Title 14—AERONAUTICS AND SPACE

Chapter I—Federal Aviation Agency

[Reg. Docket No. 3025; Amdt. 1-5]

SUBCHAPTER A—DEFINITIONS [NEW]

PART 1—DEFINITIONS [NEW]

SUBCHAPTER A—CIVIL AIR REGULATIONS

PART 13—AIRCRAFT ENGINE AIRWORTHINESS

SUBCHAPTER C—AIRCRAFT [NEW]

PART 33—AIRWORTHINESS STANDARDS; AIRCRAFT ENGINES [NEW]

Miscellaneous Amendments

This amendment adds Part 33 [New] to the Federal Aviation Regulations to replace the airworthiness requirements contained in Part 13 of the Civil Air Regulations and is part of the Agency recodification program. Part 33 [New] was published as a notice of proposed rule making in the FEDERAL REGISTER on January 1, 1964 (29 F.R. 15). In addition, Part 1 [New] is being amended to add definitions of "2½ minute power" and "30 minute power" and to correct the definition of "fire resistant".

It should be noted that at this time no definite effective date for this part is stated. The procedural requirements of Part 13 of the Civil Air Regulations are proposed to be included in Part 21 [New] as published in the FEDERAL REGISTER on May 27, 1964 (29 F.R. 7000). Part 33 [New] will be made effective on the same date as Part 21 [New] is made effective. In addition, at that time Part 13 will be rescinded in its entirety.

Recodification

A number of changes have been made in the proposal, both as a result of comments received and as a result of further review by the Agency. Some of the comments received recommended substantive changes of the regulations. Although some of the recommendations might, upon further study, appear to be meritorious, they cannot be adopted as a part of the recodification program. However, all comments of this nature will be preserved and considered in any later substantive revision of this part.

Several comments were addressed to the disposition of the procedural requirements of Part 13. As previously indicated, these requirements are proposed to be included in Part 21 [New]. In particular it should be noted that the "equivalent level of safety" provisions presently contained in § 13.10 are proposed to be included in § 21.21 [New].

One comment requested the retention of the phrase "as well as aluminum alloy" in paragraph (2) of the definition of "fire resistant". As indicated in the preamble to the NPRM on Part 33 [New], the inclusion of this phrase in the Part 1 [New] definition of "fire resistant" makes this definition inconsistent with the present definition in CAR Part 3. Since there was no intention to make a substantive change when the Part 1 [New] definition was enacted, the Agency feels that the definition in Part 1 [New] should be restated to be consistent with the definition in CAR Part 3.

Comments received questioned the substitution of the phrase "with a propeller ordinarily used on a similar engine" in place of the phrase "with a representative propeller" whenever a propeller is required for an engine test under this part. Since the proposed language might cause some confusion and might appear to be a substantive change, the Agency is returning to the phrase "with a representative propeller".

In addition, the phrase "when practicable" has been added to § 33.87(c)(7) to make that section consistent with § 33.87(b)(7) and with the present requirements of Part 13. The requirements of § 13.16(a), originally scheduled to be included in Part 21 [New] have been included in §§ 33.57 and 33.99.

The amendment to § 13.254 relating to 2½ minute power for helicopter turbine engines that became effective April 22, 1964 (29 F.R. 5381) has been included as paragraph (d) of § 33.87 and a definition of "2½ minute power" is being added to Part 1 [New].

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

The definitions, abbreviations, and rules of construction contained in Part 1 [New] of the Federal Aviation Regulations apply to Part 33 [New].

In consideration of the foregoing, § 1.1 of Part 1—Definitions and Abbreviations [New] (14 CFR Part 1 [New]) is amended as follows:

1. By amending the definition of "fire resistant" to read as follows:

"Fire resistant—"

(1) With respect to sheet or structural members, means the capacity to withstand heat at least as well as aluminum alloy in dimensions appropriate for the purpose for which they are used; and

(2) With respect to fluid-carrying lines, other flammable fluid system parts, wiring, air ducts, fittings, and powerplant controls, means the capacity to perform the intended functions under the heat and other conditions likely to occur at the place concerned.

2. By adding a definition of "30-minute power" reading as follows:

"30-minute power", with respect to helicopter turbine engines, means the maximum brake horsepower, developed under static conditions at specified altitudes and atmospheric temperatures, under the maximum conditions of rotor shaft rotational speed and gas temperature, and limited in use to periods of not over 30 minutes as shown on the engine data sheet.

