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ADVISORY CIRCULAR

AIRCRAFT ENGINE TYPE CERTIFICATION HANDBOOK

DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION

Initiated by: FS-140

AC NO: 33-2A

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DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION

SUBJECT: AIRCRAFT ENGINE TYPE CERTIFICATION HANDBOOK

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. CANCELLATION. This revision completely replaces AC 33-2 issued 30 March 1966 and AC 33-2 CH 1 issued 13 September 1967, both of which are canceled.

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

4. HOW TO GET COPIES OF THIS HANDBOOK.

   a. Order copies of this publication from:

      Department of Transporation
      Distribution Requirements Section, M-494.1
      Washington, D.C. 20590

   b. Identify the publication in your order as:

      FAA AC 33-2A
      Aircraft Engine Type Certification Handbook
      Dated 5 June 1972

   c. This publication will be furnished free of charge.

C. R. MELUGIN, JR.
Acting Director, Flight Standards Service

Initiated by: FS-140

TABLE OF CONTENTS

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. This circular includes instructions formerly contained in Civil Aeronautics Manual Part 13.

   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. TYPE CERTIFICATION OF AIRCRAFT ENGINES. (Ref. FAR, Sections 21.13, 21.15, 21.16, 21.17, 21.21, 21.27, 21.29, and Part 33.)

   a. Engines complying with FAR, Part 33, and Part 21. Engines tested and approved to the airworthiness standards of FAR, Part 33, are eligible to receive a type certificate. Section 21.13 covers applicant eligibility, Section 21.15 covers application for type certificate, Section 21.16 covers the establishment of any special conditions, and Section 21.17 covers designation of the applicable version of Part 33 which should be met.

   b. Import Engines. Federal Aviation Regulations, Section 21.29, and SFAR 26 prescribe the conditions for eligibility for type certification of import engines. SFAR 26, issued on 8/3/70 as an interim step to modified bilateral agreements, provides for temporary continued acceptance of existing kinds of import engines, and expires 1 March 1972.

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 are 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 made effective on May 15, 1953, in Civil Air Regulations, Part 13, it became evident from service experience that some engines operated in helicopters 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.

6. RESERVED.

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

a. General. Federal Aviation Regulations, Section 21.19, provides 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 or changes affecting performance are 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.

8. TYPE CERTIFICATE DATA SHEET. (Reference FAR, Section 21.41.) The type certificate data sheet, formerly called the aircraft engine specification, is part of the type certificate, as provided in Section 21.4. of the FAR. It includes the manufacturer, model designation, limitations, and certification basis. This sheet is prepared by the FAA project engineer with assistance from the applicant. See Handbook 8110.4, para. 35, for details on preparations for printing. There is no FAA form provided for type certificate data sheets because of the variations in the required data associated with the various products. The following guidelines provide general information relative to uniform handling of the engine data sheet with reference to the desired descriptive data content and general arrangement to be considered in the preparation of this sheet.

a. General. Applicable details, as prescribed in following paragraphs, constitute the official status of the engine(s) and serve as a guide for identification, use, and installation of engines in aircraft. The formal arrangement of data, explanatory notes, and extent of detail provided should conform, in general, to that shown for the most recently certificated comparable types of engines. Extensive details of engineering installation data are not desirable and this data may be merely referenced, but specific data should be indicated if feasible. The assistance of the applicant is desirable in formulating and assuring the accuracy of the data sheets. Standardization of data sheet format is desirable whenever possible, and specifically for the same generic type engines consistent with the following recommendations. The project engineer should have the final data sheet completed by the time the type certificate is issued.

b. Detailed Description.

(1) Heading - Numbering. The data sheet number will appear in the upper right-hand corner of page 1. This number will be the same as the type certificate number. When the data sheet is revised, the revision number will be shown as a suffix. The name of the type certificate holder, in abbreviated form, will be included next together with all the approved models listed in alphabetical or numerical order for reference convenience. The issue date will complete this group, which then will be enclosed in a box to set it off.

(2) Title. The title of the document (Type Certificate Data Sheet No._____) will appear in the center of the page, after the heading box. Title will include exact unmodified type certificate number as shown on the type certificate.

