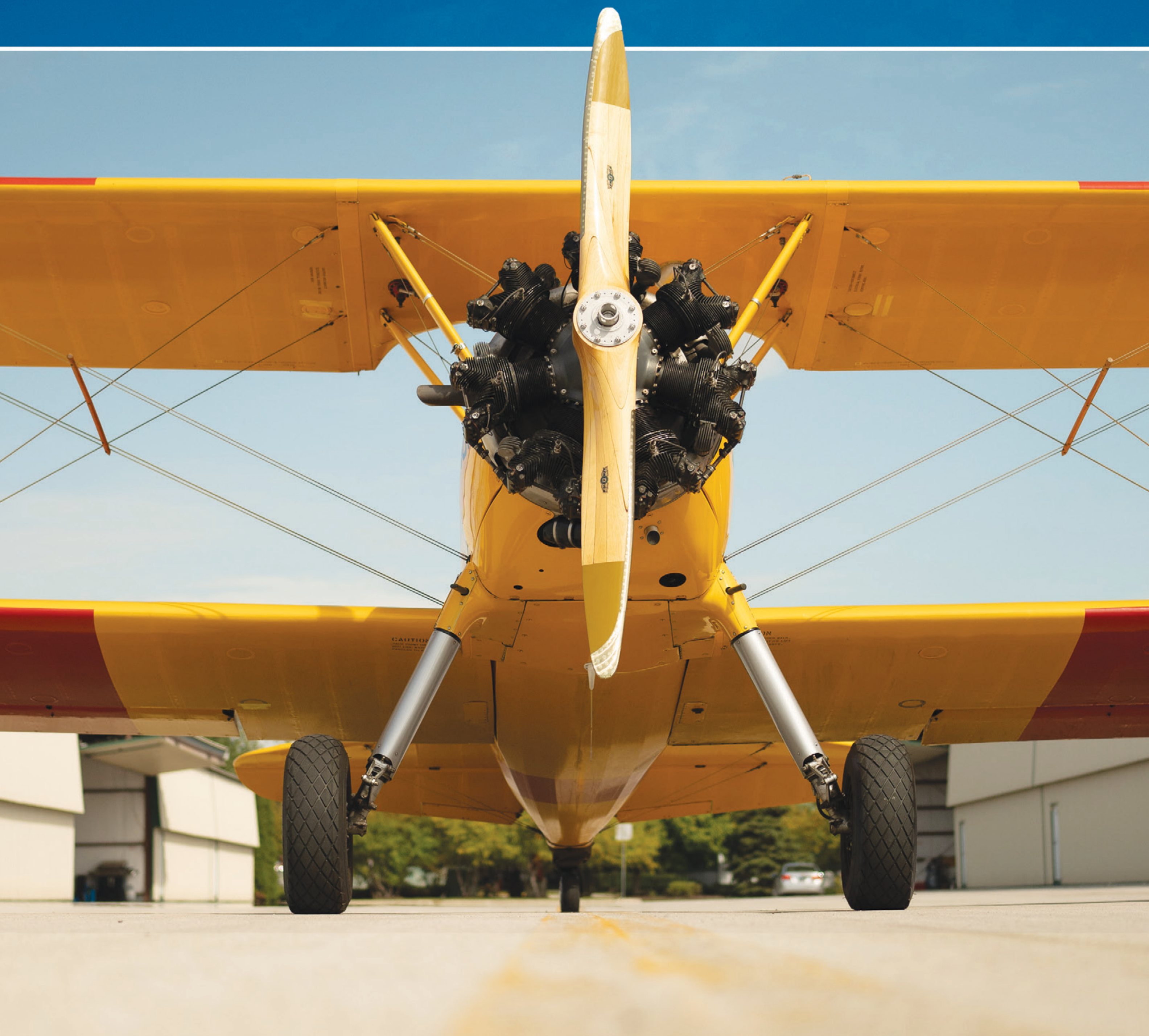
2025 FAR-AMT

Federal Aviation Regulations for Aviation Maintenance Technicians

Rules for Aviation Mechanics, Maintenance Operations, and Repair Shops
U.S. Department of Transportation
From Title 14 of the Code of Federal Regulations



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AVIATION SUPPLIES & ACADEMICS, INC.
NEWCASTLE, WASHINGTON

FAR-AMT
Federal Aviation Regulations for Aviation Maintenance Technicians
2025 Edition

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2025 FAR-AMT

Federal Aviation Regulations for Aviation Maintenance Technicians

Contents

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Introduction

ASA 2025 FAR/AIM Series
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ASA has been supplying the standard reference of the industry, the FAR/AIM series, for nearly 80 years. The 2025 series continues to provide information directly from the Federal Aviation Regulations and the *Aeronautical Information Manual*.

Each regulation Part is preceded by a detailed table of contents. Changes since last year's printing are identified on Page vii and in the table of contents for each regulation Part (in bold and marked with an asterisk), as well as within the text for quick reference (changed text is indicated with a bold line in the margin). In the *AIM*, changes are explained in a list at the beginning and with bold lines in the margins. It is recommended that you familiarize yourself with all the changes to identify those that affect your aviation activities.

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Although ASA is not a government agency, and we do not write the regulations or the *AIM*, we do work closely with the FAA. Questions or concerns can be forwarded to our attention, and we will in turn pass the comments on to the responsible office within the agency. The FAA is interested in user feedback and your comments could foster improvements in the regulations that affect the entire industry.

FAR/AIM Comments
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Identifying Regulation Changes Since Last Year

Changes since last year's printing of the book are noted in the table of contents of each Part with an asterisk and bold title:

Example:

***61.5 Certificates and ratings issued under this part.**

The updated text within the context of the regulation is indicated by a bold line in the margin:

(a) The following certificates are issued under this part to an applicant who satisfactorily accomplishes the training and certification requirements for the certificate sought:
(1) Pilot certificates—
(i) Student pilot.
(ii) Sport pilot.
(iii) Recreational pilot.
(iv) Private pilot.
(v) Commercial pilot.
(vi) Airline transport pilot.
(2) Flight instructor certificates.
(3) Ground instructor certificates.

How to Identify the Currency of the Regulations

In each Part following the Table of Contents is a Source, with the date of origin for that regulation.

Example:

Docket number within the Federal Registers, where original text can be found

Federal Register volume 74, page 42552

SOURCE: Docket No. FAA–2006–26661, 74 FR 42552, Aug. 21, 2009, unless otherwise noted.

Date regulation was written

If a change has taken place since the original Regulation was written, it is noted at the end of the regulation.

Example:

Docket number within the Federal Registers

Federal Register volume 74, page 42552, where the original text of regulation is

Date original regulation was written

[Docket No. FAA–2006–26661, 74 FR 42552, Aug. 21, 2009; as amended by Amdt. 61–125, 75 FR 5220, Feb. 1, 2010]

Amendment number, the change to the regulation; in the Federal Register

Federal Register volume 75, page 5220, where Amendment can be found

Date change took place

Summary of Major FAR Changes Since the 2024 Book Was Published

All changes are identified in the table of contents of each Part with bold Section titles and asterisks and in the regulation text with bold lines in the margins.

These regulation changes from the *Federal Register* and revisions to FAA advisory circulars affect this book as follows:

14 CFR

Part 5

- Updates requirements for safety management systems and requires certain certificate holders and commercial air tour operators to develop and implement a safety management system (SMS).

Part 13

- Provides the statutorily prescribed 2024 adjustment to civil penalty amounts that may be imposed for violations of certain DOT regulations.

Part 21

- Adopts fuel efficiency requirements for certification of certain airplanes.
- Updates requirements for safety management systems and requires certain certificate holders and commercial air tour operators to develop and implement a safety management system (SMS).

Part 34

- Adopts standards for measuring non-volatile particulate matter (nvPM) exhaust emissions from aircraft engines.

