U.S. Department
of Transportation
Federal Aviation
Administration

Advisory Circular

Subject: Approval of Propulsion Fuels and Lubricating Oils

Date: 7/29/11 **AC No:** 20-24C
Initiated by: ANE-111

1. Purpose. This advisory circular (AC) provides guidance applicable to adding fuels and oils as engine, aircraft, or auxiliary power unit (APU) operating limitations. It also provides acceptable methods, but not the only methods, that may be used to approve aircraft, engines, or APUs to operate with specified propulsion fuels and lubricating oils.

2. Applicability.

a. The guidance provided in this document is directed to engine and APU manufacturers, airplane manufacturers, rotorcraft manufacturers, modifiers, and foreign regulatory authorities. This guidance also applies to manufacturers of aviation fuels and lubricating oils.

b. This material is neither mandatory nor regulatory in nature and does not constitute a regulation. It describes acceptable means, but not the only means, for demonstrating compliance with the applicable regulations. We ("the FAA") will consider other methods an applicant may present to demonstrate compliance. Terms such as "should," "shall," "may," and "must" are used only in the sense of ensuring applicability of this particular method of compliance when the method in this document is used. While these guidelines are not mandatory, they are derived from extensive FAA and industry experience in determining compliance with the relevant regulations. If we find that following this AC would not result in compliance with the applicable regulations, we will not be bound by this AC, and we may require additional substantiation as the basis for finding compliance.

c. Projects proposing fuels or lubricating oils identified by means other than an ASTM International aviation fuel specification, SAE International oil standard, or a brand name that meets an SAE International standard, governmental or military specification or other industry-based consensus organization specification, will be reviewed on a case-by-case basis.

d. This material does not change, create any additional, authorize changes in, or permit deviations from existing regulatory requirements.

3. Cancellation. AC 20-24B, Qualification of Fuels, Lubricants and Additives for Aircraft Engines, December 20, 1985, is cancelled.

4. Related Regulations. The following regulations from Title 14 of the Code of Federal Regulations (14 CFR) are some of the regulations that apply:

a. Section 33.7(b)(2) and (3), Engine ratings and operating limitations (Fuel, Oil).

b. Section 23.1521(d), Powerplant limitations (Fuel grade).

c. Section 23.1522, Auxiliary power unit limitations.

d. Section 23.1583(b)(1), Operating limitations (Fuel grade).

e. Section 25.1521, Powerplant limitations.

f. Section 25.1583(b)(1), Operating limitations.

g. Section 27.1521(d), Powerplant limitations.

h. Section 27.1583(b)(1), Operating limitations.

i. Section 29.1521(d), Powerplant limitations.

j. Section 29.1583(b)(1), Operating limitations.

k. Section 91.9, Civil aircraft flight manual, marking, and placard requirements.

5. References and Related Reading.

a. FAA Guidance.

(1) Policy Memorandum ANE-2006-33.7-4-1, “Policy for Diesel (Compression Ignition) Engine Certification,” September 6, 2007.

(2) Advisory Circular 23.1521-1B, “Type Certification of Automobile Gasoline in Part 23 Airplanes with Reciprocating Engines,” March 2, 1995.

(3) Advisory Circular 23.1521-2, Change 1, “Type Certification of Oxygenates and Oxygenated Gasoline Fuels in Part 23 Airplanes with Reciprocating Engines,” April 24, 1996.

(4) Advisory Circular 33.47-1, “Detonation Testing in Reciprocating Aircraft Engines,” June 27, 1988.

(5) Advisory Circular 91-33A, "Use of Alternate Grades of Aviation Gasoline for Grade 80/87, and Use of Automotive Gasoline," July 18, 1984.

(6) Policy Memorandum ANE-2010-33.7-5A, "Policy for Aviation Fuel and Oil Operating Limitations, § 33.7," July 26, 2011.

b. Industry Guidance.

(1) ASTM International Standard D1655, "Standard Specification for Aviation Turbine Fuels."

(2) ASTM International Standard D6615, "Standard Specification for Jet B Wide-Cut Aviation Turbine Fuels."

(3) ASTM International Standard D7223, "Standard Specification for Aviation Certification Turbine Fuel."