(3) Sample Preamble. Engines of models described herein conforming with this data sheet (which is a part of type certificate No._____) and other approved data on file with the Federal Aviation Administration, meet the minimum standards for use in certificated aircraft in accordance with pertinent aircraft data sheets and applicable portions of the Federal Aviation Regulations provided they are installed, operated, and maintained as prescribed by the FAA approved manufacturer's manuals and other FAA approved instructions.

(4) Type Certificate Holder. Insert the exact name and address of the type certificate holder as shown on the type certificate.

(5) Basic Data. (Main Section)

(a) Model Designation. Show model designations in one or more columns as necessary to exhibit correct ratings and other values or parameters for the one or more models heading given columns. Reference to the recently issued type certificate data sheets will illustrate representative ways of grouping engines in columns and ways of accomplishing the following instructions.

(b) Type. Describe engine models in terms of major generic features and processes, e.g.,

1 Reciprocating, cam, etc. - number of cylinders, cylinder arrangement and cooling method, reduction gear ratio, fuel injection, supercharging, e.g., 9RA, 6HOA, IGO, TS10, etc.

2 Turbojet, turbofan, etc., number of compressor and turbine stages, single or multiple spool, radial or axial flow, bypass, etc., e.g., 12-stage axial flow compressor, annular combustion chamber, reverse-flow four-stage turbine.

3 Turboprop, turboshaft, etc. Same as in item 2 plus free turbine.

(c) Rating. State certificated maximum power ratings at control setting, rotational speed, pressure altitude, or other conditions as applicable for the following generic type engines.

1 For reciprocating engines;
Maximum continuous, hp., r.p.m., in. Hg at:
Rated pressure altitude ft. ___ ___ ___ ___
Sea level pressure altitude ft. ___ ___ ___ S.L.
Takeoff (5 minutes) hp., r.p.m., in. Hg at:
Rated pressure altitude ft. ___ ___ ___ ___
Sea level pressure altitude ft. ___ ___ ___ S.L.
Other, if applicable, e.g., with both low and high impeller gear ratios, antidetonant injection, and alternate fuels.

2 For turbojet, turbofan, and ramjet engines;
Maximum continuous static thrust, lbs. ___ ___
and r.p.m. at sea level.
Other, if applicable.
Takeoff (5 minutes) static thrust, lbs. ___ ___
and r.p.m. at sea level.
Other, if applicable, e.g., with water-alcohol injection, reheat, reverse thrust, or alternate ratings.

3 For (1) turboshaft and (2) turboprop engines;
(1) At power turbine speed of ___ (___output shaft r.p.m.)
Maximum continuous at sea level; hp. ___
Takeoff (5 minutes) at sea level; hp. ___
30-minute helicopter rating at sea level; hp.___
2 1/2-minute helicopter rating at sea level;hp.___
Other, if applicable, e.g., with water-alcohol injection, reheat, or alternate ratings.

(2) Maximum continuous at sea level;
ESHP, SHP, jet thrust, r.p.m. ___ ___ ___ ___
Takeoff (5 minutes) at sea level,
ESHP, SHP, jet thrust, r.p.m. ___ ___ ___ ___
Other, if applicable, e.g., with water-alcohol injection, reverse thrust, reheat, or alternate ratings.

(d) Fuel.

1 Fuel - octane, grade, or type as applicable.

2 Carburetor, fuel injector, fuel control - manufacturer, model designation, setting, or other relevant information.

3 Fuel pump (if applicable) - manufacturer, model.

4 Fuel filtration (if required for fuel at engine inlet) - mesh value.

(e) Oil.

1 Oil type or specification.

2 Oil sump (dry or wet) and capacity.

3 Usable oil - engine in critical positions (degrees from reference).

(f) Coolant.

1 Coolant (liquid-cooled engine) type, specification.

2 Coolant capacity (engine only).

(g) Ignition.

1 Ignition (dual) magnetos or ignition supply box - models.

2 Timing (degrees BTC).

3 Spark plugs, igniters, and ignition exciters - models. (If extensive, put into a note.)

(h) Compressor - Compression.