Part 38

- Adopts fuel efficiency requirements for certification of certain airplanes.

Part 43

- Amends the Automatic Dependent Surveillance–Broadcast (ADS-B) Out requirements to allow aircraft meeting the performance requirements in Technical Standard Order (TSO)-C166c or TSO-C154d to meet the regulations.

Part 65

- Revises certain regulations governing airman certification by incorporating by reference the FAA Practical Test Standards into the certification requirements for aircraft dispatchers and parachute riggers.

Part 91

- Amends the regulatory definitions of certain air carrier and commercial operations to add powered-lift to these definitions to ensure the appropriate sets of rules apply to air carriers' and certain commercial operators' operations of aircraft that FAA regulations define as powered-lift.
- Amends the Automatic Dependent Surveillance–Broadcast (ADS-B) Out requirements to allow aircraft meeting the performance requirements in Technical Standard Order (TSO)-C166c or TSO-C154d to meet the regulations.
- Updates certain basic requirements that apply to management specifications that persons who participate in a fractional ownership program under Part 91, Subpart K, must maintain.
- Updates requirements for safety management systems and requires certain certificate holders and commercial air tour operators to develop and implement a safety management system (SMS).
- Extends SFAR No. 79—Prohibition Against Certain Flights in the Pyongyang Flight Information Region (FIR) (ZKKP).

(continued)

- Removes SFAR No. 113—Prohibition Against Certain Flights in Specified Areas of the Dnipro Flight Information Region (FIR) (UKDV).
- Extends SFAR No. 114—Prohibition Against Certain Flights in the Damascus Flight Information Region (FIR) (OSTT).
- Amends SFAR No. 115—Prohibition Against Certain Flights in Specified Areas of the Sanaa Flight Information Region (FIR) (OYSC) to update the current waypoint names and locations.
- Adds SFAR No. 119—Prohibition Against Certain Flights in the Kabul Flight Information Region (FIR) (OAKX).

Part 110

- Amends the regulatory definitions of certain air carrier and commercial operations to add powered-lift to these definitions to ensure the appropriate sets of rules apply to air carriers' and certain commercial operators' operations of aircraft that FAA regulations define as powered-lift.

Part 119

- Amends the regulatory definitions of certain air carrier and commercial operations to add powered-lift to these definitions to ensure the appropriate sets of rules apply to air carriers' and certain commercial operators' operations of aircraft that FAA regulations define as powered-lift.
- Updates requirements for safety management systems and requires certain certificate holders and commercial air tour operators to develop and implement a safety management system (SMS).

Part 125

- Amends the regulatory definitions of certain air carrier and commercial operations to add powered-lift to these definitions to ensure the appropriate sets of rules apply to air carriers' and certain commercial operators' operations of aircraft that FAA regulations define as powered-lift.
- Amends operating regulations to ensure flight manuals contain airplane fuel efficiency certification information to ensure compliance with 14 CFR Part 38.

Advisory Circulars

- AC 20-109 has been updated to edition B.
- AC 20-62E was updated with some editorial changes.

Note: Changes affecting the regulations can take place daily. ASA tracks all changes and posts them on the ASA website so you always have the most current information. To view the rules currently in effect and to have Update notices automatically emailed to you, visit **asa2fly.com/farupdate**.

FAR-AMT Contents

Federal Aviation Regulations (from Title 14 of the Code of Federal Regulations)

PART 33

AIRWORTHINESS STANDARDS: AIRCRAFT ENGINES

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

Source: Docket No. 3025, 29 FR 7453, June 10, 1964, unless otherwise noted.

Editorial Note: *For miscellaneous amendments to cross references in this Part 33, see Amdt. 33–2, 31 FR 9211, July 6, 1966.*

Subpart A—General

§33.1 Applicability.

(a) This part prescribes airworthiness standards for the issue of type certificates and changes to those certificates, for aircraft engines.

(b) Each person who applies under part 21 for such a certificate or change must show compliance with the applicable requirements of this part and the applicable requirements of part 34 of this chapter.

[Amdt. 33–7, 41 FR 55474, Dec. 20, 1976, as amended by Amdt. 33–14, 55 FR 32861, Aug. 10, 1990]

§33.3 General.

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

§33.4 Instructions for Continued Airworthiness.

The applicant must prepare Instructions for Continued Airworthiness in accordance with Appendix A to this part that are acceptable to the Administrator. The instructions may be incomplete at type certification if a program exists to ensure their completion prior to delivery of the first aircraft with the engine installed, or upon issuance of a standard certificate of airworthiness for the aircraft with the engine installed, whichever occurs later.

[Amdt. 33–9, 45 FR 60181, Sept. 11, 1980]

§33.5 Instruction manual for installing and operating the engine.

Each applicant must prepare and make available to the Administrator prior to the issuance of the type certificate, and to the owner at the time of delivery of the engine, approved instructions for installing and operating the engine. The instructions must include at least the following:

(a) ***Installation instructions.***

(1) The location of engine mounting attachments, the method of attaching the engine to the aircraft, and the maximum allowable load for the mounting attachments and related structure.

(2) The location and description of engine connections to be attached to accessories, pipes, wires, cables, ducts, and cowling.

(3) An outline drawing of the engine including overall dimensions.

(4) A definition of the physical and functional interfaces with the aircraft and aircraft equipment, including the propeller when applicable.

(5) Where an engine system relies on components that are not part of the engine type design, the interface conditions and reliability requirements for those components upon which engine type certification is based must be specified in the engine installation instructions directly or by reference to appropriate documentation.

(6) A list of the instruments necessary for control of the engine, including the overall limits of accuracy and transient response required of such instruments for control of the operation of the engine, must also be stated so that the suitability of the instruments as installed may be assessed.

(b) ***Operation instructions.***

(1) The operating limitations established by the Administrator.

(2) The power or thrust ratings and procedures for correcting for nonstandard atmosphere.

(3) The recommended procedures, under normal and extreme ambient conditions for—

(i) Starting;

(ii) Operating on the ground; and

(iii) Operating during flight.

(4) For rotorcraft engines having one or more OEI ratings, applicants must provide data on engine performance characteristics and variability to enable the aircraft manufacturer to establish aircraft power assurance procedures.

(5) A description of the primary and all alternate modes, and any back-up system, together with any associated limitations, of the engine control system and its interface with the aircraft systems, including the propeller when applicable.

(c) ***Safety analysis assumptions.*** The assumptions of the safety analysis as described in §33.75(d) with respect to the reliability of safety devices, instrumentation, early warning devices, maintenance checks, and similar equipment or procedures that are outside the control of the engine manufacturer.

[Amdt. 33–6, 39 FR 35463, Oct. 1, 1974, as amended by Amdt. 33–9, 45 FR 60181, Sept. 11, 1980; Amdt. 33–24, 72 FR 50867, Sept. 4, 2007; Amdt. 33–25, 73 FR 48123, Aug. 18, 2008; Amdt. 33–26, 73 FR 48284, Aug. 19, 2008]

§33.7 Engine ratings and operating limitations.

(a) Engine ratings and operating limitations are established by the Administrator and included in the engine certificate data sheet specified in §21.41 of this chapter, including ratings and limitations based on the operating conditions and information specified in this section, as applicable, and any other information found necessary for safe operation of the engine.

(b) For reciprocating engines, ratings and operating limitations are established relating to the following:

(1) Horsepower or torque, r.p.m., manifold pressure, and time at critical pressure altitude and sea level pressure altitude for—

(i) Rated maximum continuous power (relating to unsupercharged operation or to operation in each supercharger mode as applicable); and

(ii) Rated takeoff power (relating to unsupercharged operation or to operation in each supercharger mode as applicable).

(2) Fuel grade or specification.

(3) Oil grade or specification.

