary by the Administrator to substantiate new and unusual features of the design.

**06.21 Structural loading conditions.**

**06.210 General.** The airworthiness rating of a rotorcraft with respect to its strength will be based on the airspeeds, rotor speeds, and load factors which can safely be developed in combination. The simultaneous air and rotor speeds which can safely be developed in combination with the specified load factors shall be determined by the applicant and shall serve as a basis for structural loading conditions and, where found necessary by the Administrator, for restricting the operation of the rotorcraft in flight.

**06.211 Design limitations.** The following values shall be established by the applicant for purposes of showing compliance with the structural requirements hereinafter specified:

(a) maximum design weight, W,
(b) main rotor maximum tip speed ratio, $\mu_m$. (If the tip speed ratio for a helicopter in the autorotation phase exceeds that for power-driven conditions, then the former value shall be used),

(c) main rotor(s) maximum design rpm, N,

(d) auxiliary rotor(s) maximum design rpm. The limitation selected shall be such as to cover safely all normal operating ranges of the aircraft.

**06.212 Flight loading condition.** The flight load factors specified hereunder will represent rotor load factors. The net load factor acting at the center of gravity of the aircraft shall be obtained by proper consideration of balancing loads acting in the specific flight conditions.

**06.2120 Maneuvering flight conditions.** The rotorcraft structure shall be substantiated for a positive maneuvering limit load factor of 3.5 (resultant force on the rotor(s) equal to 3.5 times the rotorcraft design weight) and a negative maneuvering limit load factor of 1.0, except that lesser values may be used if the manufacturer can prove by analytical study and flight demonstrations that the values selected cannot be exceeded. In no case shall the limit load factors be less than 2.5 positive and 0.5 negative. The resultant force shall be assumed to be applied at the center(s) of the rotor hub(s) and to act in such directions as necessary to represent all critical maneuvering motions of the rotorcraft applicable to the particular type, including flight at the maximum design rotor tip speed ratio under power-on and power-off conditions.

**06.2121 Gust conditions.** The structure affected shall be substantiated for the loading due to vertical gusts of $\pm 30$ feet per second velocity in conjunction with the critical rotorplane airspeeds, including hovering.

**06.213 Ground loading conditions.** The structure shall be substantiated for the ground loading conditions specified in the current ANC–2 "Ground Loads Handbook", issued by the Army-Navy-Civil Committee on Aircraft Design Criteria, modified as necessary to suit the type of landing gear employed and character of landing operations undertaken by the rotorcraft. The structure shall be substantiated for a limit load factor not less than two-thirds of the value developed in energy absorption tests specified in § 06.2130.

**06.2130 Energy absorption.** The landing gear shall be capable of absorbing the energy of a free drop from a height of not less than 20 inches measured from the bottom of the tires to the ground, except that a lesser height may be used if the value chosen can be shown to exceed that corresponding to the greatest probable sinking speed at ground contact in power-off landings likely to be made by pilots of average skill. In no case shall the drop height be less than 12 inches. The weight of the rotor blades may be neglected in the drop test. The maximum drop test acceleration developed at the c. g. shall be determined in the test.

**06.22 Main rotor structure.** The requirements specified hereunder apply to the main rotor assembly(ies) including hub(s) and blades. The structure shall be substantiated for at least the following loading conditions:

(*a*) The hub(s), blades, blade attachments and blade controls which are under cyclic flexing or alternating stresses shall be substantiated to demonstrate the airworthiness of these parts under repeated loading conditions, associated with normal operation. The vibration stresses of critical metal parts shall be determined in flight and it shall be demonstrated that these stresses do not exceed safe values for continuous operation.

(*b*) The main rotor structure shall be substantiated for the critical flight condition loads specified in § 06.212. At least the maximum design tip speed ratio condition shall be considered in conjunction with these limit loadings.

(*c*) The main rotor structure shall be substantiated for the limit loads specified by § 06.212 under conditions of autorotation necessary for normal operation. The rotor rpm used shall be such as to include the effects of altitude.