1 Bore and stroke (reciprocating).

2 Displacement (reciprocating).

3 Compression ratio (reciprocating).

4 Turbosupercharger - model.

(i) Principal dimensions.

1 Length (in.) -

2 Width (in.) -

3 Height (in.) -

(j) Weight (dry) lb. (Note any unusual inclusions or exclusions.)

(k) Center of gravity.

1 Relative to specific longitudinal reference in inches.

2 Relative to engine center line in inches.

(l) Propeller or power shaft - type and size.

(m) Crankshaft dampers - number, order, location, type.

(n) Note list - listing of note numbers applicable to model group listed under data column for that group.

(o) Legend - explanation of symbols.

1 "--" indicates "same as preceding model."

2 "__" indicates "does not apply."

(p) Certification basis.

1 CAR-FAR effectivity covering type certification of engine.

2 Engine model and data of type certification.

3 Date of type certification application.

4 Date specific models canceled.

(q) Production basis. Production certificate number or other production means.

(6) Basic Data. (Notes Section) Variations are so numerous in engine type and in conditions relative to similar types that close uniformity in the use of notes for all engines appears impractical. Uniformity for uniformity's sake might well impare the accurate presentation of technical information. The first six notes are assigned to common conditions or parameters and for uniformity should be used solely for these subjects. The remaining notes and contents may be selected according to the data to be presented. The following examples of engine data sheet notes are presented accordingly.

(a) Common Note Headings Peculiar to All Engines.

NOTE 1. Maximum permissible temperatures or temperature limits:

Maximum Cylinder Head Recip. (Type Thermometer)	Cylinder base	Oil inlet
Eng. Models °F.-°C.	°F.-°C.	°F.-°C.
" "	°F.-°C.	°F.-°C.
Turbine exhaust gas or turbine inlet temperatures measured by ___ thermocouples at _____.	Models	Models
Takeoff (5 minutes)	°F.-°C.	°F.-°C.
Maximum continuous	°F.-°C.	°F.-°C.
Maximum transient for accel. ( ) min.	°F.-°C.	°F.-°C.
Maximum transient for starting ( ) sec.	°F.-°C.	°F.-°C.
Other temperature limits as applicable.	°F.-°C.	°F.-°C.

NOTE 2. Pressure limits:

	Maximum	Minimum
Fuel inlet pressure.		Altitude limits (if applicable)
Oil operating pressures.		
Specify eng. models as necessary.		

NOTE 3. Accessory drive or mounting provisions:

Accessory Drive	Engine Models RJ123	RJC123	Rotation Facing Drive Pad	Speed Ratio to Engine	Maximum Torque (in.-lb.) Cont.	Static	Maximum Overhang Moment (in.-lb.)
Starter	-	*	CC	_____:1	-		
Starter	*	**	CC	_____:1	-		
Generator	*	**	C	_____:1			
	etc.	etc.	etc.	etc.			
Alternator							
Vacuum pump							
Fuel pump							
Fuel pump (plunger)							
Tachometer							
Propeller Governor							

Standard - *

Optional - **

"C" Clockwise, "CC" Counter Clockwise

"-" does not apply

NOTE 4. Engine rating basis: Ratings are based on static sea level standard conditions of (dry) inlet air at 59° F. and 29.92 in Hg with no aircraft accessory drive or other loads. When applicable, indicate special test stand equipment used by the manufacturer for checking out new engines' performance.

NOTE 5. Model description - similarities, differences, and special characteristics.

RJ123 - Basic Model - Brief Description.

RJC123 - Similar to RJ123 Except _____.

List major differences.

NOTE 6. The following accessories are provided as part of the engine (or are optional) and comply with the aircraft installation requirements for _____ aircraft.

NOTE 7. Model cancellations.

(b) Uncommon Notes Peculiar to Reciprocating Engines.

NOTE 8. Thrust - tractor or pusher.

NOTE 9. Horizontal or vertical installation - helicopter information.

NOTE 10. Center of gravity tabulation (if not shown in body of data sheet).