3. By adding a definition of "2½ minute power" reading as follows:

"2½ minute power", with respect to helicopter turbine engines, means the brake horsepower, developed statically in standard atmosphere at sea level, or at a specified altitude, for one-engine-out operation of multiengine helicopters for 2½ minutes at rotor shaft rotation speed and gas temperature established for this rating.

In addition, Chapter I of Title 14 is amended by adding a Part 33 [New] reading as hereinafter set forth.

Effective date. As previously noted, this amendment does not contain an effective date but will be made effective on the same date that Part 21 [New] becomes effective.

This amendment is made under the authority of sections 313(a), 601, and 603 of the Federal Aviation Act of 1958 (49 U.S.C. 1354(a), 1421, and 1423).

Issued in Washington, D.C., on June 3, 1964.

N. E. HALABY,
Administrator.

PART 33—AIRWORTHINESS STANDARDS; AIRCRAFT ENGINES [NEW]

Subpart A—General

Subpart B—Design and Construction; General

Subpart C—Design and Construction; Reciprocating Aircraft Engines

Subpart D—Block Tests; Reciprocating Aircraft Engines

Subpart E—Design and Construction; Turbine Aircraft Engines

Subpart F—Block Tests; Turbine Aircraft Engines

AUTHORITY: The provisions of this Part 33 [New] issued under secs. 313(a), 601, 603, Federal Aviation Act of 1958; 49 U.S.C. 1354(a), 1421, 1423.

Subpart A—General

§ 33.1 Applicability.

This part describes airworthiness requirements for issuing type certificates, supplemental type certificates, and changes to those certificates, for aircraft engines.

§ 33.3 General.

Each applicant must show that the aircraft engine concerned meets the applicable requirements of this part.

§ 33.5 Instruction manual.

Each applicant must prepare and make available an approved manual or manuals containing instructions for installing, operating, servicing, and maintaining the engine.

§ 33.7 Engine operating limitations.

Engine operating limitations established by the Administrator are based on the engine operating conditions demonstrated during the block tests required by this part and include those relating to power, speeds, temperature, pressures, fuels, and oils which the Administrator finds necessary for safe operation of the engine.

Subpart B—Design and Construction; General

§ 33.11 Applicability.

This subpart prescribes the general design and construction requirements for reciprocating and turbine aircraft engines.

§ 33.13 Design features.

The engine may not have design features that experience has shown to be hazardous or unreliable. The suitabil-

ity of each questionable design detail or part must be established by tests.

§ 33.15 Materials.

The suitability and durability of the materials used in the engine must be established on a basis of experience or tests. Each material must conform to approved specifications to ensure that it has the strength and other properties assumed in the design data.

§ 33.17 Fire prevention.

(a) The design and construction of the engine and the materials used must minimize the probability of the occurrence and spread of fire because of structural failure, overheating, or other causes.

(b) Each external line or fitting that conveys flammable fluids must be at least fire resistant. Appropriate design, shielding, or routing must minimize the probability of a fire hazard, caused by the deterioration of flammable fluid carrying lines, from heat, vibration, or fluid pressure.

§ 33.19 Durability.

Engine design and construction must minimize the development of an unsafe condition of the engine between overhaul periods. The design of the compressor and turbine rotor cases must provide for the containment of damage from rotor blade failure.

§ 33.21 Engine cooling.

Engine design and construction must provide the necessary cooling under conditions in which the airplane is expected to operate.

§ 33.23 Engine mounting attachments.

The mounting attachments and structure of the engine must have enough strength, when the engine is mounted on an aircraft, to withstand the loads arising from the loading conditions prescribed in the airworthiness parts of this subchapter applicable to the aircraft involved.

§ 33.25 Accessory attachments.

Each accessory drive and mounting attachment must be designed and constructed so that the engine will operate properly with the accessories attached. The design of the engine must allow for the examination, adjustment or removal of each essential engine accessory.

§ 33.27 Turbine rotors.

To minimize the probability of failure of turbine rotors—

(a) Turbine rotors must be demonstrated to be of enough strength to withstand damage inducing factors such as those that might result from abnormal rotor speeds, temperatures, or vibration; and

(b) The design and functioning of engine control devices, systems, and instrumentation must give reasonable assurance that those engine operating limitations that affect turbine rotor structural integrity will not be exceeded in service.