(4) Temperature of the—

(i) Cylinder;

(ii) Oil at the oil inlet; and

(iii) Turbosupercharger turbine wheel inlet gas.

(5) Pressure of—

(i) Fuel at the fuel inlet; and

(ii) Oil at the main oil gallery.

(6) Accessory drive torque and overhang moment.

(7) Component life.

(8) Turbosupercharger turbine wheel r.p.m.

(c) For turbine engines, ratings and operating limitations are established relating to the following:

(1) Horsepower, torque, or thrust, r.p.m., gas temperature, and time for—

(i) Rated maximum continuous power or thrust (augmented);

(ii) Rated maximum continuous power or thrust (unaugmented);

(iii) Rated takeoff power or thrust (augmented);

(iv) Rated takeoff power or thrust (unaugmented);

(v) Rated 30–minute OEI power;

(vi) Rated 2-1/2 minute OEI power;

(vii) Rated continuous OEI power; and

(viii) Rated 2-minute OEI power;

(ix) Rated 30-second OEI power; and
(x) Auxiliary power unit (APU) mode of operation.
(2) Fuel designation or specification.
(3) Oil grade or specification.
(4) Hydraulic fluid specification.
(5) Temperature of—
(i) Oil at a location specified by the applicant;
(ii) Induction air at the inlet face of a supersonic engine, including steady state operation and transient over-temperature and time allowed;
(iii) Hydraulic fluid of a supersonic engine;
(iv) Fuel at a location specified by the applicant; and
(v) External surfaces of the engine, if specified by the applicant.
(6) Pressure of—
(i) Fuel at the fuel inlet;
(ii) Oil at a location specified by the applicant;
(iii) Induction air at the inlet face of a supersonic engine, including steady state operation and transient overpressure and time allowed; and
(iv) Hydraulic fluid.
(7) Accessory drive torque and overhang moment.
(8) Component life.
(9) Fuel filtration.
(10) Oil filtration.
(11) Bleed air.
(12) The number of start-stop stress cycles approved for each rotor disc and spacer.
(13) Inlet air distortion at the engine inlet.
(14) Transient rotor shaft overspeed r.p.m., and number of overspeed occurrences.
(15) Transient gas overtemperature, and number of overtemperature occurrences.
(16) Transient engine overtorque, and number of overtorque occurrences.
(17) Maximum engine overtorque for turbopropeller and turboshaft engines incorporating free power turbines.
(18) For engines to be used in supersonic aircraft, engine rotor windmilling rotational r.p.m.

(d) In determining the engine performance and operating limitations, the overall limits of accuracy of the engine control system and of the necessary instrumentation as defined in §33.5(a)(6) must be taken into account.

[Amdt. 33–6, 39 FR 35463, Oct. 1, 1974, as amended by Amdt. 33–10, 49 FR 6850, Feb. 23, 1984; Amdt. 33–11, 51 FR 10346, Mar. 25, 1986; Amdt. 33–12, 53 FR 34220, Sept. 2, 1988; Amdt. 33–18, 61 FR 31328, June 19, 1996; Amdt. 33–26, 73 FR 48284, Aug. 19, 2008; Amdt. 33–30, 74 FR 45310, Sept. 2, 2009]

§33.8 Selection of engine power and thrust ratings.

(a) Requested engine power and thrust ratings must be selected by the applicant.

(b) Each selected rating must be for the lowest power or thrust that all engines of the same type may be expected to produce under the conditions used to determine that rating.

[Amdt. 33–3, 32 FR 3736, Mar. 4, 1967]

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 [Reserved]

§33.15 Materials.

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

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

(b) Conform to approved specifications (such as industry or military specifications) that ensure their having the strength and other properties assumed in the design data.

(Secs. 313(a), 601, and 603, 72 Stat. 759, 775, 49 U.S.C. 1354(a), 1421, and 1423; sec. 6(c), 49 U.S.C. 1655(c))

[Amdt. 33–8, 42 FR 15047, Mar. 17, 1977, as amended by Amdt. 33–10, 49 FR 6850, Feb. 23, 1984]

§33.17 Fire protection.

(a) The design and construction of the engine and the materials used must minimize the probability of the occurrence and spread of fire during normal operation and failure conditions, and must minimize the effect of such a fire. In addition, the design and construction of turbine engines must minimize the probability of the occurrence of an internal fire that could result in structural failure or other hazardous effects.

(b) Except as provided in paragraph (c) of this section, each external line, fitting, and other component, which contains or conveys flammable fluid during normal engine operation, must be fire resistant or fireproof, as determined by the Administrator. Components must be shielded or located to safeguard against the ignition of leaking flammable fluid.

(c) A tank, which contains flammable fluids and any associated shut-off means and supports, which are part of and attached to the engine, must be fireproof either by construction or by protection unless damage by fire will not cause leakage or spillage of a hazardous quantity of flammable fluid. For a reciprocating engine having an integral oil sump of less than 23.7 liters capacity, the oil sump need not be fireproof or enclosed by a fireproof shield.

(d) An engine component designed, constructed, and installed to act as a firewall must be:
(1) Fireproof;
(2) Constructed so that no hazardous quantity of air, fluid or flame can pass around or through the firewall; and,
(3) Protected against corrosion;

(e) In addition to the requirements of paragraphs (a) and (b) of this section, engine control system components that are located in a designated fire zone must be fire resistant or fireproof, as determined by the Administrator.

(f) Unintentional accumulation of hazardous quantities of flammable fluid within the engine must be prevented by draining and venting.

(g) Any components, modules, or equipment, which are susceptible to or are potential sources of static discharges or electrical fault currents must be designed and constructed to be properly grounded to the engine reference, to minimize the risk of ignition in external areas where flammable fluids or vapors could be present.

[Docket No. FAA–2007–28503, 74 FR 37930, July 30, 2009]

§33.19 Durability.

(a) 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. Energy levels and trajectories of fragments resulting from rotor blade failure that lie outside the compressor and turbine rotor cases must be defined.

(b) Each component of the propeller blade pitch control system which is a part of the engine type design must meet the requirements of §§35.21, 35.23, 35.42 and 35.43 of this chapter.

[Docket No. 3025, 29 FR 7453, June 10, 1964; as amended by Amdt. 33–9, 45 FR 60181, Sept. 11, 1980; Amdt. 33–10, 49 FR 6851, Feb. 23, 1984; Amdt. 33–28, 73 FR 63346, Oct. 24, 2008]

§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 and structure.

(a) The maximum allowable limit and ultimate loads for engine mounting attachments and related engine structure must be specified.

(b) The engine mounting attachments and related engine structure must be able to withstand—

(1) The specified limit loads without permanent deformation; and

(2) The specified ultimate loads without failure, but may exhibit permanent deformation.

[Amdt. 33–10, 49 FR 6851, Feb. 23, 1984]

§33.25 Accessory attachments.

The engine must operate properly with the accessory drive and mounting attachments loaded. Each engine accessory drive and mounting attachment must include provisions for sealing to prevent contamination of, or unacceptable leakage from, the engine interior. A drive and mounting attachment requiring lubrication for external drive splines, or coupling by engine oil, must include provisions for sealing to prevent unacceptable loss of oil and to prevent contamination from sources outside the chamber enclosing the drive connection. The design of the engine must allow for the examination, adjustment, or removal of each accessory required for engine operation.

[Amdt. 33–10, 49 FR 6851, Feb. 23, 1984]

§33.27 Turbine, compressor, fan, and turbosupercharger rotor overspeed.

(a) For each fan, compressor, turbine, and turbosupercharger rotor, the applicant must establish by test, analysis, or a combination of both, that each rotor will not burst when operated in the engine for 5 minutes at whichever of the conditions defined in paragraph (b) of this section is the most critical with respect to the integrity of such a rotor.