NOTE 11. Vibration damper provision limitations.

NOTE 12. Manufacturers bulletins and instructions covering matters of special interest.

NOTE 13. Special ratings.

NOTE 14. Military models note.

NOTE 15. Special equipment.

NOTE 16. Other applicable notes.

(c) Uncommon Notes Peculiar to All Turbine Engines.

NOTE 8. Rotational velocities at standard and overspeed, alternate ratings, etc.

NOTE 9. Bleed air extraction.

NOTE 10. Alternate fuel information.

NOTE 11. Fuel or oil additives.

NOTE 12. Anti-icing, de-icing equipment, requirements.

NOTE 13. Power ratings for non-standard conditions.

NOTE 14. Rotor disk (Disc) integrity and rotor blade containment (where special provisions apply).

NOTE 15. Operational torques, power settings, and other special limits.

NOTE 16. Engine mount system.

NOTE 17. Power boost, injection.

NOTE 18. Other applicable notes for special equipment, etc.

(d) Notes peculiar to Turboprop Engines.

NOTE 19. Propellers - Model.

NOTE 20. Engine; Controls.

NOTE 21. Equivalent shaft hp. = $\frac{\text{Jet thrust lb.}}{2.5}$ + s.hp.

(e) Other notes peculiar to special conditions assigned.

c. Type Certificate Data Sheet (for obsolete engines). When an engine model has become obsolete, e.g., if the type certificate holder does not intend to manufacture it or any of its component parts, approval under the type certificate may be cancelled upon request. After cancellation, it is no longer necessary for the type certificate holder (former) 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 the approval in effect at the time the certificate was cancelled. If reinstatement of the type certificate is desired by the former type certificate 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.)

9. DATA REQUIRED. (Reference FAR, Sections 21.15, 21.21, 21.29, 21.31, 21.41, and Part 33.)

a. FAA Form 8110-12. Application for Type Certificate (OMB 04-R0078) is the form referred to in FAR, Section 21.15(a), and should be submitted to the FAA Regional Office of the region in which the applicant is officially located.

b. Preliminary Data. Certain technical data are needed for making 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 Appendices 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 Section 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, Section 21.31)

(a) Engine Model Description. The final model description should provide data and information which is all officially verified to replace the preliminary model description.

(b) Engine Parts Drawings, Material, and Process Specifications. Acceptable data will 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; part number location; 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 (Ref. FAR, Sections 21.21(b), 21.41, and Part 33.)

(a) Test Reports and Computations. Test reports and computations to substantiate compliance with the applicable requirements of FAR Part 33. A test report should cover but not be limited to, the following:

1 Test equipment

a a complete description with photographs, or

b reference to previous report in which same equipment was used.

c manner of engine mounting in the test equipment.

d calibration status of instruments.

2 Test procedure

a name of test, part of test sequence, or FAR Section.

b chronological log of testing.

c delays in tests and their causes.

d stops for minor corrections and servicing engine.

e time required for starts.

3 Test data

a graphs showing variations in operating conditions during the endurance test.

b log sheets and calibration curves for calibration test data.

c method used in correcting test data to standard atmospheric conditions (Ref. Sections 33.45 and 33.85(a)) and substantiation of any correction factors used.

NOTE: All data should be legible, accurate data and, when plotted, use scales which are easily interpolated.

4 Teardown inspection

a describe appearance of parts before assembly and after disassembly prior to cleaning for dimensional inspection.

b describe test results with before- and after-test tables of dimensions of major parts of the engine which are likely to incur wear or change of dimension.

c include photographs and descriptions of excessively worn parts.

d discuss any unusual wear, burning, overheating, part failure or impending failure, occurrence of heavy deposits on parts.

e indicate the condition of mating, sealing and friction surfaces, e.g., air-oil seals, each engine case, valve faces, piston rings, and oil seals.

f Indicate the results of visual, X-ray, magnetic, fluorescent particle or other inspections of major parts.

5 Laboratory analysis - of the types and grades of fuel, lubricants and hydraulic fluids used in the test -

a identify the specification to which the fluids conform.

b describe the condition of the lubricant and hydraulic fluids after the test.

