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Federal Aviation Agency

AC NO: 33-2

3/30/66

ADVISORY CIRCULAR

AIRCRAFT ENGINE TYPE CERTIFICATION HANDBOOK

Federal Aviation Agency

ADVISORY CIRCULAR

CHANGE

AC NO: AC 33-2 CH 1	AIRCRAFT ENGINES
EFFECTIVE: 9/13/67	

SUBJECT: CHANGE 1 TO AC 33-2, SUBJECT: AIRCRAFT ENGINE TYPE CERTIFICATION HANDBOOK

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1. PURPOSE. This circular transmits revised pages for AC 33-2 issued 3/30/66.

2. CHANGE. New paragraphs 25 and 27 are provided to cover engine ratings and limitations, and selection of ratings.

   Paragraph 11b.(9) covering bleed air contaminants has been added.

   Minor changes have been made to paragraphs 11a., 23f., and Appendix 1.

PAGE CONTROL CHART

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i	3/30/66	i	9/13/67
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R. S. Slift

Acting Director
Flight Standards Service

Federal Aviation Agency

ADVISORY CIRCULAR

AC NO:	33-2
	AIRCRAFT ENGINES
EFFECTIVE:	3/30/66

SUBJECT: AIRCRAFT ENGINE TYPE CERTIFICATION HANDBOOK

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1. PURPOSE. This circular contains guidance relating to type certification of aircraft engines which will constitute acceptable, although not the sole means of compliance with the Federal Aviation Regulations.

2. REFERENCES. Federal Aviation Regulations, Parts 21, 33, and 45.

3. HOW TO GET COPIES OF THIS HANDBOOK.

   a. Order Copies of this publication from:

      Federal Aviation Agency
      Printing Branch, HQ-438
      Washington, D.C. 20553

   b. Identify the publication in your order as:

      FAA AC No. 33-2
      Aircraft Engine Type Certification Handbook
      Dated 3/30/66

   c. This publication will be furnished free of charge.

George S. Moore
Director
Flight Standards Service

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AIRCRAFT ENGINE TYPE CERTIFICATION HANDBOOK

CHAPTER 1. GENERAL TYPE CERTIFICATION PROCEDURES

1. PURPOSE. This circular provides information and guidance for the type certification of aircraft engines. The acceptable means of compliance suggested are not mandatory and, therefore, need not be considered as a sole means of showing compliance with the Federal Aviation Regulations. The acceptable means of compliance serve as a guide to the public and are those which experience has shown to be both practical and effective.

   a. Instructions formerly contained in Civil Aeronautics Manual, Part 13, will be included in the Aircraft Engine Type Certification Handbook.

   b. Advisory circular material for insertion in the handbook will be issued periodically as it is developed. This method of issuance will facilitate the task of keeping the handbook current without the necessity for a complete revision.

   c. The initial issue of the handbook contains instructions referring to FAR, Parts 21, 33, and 45. Certain portions have been reserved for future additions. The remaining chapters of the handbook pertaining to the design and testing of turbine and reciprocating engines will be issued as they become available.

2. RESERVED.

3. TYPE CERTIFICATE. The type certificate is defined under FAR, Section 21.41.

4. RESERVED.

5. ENGINES ELIGIBLE FOR TYPE CERTIFICATE. (Ref. FAR, Sections 21.21, 21.27, 21.29, and FAR 33.)

   a. Engines Complying with FAR, Part 33. Engines tested and approved to the airworthiness standards of FAR, Part 33, are eligible for type certification.

   b. Import Engines. Federal Aviation Regulations, Section 21.29, prescribe the conditions for eligibility for type certification of import engines.

   c. Military Surplus Engines. Engine type certification may be accomplished for military surplus engines in the same manner as is prescribed in FAR 21.21 for other engines, but these engines may also be made eligible for use without being type certificated in accordance with the provisions of FAR 21.27(c) and (e). Under FAR 21.27(c) and (e), military surplus engines may be

approved for use on military surplus aircraft if it is shown, on the basis of previous military qualifications acceptance, and service record, that the engine provides substantially the same level of airworthiness as would be provided if the engine were type certificated under Part 33, with appropriate special conditions and later requirements applied. The engine characteristics necessary for installation, operation, and identification of the engine should be listed on the pertinent military surplus aircraft, type certification data sheet. The following engine technical data is helpful in identifying engine limits and showing compliance with FAR 21.27(c):

(1) Military service record summary including details of mandatory safety changes required for the engine type for military service.

(2) Military qualification basis with engine model specification.

(3) Military technical orders comprising manual information for the engine parts list, overhaul, operation, and maintenance.

d. Helicopter Reciprocating Engines. Helicopter engines are currently required to meet the specific test requirements of FAR, Section 33.49(d) or Section 29.923. Before this special endurance test was first made effective on May 15, 1953, in Civil Air Regulations, Part 13, it became evident from service experience that some engines operated in helicopters exhibited characteristics which were hazardous and unreliable because of the characteristically high steady engine speeds and powers with the overspeeds often encountered in helicopters. To provide good reliability in the case of reciprocating engines which were not qualified under FAR, Section 33.49(d), or have not been shown to have equivalent capabilities, it is suggested that they be derated. The following method of derating is suggested and results in engine ratings, which are comparably qualified, as if the helicopter engine test had been the basis for engine qualification:

(1) Limit sea level engines to a maximum power rating (at full throttle) corresponding to an engine speed that is not more than 90% of the engine speed at which the original maximum full-throttle power rating was established.