(*d*) The rotor blades, hub(s) and flapping hinges shall be substantiated for a loading condition simulating the force of blade impact against its stop during operation on the ground. A limit load acting at the center of gravity of the blade equal to the weight of the blade multiplied by a factor of 2.67 shall be used.

(*e*) The strength of the rotor assembly shall be substantiated for loadings simulating other critical conditions which may be encountered under normal operation. These shall include "jump-off", rotor "rev-up", and rotor "overspeed" conditions in flight.

**06.23 Fuselage, landing gear, and rotor pylon structure.** The requirements specified hereunder apply to the fuselage, landing gear, and rotor pylon structure. The structure shall be substantiated for at least the following loading conditions:

(*a*) The structure shall be substantiated for the critical loads specified by § 06.212. The resultant rotor force may be represented as a single force applied at the hub attachment point. Consideration shall be given to the balancing and inertia loads occurring under the accelerated flight conditions. The thrust from auxiliary rotors shall also be considered.

(*b*) The structure shall be substantiated for the ground loads specified by § 06.213.

(*c*) The engine mount and adjacent fuselage structure shall be substantiated for loads occurring in the rotorcraft under the accelerated flight and landing conditions, including the effect of engine torque loads. In the case of engines having 5 or more cylinders the limit torque shall be obtained by multiplying the mean torque by a factor of 1.5. For 4, 3, and 2 cylinder engines the factors shall be 2, 3, and 4, respectively.

**06.24 Controls and control systems.** The structure of all auxiliary rotors (antitorque and control), fixed or movable stabilizing and control surfaces, and all systems operating any flight controls shall be substantiated in accordance with the provisions of §§ 06.240 through 06.243.

**06.240 Auxiliary rotor assemblies.** Auxiliary rotor assemblies shall be tested in accordance with the provisions of § 06.420 for rotor drives. In addition, auxiliary rotor assemblies with detachable blades shall be tested for one hour at a speed equal to 1.4 times the speed at which the rotor is driven when the engine is operating at its maximum except take-off speed. In the case of auxiliary rotors with metal blades the vibration stresses shall be determined in flight and it shall be demonstrated that these stresses do not exceed safe values for continuous operation.

**06.241 Auxiliary rotor attachment structure.** The attachment structure for the auxiliary rotors shall be substantiated for a limit load equal to the maximum balancing thrust of the rotor acting simultaneously with other loads on the structure occurring under critical maneuvering flight conditions.

The structure shall also be substantiated separately for a limit load equal to the maximum thrust of the rotor or rotors acting simultaneously with the maximum loads in the structure occurring under normal unaccelerated flight and landing conditions.

**06.242 Stabilizing and control surfaces.** Stabilizing and control surfaces shall be substantiated for a minimum limit load of 15 pounds per square foot, or for a load due to $C_N=0.55$ at the maximum design speed, whichever is greater. The load distribution shall closely simulate actual pressure distribution conditions.

**06.243 Primary control systems.** From the pilot's compartment to the point of their attachment to the rotor blades (or control areas) manual control systems shall be substantiated for the following minimum limit pilot forces:

(*a*) Foot type controls: 130 lbs.

(*b*) Stick type controls: 100 lbs. fore and aft, 67 lbs. laterally. (The forces need not be applied simultaneously.)

(*c*) Wheel type controls: 100 lbs. fore and aft, a couple equal to a 53 lb. pilot force applied on opposite sides of the control wheel.

**06.25 Miscellaneous structures.** The strength of all structural items not specifically covered by preceding loading conditions shall be shown to be adequate for their intended purpose. In addition the following specific loading conditions shall be applied:

**06.250 Seat loads.** The strength of seats and their attachments to the primary rotorcraft structure shall be substantiated for passenger loads in the accelerated flight and landing conditions based on a standard passenger weight of 170 lbs.

**06.2500 Safety belt loads.** Structures to which safety belts are attached shall be capable of withstanding an ultimate load of 1,000 lbs. per person applied through the safety belt and directed upward and forward at an angle of 45 degrees with the floor line.