Subpart C—Design and Construction; Reciprocating Aircraft Engines

§ 33.31 Applicability.

This subpart prescribes additional design and construction requirements for reciprocating aircraft engines.

§ 33.33 Vibration.

The engine must be designed and constructed to function throughout its normal operating range of crankshaft rotational speeds and engine powers without inducing excessive stress in any of the engine parts because of vibration and without imparting excessive vibration forces to the aircraft structure.

§ 33.35 Fuel and induction system.

(a) The fuel system of the engine must be designed and constructed to supply an appropriate mixture of fuel to the cylinders throughout the complete operating range of the engine under all flight and atmospheric conditions.

(b) The intake passages of the engine through which air or fuel in combination with air passes for combustion purposes must be designed and constructed to minimize the danger of ice accretion in those passages. The engine must be designed and constructed to permit the use of a means for ice prevention.

(c) The type and degree of fuel filtering necessary for protection of the engine fuel system against foreign particles in the fuel must be specified. The applicant must show that foreign particles passing through the prescribed filtering means will not critically impair engine fuel system functioning.

(d) Each passage in the induction system that conducts a mixture of fuel and air must be self-draining, to prevent a liquid lock in the cylinders, in all attitudes that the applicant establishes as those the engine can have when the aircraft in which it is installed is in the static ground attitude.

§ 33.37 Ignition system.

Each spark ignition engine must have a dual ignition system with at least two spark plugs for each cylinder and two separate electric circuits with separate sources of electrical energy, or have an ignition system of equivalent in-flight reliability.

§ 33.39 Lubrication system.

(a) The lubrication system of the engine must be designed and constructed so that it will function properly in all flight attitudes and atmospheric conditions in which the airplane is expected to operate. In wet sump engines, this requirement must be met when only one-half of the maximum lubricant supply is in the engine.

(b) The lubrication system of the engine must be designed and constructed to allow installing a means of cooling the lubricant.

(c) The crankcase must be vented to the atmosphere to preclude leakage of oil from excessive pressure in the crankcase.

Subpart D—Block Tests; Reciprocating Aircraft Engines

§ 33.41 Applicability.

This subpart prescribes the block tests and inspections for reciprocating aircraft engines.

§ 33.43 Vibration test.

Each engine must undergo a vibration survey to investigate crankshaft torsional and bending vibration characteristics over the operational range of crankshift rotational speed and engine power normally used in flight (including low-power operation), from idling speed to either 110 percent of the desired maximum continuous speed rating, or to 103 percent of the desired takeoff speed rating, whichever is higher. The survey must be conducted with a representative propeller. If any critical speed is found to be present in the operating range of the engine, it must be eliminated through design change before making the endurance test specified in § 33.49, or the endurance test must include operation under the most adverse vibration condition for a long enough period to establish the ability of the engine to operate without fatigue failure.

§ 33.45 Calibration tests.

Each engine must be subjected to the calibration tests necessary to establish its power characteristics and the conditions for the endurance test specified in § 33.49. The results of the power characteristics calibration tests form the basis for establishing the characteristics of the engine over its entire operating range of crankshift rotational speeds, manifold pressures, fuel/air mixture settings, and altitudes. Power ratings are based upon standard atmospheric conditions.

§ 33.47 Detonation test.

Each engine must be tested to establish that the engine can function without detonation throughout its range of intended conditions of operation.

§ 33.49 Endurance test.

(a) *General.* Each engine must be subjected to an endurance test (with a representative propeller) that includes a total of 150 hours of operation and, depending upon the type and contemplated use of the engine, consists of one of the series of runs specified in paragraphs (b) through (d) of this section, as applicable. The runs must be performed in the periods and order found appropriate by the Administrator for the specific engine. During the endurance test the engine power and the crankshaft rotational speed must be controlled within ± 3 percent of the specified values.

(b) *Single-speed engines.* For engines not incorporating a supercharger and for those incorporating a single-speed supercharger, each applicant must make the following runs:

(1) A 30-hour run consisting of alternate periods of five minutes at takeoff power and speed, and five minutes at maximum best economy cruising power or maximum recommended cruising power.

(2) A 20-hour run consisting of alternate periods of 1½ hours at maximum continuous power and speed, and ½ hour at 75 percent maximum continuous power and 91 percent maximum continuous speed.