(2) Limit altitude engines to a maximum power rating of not more than 95% of the original maximum power rating, at an engine speed that is not more than 90% of the engine speed at which the original maximum power rating was established.

. RESERVED.

7. TYPE CERTIFICATE DATA. (Reference FAR, Sections 21.19 and 21.41)

a. General. Federal Aviation Regulations, Section 21.19, provide that some types of design changes to engines require a new application for a type certificate. Engine models which are of the same general series, displacement, and design characteristics, are usually approved under the same type certificate. A new type certificate is required when the proposed changes in design or limitations are so extensive that a substantially complete investigation of compliance with applicable regulations is required or when the proposed change is in the principle of operation. The use of engine serial number prefixes or suffixes in lieu of new model designations is suggested to cover many changes in engines which are important enough to warrant recognition, but which do not involve considerations necessitating that a new model designation be assigned. Usually, only new model designations are assigned in the following instances:

(1) When interchangeability in a given model aircraft is affected significantly by weight and other changes made in the engine.

(2) When propeller mounting, propeller vibration damping or control provisions are changed so as to preclude use of certain types of propellers on all engines of the same model.

(3) When, as a result of design changes, the horsepower or thrust ratings are changed a significant amount in excess of the accepted tolerance of output measurement.

(4) When special ratings are granted an existing engine model because of incorporation of new design features.

(5) When a significant change is made in the mounting characteristics of an engine, design of cowling or baffles integral with the engine, exhaust port locations, oil supply sump, accessories or control characteristics.

(6) When a design change results in significant changes in vibration characteristics, heat rejection through oil or coolant, or other operational characteristics.

b. Type Certificate Data Sheet. The type certificate data sheet, formerly called the aircraft engine specification, is a part of the type certificate as provided in FAR, Section 21.41. There is no FAA form provided for certificate data sheets, hence, the following general guidelines describe the desired data content

and arrangement. The data sheet lists the manufacturer, certification basis, the assigned engine model designation, ratings, operational limitations, and principal characteristics of the engine. Such details as appear thereon and as revised, when necessary, constitute the official status of the engine and serve as a guide for identification, use and installation of engines in aircraft. The arrangement of data and the extent of detail contained on the type certificate data sheet should conform, in general, to that shown for the most recently certificated comparable types of engines. Extensive details of engineering installation data may be merely referenced to avoid lengthy notes and seldom used detail, but specific data are desired to be indicated wherever feasible. The assistance of the applicant is valuable in formulating the data sheets contents and assuring its accuracy. No single standard format is specified for the data sheet as the amount or nature of detailed information may be expected to vary for different classes or types of engines. To summarize, the data sheet when completed should specify the most important limitations and data required for operation and installation of the engine, and the objectives of clarity, completeness, accuracy and ease of reference are to be stressed.

c. Type Certificate Data Sheet for Obsolete Engines. When an engine model has become obsolete and it is intended that its manufacture or extensive parts manufacture will not be continued or resumed, approval under the type certificate may be cancelled upon request. After cancellation it is no longer necessary for the former type certificate holder to maintain up-to-date type design and type certificate data. The type certificate data sheet of the engine will be revised to reflect the change in certification status and when all models listed under one type certificate have been cancelled, the data sheet will then be transferred to a combined listing of obsolete engines. The operation of obsolete engines still in service is eligible to be continued under the status of approval in effect at the time the certificate was cancelled. If reinstatement of the type certificate is desired by the former T.C. holder for the purpose of resuming active engine production, a new application for type certificate to be based on current FARs is needed. (Reference FAR, Sections 21.15, 21.21, 21.31, and 33.5.)

8. RESERVED.

9. DATA REQUIRED. (Reference FAR, Sections 21.15, 21.21, 21.29, 21.31, and 33.)

a. Form 312. Application for Type Certificate is the form referred to in FAR, Section 21.15(a). Two copies are to be submitted to the FAA Regional Office of the region in which the applicant is officially located.

b. Preliminary Data. Certain technical data are used to begin the type certification evaluation procedures by permitting the initial evaluation of conformity with the specific design requirements and the establishment of detailed qualification testing to be prescribed in accordance with FAR, Part 33. The data most useful for these purposes include a preliminary type design description, technical design data which are required under FAR, Sections 21.21(b) and 21.29(a)(2), together with other useful background information. To facilitate this evaluation of engine design features, the preliminary data may be submitted along with the application for a type certificate. The following preliminary data are suggested:

(1) A preliminary model description, specification, or equivalent, containing the information called for in Appendix 1 and 2 as applicable and available to the applicant.

(2) Drawings showing external views and cross-sections of selected components reflecting unique and typical detailed features.

(3) A review of significant development history emphasizing the extent of development experience with the engine, with particular emphasis on unique or complex features or their combinations not hitherto used in aircraft engines.