**06.251 Local loads.** The primary structure shall be designed to withstand local loads caused by dead weights and by control loads transmitted through attachments. Baggage compartments shall be designed to withstand loads corresponding to the maximum authorized capacity. The substantiation of the adequacy of the structure to withstand dead-weight loads shall include a sufficient number of accelerated flight and landing conditions to insure that the most severe combinations have been investigated.

## 06.3 DETAIL DESIGN AND CONSTRUCTION

**06.30 General.** The primary structure and all mechanisms essential for the safe operation of the rotorcraft shall not incorporate design details which on the basis of experience the Administrator has found to be unsafe. Certain design features which are essential to the airworthiness of a rotorcraft are hereinafter specified and shall be observed.

**06.300 Materials and workmanship.** The primary structure shall be made from materials which experience or conclusive tests have proved to be uniform in quality and strength and to be otherwise suitable for rotorcraft construction. Workmanship shall be of sufficiently high grade as to insure proper functioning of all parts under reasonable service conditions.

**06.301 Inspection provisions.** Means shall be provided to permit the examination of such parts of the rotorcraft as require periodic inspection.

**06.302 Design of structural parts.** Structural parts shall be designed to avoid stress concentration which may affect adversely the strength of such parts in service, or which may introduce unknown factors into the stress analysis of the structure. Adequate fillets for this purpose shall be provided at all abrupt changes in section. Suitable allowances shall be made in the design for holes and for permissible variations in the location of holes. Joints which are likely to be subjected to appreciable wear shall be designed with replaceable bushings or allowances for oversize bolts or pins.

### 06.31 Main rotor blades.

**06.310 Pressure venting and drainage.** Internal pressure venting of the main rotor blades shall be provided. Drain holes shall be provided and, in addition, the blades shall be so designed as to preclude the possibility of water becoming trapped at any section of the blade.

**06.311 Stops.** The rotor blades shall be provided with stops, as required for the particular design, to limit the travel of the blades about their various hinges. (NOTE: It is desirable that blades should never hit the droop stops except during starting and stopping the rotor.)

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

NOTE: Based on present design, practice blades should be mass balanced at each spanwise station to such a degree that an increase in blade section angle of attack will produce an increase in pitch reducing moment. (Additional general design information on this subject will be provided as experience with various rotorcraft designs is accumulated.)

### 06.32 Stabilizing and control surfaces.

**06.320 Dynamic and static balance.** All control surfaces shall be dynamically and statically balanced to the degree necessary to safeguard against flutter at all speeds up to the maximum forward speed.

### 06.33 Control systems.

**06.330 Installation.** All control systems shall be designed and installed to provide reasonable ease of operation by the crew and to preclude the probability of inadvertent operation, jamming, and interference by loose objects and passengers. All pulleys shall be provided with guards.

**06.331 Stops.** All control systems shall be provided with stops which positively limit the range of motion of the pilot's controls. Stops shall be capable of withstanding the loads corresponding to the design conditions for the control system.

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

**06.34 Landing gear.** (See § 06.2130.)

**06.35 Fuselage and cabins.**

**06.350 Location of rotors.** All rotors shall be so located as not to endanger persons using passenger doors.

**06.351 Pilots' compartment.** The pilots' compartment shall be so constructed as to afford adequate vision to the pilot under normal flying conditions. In cabin aircraft the windows shall be so arranged that they may be readily cleaned or easily opened in flight to provide forward and downward vision for the pilot.

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

**06.353 Baggage compartments.** Each baggage and cargo compartment shall bear a placard stating the maximum allowable weight of contents, as determined by the structural strength of the compartment. Consideration shall be given to the effects of concentrated weights in the baggage compartments. Suitable means shall be provided to prevent the contents of cargo and baggage compartments from shifting.

## 06.4 POWER PLANT INSTALLATION

**06.40 General.** The power plant installation is considered to include all components of the rotocraft which are necessary for its propulsion, with the exception of the structure of the main and auxiliary rotors.