(3) A 20-hour run consisting of alternate periods of 1½ hours at maximum continuous power and speed, and ½ hour at 70 percent maximum continuous power and 89 percent maximum continuous speed.

(4) A 20-hour run consisting of alternate periods of 1½ hours at maximum continuous power and speed, and ½ hour at 65 percent maximum continuous power and 87 percent maximum continuous speed.

(5) A 20-hour run consisting of alternate periods of 1½ hours at maximum continuous power and speed, and ½ hour at 60 percent maximum continuous power and 84.5 percent maximum continuous speed.

(6) A 20-hour run consisting of alternate periods of 1½ hours at maximum continuous power and speed, and ½ hour at 50 percent maximum continuous power and 79.5 percent maximum continuous speed.

(7) A 20-hour run consisting of alternate periods of 2½ hours at maximum continuous power and speed, and 2½ hours at maximum best economy cruising power or at maximum recommended cruising power.

(c) *Two-speed engines.* Each engine incorporating a two-speed supercharger must undergo the following runs:

(1) A 30-hour run consisting of alternate periods in the lower gear ratio of five minutes at takeoff power and speed, and five minutes at maximum best economy cruising power or at maximum recommended cruising power. If a takeoff rating is desired in the higher gear ratio, 15 hours of the 30-hour run must be made in the higher gear ratio in alternate periods of five minutes at the observed horsepower obtainable with the takeoff critical altitude manifold pressure and takeoff speed, and five minutes at 70 percent high ratio maximum continuous power and 89 percent high ratio maximum continuous speed.

(2) A 15-hour run consisting of alternate periods in the lower gear ratio of one hour at maximum continuous power and speed, and ½ hour at 75 percent maximum continuous power and 91 percent maximum continuous speed.

(3) A 15-hour run consisting of alternate periods in the lower gear ratio of one hour at maximum continuous power and speed, and ½ hour at 70 percent maximum continuous power and 89 percent maximum continuous speed.

(4) A 30-hour run in the higher gear ratio at maximum continuous power and speed.

(5) A five-hour run consisting of alternate periods of five minutes in each of the supercharger gear ratios. The first five minutes of the test must be made at normal rated speed in the higher gear ratio and the observed horsepower obtainable with 90 percent of the normal rated manifold pressure in the higher gear ratio under sea level conditions. The condition for operation for the alternate five minutes in the lower gear ratio must be that obtained by shifting to the lower gear ratio at constant speed.

(6) A 10-hour run consisting of alternate periods in the lower gear ratio of one hour at maximum continuous power and speed, and one hour at 65 percent maximum continuous power and 87 percent maximum continuous speed.

(7) A 10-hour run consisting of alternate periods in the lower gear ratio of one hour at maximum continuous power and speed, and one hour at 60 percent maximum continuous power and 84.5 percent maximum continuous speed.

(8) A 10-hour run consisting of alternate periods in the lower gear ratio of one hour at maximum continuous power and speed, and one hour at 50 percent maximum continuous power and 79.5 percent maximum continuous speed.

(9) A 20-hour run consisting of alternate periods in the lower gear ratio of two hours at maximum continuous power and speed, and two hours at maximum best economy cruising power and speed or at maximum recommended cruising power.

(10) A five-hour run in the lower gear ratio at maximum best economy cruising power and speed or at maximum recommended cruising power and speed.

Where simulated altitude test equipment is not available when operating in the higher gear ratio, the runs may be made at the observed horsepower obtained with the critical altitude manifold pressure or specified percentages thereof, and the fuel-air mixtures may be adjusted to be rich enough to suppress detonation.

(d) *Helicopter engines.* To be eligible for use on a helicopter each engine must either comply with § 29.____ (present § 7.405(a)) or must undergo the following series of runs:

(1) A 35-hour run consisting of alternate periods of 30 minutes each at takeoff power and speed, and at maximum continuous power and speed.

(2) A 25-hour run consisting of alternate periods of 2½ hours each at maximum continuous power and speed, and at 70 percent maximum continuous power at maximum continuous speed.

(3) A 25-hour run consisting of alternate periods of 2½ hours each at maximum continuous power and speed, and at 70 percent maximum continuous power at 80 to 90 percent maximum continuous speed.

(4) A 25-hour run consisting of alternate periods of 2½ hours each at 80 percent maximum continuous power at takeoff speed, and at 80 percent maximum continuous power at 80 to 90 percent maximum continuous speed.