(4) Proposals for substantiating compliance with the requirements of FAR, Part 33, for U.S. applicants engines and Part 21.29 for import engines, by means of technical analyses or testing. Test proposals are desired appreciably before the proposed starting date of the test in sufficient detail to serve as a guide for testing whereupon they may be incorporated in the type inspection authorization.

c. Final Type Design and Type Certificate Data for U.S. Manufactured Engines. Acceptable type design and type certificate data, test reports and computations data, required under FAR, Section 21.21(b) cover the engine design which completed the prescribed qualification testing. Acceptable data are described as follows:

(1) Type Design Data. (FAR 21.31)

(a) Engine Model Description. The model description should provide data and information which is all officially test verified except where flight data are needed and are not yet available.

(b) Engine Parts Drawings, Material, and Process Specifications. Acceptable data will adequately show the configuration of the type design which successfully complied with the required tests and inspections. A numerically arranged drawing list which shows the latest design change identification is recommended to accompany the drawings. Drawings should be sufficiently detailed to identify and completely describe the design features; supply information on dimensions, materials and processes necessary to define the structural strength of the product; and any other data necessary to allow, by comparison, the determination of the airworthiness of later products of the same type.

(2) Type Certificate Data. (FAR, Section 21.41)

(a) Test Reports and Computations. Test reports and computations to substantiate compliance with the required tests of the engine and components, and design criteria of the applicable requirements of FAR, Part 33. (FAR 21.21(b)). An acceptable test report will include essentially the following:

1 Either a complete description, including photographs, of the test equipment utilized and the manner in which the engine was mounted and tested, or reference may be made to a previously submitted report which adequately describes the same equipment; a chronological description of the testing, indicating the manner in which the tests were conducted; the calibration status of instruments; report of all delays and their causes, including the stops made for minor corrections and any servicing to the engine; graphical plots showing variations in operating conditions during the endurance test; log sheets and calibration curves for the calibration test data; all data will be legible, accurate, and when plotted, to scales easily interpolated; the method of correcting data to the operating conditions and substantiation of any correction factors used by the applicant for his engine.

2 A teardown inspection report describing test results by both dimensional tables of all major parts of the engine which incur wear or change of dimension as well as by pnotographs and descriptions; include discussion of any unusual waar, burning, overheating, part failure, impending failure, or the occurrence of heavy deposits on engine parts; will indicate the appearance of the engine parts before and

after disassembly, but prior to being cleaned for detailed and dimensional inspection, where applicable; will indicate the condition of mating, sealing, and friction surfaces, such as air oil seals, compressor cases, valve faces, piston rings, and oil seals; will report the results of visual, x-ray, magnetic or flourescent particle inspection, or other procedures as applicable, with respect to the major parts.

3 Laboratory analyses representing the types and grades of the fuel, lubricants, and hydraulic fluids used in the testing should be included in the report. The condition of the lubricant and hydraulic fluids after use in the engine should be covered. These materials should conform to either recognized industry specifications, or other acceptable specifications.

(b) Instruction Manuals. These manuals are prescribed in FAR, Section 33.5, cover installing, operating, servicing and maintaining the engine, and are normally made available to the operator at the time all other required data are submitted prior to issuance of the type certificate. However, since overhaul and maintenance instructions are not essential for continued airworthiness until the engine goes into service, these manuals may be made available after the engine type certificate is issued. This is permissible under FAR, Section 21.21(b)(1) by providing an equivalent level of safety with a note incorporated on the engine type certificate data sheet indicating ineligibility of the engine in type certificated aircraft until all required manuals are made available by the engine manufacturer.

d. Type Design and Type Certificate Data for Import Engines. Certain technical data are required under FAR 21.29(a)(2) for import engines when a U.S. type certificate has been applied for. The requirements for such import engines are based on reciprocal airworthiness agreements between the U.S. and the country of manufacture involved as indicated by FAR 21.29. The airworthiness bases, and the exact extent and type of technical data to be supplied the FAA, for showing compliance with FAA requirements may vary in accordance with specific agreements between the Administrator and the Airworthiness Authority of the country of manufacture, but includes the usual application and preliminary data already covered, and usually the following:

(1) Type Design Data. Engine model description as discussed in paragraph c(1) of this section.

(2) Type Certificate Data.

(a) Certification compliance table.

(b) Engine manuals described in paragraph c(2)(b) of this section. If not included in the manuals, engine installation and general arrangement drawings are to be submitted in addition.

(c) Statement of compliance by the Airworthiness Authority of the country of manufacture, with the applicable airworthiness requirements.

10. RESERVED.

11. INSTALLATION CONSIDERATIONS OF ENGINES. (FAR, Section 21.21.)

a. General. An engine type certificate may be obtained upon examination of the type design, completing all engine tests, and applying all * applicable provisions of FAR, Part 33. This does not obviate * the very evident desirability that the engine applicant cater to all aircraft installation characteristics in the engine to be certificated, but this is not a requirement for engine certification. Thus, as a type certificated engine may not necessarily meet all requirements to be imposed by the aircraft installation of all specific models of aircraft, the installation criteria appearing in the aircraft and propeller requirements which concern engines, where applicable, are to be complied with but as aircraft or propeller certification requirements. Such considerations are more specifically related to the engine-aircraft or engine-propeller combination and, therefore, require evaluation either apart from or, at times, after engine certification may have been accomplished. While it is usually obvious what data the aircraft applicant is responsible for when showing compliance with the aircraft installation requirements, there are occasions when the engine type certificate holders installation data may be utilized for this purpose. It then becomes desirable that such data be submitted with the engine type certificate data, for later coordination among FAA Regional Engineering and Manufacturing Offices. The foregoing procedure is for new engine models. Refer to Section 13 of this handbook for procedures for handling certain design changes to engines which may require changes to the installation.