All components of the power plant installation shall be constructed and installed in such a manner as to assure safe operation of the rotorcraft and shall be provided with all the controls and accessories necessary to assure such operation. Adequate accessibility shall be provided to permit the inspection and maintenance necessary to assure the continued airworthiness of all components of the power plant installation. Fuel, oil, cooling, or other fluid systems shall be made of materials which, including their normal or inherent impurities, will not react chemically with any fuels, oils, or liquids that are likely to be placed in them.

**06.41 Engine installation.**

**06.410 Engines.** The engine shall be of a type which has been type certificated or otherwise found eligible for use in certificated aircraft. (See Part 13 of the Regulations.)

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

**06.42 Rotor drive mechanism.** The rotor drive mechanism shall incorporate a unit which will automatically disengage the rotor drive and engine from the main and auxiliary rotors in the event of power failure. The rotor drive mechanism shall be so arranged that all rotors necessary for control of the rotorcraft in autorotative flight will continue to be driven by the main rotor(s) after disengagement of the engine and rotor drive from the main and auxiliary rotors.

**06.420 Rotor drive and control mechanism endurance test.** The rotor drive and control mechanism shall be tested for not less than 100 hours. The test shall be conducted on the rotorcraft and the power shall be absorbed by the actual rotors to be installed, except that the use of other ground or flight test facilities with any other suitable method of power absorption will be considered satisfactory provided all conditions of support and vibration closely simulate the conditions that would exist during a test on the actual rotorcraft. The endurance test shall consist of the following:

(*a*) Sixty hours at not less than maximum continuous engine speed in conjunction with maximum continuous engine power. In this test, the main rotor controls shall be set in the position which will give maximum longitudinal cyclic pitch change to simulate forward flight. The auxiliary rotor controls shall be in the position for normal operation under the conditions of the test.

(*b*) Thirty hours at not less than 90 percent of maximum continuous engine speed and 75 percent of maximum continuous engine power. The main and auxiliary rotor controls during this test shall be in the same position as for (a).

(*c*) Ten hours at not less than take-off engine power and speed. The main and auxiliary rotor controls shall be in the normal position for vertical ascent during this test.

All of the tests described in (a), (b), and (c) above may be conducted either on the ground or in flight. These tests shall be conducted for intervals of not less than 30 minutes except in the case of paragraph (c). The testing of paragraph (c) may be accomplished in intervals of 5 minutes or more if desired.

At intervals of not more than every 5 hours during the endurance tests the engine shall be stopped rapidly enough to allow the engine and rotor drive to be automatically disengaged from the rotors.

Five hundred complete cycles of lateral control and 500 complete cycles of longitudinal control of the main rotors shall be accomplished under the operating conditions as specified in paragraph (a) above. Five hundred complete cycles of control of all auxiliary rotors shall be accomplished under the operating conditions as specified in paragraph (a) above. A complete control cycle is considered to involve movement of the controls from the neutral position, through both extreme positions, back to neutral position. The control cycling may be accomplished during the testing prescribed in paragraph (a) above or may be accomplished separately. The remainder of the testing prescribed in paragraphs (a) and (b) shall be accomplished with the main rotor controls in the position which will give maximum longitudinal cyclical pitch change to simulate forward flight and with the auxiliary rotor controls in the position for normal operation under the conditions of the test. The part of the endurance test specified in paragraph (c) shall be accomplished with the main rotor controls neutral and the auxiliary rotor controls in the position for normal operation in a vertical ascent under the power conditions of this portion of the test. Such additional dynamic, endurance, and operational tests or vibratory investigations shall be conducted as are found necessary by the Administrator to substantiate the airworthiness of the rotor drive mechanism.

**06.421 Shafting critical speeds.** An investigation shall be made to determine that the critical speeds of all shafting lie outside the range of permissible engine speeds under idling, power-on, and autorotation conditions. It shall be demonstrated by actual operation that this condition is satisfied with the mechanism installed in the rotorcraft.