(5) A 25-hour run consisting of alternate periods of 2½ hours each at 80 percent maximum continuous power at takeoff speed, and at either maximum continuous power at 110 percent maximum continuous speed or at takeoff power at 103 percent takeoff speed, whichever results in the greater speed.

(6) A 15-hour run at 105 percent maximum continuous power and 105 percent maximum continuous speed or at full throttle and corresponding speed at standard sea level carburetor entrance pressure, if 105 percent of the maximum continuous power is not exceeded.

§ 33.51 Operation test.

The operation test must include the testing found necessary by the Administrator to demonstrate backfire characteristics, starting, idling, acceleration, overspeeding, functioning of propeller and ignition, and any other operational characteristic of the engine. If the engine incorporates a multispeed supercharger drive, the design and construction must allow the supercharger to be shifted from operation at the lower speed ratio to the higher and the power appropriate to the manifold pressure and speed settings for maximum continuous power at the higher supercharger speed ratio must be obtainable within five seconds.

§ 33.53 Engine component tests.

(a) For each engine that cannot be adequately substantiated by endurance testing in accordance with § 33.49, the applicant must conduct additional tests to establish that components are able to function reliably in all normally anticipated flight and atmospheric conditions.

(b) Temperature limits must be established for each component that requires temperature controlling provisions in the aircraft installation to assure satisfactory functioning, reliability, and durability.

§ 33.55 Teardown inspection.

After completing the endurance test the engine must be completely disassembled and a detailed inspection made of each engine part to check for fatigue and wear.

§ 33.57 General conduct of block tests.

(a) The applicant may, in conducting the block tests, use separate engines of identical design and construction in the vibration, calibration, detonation, endurance, and operation tests, except that, if a separate engine is used for the endurance test it must be subjected to a calibration check before starting the endurance test.

(b) The applicant may service and make minor repairs to the engine during the block tests. If major repairs or replacement of parts are necessary during the tests or in the teardown inspection, the parts in question must be subjected to any additional tests the Administrator may require.

(c) Each applicant must furnish all testing facilities, including equipment and competent personnel, to conduct the block tests.

Subpart E—Design and Construction; Turbine Aircraft Engines

§ 33.61 Applicability.

This subpart prescribes additional design and construction requirements for turbine aircraft engines.

§ 33.63 Vibration.

Each engine must be designed and constructed to function throughout its normal operating range of rotational speeds and engine power without inducing excessive stress in any engine part because of vibration and without im-

parting excessive vibration forces to the aircraft structure.

§ 33.65 Surge characteristics.

Each engine must be free of detrimental surge throughout its operating range in the minimum ambient air temperature in which it is to be operated.

§ 33.67 Fuel and induction system.

(a) The fuel system must be designed and constructed to supply an appropriate mixture of fuel to the combustion chamber throughout the complete operating range of the engine under all flight and atmospheric conditions.

(b) Each intake passage of the engine through which air, or fuel in combination with air, passes for combustion purposes, must be designed and constructed to minimize the danger of ice accretion in those passages and to allow for a means of ice prevention.

(c) Each engine, with all icing protection systems operating, must be capable of operation throughout the flight power range without the accumulation of ice on the engine components that adversely affects engine operation or that causes a serious loss of power or thrust in continuous maximum and intermittent maximum icing conditions as defined in § _____ (present § 4b.1(b) (7) and (8)).

(d) The type and degree of fuel filtering necessary for protection of the engine fuel system against foreign particles in the fuel must be specified. The applicant must demonstrate that foreign particles passing through the specified filtering means do not critically impair engine fuel system functioning.

(e) If air is bled from the compressor for protection of the engine in icing conditions, provision must be made for positive indication that air is being directed to the proper passages.

§ 33.69 Ignition system.

Each engine must be equipped with an ignition system for starting the engine on the ground and in flight. An electric ignition system must have at least two igniters and two separate secondary electric circuits.

§ 33.71 Lubrication system.

The lubrication system must be designed and constructed to function properly in all flight attitudes and atmospheric conditions in which the airplane is expected to operate.

§ 33.73 Power or thrust response.

The design and construction of the engine must enable an increase, under static conditions, from flight idle power or thrust to 95 percent of takeoff power or thrust in not over five seconds.

Subpart F—Block Tests; Turbine Aircraft Engines

§ 33.81 Applicability.

This subpart prescribes the block tests and inspections for turbine engines. Unless otherwise applicable, the controlled air extraction must be zero during all tests.