(1) Test rotors used to demonstrate compliance with this section that do not have the most adverse combination of material properties and dimensional tolerances must be tested at conditions which have been adjusted to ensure the minimum specification rotor possesses the required overspeed capability. This can be accomplished by increasing test speed, temperature, and/or loads.

(2) When an engine test is being used to demonstrate compliance with the overspeed conditions listed in paragraph (b)(3) or (b)(4) of this section and the failure of a component or system is sudden and transient, it may not be possible to operate the engine for 5 minutes after the failure. Under these circumstances, the actual overspeed duration is acceptable if the required maximum overspeed is achieved.

(b) When determining the maximum overspeed condition applicable to each rotor in order to comply with paragraphs (a) and (c) of this section, the applicant must evaluate the following rotor speeds taking into consideration the part's operating temperatures and temperature gradients throughout the engine's operating envelope:

(1) 120 percent of the maximum permissible rotor speed associated with any of the engine ratings except one-engine-inoperative (OEI) ratings of less than 2-1/2 minutes.

(2) 115 percent of the maximum permissible rotor speed associated with any OEI ratings of less than 2-1/2 minutes.

(3) 105 percent of the highest rotor speed that would result from either:

(i) The failure of the component or system which, in a representative installation of the engine, is the most critical with respect to overspeed when operating at any rating condition except OEI ratings of less than 2-1/2 minutes, or

(ii) The failure of any component or system in a representative installation of the engine, in combination with any other failure of a component or system that would not normally be detected during a routine pre-flight check or during normal flight operation, that is the most critical with respect to overspeed, except as provided by paragraph (c) of this section, when operating at any rating condition except OEI ratings of less than 2-1/2 minutes.

(4) 100 percent of the highest rotor speed that would result from the failure of the component or system which, in a representative installation of the engine, is the most critical with respect to overspeed when operating at any OEI rating of less than 2-1/2 minutes.

(c) The highest overspeed that results from a complete loss of load on a turbine rotor, except as provided by paragraph (f) of this section, must be included in the overspeed conditions considered by paragraphs (b)(3)(i), (b)(3)(ii), and (b)(4) of this section, regardless of whether that overspeed results from a failure within the engine or external to the engine. The overspeed resulting from any other single failure must be considered when selecting the most limiting overspeed conditions applicable to each rotor. Overspeeds resulting from combinations of failures must also be considered unless the applicant can show that the probability of occurrence is not greater than extremely remote (probability range of 10-7 to 10-9 per engine flight hour).

(d) In addition, the applicant must demonstrate that each fan, compressor, turbine, and turbosupercharger rotor complies with paragraphs (d)(1) and (d)(2) of this section for the maximum overspeed achieved when subjected to the conditions specified in paragraphs (b)(3) and (b)(4) of this section. The applicant must use the approach in paragraph (a) of this section which specifies the required test conditions.

(1) Rotor Growth must not cause the engine to:

(i) Catch fire,

(ii) Release high-energy debris through the engine casing or result in a hazardous failure of the engine casing,

(iii) Generate loads greater than those ultimate loads specified in §33.23(a), or

(iv) Lose the capability of being shut down.

(2) Following an overspeed event and after continued operation, the rotor may not exhibit conditions such as cracking or distortion which preclude continued safe operation.

(e) The design and functioning of engine control systems, instruments, and other methods not covered under §33.28 must ensure that the engine operating limitations that affect turbine, compressor, fan, and turbosupercharger rotor structural integrity will not be exceeded in service.

(f) Failure of a shaft section may be excluded from consideration in determining the highest overspeed that would result from a complete loss of load on a turbine rotor if the applicant:

(1) Identifies the shaft as an engine life-limited-part and complies with §33.70.

(2) Uses material and design features that are well understood and that can be analyzed by well-established and validated stress analysis techniques.

(3) Determines, based on an assessment of the environment surrounding the shaft section, that environmental influences are unlikely to cause a shaft failure. This assessment must include complexity of design, corrosion, wear, vibration, fire, contact with adjacent components or structure, overheating, and secondary effects from other failures or combination of failures.

(4) Identifies and declares, in accordance with §33.5, any assumptions regarding the engine installation in making the assessment described above in paragraph (f)(3) of this section.

(5) Assesses, and considers as appropriate, experience with shaft sections of similar design.

(6) Does not exclude the entire shaft.

(g) If analysis is used to meet the overspeed requirements, then the analytical tool must be validated to prior overspeed test results of a similar rotor. The tool must be validated for each material. The rotor being certified must not exceed the boundaries of the rotors being used to validate the analytical tool in terms of geometric shape, operating stress, and temperature. Validation includes the ability to accurately predict rotor dimensional growth and the burst speed. The predictions must also show that the rotor being certified does not have lower burst and growth margins than rotors used to validate the tool.

[Amdt. 33–10, 49 FR 6851, Feb. 23, 1984; as amended by Amdt. 33–26, 73 FR 48284, Aug. 19, 2008; Amdt. 33–31, 76 FR 42023, July 18, 2011]

§33.28 Engine control systems.

(a) ***Applicability.*** These requirements are applicable to any system or device that is part of engine type design, that controls, limits, or monitors engine operation, and is necessary for the continued airworthiness of the engine.

(b) ***Validation.***

(1) *Functional aspects*. The applicant must substantiate by tests, analysis, or a combination thereof, that the engine control system performs the intended functions in a manner which:

(i) Enables selected values of relevant control parameters to be maintained and the engine kept within the approved operating limits over changing atmospheric conditions in the declared flight envelope;

(ii) Complies with the operability requirements of §§33.51, 33.65 and 33.73, as appropriate, under all likely system inputs and allowable engine power or thrust demands, unless it can be demonstrated that failure of the control function results in a non-dispatchable condition in the intended application;

(iii) Allows modulation of engine power or thrust with adequate sensitivity over the declared range of engine operating conditions; and

(iv) Does not create unacceptable power or thrust oscillations.

(2) *Environmental limits*. The applicant must demonstrate, when complying with §§33.53 or 33.91, that the engine control system functionality will not be adversely affected by declared environmental conditions, including electromagnetic interference (EMI), High Intensity Radiated Fields (HIRF), and lightning. The limits to which the system has been qualified must be documented in the engine installation instructions.

(c) ***Control transitions.***

(1) The applicant must demonstrate that, when fault or failure results in a change from one control mode to another, from one channel to another, or from the primary system to the back-up system, the change occurs so that:

(i) The engine does not exceed any of its operating limitations;

(ii) The engine does not surge, stall, or experience unacceptable thrust or power changes or oscillations or other unacceptable characteristics; and

(iii) There is a means to alert the flight crew if the crew is required to initiate, respond to, or be aware of the control mode change. The means to alert the crew must be described in the engine installation instructions, and the crew action must be described in the engine operating instructions;

(2) The magnitude of any change in thrust or power and the associated transition time must be identified and described in the engine installation instructions and the engine operating instructions.

(d) ***Engine control system failures.*** The applicant must design and construct the engine control system so that:

(1) The rate for Loss of Thrust (or Power) Control (LOTC/LOPC) events, consistent with the safety objective associated with the intended application can be achieved;

(2) In the full-up configuration, the system is single fault tolerant, as determined by the Administrator, for electrical or electronic failures with respect to LOTC/LOPC events;

(3) Single failures of engine control system components do not result in a hazardous engine effect; and

(4) Foreseeable failures or malfunctions leading to local events in the intended aircraft installation, such as fire, overheat, or failures leading to damage to engine control system components, do not result in a hazardous engine effect due to engine control system failures or malfunctions.

(e) ***System safety assessment.*** When complying with this section and §33.75, the applicant must complete a System Safety Assessment for the engine control system. This assessment must identify faults or failures that result in a change in thrust or power, transmission of erroneous data, or an effect on engine operability producing a surge or stall together with the predicted frequency of occurrence of these faults or failures.

