

APPENDIX 1. TURBINE ENGINE MODEL DESCRIPTION

1. PURPOSE. This appendix outlines the turbine engine model descriptive information that should be submitted in order to establish those features of the engine that are involved in the certification and safe operation of the engine.
2. DISCUSSION. The applicant should submit, where applicable, the following information, plus any additional information which, in the applicant's opinion, is essential to the certification and safe operation of the engine.
 - a. Applicant's name.
 - b. Engine model, type, number of rotors, stages and their arrangement.
 - c. Performance ratings as defined in FAR Part 1 (See Table 1 of this appendix).
 - d. Performance charts consistent with the ratings.
 - e. Maximum structural loading envelope, including mounting attachments and allowable loads.
 - f. Maximum time the 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 characteristic including temperature, pressure, and flow limits, and the extent and nature of contaminants that may be present and possibly harmful, if breathed.
 - i. Maximum permissible air inlet duct attachment loads.
 - (1) Shear loads.
 - (2) Loads normal to mounting surfaces.
 - (3) Overhang 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 flange attachment loads.
 - (1) Shear loads.
 - (2) Loads normal to mounting surfaces.
 - (3) Overhang moment.
- n. Bleed air duct/port 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, and speed ratio, with main rotor and nominal drive shaft speed.
- q. Instrumentation. Describe all instrumentation provisions, including required range, accuracy, readability, and assumptions of precision in detail. Describe provisions for connecting permanent and optional instrumentation, including provisions for trend or condition monitoring equipment.

r. External accessory units (Ref. NOTE 8 of TCDS, Paragraph 5(b)(6)). List the function, model designation, setting numbers, or any other pertinent identifying information relative to the following categories of major engine accessories, controls, and special equipment that 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 plots, charts, tables, or acceptable electronic media form, and 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, power extraction, 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. Radiated electromagnetic interference (EMI/HERF) protection requirements of the engine.

v. Lightning protection requirements of the engine.

w. Induction icing protection system description, requirements, and limitations.

x. Engine vibration (include pickup locations and planes) characteristics and limits (where applicable); acceleration; velocity; and/or displacement; and frequency for installation and maintenance considerations.

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

engine, including the engine reference parameter used to set thrust, where applicable.

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

aa. 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).

ab. 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. PERFORMANCE RATINGS AT STANDARD DAY SEA LEVEL STATIC
CONDITIONS

RATINGS	Shaft Horse- power (min- rated)	Jet Thrust -lbs. (min- rated)	Rotor r.p.m. (max.)	Measured Gas Temperature °C, °F (max)
Takeoff (wet)				
Takeoff (dry)				
Maximum Continuous				
30-Minute OEI power				
2-1/2 Min OEI power				
Continuous OEI power				
Maximum Reverse (Operating parameter)				
Flight Idle				
Ground Idle				

APPENDIX 2. RECIPROCATING ENGINE MODEL DESCRIPTION

1. PURPOSE. This appendix outlines the reciprocating engine model descriptive information that should be submitted in order to establish those features of the engine that are involved in the certification and safe operation of the engine.

2. DISCUSSION. The applicant should submit, where applicable, the following information, plus any additional information which, in the applicant's 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 1 of this appendix).
- d. Performance charts consistent with the ratings.
- e. Design structural loading envelope for mounting attachments and maximum allowable loads.
- f. Maximum time the 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 in order 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 recommended data on rich and 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.

g. 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, mounting provisions, and accessory and component installation/removal envelopes.

r. Radiated electromagnetic interference (EMI/HERF) protection requirements of the engine.

s. Lightning protection requirements of the engine.

t. Any additional information to adequately describe the operational and installation limitations of the engine.

u. Engine requirements for any externally supplied electricity.

v. 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 or residual fuel and lube oil.

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

w. 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 1. PERFORMANCE RATINGS AT STANDARD SEA LEVEL CONDITIONS

RATINGS	Shaft Horse- power (min- rated)	Speed r.p.m. (max)	Cylinder Head & Base Temperature °C, °F (max)	Manifold Pressure Limit in. Hg.
Takeoff Wet				
Takeoff Dry				
Maximum Continuous				
Idle				

APPENDIX 3. INDEX OF INCORPORATED GUIDANCE MATERIAL AND REFERENCES

<u>Incorporated Guidance Material and References</u>		<u>Related FAR</u>
AC 20.18A	"Qualification Testing of Turbojet Engine Thrust Reversers," 3/16/66	33.87, 33.97
AC 20.26	"Turbine and Compressor Rotors Type Certification Substantiation Procedures," 7/22/64	33.27
AC 20.73	"Aircraft Ice Protection," 4/21/71	33.68
AC 20-135	"Powerplant Installation and Propulsion System Component Fire Protection Test Methods, Standards and Criteria," 2/6/90	33.68
AC 21.1B	"Production Certificates," 5/10/76	33.7
AC 21.6A	"Production Under Type Certificate Only," 7/1/82	33.7
AC 21.23	"Airworthiness Certification of Civil Aircraft, Engines, Propellers, and Related Products Imported to the United States," 7/7/87	21.29
AC 21.303-1A	"Certification Procedures for Products and Parts," 8/10/72	21.303, 21.19, 21.113
AC 23.909-1	"Installation of Turbochargers in Small Airplanes With Reciprocating Engines," 2/3/86	33.51
AC 33.1B	"Turbine Engine Foreign Object Ingestion and Rotor Blade Containment Type Certification Procedures," 4/22/70	33.77
AC 33.3	"Turbine and Compressor Rotors Type Certification Substantiation Procedures," 9/9/68	33.14, 33.27, 33.88
AC 33.4	"Design Considerations Concerning the Use of Titanium in Aircraft Turbine Engines," 7/28/83	33.15, 33.17, 33.19
AC 33.5	"Turbine Engine Rotor Blade Containment/Durability," 11/7/89	33.19, 33.94