b. Installation Features to be Considered. Installation considerations include but are not limited to the following:

(1) When the engine is used to drive a propeller, the engine vibration investigation must be conducted with a representative propeller as required by FAR, Section 33.43. A satisfactory finding from the engine vibration survey will serve to permit certification of the engine, as far as its vibration is concerned. The installation, however, of the engine in an aircraft and the use of a different propeller, and metal propellers in particular, may require further vibration testing by the aircraft manufacturer for each installation undertaken. For engine vibration testing, use of a representative flight propeller is recommended as an acceptable means.

(2) A suggested way to take into account the effect of inlet design on turbine engine vibration is to conduct the vibration investigation required in FAR, Sections 33.63 and 33.83 using a representative inlet. Operation under air distortion conditions should identify safe limits for the engine. A finding of safe blade and associated engine stresses from such tests is sufficient for the purposes of engine certification. Comparison with the actual flight inlet characteristics will be made as in (3) following.

(3) Use of a bellmouth inlet and special exhaust nozzle is acceptable for all endurance testing of turbine engines; however, to assure proper engine matching and minimize operation problems from air to gas flow variations, flight testing with the flight type inlet and exhaust nozzle will be required in meeting aircraft requirements to determine whether engine limits are being met after its installation in the aircraft. If the inlet or exhaust nozzle contain variable geometry features or integrated engine control features, more involved flight testing to verify the compatibility of the engine and such design features will be required in the prototype aircraft.

(4) Type testing of the engine will substantiate the maximum allowable temperatures of assemblies, components and fluids as required under FAR, Section 33.7. Installation in the prototype aircraft is checked as provided in the aircraft installation requirements to establish that these limits will not be exceeded in operation.

(5) Operating pressures are treated the same as temperatures in (4) above and substantiated under FAR, Section 33.7. If the proposed installation of a piston engine imposes an exhaust back pressure significantly greater than two inches Hg. above that substantiated by type test, the higher pressure requires resubstantiation to be acceptable. If turbosuperchargers are to be used which impose a back pressure greater than two inches of Hg., an acceptable means of complying without engine resubstantiation would be to establish operating procedures which assure that the back pressure is no higher than a maximum of two inches of Hg.

(6) Engines for use in helicopters are tested extensively in the installation under aircraft requirements to determine the vibration characteristics of the drive system and substantiate its influence on engine vibration loads.

(7) A type certificated engine may include some external lines, equipment mountings, diaphragms or firewalls which do not meet all certification requirements of some installations. Added line shrouding, relocation or substantiation or fluid lines, or other changes constituting engine type design changes may thus be required for the aircraft installation. Such changes are accomplished preferably by the engine type certificate holder as approval based on engine compatibility and endurance qualification is usually necessary. However, upon achieving satisfactory coordination with the engine type certificate holder, accomplishment of such changes by the aircraft applicant is often acceptable as alternates.

(8) With some engines the engine type certificate holder or applicant may elect to incorporate items of equipment or accessories which are oftentimes handled solely as part of the aircraft installation responsibility. Examples of such items are engine mounted oil tanks, oil coolers, fuel heaters, generators, thrust reversers, inlet and exhaust nozzles, and various fluid pumps. When the engine manufacturer elects to furnish such accessories, it is basically implied that he will substantiate them for engine compatibility. If the engine type certificate holder elects to establish aircraft installation compliance, he should develop and provide the necessary installation data in accordance with applicable aircraft requirements.

* (9) When considering the acceptability of using turbine engine bleed air for direct cabin air, the information called for in the model description regarding the extent of bleed air contaminants will be useful.

12. RESERVED.

13. ENGINE CHANGES WHICH AFFECT INSTALLATIONS. (FAR, Sections 21.19 and 21.97)

a. This section discusses changes in design to certificated engine components whereby the engine operating limits, engine installation details, or airplane performance characteristics may possibly be altered significantly and require reinvestigation of the aircraft approval. Such engine changes which are major are to be handled in accordance with FAR, Sections 21.19 and 21.97, for approval in the engine.

b. Extensive changes may result in engine model redesignation, and major changes of a lesser but significant degree may require revisions to limitations affecting data in type certificate data sheets, operating manuals and/or engine manuals. It is cautioned that seemingly slight changes in engine components may at times adversely affect aircraft performance and installation limitations. Some changes which have resulted in certain problems involve the engine fuel metering components for various engines, and bleed air supply scheduling for turbine engines. Before the FAA approves engine changes for incorporation in production engines and for general use, which are considered to possibly affect aircraft installations, the degree of compatibility with existing aircraft installations is established. This involves coordination by the FAA and the engine manufacturer with the responsible aircraft type certificate holder and suggested procedures are discussed in paragraph 13 c. If engine interchangeability is adversely affected in existing installations, the manufacturers may be influenced to initiate remedial modifications rather than have to establish and qualify a new model of engine. Approval of engine type design changes on a basis of engine compatibility alone may be granted but the possible need of reexamination of the affected aircraft aspects should be emphasized when coordinating the change.

c. To assist the FAA in evaluating engine type design changes for effects on engine interchangeability in existing aircraft, it is suggested that the engine manufacture coordinate the change with affected aircraft manufacturers. It is suggested also that the engine manufacturer establish a written procedure whereby he will notify the FAA engine controlling region of the results when he has completed coordination of each affected engine change. Accomplishment of this step should reasonably assure thorough evaluation of each design change and expedite its approval on the aircraft. If any doubt remains concerning the compatibility status of an engine change, its status should be resolved between the FAA engine and aircraft controlling regions.