**06.43 Fuel systems.**

**06.430 Capacity and feed.** The fuel capacity shall be not less than 0.15 gallon per maximum (continuous) horsepower for which the rotorcraft is to be certificated. Air-pressure fuel systems shall not be used. Only gravity feed or mechanical pumping of fuel is permitted. The system shall be so arranged that, insofar as practicable, the entire fuel supply may be utilized in the steepest climb and at the best gliding angle and so that the feed ports will not be uncovered during normal maneuvers involving moderate rolling or sideslipping. The system

shall also feed fuel promptly after one tank has run dry and another tank is turned on. If a mechanical pump is used, an emergency pump shall also be installed and shall be available for immediate use in case of a mechanical pump failure. Pumps of adequate capacity may also be used for pumping fuel from an auxiliary tank to a main fuel tank.

**06.431 Tank installation.** Fuel tanks shall be separated from the engine compartment by a firewall. At least one-half inch clear air space shall be provided between the tank and firewall. Spaces adjacent to the surfaces of the tank shall be ventilated so that fumes cannot accumulate in the tank compartment in case of leakage. If two or more tanks have their outlets interconnected they shall be considered as one tank. The air spaces in such tanks shall be interconnected to prevent the flow of fuel from one tank to another as the result of a difference in pressure in the respective tank air spaces. Mechanical pump systems shall be so arranged that they cannot feed from more than one tank at a time.

**06.432 Tank construction.** Each fuel tank shall incorporate a sump and drain located at the point in the tank which is lowest when the rotorcraft is in its normal ground position. The main fuel supply shall not be drawn from the bottom of this sump. All fuel tank outlets shall be provided with large-mesh finger strainers. Each tank shall be suitably vented from the top portion of the air space. Such air vents shall be arranged to minimize the possibility of stoppage by dirt or ice formation. Tanks of 10 gallons or more capacity shall be provided with internal baffles unless suitable external support is provided to resist surging.

**06.433 Tank strength.** Fuel tanks shall be capable of withstanding, without failure or leakage, an internal pressure of either 3½ pounds per square inch, or the pressure developed during the maximum limit acceleration with fuel tanks, whichever is greater. Tanks shall be capable of withstanding, without leakage or failure, all vibration, inertia, and fluid loads to which they may be subjected in normal operation.

**06.434 Fuel quantity gauge.** The fuel quantity gauge shall be so installed as to indicate readily to a pilot or a flight mechanic the quantity of fuel in each tank while in flight. When two or more tanks in a gravity feed system are closely interconnected and vented, and it is impossible to feed from each one separately, only one fuel quantity gauge need be installed. If a glass gauge is used, it shall be suitably protected against breakage.

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

(*a*) For gravity feed systems: double the normal flow required to operate the engine at take-off power;

(*b*) For pump systems: 1½ times the normal flow required to operate the engine at take-off power.

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

All fuel lines shall be supported to prevent excessive vibration and should be located so that no structural loads can be applied. Bends of small radius or vertical humps in the lines shall be avoided. Copper fuel lines which have been bent shall be annealed before installation. Lines which are connected to components of the rotorcraft between which relative motion may exist shall incorporate provisions for flexibility. Flexible hose and fittings used in fuel line connections shall be of an approved type.

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

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

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

**06.439 Miscellaneous fuel system requirements.**

**06.4390 Filler openings.** All fuel tank filler openings shall be plainly marked with the capacity, the word "fuel", and the minimum allowable fuel octane number for the engine installed. Provision shall be made to prevent fuel overflow from entering the compartments in which the fuel tanks are located.

**06.4391 Carburetor de-icing and anti-icing provisions.** Provisions shall be incorporated for preventing the formation and for the elimination of ice in the engine air induction system in accordance with the following:

(*a*) Rotorcraft employing sea level engines with conventional venturi carburetors shall be equipped with a carburetor air preheater capable of providing a heat rise of not less than 90° F. when the engine is operating at 75 percent of its maximum continuous power in air at a temperature of 30° F.

(*b*) Rotorcraft employing altitude engines with conventional venturi carburetors shall be equipped with a carburetor air preheater capable of providing a heat rise of not less than 120° F. when the engine is operating at 75 percent of its maximum continuous power in air at a temperature of 30° F.