(f) ***Protection systems.***

(1) The design and functioning of engine control devices and systems, together with engine instruments and operating and maintenance instructions, must provide reasonable assurance that those engine operating limitations that affect turbine, compressor, fan, and turbosupercharger rotor structural integrity will not be exceeded in service.

(2) When electronic overspeed protection systems are provided, the design must include a means for testing, at least once per engine start/stop cycle, to establish the availability of the protection function. The means must be such that a complete test of the system can be achieved in the minimum number of cycles. If the test is not fully automatic, the requirement for a manual test must be contained in the engine instructions for operation.

(3) When overspeed protection is provided through hydromechanical or mechanical means, the applicant must demonstrate by test or other acceptable means that the overspeed function remains available between inspection and maintenance periods.

(g) ***Software.*** The applicant must design, implement, and verify all associated software to minimize the existence of errors by using a method, approved by the FAA, consistent with the criticality of the performed functions.

(h) ***Aircraft-supplied data.*** Single failures leading to loss, interruption or corruption of aircraft-supplied data (other than thrust or power command signals from the aircraft), or data shared between engines must:

(1) Not result in a hazardous engine effect for any engine; and

(2) Be detected and accommodated. The accommodation strategy must not result in an unacceptable change in thrust or power or an unacceptable change in engine operating and starting characteristics. The applicant must evaluate and document in the engine installation instructions the effects of these failures on engine power or thrust, engine operability, and starting characteristics throughout the flight envelope.

(i) ***Aircraft-supplied electrical power.***

(1) The applicant must design the engine control system so that the loss, malfunction, or interruption of electrical power supplied from the aircraft to the engine control system will not result in any of the following:

(i) A hazardous engine effect, or

(ii) The unacceptable transmission of erroneous data.

(2) When an engine dedicated power source is required for compliance with paragraph (i)(1) of this section, its capacity should provide sufficient margin to account for engine operation below idle where the engine control system is designed and expected to recover engine operation automatically.

(3) The applicant must identify and declare the need for, and the characteristics of, any electrical power supplied from the aircraft to the engine control system for starting and operating the engine, including transient and steady state voltage limits, in the engine instructions for installation.

(4) Low voltage transients outside the power supply voltage limitations declared in paragraph (i)(3) of this section must meet the requirements of paragraph (i)(1) of this section. The engine control system must be capable of resuming normal operation when aircraft-supplied power returns to within the declared limits.

(j) ***Air pressure signal.*** The applicant must consider the effects of blockage or leakage of the signal lines on the engine control system as part of the System Safety Assessment of paragraph (e) of this section and must adopt the appropriate design precautions.

(k) ***Automatic availability and control of engine power for 30-second OEI rating.*** Rotorcraft engines having a 30-second OEI rating must incorporate a means, or a provision for a means, for automatic availability and automatic control of the 30-second OEI power within its operating limitations.

(l) ***Engine shut down means.*** Means must be provided for shutting down the engine rapidly.

(m) ***Programmable logic devices.*** The development of programmable logic devices using digital logic or other complex design technologies must provide a level of assurance for the encoded logic commensurate with the hazard associated with the failure or malfunction of the systems in which the devices are located. The applicant must provide evidence that the development of these devices has been done by using a method, approved by the FAA, that is consistent with the criticality of the performed function.

[Docket No. FAA–2007–27311, 73 FR 48284, Aug. 19, 2008]

§33.29 Instrument connection.

(a) Unless it is constructed to prevent its connection to an incorrect instrument, each connection provided for powerplant instruments required by aircraft airworthiness regulations or necessary to insure operation of the engine in compliance with any engine limitation must be marked to identify it with its corresponding instrument.

(b) A connection must be provided on each turbojet engine for an indicator system to indicate rotor system unbalance.

(c) Each rotorcraft turbine engine having a 30-second OEI rating and a 2-minute OEI rating must have a means or a provision for a means to:

(1) Alert the pilot when the engine is at the 30-second OEI and the 2-minute OEI power levels, when the event begins, and when the time interval expires;

(2) Automatically record each usage and duration of power at the 30-second OEI and 2-minute OEI levels;

(3) Alert maintenance personnel in a positive manner that the engine has been operated at either or both of the 30-second and 2-minute OEI power levels, and permit retrieval of the recorded data; and

(4) Enable routine verification of the proper operation of the above means.

(d) The means, or the provision for a means, of paragraphs (c)(2) and (c)(3) of this section must not be capable of being reset in flight.

(e) The applicant must make provision for the installation of instrumentation necessary to ensure operation in compliance with engine operating limitations. Where, in presenting the safety analysis, or complying with any other requirement, dependence is placed on instrumentation that is not otherwise mandatory in the assumed aircraft installation, then the applicant must specify this instrumentation in the engine installation instructions and declare it mandatory in the engine approval documentation.

(f) As part of the System Safety Assessment of §33.28(e), the applicant must assess the possibility and subsequent effect of incorrect fit of instruments, sensors, or connectors. Where necessary, the applicant must take design precautions to prevent incorrect configuration of the system.

(g) The sensors, together with associated wiring and signal conditioning, must be segregated, electrically and physically, to the extent necessary to ensure that the probability of a fault propagating from instrumentation and monitoring functions to control functions, or vice versa, is consistent with the failure effect of the fault.

(h) The applicant must provide instrumentation enabling the flight crew to monitor the functioning of the turbine cooling system unless appropriate inspections are published in the relevant manuals and evidence shows that:

(1) Other existing instrumentation provides adequate warning of failure or impending failure;

(2) Failure of the cooling system would not lead to hazardous engine effects before detection; or

(3) The probability of failure of the cooling system is extremely remote.

[Amdt. 33–5, 39 FR 1831, Jan. 15, 1974, as amended by Amdt. 33–6, 39 FR 35465, Oct. 1, 1974; Amdt. 33–18, 61 FR 31328, June 19, 1996; Amdt. 33–25, 73 FR 48123, Aug. 18, 2008; Amdt. 33–26, 73 FR 48285, Aug. 19, 2008]

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.

§33.34 Turbocharger rotors.

Each turbocharger case must be designed and constructed to be able to contain fragments of a compressor or turbine that fails at the highest speed that is obtainable with normal speed control devices inoperative.

[Docket No. FAA–2006–23732, 72 FR 50860, Sept. 4, 2007]

§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.

(e) If provided as part of the engine, the applicant must show for each fluid injection (other than fuel) system and its controls that the flow of the injected fluid is adequately controlled.

[Docket No. 3025, 29 FR 7453, June 10, 1964; as amended by Amdt. 33–10, 49 FR 6851, Feb. 23, 1984]

§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.

§33.42 General.

Before each endurance test required by this subpart, the adjustment setting and functioning characteristic of each component having an adjustment setting and a functioning characteristic that can be established independent of installation on the engine must be established and recorded.

[Amdt. 33–6, 39 FR 35465, Oct. 1, 1974]

§33.43 Vibration test.

(a) Each engine must undergo a vibration survey to establish the torsional and bending vibration characteristics of the crankshaft and the propeller shaft or other output shaft, over the range of crankshaft speed and engine power, under steady state and transient conditions, from idling speed to either 110 percent of the desired maximum continuous speed rating or 103 percent of the maximum desired takeoff speed rating, whichever is higher. The survey must be conducted using, for airplane engines, the same configuration of the propeller type which is used for the endurance test, and using, for other engines, the same configuration of the loading device type which is used for the endurance test.

(b) The torsional and bending vibration stresses of the crankshaft and the propeller shaft or other output shaft may not exceed the endurance limit stress of the material from which the shaft is made. If the maximum stress in the shaft cannot be shown to be below the endurance limit by measurement, the vibration frequency and amplitude must be measured. The peak amplitude must be shown to produce a stress below the endurance limit; if not, the engine must be run at the condition producing the peak amplitude until, for steel shafts, 10 million stress reversals have been sustained without fatigue failure and, for other shafts, until it is shown that fatigue will not occur within the endurance limit stress of the material.