14. RESERVED.

15. OFFICIAL ENGINE TESTS. (FAR, Sections 21.33, and Part 33.)

a. Official engine certification tests are to be conducted in accordance with the authorization directed to the applicant. The tests required for engine certification are as prescribed by pertinent sections of FAR, Part 33. The authorization may be a letter or a type inspection authorization (FAA Form-316.) The latter is used to request participation of representatives from other than the cognizant propulsion engineering office.

b. Witnessing of tests by FAA representatives as prescribed in FAR, Section 21.33, is accomplished at least for the engine calibration, endurance, and operation tests, and the teardown inspection following these tests. Federal Aviation Agency representatives may also witness such specialized tests as vibration measurement, detonation, rotor integrity, rotor blade containment, icing and ingestion tests. The engine manufacturer's designated engineering representative should witness all certification testing and subsequent parts improvement tests, conducted by the manufacturer, for the purpose of authenticating the tests and the results.

c. The test authorization identifies the following details relating to official tests:

(1) The engine to be tested and the specific tests with the schedule of runs and test limits to be employed.

(2) The test equipment to be utilized.

(3) The test witnessing desired.

(4) Inspections to be conducted, covering both the engine and the test equipment as appropriate.

16. RESERVED.

17. APPROVAL OF ENGINE PARTS AND MATERIALS. (FAR, Sections 21.19, 21.113, 21.303, and Part 33.)

a. General. All engine parts and materials which have met the design and test requirements of FAR, Part 33, for engine type certification are eligible to be approved parts.

b. Changes by Type Certificate Holder. Changes to the type design of the engine may be made by and approval granted the type certificate holder when he meets the requirements prescribed under FAR, Part 33, and Part 21, Subpart D, discussed in Section 19

of this handbook. As indicated for major changes, the parts should undergo testing similar to the original substantiation unless alternate acceptable substantiation is provided. Minor changes do not usually require testing for their substantiation, but submittal of descriptive data are needed for FAA approval or for the DER approval when appropriately authorized.

c. Replacement or Modification Parts Produced by Other Than the Engine Type Certificate Holder. Design approvals of these parts may be granted as either identical parts to those in the engine type design, or as modifications to the type design. Acceptable means of compliance for processing these replacement parts in complying with FAR, Section 21.303, are contained in Advisory Circular No. 21.303-1. When the applicant desires to substantiate parts embodying extensive new design, complete type design data are required in the manner applicable to new applications for type certificates as prescribed in FAR, Section 21.19. When the applicant desires to substantiate parts embodying major type design changes not great enough to require a new application for type certificate, a supplemental type certificate as prescribed in FAR, Section 21.113, may be issued.

18. RESERVED.

19. PROCESSING CHANGES IN TYPE DESIGN. (FAR, Part 21, Subparts D and E)

a. Minor Changes. Section 21.95 of the FAR applies to the approval of minor changes in type design. These changes may be approved by the applicant's appropriately authorized DER. An acceptable method of handling these changes includes submitting to FAA the engineering design change notices, where necessary to fully describe the changes, and detail drawings showing the changes. Intervals between submittal of each new change or group of changes should not exceed six months.

b. Major Changes. Section 21.97 of the FAR applies to the approval of major changes in the type design. To substantiate major changes to a certificated engine, substantiating data must be submitted. Acceptable substantiating data include at least technical data and drawings, together with reports of tests, when applicable. As provided in FAR, Part 21, Subpart D, a type certificate holder may apply for amendment of the original type certificate for major changes. As provided in FAR, Part 21, Subpart E, applicants other than the type certificate holder may apply for a supplemental type certificate when appropriate for major changes. The applicant should meet at least the minimum airworthiness standards applicable to the original engine when qualifying design changes. When an

unsafe condition has developed, special substantiation may be required to demonstrate that the unsafe condition has been overcome by the proposed type design change. Changes that will contribute to improved safety are often developed as a result of service experience and may be approved as constituting the current type design standard in compliance with FAR, Section 21.99(b). Major changes may be recommended for approval by the type certificate holder's appropriately designated DER, but may not be introduced into service use until approved by the FAA Regional Engineering Office.

c. Type Design Data Lists. A drawing list as discussed in paragraph 9c(1)(b) is recommended reflecting both major and minor changes, to be provided at intervals not exceeding six months to cover each certificated engine model which has a currently effective type certificate.