§ 33.83 Vibration test.

Each engine must undergo a vibration survey to investigate the vibration characteristics of the engine over the operational range of rotational speed and engine power. If critical vibration is found in the operating range of the engine, the engine design must be changed to eliminate that vibration before making the endurance test specified in § 33.87, or the endurance test must include operation under the most adverse vibration condition for a long enough period to establish the ability of the engine to operate without fatigue failure.

§ 33.85 Calibration tests.

(a) Each engine must be subjected to those calibration tests necessary to establish its power characteristics and the conditions for the endurance test specified § 33.87. The results of the power characteristics calibration tests form the basis for establishing the characteristics of the engine over its entire operating range of speeds pressures, temperatures, and altitudes. Power ratings are based upon standard atmospheric conditions.

(b) Before the endurance test the power control must be adjusted to produce the maximum allowable gas temperatures and rotor speeds at takeoff operating conditions. The adjustment may not be changed during the relevant calibration tests and the relevant runs of the endurance test.

§ 33.87 Endurance test.

(a) *General.* Each engine must be subjected to an endurance test (with a representative propeller if the engine is designed to operate with a propeller) that must include a total of 150 hours of operation, consisting of 25 periods of six hours each as specified in either paragraph (b), (c), or (d) of this section. The runs must be made in the order found appropriate by the Administrator for the specific engine. During the endurance test, the engine power and thrust and the engine rotational speed may not be less than 100 percent of the specified values, except that substantiating evidence must be submitted if the engine parameters are not controlled within this limitation.

(b) *Engines other than certain helicopter engines.* For each engine, except a helicopter engine for which a rating is desired under paragraph (c) or (d) of this section, the applicant must conduct the following runs:

(1) *Takeoff and idling.* One hour of alternate five-minute periods at takeoff power and thrust and at idling power and thrust. The developed powers and thrusts at takeoff and idling conditions and their corresponding rotor speed and gas temperature conditions must be as established by the power control in accordance with the schedule established by the manufacturer. The applicant may, during any one period, manually control the rotor speed, power, and thrust while taking data to check performance. For engines with augmented takeoff ratings that involve increases in turbine inlet temperature, rotor speed, or shaft power, this period of running at takeoff must be at the augmented rating. For engines with augmented takeoff ratings that do not materially increase operating severity, the amount of running conducted at the augmented rating is determined by the Administrator. In changing the power setting after each period, the power-control lever must be moved in the manner prescribed in subparagraph (5) of this paragraph.

(2) *Maximum continuous and takeoff power and thrust.* Fifteen periods each of 30 minutes duration at maximum continuous power and thrust and 10 periods each of 30 minutes duration at takeoff power and thrust.

(3) *Maximum continuous power and thrust.* One hour and 30 minutes at the maximum continuous power and thrust.

(4) *Incremental cruise power and thrust.* Two hours and 30 minutes at the successive power lever positions corresponding to at least 15 approximately equal speed and time increments between maximum continuous engine rotational speed and ground or minimum idle rotational speed. For engines operating at constant speed, the thrust and power may be varied in place of speed. If there is significant peak vibration anywhere between ground idle and maximum continuous conditions, the number of increments chosen may be changed to increase the amount of running made while subject to the peak vibrations up to not more than 50 percent of the total time spent in incremental running.

(5) *Acceleration and deceleration runs.* 30 minutes of accelerations and decelerations, consisting of six cycles from idling power and thrust to takeoff power and thrust and maintained at the takeoff power lever position for 30 seconds and at the idling power lever position for approximately four and one-half minutes. In complying with this subparagraph, the power-control lever must be moved from one extreme position to the other in not more than one second, except that, if different regimes of control operations are incorporated necessitating scheduling of the power-control lever motion in going from one extreme position to the other, a longer period of time is acceptable, but not more than two seconds.

(6) *Starts.* One hundred starts must be made, of which 25 starts must be preceded by at least a two-hour engine shutdown. There must be at least 10 false engine starts, pausing for the applicant's specified minimum fuel drainage time, before attempting a normal start. There must be at least 10 normal restarts with not longer than 15 minutes since engine shutdown. The remaining starts may be made after completing the 150 hours of endurance testing.