(*c*) Rotorcraft employing altitude engines with carburetors embodying features which tend to prevent ice formation in the induction system shall be equipped with either one of the following:

(*1*) a carburetor air preheater capable of providing a heat rise of not less than 100° F., when the engine is operating at 75 percent of its maximum continuous power in air at a temperature of 30° F., or

(*2*) a carburetor air preheater capable of providing a heat rise of not less than 40° F., when the engine is operating at 75 percent of its maximum continuous power in air at a temperature of 30° F., together with a fluid de-icing system.

**06.44 Lubrication systems.**

**06.440 General.** Each engine shall have an independent oil supply. The oil capacity of the system shall be not less than either one gallon for every 25 gallons of fuel or one gallon for each 100 maximum (continuous) rated horsepower of the engine or engines, whichever capacity is greater. When suitable provisions are made to transfer oil between engines in flight or when a suitable reserve supply is provided the use of a smaller capacity oil system may be permitted. The suitability of the lubrication system shall be demonstrated in flight tests in which engine temperature measurements are obtained. The system shall provide the engine with an ample quantity of oil at a temperature suitable for satisfactory engine operation.

**06.441 Tank installation.** Oil tanks shall be vented and shall be provided with an expansion space which cannot be inadvertently filled with oil. The expansion space shall be at least 10 percent of the total tank volume, except that it shall in no case be less than one-half gallon.

**06.442 Tank strength.** Oil tanks shall be capable of withstanding an internal test pressure of 5 pounds per square inch without failure or leakage. Tanks shall be capable of withstanding, without leakage or failure, all vibration, inertia and fluid loads to which they may be subjected in normal operation.

**06.443 Quantity gauge.** A suitable means shall be provided to determine the amount of oil in the oil tank during the filling operation.

**06.444 Piping.** Oil piping shall have an inside diameter not less than the inside diameter of the engine inlet or outlet and shall have no splices between connections. All oil lines shall be so supported as to prevent excessive vibration and should be so located that no structural loads can be applied. Lines which are connected to components of the rotorcraft between which relative motion may exist shall incorporate provisions for flexibility. Flexible hose used in the oil system shall be of an approved type.

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

**06.446 Oil temperature.** A suitable means shall be provided for measuring the oil temperature at the engine inlet during flight.

**06.447 Filler openings.** All filler openings in the oil system shall be plainly marked with the capacity and the word "oil".

**06.45 Cooling systems.**

**06.450 General.** The cooling system shall be capable of maintaining engine temperatures within safe operating limits under all conditions of flight during a period at least equal to that established by the fuel capacity of the rotorcraft, assuming normal engine power and speeds. Compliance with this requirement shall be demonstrated in flight tests in which engine temperature measurements are obtained under critical flight conditions. Such tests shall be conducted in air at temperatures corresponding to the highest anticipated summer air temperatures as specified in § 06.451 or, if the flight tests are conducted at temperatures that deviate from these temperatures, the recorded engine temperatures shall be corrected in accordance with the following:

(a) Cylinder head temperatures of air-cooled engines and engine oil inlet temperatures shall be corrected by adding the difference between the highest anticipated summer air temperature and the average temperature of the ambient air at the time of the first occurrence of the maximum cylinder head or oil inlet temperature recorded.

(b) Cylinder barrel temperatures of air-cooled engines shall be corrected by adding seven-tenths of the difference between the highest anticipated summer air temperature and the average temperature of the ambient air at the time of the first occurrence of the maximum cylinder barrel temperature recorded.

**06.451 Highest anticipated summer air temperatures.** The temperatures employed in correcting engine temperatures observed in flight tests conducted to show compliance with the requirements of § 06.450, shall be 100° F. at sea level and shall decrease from that value at the rate of 3.6° F. per thousand feet above sea level.

**06.452 Radiators.** Radiators shall be so mounted as not to induce vibrations and strains causing distortion.

**06.453 Piping.** Piping and connections shall conform to accepted standards and by their presence shall not induce vibration to the radiator or to the structure of the rotorcraft.