20. RESERVED.

21. IDENTIFICATION PLATE. (FAR, Sections 33 and 45, Subpart B.)

a. General. An acceptable method of complying with the fireproof and location requirements of FAR, Section 45.11(a) is to meet the following conditions:

(1) The data thereon is legible after the application of a 2,000°F. flame for 15 minutes.

(2) The plate is located in an accessible place on the engine for easy viewing and is not expected to be easily defaced or dislodged.

b. Identification Data. The type of information to be included on the identification plate is prescribed in FAR, Section 45.13.

c. Identification Plate Attachment. Compliance with FAR, Sections 33.13 and 33.19 must be shown in that the means of attaching the identification plate will not cause cracks, induce fluid leaks, or be susceptible to dislodgement within the interior of the engine, or otherwise adversely affect the engine durability or introduce design features shown to be hazardous or unreliable.

22. RESERVED.

23. INSTRUCTION MANUAL. (FAR, Section 33.5) The applicant's manual or manuals containing at least the following is considered to be acceptable compliance with FAR, Section 33.5:

a. A description of the engine, including its components, accessories, and principles of operation.

b. Installation instructions with recommended installation practices.

c. Operating instructions including FAA-approved operation limitations and approved methods for correcting performance data. The performance data should provide both the aircraft applicant and the operator with the necessary information, and it may be provided in two different manuals.

d. Methods of rectifying typical faults.

e. Recommended inspection instructions and periods at which the engine, its components and accessories should be inspected, cleaned, lubricated, adjusted, and tested by general aviation operators. Recommendations for initial inspection periods for other operators may be supplied in a manner applicable to air carrier uses.

f. Recommended periods at which overhauls and replacements should be made by general aviation operators. Recommendations for initial * overhauls and replacements for other operators may be supplied in * a manner applicable to air carrier uses. Include life limits for all affected components.

g. A list of any special tools and equipment required to perform inspections, assembly, and disassembly together with details of their use.

h. The order and method of dismantling.

i. The order and method of reassembly.

j. Recommended methods of testing after overhaul.

k. Table of fits and clearances for use in assembly and checking.

l. Diagrams of the fuel, oil, ignition, coolant, and control systems.

m. Approved fuels and oils.

24. RESERVED.

25. ENGINE RATINGS AND OPERATING LIMITATIONS (FAR 33.7). Acceptable means of complying with the requirements of FAR 33.7 for establishing engine ratings and operating limitations are as follows:

a. Tests.

(1) Specific block tests are conducted to establish the various rated powers and thrusts and the maximum and minimum operating limitations.

(2) The limiting maximum ratings, speeds, and temperatures should be qualified by operation as indicated in the 150-hour FAA endurance test. Other limitations may be qualified by testing in which the limiting value may be the average attained for appropriate durations.

(3) Special or additional tests may be necessary at times to qualify some limitations for either complex engines such as turbine engines with several rotor systems when limiting test conditions cannot be easily maintained for all rotors simultaneously, or where limits for components may be tested separately on rig tests.

b. Ratings and Limitations.

(1) Rated engine powers and thrusts are usually established on the basis of engine operation on a test stand in its normal operating configuration but usually with at least a test stand inlet in place of the aircraft installation hardware. Ratings are included on the engine type certificate data sheet.

(2) Any operating limitations that may be considered by the applicant to affect flight safety, if exceeded, are to be noted in the model description and should include such items as the following:

(a) Maximum engine speeds.

(b) Temperatures. For reciprocating engines, this may include maximum limits for cylinder heads and barrels, coolant, lubricant, fuel, inlet air or supercharger outlet air, and designated essential engine accessories. Minimum limits may apply to lubricants. For turbine engines, maximum limits may include limits for inlet air, bleed air, exhaust or turbine gas, lubricant, fuel, hydraulic fluids, and designated external points such as essential engine accessories. Minimum limits may apply to lubricants, fuel, and hydraulic fluids.

(c) Maximum and minimum pressures. These may include limits on fuel, lubricants, hydraulic fluids, pneumatic systems, manifold pressures and exhaust back pressure for reciprocating engines, inlet and exhaust pressures and bleed air pressure for turbine engines.

(d) Limitations on the type and quality of fuels, lubricants, and, when used, hydraulic oils. The essential limitations are normally identified in the material specification which identifies the fluid. Any optional additives which have been approved for use with these fluids should be designated by the applicant and instructions for their use included.

(e) These limitations will be included on the engine TC data sheet with other data necessary for operation and installation in aircraft covered in installation or operation instructions.

26. RESERVED.

27. SELECTION OF ENGINE POWER AND THRUST RATINGS. FAR 33.8. The following covers an acceptable means of showing compliance with the rating establishment requirements of FAR 33.8:

a. General. The objective of this requirement is to establish uniform engine ratings which all new engines of a given model are required to achieve and with which consistent minimum aircraft performance may be assured.

b. Applicability. This requirement, effective April 3, 1967, is for engines of new type design whose applications for TC were submitted on or after this date. Also included are engines for which type design changes are proposed and the Administrator finds that a new application for type certificate is necessary because of extensive changes in accordance with FAR 21.19.

c. Establishment of Ratings. The selected ratings are established by the FAA block tests. Ratings are based on standard atmospheric conditions using test methods which will provide accuracies comparable to good industry practice. The applicant's experience on the calibrated output of a number of engines of both the applicable new model and of engines of closely similar design characteristics should be reviewed to evaluate the range of output

expected in all other engines of that type. The selected ratings should be consistent with the output of the lowest output engine anticipated.