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<u>Incorporated Guidance Material and References</u>		<u>Related FAR</u>
AC 33.47-1	"Detonation Testing in Reciprocating Aircraft Engines," 6/27/88	33.47
AC 33.65-1	"Surge and Stall Characteristics of Aircraft Turbine Engines," 12/6/85	33.65, 33.73
AC 43.17	"Methods, Techniques, and Practices Acceptable to the Administrator Governing the Installation, Removal, or Change of Identification Data and Identification Plates," 9/5/79	43.3, 45.13
AC 91.33A	"Use of Alternate Grades of Aviation Gasoline for Grade 80/87 and Use of Automotive Gasoline," 7/84	33.7
FAA Order (Handbook) 8110.4	"Type Certification," 6/85	21.21, 21.29, 21.41
FAA Order 8120.2A	"Production Approval and Surveillance Procedures," Rev. 3/12/87	21.33
FAA Order NE CD 8110.1A	"Evaluation and Approval Responsibilities for Manufacturer's Material and/or Process Specifications Specified in the Type Design," 5/28/86	21.33
FAA Order NE CD 8110.2A	"Confirmation of Satisfactory Conformity Inspection," 8/7/86	21.33
FAA Policy Memo	"Turbine and Compressor Rotor Integrity Substantiation," 2/9/59	33.27
FAA Powerplant Engineering Report No. 3A	"Standard Fire Test Apparatus and Procedure (for Flexible Hose Assemblies)," Rev. 3/78	33.17
FAA Report FAA-RD-75-155	"Ignition and Propagation Rates for Flames in a Fuel Mist," 10/75	33.17

APPENDIX 3. INDEX OF INCORPORATED GUIDANCE MATERIAL AND REFERENCES

<u>Incorporated Guidance Material and References</u>		<u>Related FAR</u>
FAA Report FAA-RD-79-51	"Titanium Combustion in Turbine Engines," 7/79	33.17
JAR-E, Section 2, Paragraph ACJ E 530 (c)	"Titanium Fires"	33.17
{RTCA DO- 160B}		{33.28}
{RTCA DO-178}		{33.28}
SAE AIR 1377A	"Fire Test Equipment for Flexible Hose and Tube Assemblies," 1/80	33.17
SAE ARP 1507	"Helicopter Engine/Airframe Interface Document and Checklist," 9/85	33.5
SAE ARP 926A	"Fault/Failure Analysis Procedure," Rev. 11/15/79	33.75
SAE AS 1055B	"Fire Testing of Flexible Hose, Tube Assemblies, Coils, Fittings, and Similar System Components," Rev. 3/1/78	33.17
{SAE Committee Report No. AE4EL}		{33.28}
SAE Paper No 690436	"Ignition of Aircraft Fluids on High Temperature Engine Surfaces," William T. Westfield, 4/21/69	33.17

NOTE: {33.28} is pending.

APPENDIX 4. GLOSSARY OF ACRONYMS AND ABBREVIATIONS

AC	Advisory Circular
ACO	Aircraft Certification Office
AIR	Aerospace Information Report (SAE)
APU	Auxiliary Power Unit
ARP	Aerospace Recommended Practice (SAE)
AS	Aerospace Standard (SAE)
BTC	Before Top Center
BTU	British Thermal Unit
CAR	Civil Aviation Regulations (predecessor of FAR)
CRes	Corrosion Resistant
D_e	Engine front face inlet equivalent diameter
DER	Designated Engineering Representative
D_s	Nacelle inlet lip stagnation point equivalent diameter
D_t	Nacelle inlet throat equivalent diameter
ECO	Engine Certification Office
EEC	Engine Electronic Control
EMC	Electromagnetic Compatibility
EMI	Electromagnetic Interference
FAA	Federal Aviation Administration
FAR	Federal Aviation Regulations
"ft.," ""	Feet (measurement)
g	Gravitational constant
HERF	High Energy Radiated Fields
hr.	Hour (time)

APPENDIX 4. GLOSSARY OF ACRONYMS AND ABBREVIATIONS

HSI	Hot Surface Ignition
"in.," ""	Inch (measurement)
in. Hg	Inches of Mercury
JAR-E	Joint Airworthiness Requirements-Engines (European)
JP	Jet Propellant (turbine) fuel
lbs.	Pounds (force or mass)
LCF	Low Cycle Fatigue
max.	Maximum
min.	Minimum
o'hg. mom.	Overhang moment
°C	Degrees Celsius
OEI	One-Engine-Inoperative
°F	Degrees Fahrenheit
p.s.i./psi	Pounds per Square Inch
r.p.m./rpm	Revolutions Per Minute
S.L.	Sea Level
SAE	Society of Automotive Engineers
SHP	Shaft Horse Power
TC	Type Certificate
TCDS	Type Certificate Data Sheet
TIA	Type Inspection Authorization