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

**06.455 Filler openings.** All filler openings in the cooling system shall be plainly marked with the capacity of the system and the name of the proper cooling liquid.

**06.46 Power plant instruments, controls, and accessories.**

**06.460 Instruments.** The engine instruments required are specified in § 06.51.

**06.461 Controls.** All power plant controls, including those of the fuel system, shall be plainly marked to show their function and method of operation.

**06.4610 Throttle controls.** Throttle controls shall be easily accessible to both pilots and shall be so arranged as to afford a positive and immediately responsive means of controlling all engines both separately and simultaneously. Flexible throttle control systems shall be of an approved type. Throttle controls may be combined with the main pitch control if desired.

**06.4611 Ignition switches.** Ignition switches shall be easily accessible to both pilots. A positive means for shutting off quickly all ignition of multi-engine rotorcraft, by grouping of switches or otherwise, shall be provided.

**06.47 Manifolding, firewall, and cowling or engine compartment covering.**

**06.470 General.** All manifolds, cowling, and firewalls shall be so designed and installed as to reduce to a minimum the possibility of fire either during flight or following an accident and shall comply with accepted practice in all details of installation not hereinafter specified.

**06.471 Exhaust manifolds.** Exhaust manifolds shall be constructed of suitable materials, shall provide for expansion, and shall be so arranged and cooled that local hot points do not form. Exhaust gases shall be discharged clear of the cowling, rotorcraft structure, carburetor air intake, and fuel system parts or drains. Exhaust gases shall not discharge in a manner that will impair pilot vision at night due to glare. No exhaust manifolding shall be located immediately adjacent to or under the carburetor or fuel system parts unless such parts are properly protected against possible leakage.

**06.472 Air intakes.** Carburetor air intakes shall be provided with suitable drains. Cold air intakes shall open completely outside the cowling unless the emergence of backfire flames is positively prevented. The air intake drain shall not discharge fuel in the possible path of exhaust flames.

**06.473 Firewall.** The engine compartment shall be isolated from the remainder of the rotorcraft by means of fire-resistant bulkheads unless the engine is located in a nacelle which is remote from the remainder of the rotorcraft structure and contains no fuel tanks. The firewalls shall be constructed of one of the following materials, or of a material of equivalent fire-resistant qualities and strength characteristics:

(a) a single sheet of heat and corrosion-resistant steel not less than 0.012 inch thick;

(b) a single sheet of nickel-chromium-iron alloy not less than 0.015 inch thick;

(c) a single sheet of low carbon steel not less than 0.018 inch thick, coated with aluminum or otherwise protected against corrosion;

(d) a single sheet of monel metal not less than 0.018 inch thick;

(e) a single sheet of terneplate not less than 0.018 inch thick;

(f) two sheets of aluminum alloy, each not less than 0.020 inch thick, which are separated by a sheet of asbestos millboard or asbestos fabric sheet not less than 0.125 inch thick, the entire assembly being adequately fastened together.

The firewall shall have all necessary openings provided with close-fitting, fire-resistant grommets, bushings, or firewall fittings. Adjacent inflammable structural members or other inflammable components of the rotorcraft shall be protected by asbestos or other fire-resistant material and provisions shall be made to prevent fuel and oil from permeating the insulation.

**06.474 Engine cowling and engine compartment covering.** All cowling or engine compartment covering shall be made of noninflammable material and shall be so arranged that any accumulations of dirt, waste, fuel, or oil may be readily observed without complete removal of the cowling or engine compartment covering. The cowling or covering shall fit tightly to the firewall. However, openings may be provided if the surface of the aircraft within 15 inches of all such openings is protected with metal or other suitable fire-resistant material. The cowling or engine compartment shall be completely drainable in all operating attitudes of the rotorcraft. All drains shall discharge clear of the exhaust manifold, the path of the exhaust gases, and all parts of the rotorcraft.