(7) *Maximum temperatures.* The limiting maximum hot gas and, when practicable, oil inlet temperatures must be substantiated by operation at these limits during all the takeoff and maximum continuous running of the endurance test, except where the test periods are not longer than five minutes and do not always allow stabilization.

(c) *Helicopter engines for which a 30-minute power rating is desired.* For each helicopter engine for which a 30-minute power rating is desired the ap-

plicant must conduct the following series of tests:

(1) *Takeoff and idling.* One hour of alternate five-minute periods at takeoff power and thrust and at idling power and thrust. The developed powers and thrusts at takeoff and idling conditions and their corresponding rotor speed and gas temperature conditions must be as established by the power control in accordance with the schedule established by the manufacturer. During any one period the rotor speed, power, and thrust may be controlled manually while taking data to check performance. For engines with augmented takeoff ratings that involve increases in turbine inlet temperature, rotor speed, or shaft power, this period of running at rated takeoff power must be at the augmented rating. In changing the power setting after each period, the power-control lever must be moved in the manner prescribed in subparagraph (5) of this paragraph.

(2) *30-minute power.* 30 minutes at 30-minute power and thrust.

(3) *Maximum continuous power and thrust.* Two hours at the maximum continuous power and thrust.

(4) *Incremental cruise power and thrust.* Two hours at the successive power-lever positions corresponding with not less than 12 approximately equal speed and time increments between maximum continuous engine rotational speed and ground or minimum idle rotational speed. For engines operating at constant speed, the thrust and power may be varied in place of speed. If there are significant peak vibrations anywhere between ground idle and maximum continuous conditions, the number of increments chosen must be changed to increase the amount of running conducted while being subjected to the peak vibrations up to not more than 50 percent of the total time spent in incremental running.

(5) *Acceleration and deceleration runs.* 30 minutes of accelerations and decelerations, consisting of six cycles from idling power and thrust to takeoff power and thrust and maintained at the takeoff power lever position for 30 seconds and at the idling power lever position for approximately 4½ minutes. In complying with this subparagraph, the power-control lever must be moved from one extreme position to the other in not more than one second, except that, if different regimes of control operations are incorporated necessitating scheduling of the power-control lever motion in going from one extreme position to the other, a longer period of time is acceptable, but not more than two seconds.

(6) *Starts.* One hundred starts, of which 25 starts must be preceded by at least a two-hour engine shutdown. There must be at least 10 false engine starts, pausing for the applicant's specified minimum fuel drainage time, before attempting a normal start. There must be at least 10 normal restarts with not longer than 15 minutes since engine shutdown. The remaining starts may be made after completing the 150 hours of endurance testing.

(7) *Maximum temperatures.* The limiting maximum hot gas and, when practicable, oil inlet temperatures must be substantiated by operation at these limits during all the takeoff power, 30-minute power, and maximum continuous running of the endurance test except where the test periods are not longer than five minutes and do not allow stabilization.

(d) *Helicopter engines for which a 2½ minute power rating is desired.* For each helicopter engine for which a 2½ minute power rating is desired the applicant must conduct the following series of tests:

(1) One hour of alternate five-minute periods at takeoff power and thrust and at idling power and thrust except that, during the third and sixth takeoff power periods, only 2½ minutes need be conducted at takeoff power and the remaining 2½ minutes must be conducted at 2½ minute power. The developed powers and thrusts at takeoff, 2½ minute, and idling conditions and their corresponding rotor speed and gas temperature conditions must be as established by the power control in accordance with the schedule established by the manufacturer. The applicant may, during any one period, control manually the rotor speed, power, and thrust while taking data to check performance. For engines with augmented takeoff ratings that involve increases in turbine inlet temperature, rotor speed, or shaft power, this period of running at rated takeoff power must be at the augmented rating. In changing the power setting after or during each period, the power control lever must be moved in the manner prescribed in subparagraph (5) of paragraph (c) of this section.

(2) The tests required in subparagraphs (2) through (6) of paragraph (c) of this section.

(3) *Maximum temperatures.* The limiting maximum hot gas and oil inlet temperatures must be substantiated by operation at these limits during all the takeoff, 2½ minute power, 30-minute power, and maximum continuous running of the endurance test, except where the test periods are not longer than five minutes and do not allow stabilization.

§ 33.89 Operation test.

The operation test must include all testing found necessary by the Administrator to demonstrate starting, idling, acceleration, overspeeding, ignition, functioning of the propeller (if the engine is designed to operate with a propeller), and any other operational characteristic of the engine.