(c) Each accessory drive and mounting attachment must be loaded, with the loads imposed by each accessory used only for an aircraft service being the limit load specified by the applicant for the drive or attachment point.

(d) The vibration survey described in paragraph (a) of this section must be repeated with that cylinder not firing which has the most adverse vibration effect, in order to establish the conditions under which the engine can be operated safely in that abnormal state. However, for this vibration survey, the engine speed range need only extend from idle to the maximum desired takeoff speed, and compliance with paragraph (b) of this section need not be shown.

[Amdt. 33–6, 39 FR 35465, Oct. 1, 1974, as amended by Amdt. 33–10, 49 FR 6851, Feb. 23, 1984]

§33.45 Calibration tests.

(a) 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 crankshaft rotational speeds, manifold pressures, fuel/air mixture settings, and altitudes. Power ratings are based upon standard atmospheric conditions with only those accessories installed which are essential for engine functioning.

(b) A power check at sea level conditions must be accomplished on the endurance test engine after the endurance test. Any change in power characteristics which occurs during the endurance test must be determined. Measurements taken during the final portion of the endurance test may be used in showing compliance with the requirements of this paragraph.

[Docket No. 3025, 29 FR 7453, June 10, 1964; as amended by Amdt. 33–6, 39 FR 35465, Oct. 1, 1974]

§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 that includes a total of 150 hours of operation (except as provided in paragraph (e)(1)(iii) of this section) and, depending upon the type and contemplated use of the engine, consists of one of the series of runs specified in paragraphs (b) through (e) of this section, as applicable. The runs must be made in the order found appropriate by the Administrator for the particular engine being tested. During the endurance test the engine power and the crankshaft rotational speed must be kept within ± 3 percent of the rated values. During the runs at rated takeoff power and for at least 35 hours at rated maximum continuous power, one cylinder must be operated at not less than the limiting temperature, the other cylinders must be operated at a temperature not lower than 50 degrees F below the limiting temperature, and the oil inlet temperature must be maintained within ±10 degrees F of the limiting temperature. An engine that is equipped with a propeller shaft must be fitted for the endurance test with a propeller that thrust-loads the engine to the maximum thrust which the engine is designed to resist at each applicable operating condition specified in this section. Each accessory drive and mounting attachment must be loaded. During operation at rated takeoff power and rated maximum continuous power, the load imposed by each accessory used only for an aircraft service must be the limit load specified by the applicant for the engine drive or attachment point.

(b) *Unsupercharged engines and engines incorporating a gear-driven single-speed supercharger.* For engines not incorporating a supercharger and for engines incorporating a gear-driven single-speed supercharger the applicant must conduct the following runs:

(1) A 30-hour run consisting of alternate periods of 5 minutes at rated takeoff power with takeoff speed, and 5 minutes at maximum best economy cruising power or maximum recommended cruising power.

(2) A 20-hour run consisting of alternate periods of 1-1/2 hours at rated maximum continuous power with maximum continuous speed, and 1/2 hour at 75 percent rated maximum continuous power and 91 percent maximum continuous speed.

(3) A 20-hour run consisting of alternate periods of 1-1/2 hours at rated maximum continuous power with maximum continuous speed, and 1/2 hour at 70 percent rated maximum continuous power and 89 percent maximum continuous speed.

(4) A 20-hour run consisting of alternate periods of 1-1/2 hours at rated maximum continuous power with maximum continuous speed, and 1/2 hour at 65 percent rated maximum continuous power and 87 percent maximum continuous speed.

(5) A 20-hour run consisting of alternate periods of 1-1/2 hours at rated maximum continuous power with maximum continuous speed, and 1/2 hour at 60 percent rated maximum continuous power and 84.5 percent maximum continuous speed.

(6) A 20-hour run consisting of alternate periods of 1-1/2 hours at rated maximum continuous power with maximum continuous speed, and 1/2 hour at 50 percent rated maximum continuous power and 79.5 percent maximum continuous speed.

(7) A 20-hour run consisting of alternate periods of 2-1/2 hours at rated maximum continuous power with maximum continuous speed, and 2-1/2 hours at maximum best economy cruising power or at maximum recommended cruising power.

(c) *Engines incorporating a gear-driven two-speed supercharger.* For engines incorporating a gear-driven two-speed supercharger the applicant must conduct the following runs:

(1) A 30-hour run consisting of alternate periods in the lower gear ratio of 5 minutes at rated takeoff power with takeoff speed, and 5 minutes at maximum best economy cruising power or at maximum recommended cruising power. If a takeoff power 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 5 minutes at the observed horsepower obtainable with the takeoff critical altitude manifold pressure and takeoff speed, and 5 minutes at 70 percent high ratio rated 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 1 hour at rated maximum continuous power with maximum continuous speed, and 1/2 hour at 75 percent rated maximum continuous power and 91 percent maximum continuous speed.

(3) A 15-hour run consisting of alternate periods in the lower gear ratio of 1 hour at rated maximum continuous power with maximum continuous speed, and 1/2 hour at 70 percent rated maximum continuous power and 89 percent maximum continuous speed.

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

(5) A 5-hour run consisting of alternate periods of 5 minutes in each of the supercharger gear ratios. The first 5 minutes of the test must be made at maximum continuous speed in the higher gear ratio and the observed horsepower obtainable with 90 percent of maximum continuous manifold pressure in the higher gear ratio under sea level conditions. The condition for operation for the alternate 5 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 1 hour at rated maximum continuous power with maximum continuous speed, and 1 hour at 65 percent rated maximum continuous power and 87 percent maximum continuous speed.

(7) A 10-hour run consisting of alternate periods in the lower gear ratio of 1 hour at rated maximum continuous power with maximum continuous speed, and 1 hour at 60 percent rated 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 1 hour at rated maximum continuous power with maximum continuous speed, and 1 hour at 50 percent rated 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 2 hours at rated maximum continuous power with maximum continuous speed, and 2 hours at maximum best economy cruising power and speed or at maximum recommended cruising power.

(10) A 5-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 paragraphs (a) through (j) of §29.923 of this chapter, or must undergo the following series of runs:

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

(2) A 25-hour run consisting of alternate periods of 2-1/2 hours each at rated maximum continuous power with maximum continuous speed, and at 70 percent rated maximum continuous power with maximum continuous speed.

(3) A 25-hour run consisting of alternate periods of 2-1/2 hours each at rated maximum continuous power with maximum continuous speed, and at 70 percent rated maximum continuous power with 80 to 90 percent maximum continuous speed.

(4) A 25-hour run consisting of alternate periods of 2-1/2 hours each at 30 percent rated maximum continuous power with takeoff speed, and at 30 percent rated maximum continuous power with 80 to 90 percent maximum continuous speed.

(5) A 25-hour run consisting of alternate periods of 2-1/2 hours each at 80 percent rated maximum continuous power with takeoff speed, and at either rated maximum continuous power with 110 percent maximum continuous speed or at rated takeoff power with 103 percent takeoff speed, whichever results in the greater speed.

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

(e) ***Turbosupercharged engines.*** For engines incorporating a turbosupercharger the following apply except that altitude testing may be simulated provided the applicant shows that the engine and supercharger are being subjected to mechanical loads and operating temperatures no less severe than if run at actual altitude conditions:

(1) For engines used in airplanes the applicant must conduct the runs specified in paragraph (b) of this section, except—

(i) The entire run specified in paragraph (b)(1) of this section must be made at sea level altitude pressure;

(ii) The portions of the runs specified in paragraphs (b)(2) through (7) of this section at rated maximum continuous power must be made at critical altitude pressure, and the portions of the runs at other power must be made at 8,000 feet altitude pressure; and

(iii) The turbosupercharger used during the 150-hour endurance test must be run on the bench for an additional 50 hours at the limiting turbine wheel inlet gas temperature and rotational speed for rated maximum continuous power operation unless the limiting temperature and speed are maintained during 50 hours of the rated maximum continuous power operation.