(b) Instruction manual(s). (Ref. FAR, Section 33.5.)

The manual or manuals cover information for installing, operating, servicing, and maintaining the engine. The content of the manual or manuals is covered in paragraph 23 of this circular. Installation and operating manual data which have been substantiated, FAA approved, and are specifically required for engine approval in aircraft should be so indicated. For convenience, such data may appropriately be contained in a separate portion of the manual (s).

d. Type Design and Type Certificate Data for Import Engines. Certain technical data are required under FAR, Section 21.29(a) 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, Section 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, and FAR, Section 21.21. While it is desirable that the engine applicant cater to all possible aircraft installation characteristics, this is not always possible because of the timing of and is not a requirement for engine certification. This does not obviate the desirability of intimately interrelated installation requirements being introduced into an engine certification program when the aircraft characteristics are known in sufficient time to do so. In this manner, new engines being developed concurrently with new aircraft may be expected to originally meet the applicable aircraft installation requirements. Otherwise, interrelated installations requirements may be met by either engine design changes or installation features. Such considerations are often specifically related to the engine-aircraft or engine-propeller combination under consideration and 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 applicant's substantiation data may be utilized for this purpose. It is recommended, therefore, that at the initial engine type board meeting, the engine applicant establish the extent to which he plans to provide substantiation data for the installation. 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. When components of the installation are provided as part of the engine type certification design (e.g., pumps, reversers, coolers, etc.), the engine type certificate data sheet should reflect this.

b. Effects of Typical Installation Features. 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 endurance testing of turbine engines; however, to assure proper engine matching and minimize operation problems from air or gas flow variations, the flight type inlet and exhaust nozzle will be flight tested in meeting aircraft requirements to determine whether engine operating parameters and limits are being met when engine is operated in the aircraft. If the inlet or exhaust nozzle contains variable geometry features or integrated engine control features, more involved flight testing to verify the compatibility of the engine and such design features will normally be conducted 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 that substantiated by type test, the higher pressure requires engine resubstantiation. Turbosuperchargers or mufflers may at times impose a back pressure greater than two inches of Hg. which is considered appreciable. An acceptable means of complying with established back pressure limits would be to establish operating procedures which assure that the back pressure limits are not exceeded.

(6) Helicopter drive systems may impose high vibration loads on engines. The vibration characteristics of the engine-installation combination should be investigated for compatibility to determine whether established engine limits on vibration are exceeded.

(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 of fluid lines, or other changes constitute engine type design changes and 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 alternatives.

(8) With some engines, the engine type certificate holder or applicant may elect to incorporate items of equipment or accessories which are oftentimes handled 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 and be responsible for dealing with service difficulties. 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 and should include the engine manufacturer's engine failure analysis results affecting bleed air contamination.

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 datasheets, 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. For 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 first 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 for existing installations, it is desirable that either the engine or aircraft manufacturer initiate remedial modifications rather than establishing and qualifying a new model of engine. Engine type design changes should not be approved unless they are compatible with the aircraft installations in which the engine is being used as all engines of the same model designation should be interchangeable in the aircraft.

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 manufacturer 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 these steps 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, Section 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 Administration 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. Experience has indicated that the cumulative effects of both major and minor changes, especially when groups of new changes are incorporated in production engines, may have significant adverse effects on safety or durability.

Therefore, retesting of engines with all recent design changes appears desirable when incorporating a design change or group of design changes in order to assess these effects and may include development, endurance, vibration, and fatigue testing. Submittal of descriptive data is needed for FAA approval or for 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 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. Such changes normally require only a drawing comparison to substantiate their airworthiness. Typical examples of minor changes are included in the list which follows this paragraph. 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. Consideration should be given to the possibility that, while certain design changes may well be considered minor when evaluated singly, the cumulative influence of numbers of such changes may have an adverse effect and may have to be evaluated as major changes. The following is a list of typical minor changes:

(1) Slight variations in clearances.

(2) Reasonable increase in radius of fillets.

(3) Increase in thickness where the design permits it without adverse effects.