28. RESERVED.

APPENDIX 1. TURBINE ENGINE MODEL DESCRIPTION

The model description is for the purpose of establishing those features of the engine that are involved in the certification and safe operation of the engine. The applicant should submit, where applicable, the following information plus any additional information which in his opinion is essential to the certification or safe operation of the engine:

a. Applicant's name.

b. Engine model, cycle used, number of rotors, stages and their arrangement.

c. Performance ratings as defined in FAR, Part 1. (See Table 1.)

d. Estimated engine performance graphs consistent with the ratings.

e. Maximum structural loading envelope, including mounting attachments and allowable loads.

f. Maximum time engine may be operated under negative and zero "g" conditions.

g. Maximum permissible temperature limits and cooling criteria for * engine components and accessories including effects of heat soak * after shutdown.

(1) Type and location of thermocouple to use for cooling test as applicable.

(2) Description of temperature sensing provisions if incorporated.

* h. Bleed air temperature, pressure, flow limits, and the extent of con- * taminants which may be present and are possibly harmful if breathed.

i. Maximum permissible air inlet duct attachment loads.

(1) Shear loads.
(2) Loads normal to mounting surfaces.
(3) Overhung moment.

j. Inlet air requirements.

(1) Maximum limits of radial and circumferential distortion.
(2) Maximum limits of velocity distribution.
(3) Correction factors for inlet pressure losses.

k. Lubrication system.

(1) Oil grade, type and specification.

(2) Oil consumption rate (normal and maximum).

(3) Oil inlet pressure limits.

(4) Oil system vent pressure limits.

(5) Oil inlet and scavenge temperature limits.

(6) Inlet oil flow rate.

(7) Usable oil capacity, if oil tank is part of engine.

(8) Maximum heat rejection tooil.

(9) Oil pump outlet pressure limits for normal operation and idle, if oil tank is not part of the engine.

(10) Oil filter provisions and requirements.

l. Fuel system.

(1) Fuel, grade, type, and specification.

(2) Fuel inlet pressure limits.

(3) Fuel inlet temperature limits, where applicable, for external connection.

(4) Fuel return pressure limits.

(5) Inlet fuel flow rate.

(6) Method of preventing filter icing.

(7) Fuel filter provisions and requirements.

m. Maximum permissible exhaust attachment loads.

(1) Shear loads.

(2) Loads normal to mounting surfaces.

(3) Overhang moment.

n. Bleed air attachment loads.

(1) Shear loads.

(2) Loads normal to mounting points.

(3) Overhang moment.

o. Accessory attachments. For each accessory drive, give the following information:

(1) Type of drive and mounting arrangement.

(2) Direction of rotation.

(3) Static torque (maximum limit).

(4) Continuous torque (limit).

(5) Drive shaft speed ratio with rotor or crankshaft.

(6) Maximum overhang moment.

(7) Vibration limits.

p. Output shaft. For propeller shaft or turboshaft engine.

(1) Maximum steady state allowable torque or power limits of the output shaft.

(2) Maximum allowable transient power output torque.

(3) Maximum bending load limits on the output shaft.

(4) The type and dimensions of the output shaft, direction of rotation, speed ratio with main rotor and nominal drive shaft speed.

q. Instrumentation. Describe all instrumentation provisions in detail. Describe provisions for connecting permanent and optional instrumentation including provisions for trend or conditions monitoring equipment.

r. External accessory units. List the function, model designation, setting numbers, or other pertinent identifying information relative to the following categories of major engine accessories, controls and special equipment which comprise externally located separate assemblies or units:

(1) Fuel control and subsystems.

(2) Ignition system and subsystems.

(3) Propeller, air bleed, or anti-icing control units.

(4) Safety devices.

(5) Other engine accessories or components to be furnished as part of or with the engine.

(6) Optional aircraft or engine accessories available with the engine for mounting on or for use with the engine.

s. Performance data. Data should be presented in the form of suitable curves and tables, or should portray the relationship of the various parameters of a minimum engine of the model. Data covering the effects of varying ram pressure ratio, ambient temperature, air bleed and altitude should be provided, and the data basis indicated (e.g. estimated, test, minimum, mean, maximum.)

t. Installation drawing. The applicant should provide an installation drawing of the engine showing all the dimensions and details necessary for proper installation of the engine in an aircraft.

u. Electronic radiation. The applicant should specify the maximum radiated electronic interference produced by the engine.

v. Operating and installation limitations. The applicant should specify any additional information needed to describe adequately the operational and installational limitations of the engine.

w. Electrical supply required. The applicant should specify the engine requirements for any externally supplied electricity.

x. Weight data.

(1) Dry weight of complete engine with all required equipment and no residual fuel or oil.

(2) Weights of optional external equipment and accessories.

(3) Estimated weight of residual fuel and lube oil.

(4) Center of gravity location of engine (dry).

y. Mass moment of inertia of rotating system.

(1) Estimated effective mass moment of inertia of those engine rotating components involved in starting when using the designated engine starting system.

(2) Estimated mass moment of inertia of main engine rotating component assemblies.