(2) For engines used in helicopters the applicant must conduct the runs specified in paragraph (d) of this section, except—

(i) The entire run specified in paragraph (d)(1) of this section must be made at critical altitude pressure;

(ii) The portions of the runs specified in paragraphs (d)(2) and (3) of this section at rated maximum continuous power must be made at critical altitude pressure and the portions of the runs at other power must be made at 8,000 feet altitude pressure;

(iii) The entire run specified in paragraph (d)(4) of this section must be made at 8,000 feet altitude pressure;

(iv) The portion of the runs specified in paragraph (d)(5) of this section at 80 percent of rated maximum continuous power must be made at 8,000 feet altitude pressure and the portions of the runs at other power must be made at critical altitude pressure;

(v) The entire run specified in paragraph (d)(6) of this section must be made at critical altitude pressure; and

(vi) The turbosupercharger used during the endurance test must be run on the bench for 50 hours at the limiting turbine wheel inlet gas temperature and rotational speed for rated maximum continuous power operation unless the limiting temperature and speed are maintained during 50 hours of the rated maximum continuous power operation.

[Amdt. 33–3, 32 FR 3736, Mar. 4, 1967, as amended by Amdt. 33–6, 39 FR 35465, Oct. 1, 1974; Amdt. 33–10, 49 FR 6851, Feb. 23, 1984]

§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 rated maximum continuous power at the higher supercharger speed ratio must be obtainable within five seconds.

[Docket No. 3025, 29 FR 7453, June 10, 1964; as amended by Amdt. 33–3, 32 FR 3737, Mar. 4, 1967]

§33.53 Engine system and component tests.

(a) For those systems and components that cannot be adequately substantiated in accordance with endurance testing of §33.49, the applicant must conduct additional tests to demonstrate that systems or components are able to perform the intended functions in all declared environmental and operating 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.

[Docket No. 3025, 29 FR 7453, June 10, 1964; as amended by Amdt. 33–26, 73 FR 48285, Aug. 19, 2008]

§33.55 Teardown inspection.

After completing the endurance test—

(a) Each engine must be completely disassembled;

(b) Each component having an adjustment setting and a functioning characteristic that can be established independent of installation on the engine must retain each setting and functioning characteristic within the limits that were established and recorded at the beginning of the test; and

(c) Each engine component must conform to the type design and be eligible for incorporation into an engine for continued operation, in accordance with information submitted in compliance with §33.4.

[Amdt. 33–6, 39 FR 35466, Oct. 1, 1974, as amended by Amdt. 33–9, 45 FR 60181, Sept. 11, 1980]

§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 in accordance with the service and maintenance instructions submitted in compliance with §33.4. If the frequency of the service is excessive, or the number of stops due to engine malfunction is excessive, or a major repair, or replacement of a part is found necessary during the block tests or as the result of findings from the teardown inspection, the engine or its parts may be subjected to any additional test the Administrator finds necessary.

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

[Docket No. 3025, 29 FR 7453, June 10, 1964; as amended by Amdt. 33–6, 39 FR 35466, Oct. 1, 1974; Amdt. 33–9, 45 FR 60181, Sept. 11, 1980]

Subpart E— Design and Construction: Turbine Aircraft Engines

§33.61 Applicability.

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

§33.62 Stress analysis.

A stress analysis must be performed on each turbine engine showing the design safety margin of each turbine engine rotor, spacer, and rotor shaft.

[Amdt. 33–6, 39 FR 35466, Oct. 1, 1974]

§33.63 Vibration.

Each engine must be designed and constructed to function throughout its declared flight envelope and operating range of rotational speeds and power/thrust, without inducing excessive stress in any engine part because of vibration and without imparting excessive vibration forces to the aircraft structure.

[Docket No. 28107, 61 FR 28433, June 4, 1996]

§33.64 Pressurized engine static parts.

(a) ***Strength.*** The applicant must establish by test, validated analysis, or a combination of both, that all static parts subject to significant gas or liquid pressure loads for a stabilized period of one minute will not:

(1) Exhibit permanent distortion beyond serviceable limits or exhibit leakage that could create a hazardous condition when subjected to the greater of the following pressures:

(i) 1.1 times the maximum working pressure;

(ii) 1.33 times the normal working pressure; or

(iii) 35 kPa (5 p.s.i.) above the normal working pressure.

(2) Exhibit fracture or burst when subjected to the greater of the following pressures:

(i) 1.15 times the maximum possible pressure;

(ii) 1.5 times the maximum working pressure; or

(iii) 35 kPa (5 p.s.i.) above the maximum possible pressure.

(b) Compliance with this section must take into account:

(1) The operating temperature of the part;

(2) Any other significant static loads in addition to pressure loads;

(3) Minimum properties representative of both the material and the processes used in the construction of the part; and

(4) Any adverse geometry conditions allowed by the type design.

[Docket No. FAA–2007–28501, 73 FR 55437, Sept. 25, 2008]

§33.65 Surge and stall characteristics.

When the engine is operated in accordance with operating instructions required by §33.5(b), starting, a change of power or thrust, power or thrust augmentation, limiting inlet air distortion, or inlet air temperature may not cause surge or stall to the extent that flameout, structural failure, overtemperature, or failure of the engine to recover power or thrust will occur at any point in the operating envelope.

[Amdt. 33–6, 39 FR 35466, Oct. 1, 1974]

§33.66 Bleed air system.

The engine must supply bleed air without adverse effect on the engine, excluding reduced thrust or power output, at all conditions up to the discharge flow conditions established as a limitation under §33.7(c)(11). If bleed air used for engine anti-icing can be controlled, provision must be made for a means to indicate the functioning of the engine ice protection system.

[Amdt. 33–10, 49 FR 6851, Feb. 23, 1984]

§33.67 Fuel system.

(a) With fuel supplied to the engine at the flow and pressure specified by the applicant, the engine must function properly under each operating condition required by this part. Each fuel control adjusting means that may not be manipulated while the fuel control device is mounted on the engine must be secured by a locking device and sealed, or otherwise be inaccessible. All other fuel control adjusting means must be accessible and marked to indicate the function of the adjustment unless the function is obvious.

(b) There must be a fuel strainer or filter between the engine fuel inlet opening and the inlet of either the fuel metering device or the engine-driven positive displacement pump whichever is nearer the engine fuel inlet. In addition, the following provisions apply to each strainer or filter required by this paragraph (b):

(1) It must be accessible for draining and cleaning and must incorporate a screen or element that is easily removable.

(2) It must have a sediment trap and drain except that it need not have a drain if the strainer or filter is easily removable for drain purposes.

(3) It must be mounted so that its weight is not supported by the connecting lines or by the inlet or outlet connections of the strainer or filter, unless adequate strength margins under all loading conditions are provided in the lines and connections.

(4) It must have the type and degree of fuel filtering specified as necessary for protection of the engine fuel system against foreign particles in the fuel. The applicant must show:

(i) That foreign particles passing through the specified filtering means do not impair the engine fuel system functioning; and

(ii) That the fuel system is capable of sustained operation throughout its flow and pressure range with the fuel initially saturated with water at 80°F (27°C) and having 0.025 fluid ounces per gallon (0.20 milliliters per liter) of free water added and cooled to the most critical condition for icing likely to be encountered in operation. However, this requirement may be met by demonstrating the effectiveness of specified approved fuel anti-icing additives, or that the fuel system incorporates a fuel heater which maintains the fuel temperature at the fuel strainer or fuel inlet above 32°F (0°C) under the most critical conditions.