§ 33.91 Engine component tests.

(a) For those systems that cannot be adequately substantiated by endurance testing in accordance with the provisions of § 33.87, additional tests must be made to establish that components are able to function reliably in all normally anticipated flight and atmospheric conditions.

(b) Temperature limits must be established for those components that require temperature controlling provisions in the aircraft installation to assure satisfactory functioning, reliability, and durability.

§ 33.93 Teardown inspection.

After completing the endurance test the engine must be completely disassembled and a detailed inspection made of each engine part to check for fatigue and wear.

§ 33.95 Engine-propeller systems tests.

If the engine is designed to operate with a propeller, the following tests must be made with a representative propeller installed by either including the tests in the endurance run or otherwise performing them in a manner acceptable to the Administrator:

(a) Feathering operation: 25 cycles.

(b) Negative torque and thrust system operation: 25 cycles from maximum continuous power.

(c) Automatic decoupler operation: 25 cycles from maximum continuous power (if repeated decoupling and recoupling in service is the intended function of the device).

(d) Reverse thrust operation: 175 cycles from the flight-idle position to full reverse and 25 cycles at maximum continuous power from full forward to full reverse thrust. At the end of each cycle the propeller must be operated in reverse pitch for a period of 30 seconds at the maximum rotational speed and power specified by the applicant for reverse pitch operation.

§ 33.97 Thrust reversers.

(a) If the engine incorporates a reverser, the endurance calibration, operation, and vibration tests prescribed in this subpart must be run with the reverser installed. In complying with this section, the power control lever must be moved from one extreme position to the other in not more than one second except, if regimes of control operations are incorporated necessitating scheduling of the power-control lever motion in going from one extreme position to the other, a longer period of time is acceptable but not more than three seconds. In addition, the test prescribed in paragraph (b) of this section must be made. This test may be scheduled as part of the endurance run.

(b) 175 reversals must be made from flight-idle forward thrust to maximum reverse thrust and 25 reversals must be made from maximum forward to maximum reverse thrust. After each reversal, the reverser must be operated at full reverse thrust for a period of one minute, except that, in the case of a reverser intended for use only as a braking means on the ground, the reverser need only be operated at full reverse thrust for 30 seconds.

§ 33.99 General conduct of block tests.

(a) Each applicant may, in making a block test, use separate engines of identical design and construction in the vibration, calibration, endurance, and operation tests, except that, if a separate engine is used for the endurance test it must be subjected to a calibration check before starting the endurance test.

(b) Each applicant may service and make minor repairs to the engine during the block tests. If major repairs or replacement of parts are found necessary

during the tests or in the teardown inspection, the parts in question must be subjected to any additional tests the Administrator finds necessary.

(c) Each applicant must furnish all testing facilities, including equipment and competent personnel, to conduct the block tests.

DISTRIBUTION TABLE

Former section	*Revised section*
13.0	33.1
13.1	(1)
13.10—13.19 (except § 13.16)	Part 21 [New]
13.16(b)	Surplusage
13.16 (less (a), (b), and (d))	33.7
13.16 (a) and (d))	33.57, 33.99
13.20	Part 45 [New]
13.21	33.5
13.100 (opening sentence)	33.31
13.100(a)	33.13
13.100 (less opening sentence and (a)).	Obsolete
13.101	33.15
13.102	33.17
13.103	33.33
13.104	33.19
13.110	33.35
13.111	33.37
13.112	33.39
13.113	33.21
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13.115	33.25
13.116	33.27
13.150	33.41
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13.152	33.45
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13.154	33.49
13.155	33.51
13.156	33.53
13.157	33.55
13.158	33.57
13.200 (opening sentence)	33.61
13.200(a)	33.13
13.200 (less opening sentence and (a)).	Obsolete
13.201	33.15
13.202	33.17
13.203	33.63
13.204	33.19
13.205	33.65
13.210	33.67
13.211	33.69
13.212	33.71
13.213	33.21
13.214	33.23
13.215	33.25
13.216	33.27
13.217	33.73
13.250	33.81
13.251	33.83
13.252	33.85
13.254	33.87
13.255	33.89
13.256	33.91
13.257	33.93
13.258	33.99
13.259	33.95
13.260	33.97

[1] Trfd. to Part 1 [New] or executed.

[F.R. Doc. 64-5726; Filed, June 9, 1964; 8:46 a.m.]