**06.475 Heating systems.** Heating systems involving the passage of cabin air over or in close proximity to engine exhaust manifolds shall not be used unless adequate precautions are incorporated in the design to prevent the introduction of carbon monoxide into the cabin or pilot's compartment. Heat exchangers shall be constructed of suitable materials, shall be cooled adequately under all conditions, and shall be susceptible to ready disassembly for inspection.

**06.48 Fire protection.** The power plant installation shall be constructed and installed in such a manner as to preclude the possibility of fire.

**06.480 Fire protection of flight controls.** All primary flight controls passing through the engine compartment shall be constructed of fire-resistant material, or shall be enclosed in a suitably ventilated and drained enclosure of 0.012-inch thick stainless steel, or material of equivalent fire-resistant qualities.

## 06.5 EQUIPMENT

**06.50 General.** The equipment required shall be dependent upon the type of operation for which certification is desired. Basic minimum requirements are set forth below.

**06.500 Acceptability.** Equipment items for which certification is required shall be certificated in accordance with the provisions of Part 15 of the Regulations. Other items of equipment shall be of a type and design found by the Administrator to be adequate for the purpose intended.

**06.51 Minimum equipment.** All rotorcraft shall be equipped with at least the following:
(a) an airspeed indicator,
(b) an altimeter,
(c) a tachometer for the main rotor or for each main rotor, the speed of which can vary appreciably with respect to another main rotor. (See § 06.521),
(d) a tachometer for each engine. (See § 06.521),
(e) an engine oil-pressure gauge when the engine employs a pressure oil system,
(f) a coolant thermometer for each liquid-cooled engine,
(g) an oil inlet temperature thermometer,
(h) a manifold-pressure gauge for each altitude engine,
(i) a fuel quantity gauge. (See § 06.434 for requirements),
(j) certificated safety belts for all passengers and members of the crew. (See Part 15 of the Regulations for belt requirements and § 06.2500 for installation strength requirements),
(k) a device for measuring or indicating the amount of oil in the tanks. (See § 06.443 for requirements).

**06.52 Installation requirements.**

**06.520 General.** The required equipment shall be so installed as to function dependably.

**06.521 Rotor and engine tachometers.** The tachometers required by § 06.51 (c) and (d) may be combined in a single instrument; however, such an instrument shall indicate rotor rpm during autorotation.

## 06.6 OPERATIONAL DATA

**06.60 Operation limitations and information.** A flight manual shall be provided in the rotorcraft by which the operating personnel are informed of all operation limitations and information necessary for its safe operation. The manual shall include information essential to the proper maintenance of the rotorcraft.

**06.61 Identification plate.** An identification plate shall be permanently affixed in a visible location in the pilots' compartment of each rotorcraft. This plate shall contain the manufacturer's name, the model designation of the rotorcraft, its date of manufacture, and the manufacturer's serial number.

**TABLE 06–1.—Additional (Multiplying) Factors of Safety (See § 06.201)**

| Item | Component | Additional Factor of Safety | May be Covered by Item No. |
|---|---|---|---|
| 1 | Fittings (except control system fittings)[1] | 1.15 | 2, 3, 4, 5, 6, 7. |
| 2 | Castings [2] | 2.00 | 3, 4, 5. |
| 3 | Rotor hubs and blade attachments | See § 06.22 (d) | |
| 4 | Control system joints (plain bearings)[3] | 6.67 | |
| 5 | Control surface hinges (plain bearings)[3] | 1.50 | |
| 6 | Torque tubes in direct bearing used as hinges | 1.50 | |
| 7 | Ball and roller bearings in primary systems[4] | | |

[1] Fittings are defined as parts used to connect one primary member to another and shall include the bearing of those parts on the members thus connected. Continuous joints in metal plating and welded joints between primary structural members are not classified as fittings.
[2] A lower value than 2 will be acceptable where radiographic inspection is employed in accordance with a process specification approved by the Administrator.
[3] For bearing stresses only.
[4] For ball or roller bearings the manufacturer's non-Brinell rating shall equal or exceed the *limit* load.

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