(5) The applicant must demonstrate that the filtering means has the capacity (with respect to engine operating limitations) to ensure that the engine will continue to operate within approved limits, with fuel contaminated to the maximum degree of particle size and density likely to be encountered in service. Operation under these conditions must be demonstrated for a period acceptable to the Administrator, beginning when indication of impending filter blockage is first given by either:

(i) Existing engine instrumentation; or

(ii) Additional means incorporated into the engine fuel system.

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

(c) If provided as part of the engine, the applicant must show for each fluid injection (other than fuel) system and its controls that the flow of the injected fluid is adequately controlled.

[Amdt. 33–6, 39 FR 35466, Oct. 1, 1974, as amended by Amdt. 33–10, 49 FR 6851, Feb. 23, 1984; Amdt. 33–18, 61 FR 31328, June 19, 1996; Amdt. 33–25, 73 FR 48123, Aug. 18, 2008; Amdt. 33–26, 73 FR 48285, Aug. 19, 2008]

§33.68 Induction system icing.

Each engine, with all icing protection systems operating, must:

(a) Operate throughout its flight power range, including the minimum descent idle rotor speeds achievable in flight, in the icing conditions defined for turbojet, turbofan, and turboprop engines in Appendices C and O of part 25 of this chapter, and Appendix D of this part, and for turboshaft engines in Appendix C of part 29 of this chapter, without the accumulation of ice on the engine components that:

(1) Adversely affects engine operation or that causes an unacceptable permanent loss of power or thrust or unacceptable increase in engine operating temperature; or

(2) Results in unacceptable temporary power loss or engine damage; or

(3) Causes a stall, surge, or flameout or loss of engine controllability. The applicant must account for in-flight ram effects in any critical point analysis or test demonstration of these flight conditions.

(b) Operate throughout its flight power range, including minimum descent idle rotor speeds achievable in flight, in the icing conditions defined for turbojet, turbofan, and turboprop engines in Appendices C and O of part 25 of this chapter, and for turboshaft engines in Appendix C of part 29 of this chapter. In addition:

(1) It must be shown through Critical Point Analysis (CPA) that the complete ice envelope has been analyzed, and that the most critical points must be demonstrated by engine test, analysis, or a combination of the two to operate acceptably. Extended flight in critical flight conditions such as hold, descent, approach, climb, and cruise, must be addressed, for the ice conditions defined in these appendices.

(2) It must be shown by engine test, analysis, or a combination of the two that the engine can operate acceptably for the following durations:

(i) At engine powers that can sustain level flight: A duration that achieves repetitive, stabilized operation for turbojet, turbofan, and turboprop engines in the icing conditions defined in Appendices C and O of part 25 of this chapter, and for turboshaft engines in the icing conditions defined in Appendix C of part 29 of this chapter.

(ii) At engine power below that which can sustain level flight:

(A) Demonstration in altitude flight simulation test facility: A duration of 10 minutes consistent with a simulated flight descent of 10,000 ft (3 km) in altitude while operating in Continuous Maximum icing conditions defined in Appendix C of part 25 of this chapter for turbojet, turbofan, and turboprop engines, and for turboshaft engines in the icing conditions defined in Appendix C of part 29 of this chapter, plus 40 percent liquid water content margin, at the critical level of airspeed and air temperature; or

(B) Demonstration in ground test facility: A duration of 3 cycles of alternating icing exposure corresponding to the liquid water content levels and standard cloud lengths starting in Intermittent Maximum and then in Continuous Maximum icing conditions defined in Appendix C of part 25 of this chapter for turbojet, turbofan, and turboprop engines, and for turboshaft engines in the icing conditions defined in Appendix C of part 29 of this chapter, at the critical level of air temperature.

(c) In addition to complying with paragraph (b) of this section, the following conditions shown in Table 1 of this section unless replaced by similar CPA test conditions that are more critical or produce an equivalent level of severity, must be demonstrated by an engine test:

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TABLE 1—CONDITIONS THAT MUST BE DEMONSTRATED BY AN ENGINE TEST

Condition	Total air temperature	Supercooled water concentrations (minimum)	Median volume drop diameter	Duration
1. Glaze ice conditions	21 to 25°F (-6 to -4°C)	2 g/m^3	25 to 35 microns	(a) 10-minutes for power below sustainable level flight (idle descent). (b) Must show repetitive, stabilized operation for higher powers (50%, 75%, 100%MC).
2. Rime ice conditions	-10 to 0°F (-23 to -18°C)	1 g/m^3	15 to 25 microns	(a) 10-minutes for power below sustainable level flight (idle descent). (b) Must show repetitive, stabilized operation for higher powers (50%, 75%, 100%MC).
3. Glaze ice holding conditions. (Turbojet, turbofan, and turboprop only).	Turbojet and Turbofan, only: 10 to 18°F (-12 to -8°C)	Alternating cycle: First 1.7 g/m^3 (1 minute), Then 0.3 g/m^3 (6 minute).	20 to 30 microns	Must show repetitive, stabilized operation (or 45 minutes max).
	Turboprop, only: 2 to 10°F (-17 to -12°C)			
4. Rime ice holding conditions. (Turbojet, turbofan, and turboprop only).	Turbojet and Turbofan, only: -10 to 0°F (-23 to -18°C)	0.25 g/m^3	20 to 30 microns	Must show repetitive, stabilized operation (or 45 minutes max).
	Turboprop, only: 2 to 10°F (-17 to -12°C)			

(d) Operate at ground idle speed for a minimum of 30 minutes at each of the following icing conditions shown in Table 2 of this section with the available air bleed for icing protection at its critical condition, without adverse effect, followed by acceleration to takeoff power or thrust. During the idle operation, the engine may be run up periodically to a moderate power or thrust setting in a manner acceptable to the Administrator. Analysis may be used to show ambient temperatures below the tested temperature are less critical. The applicant must document any demonstrated run ups and minimum ambient temperature capability in the engine operating manual as mandatory in icing conditions. The applicant must demonstrate, with consideration of expected airport elevations, the following:

TABLE 2—DEMONSTRATION METHODS FOR SPECIFIC ICING CONDITIONS

Condition	Total air temperature	Supercooled water concentrations (minimum)	Mean effective particle diameter	Demonstration
1. Rime ice condition	0 to 15°F (-18 to -9°C)	Liquid—0.3 g/m^3	15–25 microns	By engine test.
2. Glaze ice condition	20 to 30°F (-7 to -1°C)	Liquid—0.3 g/m^3	15–25 microns	By engine test.
3. Snow ice condition	26 to 32°F (-3 to 0°C)	Ice—0.9 g/m^3	100 microns (minimum)	By test, analysis or combination of the two.
4. Large drop glaze ice condition (Turbojet, turbofan, and turboprop only).	15 to 30°F (-9 to -1°C)	Liquid—0.3 g/m^3	100 microns (minimum)	By test, analysis or combination of the two.

(e) Demonstrate by test, analysis, or combination of the two, acceptable operation for turbojet, turbofan, and turboprop engines in mixed phase and ice crystal icing conditions throughout Appendix D of this part, icing envelope throughout its flight power range, including minimum descent idling speeds.

[Amdt. 33–6, 39 FR 35466, Oct. 1, 1974, as amended by Amdt. 33–10, 49 FR 6852, Feb. 23, 1984; Amdt. 33–34, 79 FR 65536, Nov. 4, 2014]

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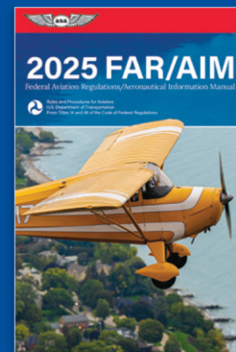

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