(3) Estimated effective mass moment of inertia of only the power turbine rotor (for a shaft power type engine).

(Preliminary) Performance Ratings at Standards Sea Level
Static Conditions

RATINGS	Shaft horsepower (Minimum Rated)	Jet Thrust Pounds (Minimum Rated	Rotor(s) r.p.m. (Maximum)	Specific Fuel Consumption lb/hr/lb thrust or lb/hr/s.hp (Maximum)	Measured Gas Temperature (Maximum)
Takeoff (Wet)					
+Takeoff (Dry)					
30-Minute Power					
2½-Minute Power					
Maximum Continuous					
Maximum Reverse (Operating Parameter)					
Idle Flight / Ground	(Max)	(Min)	(Max)	lb/hr	(Max)

APPENDIX 2. RECIPROCATING ENGINE MODEL DESCRIPTION

The model description is for the purpose of establishing those features of the engine that are involved in the certification and safe operation of the engine. The applicant should submit, where applicable, the following information plus any additional information which in his opinion is essential to the certification or safe operation of the engine:

a. Applicant's name.

b. Engine model, cylinder arrangement, number of cylinders, valve arrangement, cycle used, and type of cooling, etc.

c. Performance ratings as defined in FAR, Part 1.

d. Performance charts.

e. Design structural loading envelope for mounting attachments and maximum allowable loads.

f. Maximum time engine may be operated under negative and zero "g" conditions.

g. Maximum permissible temperature limits and cooling criteria for engine components and accessories.

   (1) Type and location of thermocouples used for cooling test.

   (2) Description of temperature sensing provisions.

h. Maximum carburetor air inlet duct attachment loads.

   (1) Shear load.

   (2) Loads normal to mounting surfaces.

   (3) Overhang moment.

i. Lubrication system.

   (1) Oil grade, type and specification.

   (2) Oil consumption rate (normal and maximum).

   (3) Oil inlet pressure limits.

   (4) Oil system vent pressure limits.

(5) Oil inlet and scavenge temperature limits.

(6) Inlet oil flow rate.

(7) Usable oil capacity, if oil tank is part of engine.

(8) Maximum heat rejection to oil including turbosuperchargers.

(9) Oil pump outlet pressure limits for normal operation and idle, if oil tank is not part of engine.

(10) Oil filter provisions and requirements.

(11) Oil pressure limits for propeller governing engine oil passages.

j. Fuel system.

(1) Grade, type, and specification.

(2) Fuel inlet pressure limits.

(3) Inlet fuel flow rate (maximum).

(4) Method of providing for carburetor icing precautions.

(5) Fuel filter provisions and requirements.

k. Maximum permissible exhaust attachment loads.

(1) Shear load.

(2) Loads normal to mounting surfaces.

(3) Overhang moment.

l. Accessory Attachments. For each aircraft accessory drive, give the following information:

(1) Type of drive and mounting arrangement.

(2) Direction of rotation.

(3) Static torque (maximum limit).

(4) Continuous torque (limit).

(5) Drive speed ratio with crankshaft.

(6) Maximum overhang moment.

(7) Vibration limits (if applicable).

m. Output shaft.

(1) Maximum steady state allowable torque or power limits of the output shaft.

(2) Maximum allowable transient power output torque.

(3) Maximum bending load limits on the output shaft.

(4) The type and dimensions of the output shaft, direction of rotation, speed ratio with crankshaft, and nominal speed.

n. Describe all instrumentation in detail. Describe provisions for connecting permanent and optional instrumentation including provisions for trend or condition monitoring equipment.

o. Give model designation, setting numbers, or other pertinent identifying information relative to the engine accessories or controls and special equipment such as:

(1) Carburetor, injectors and subsystems.

(2) Ignition system.

(3) Spark plugs.

(4) Safety devices.

(5) Other accessories or components to be furnished as part of or with the engine.

(6) Optional accessories available with the engine for mounting on or for use with the engine.

p. Performance data should be presented in the form of suitable curves to portray the relationship of the various parameters of a minimum engine of the model including the effects of varying ambient temperature and altitude. The maximum or limiting air intake temperature(s) should be specified together with all other engine performance limitations.

(1) For engines incorporating manual mixture controls, performance charts should include data on rich and recommended lean operation.

(2) For engines to be used with variable pitch propellers and in helicopters, performance charts should include manifold pressure variations starting from several representative full throttle points in the engine operating speed range.

(3) For all engines include altitude performance charts.

q. The applicant should include in the engine description an installation drawing of the engine showing all the dimensions and details necessary for proper installation of the engine in an aircraft including mounting and mounting provisions.

r. The maximum radiated electronic interference produced by the engine.

s. Any additional information to describe adequately the operational and installational limitations of the engine.

t. Engine requirements for any externally supplied electricity.

u. Weight:

(1) Dry weight of complete engine with all required equipment and no residual fuel or oil.

(2) Weights of optional external equipment and accessories.

(3) Estimated weight of residual fuel and lube oil.

(4) Center of gravity location of engine (dry).

v. Mass moment of inertia of rotating system - frictional horsepower.

(1) Estimated effective mass moment of inertia of those engine rotating components involved in starting.

(2) Estimated mass moment of inertia of main engine rotating component assemblies.