(4) Change to equivalent or improved material in minor parts.

(5) Improvements in heat treatments of parts, without reducing elongation of parts subjected to high stress.

(6) Small changes in the design of unimportant parts of the engine.

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. Typical examples of major changes are included in the list which follows this paragraph. 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. The following is a list of typical major changes:

(1) A change of either compression ratio or supercharger gear ratio.

(2) Establishing the eligibility of engines for either an increase in the oil inlet temperature, rating, inlet or exhaust gas temperatures, cylinder base or head temperatures, or speed.

(3) A change in the material or design of highly stressed parts, either rotating, reciprocating, or non-rotating, likely to affect adversely the airworthiness of such parts.

(4) A change involving method of clamping or attaching rotating, reciprocating, or non-rotating parts.

(5) Any change of parts or materials from which a conclusive decision cannot be made concerning the integrity of the engine from reliability, durability, and dependability standpoints.

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, Parts 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 should contain at least the following:

a. An engine description covering its major components, all accessories, its fuel, lubrication, ignition, cooling, and control systems, and principles of operation. Appropriate charts, diagrams, and illustrations are recommended.

b. Installation criteria including pertinent engineering data and limits for parameters affecting the installed engine and general recommended installation practices to assist in achieving compatibility of engine and installation.

c. Operating instructions including specified fuels, oil, and hydraulic fluids, starting and operation under normal and extreme ambient and engine temperatures and altitudes. Engine operating characteristics including operating limits, engine acceleration characteristics from idle settings with handling characteristics on the ground and in flight. Engine performance characteristics data to provide both aircraft applicant and operator with the necessary data for determining output levels at all applicable flight altitudes.

d. Maintenance, servicing, and overhaul instructions including:

(1) Methods of rectifying typical faults.

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

(3) Recommended periods at which overhauls and replacements should be made by the 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.

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

(5) The order and method of dismantling.

(6) The order and method of reassembly.

(7) Recommended methods of testing after overhaul or maintenance.

(8) Table of fits, clearances, and torque limits for use in assembly and checking.

24. RESERVED.

25. ENGINE RATINGS AND OPERATING LIMITATIONS. (FAR, Section 33.7) Acceptable means of complying with the requirements of FAR, Section 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. The effects of altitude on engine ratings and operating limitations should be determined acceptably. This is usually accomplished by means of altitude chamber testing or flight testing or simulated altitude tests. Analytical data have been acceptable occasionally.

(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. It is recommended that turbine gas temperature operating limits should encompass allowances to ensure that substantiated turbine inlet temperature will not be exceeded when the engine is operated to the speed and power limits under normal flight conditions. If the gas temperature limits vary with changing flight conditions, they should be such as to permit operation within safe limits using average pilot attention and skill.

(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) Accessory drive limit loads, including overhang moment, torque or power and vibratory loads, for aircraft accessories drive and mounting provisions on the engine.

Note: 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, Section 33.8.)

a. General. The objective of this requirement is to establish on a uniform basis the power or thrust ratings which new engines and engines restored to new condition are required to produce. These ratings are used in establishing aircraft performance for which consistent minimum performance is desired.

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, Section 21.19.

c. Establishment of Ratings. The ratings are selected by the applicant and 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.

CHAPTER 2. 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 and 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.

   (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, and flow limits, and the extent and nature of contaminants 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 to oil.

(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 turboprop 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)

(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).

Table 1 -(Preliminary) Performance Ratings at Standard 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)					
Flight Idle 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 and 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. (See Table 2.)

d. Performance charts consistent with the ratings.

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 loads.

(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.

TABLE 2 - PERFORMANCE RATINGS AT STANDARD SEA LEVEL CONDITIONS

Ratings	Shaft Horse Power -(Minimum Rated)	RPM (Maximum)	Specific Fuel Consumption lb/hr/hp (Maximum)	Cylinder Head & Base Temperatures (Maximum)	Manifold Pressure Limit
Takeoff Wet					
Takeoff Dry					
Maximum Continuous					
Maximum Recommended Cruise					
Low Recommended Cruise					
Idle					