(4) ASTM International Standard D7566, "Standard Specification for Aviation Turbine Fuel Containing Synthesized Hydrocarbons."

(5) ASTM International Standard D910, "Standard Specification for Aviation Gasolines."

(6) ASTM International Standard D6227, "Standard Specification for Grade UL82 and UL87 Unleaded Aviation Gasoline."

(7) ASTM International Standard D7547, "Standard Specification for Unleaded Aviation Gasoline."

(8) ASTM International Standard Practice D4054, "Guideline for the Qualification and Approval of New Aviation Turbine Fuels and Fuel Additives."

(9) ASTM International Subcommittee D.02.J Operating Procedures, Annex A6, "Guidelines for the Development and Acceptance of a New Aviation Fuel Specification For Spark-Ignition Reciprocating Engines."

(10) Defence Standard 91-90: "Gasoline, Aviation: Grades 80/87, 100/130 and 100/130 Low Lead. Joint service Designation: AVGAS 80, AVGAS 100 and AVGAS 100LL."

(11) Defence Standard 91-91: "Turbine Fuel, Aviation Kerosine Type, Jet A-1 NATO Code: F-35, Joint Service Designation: AVTUR."

(12) SAE International Surface Vehicle Standard J1899, "Lubricating Oil, Aircraft Piston Engine (Ashless Dispersant)."

(13) SAE International Surface Vehicle Standard J1966, "Lubricating Oils, Aircraft Piston Engine (Non-Dispersant Mineral Oil)."

(14) SAE International Aerospace Standard AS5780, "Specification for Aero and Aero Derived Gas Turbine Engine Lubricants."

(15) ASTM International Standard Practice D6424, "Standard Practice for Octane Rating Naturally Aspirated Spark Ignition Aircraft Engines."

(16) ASTM International Standard Practice D6812, "Standard Practice for Ground-Based Octane Rating Procedures for Turbocharged/Supercharged Spark Ignition Aircraft Engines."

6. Definitions. The following definitions apply for the purposes of this AC:

a. Consensus. A general agreement, but not necessarily unanimity, that includes a process for attempting to resolve objections by interested parties. This process is a comment resolution process, which requires that all comments have been considered fairly and each objector is advised of the disposition of his or her objection(s) and the reasons why. Also, consensus body members may change their votes after reviewing the comments.

b. Voluntary Consensus Standards. Standards developed or adopted by voluntary consensus standards bodies, both domestic and international. ''Technical standards that are developed or adopted by voluntary consensus standard bodies'' is an equivalent term.

c. Voluntary Consensus Standards Bodies. Domestic or international organizations which plan, develop, establish, or coordinate voluntary consensus standards using agreed-upon procedures. ''Voluntary, private sector, consensus standards bodies,'' is equivalent to voluntary consensus standards bodies. Federal law encourages the participation of federal representatives in these bodies to increase the likelihood that the standards they develop will meet public and private sector needs. A voluntary consensus standards body has the following attributes:

(1) Openness;

(2) Balanced interests;

(3) An appeals process; and

(4) Consensus.

7. Background.

a. 14 CFR requires that type certificate applicants identify the fuel and oil grade or specifications that are used in their products during certification. Once compliance with

the airworthiness certification regulations has been demonstrated, the grade designation or specification becomes part of the airplane, rotorcraft, and engine operating limitations. These operating limitations are specified in the type certificate data sheet (TCDS) and in the airplane flight manual (AFM) or rotorcraft flight manual (RFM). Aircraft operators are required by § 91.9 to only use fuels and oils listed in the AFM or RFM. These fuels and oils must, therefore, be identified with sufficient specificity to ensure that the engine and aircraft continue to meet their airworthiness certification basis during service.

b. Historically, the FAA has used the voluntary consensus standards from ASTM International (ASTM) or SAE International (SAE) to identify fuel and oil grades, designations, or specifications that were to be identified on a TCDS. Functionally, applicants showed (and continue to do so) that the product; for example, the engine, or airplane, operated as designed over its complete operating range using the proposed fuel or oil. Applicants made this showing during TC, amended TC, or supplemental TC (STC) programs. Once shown, the FAA issued the TC, amended TC, or STC with the fuel or oil identified as an operating limitation.

(1) Thereafter, when applicants proposed adding new fuels or oils to an existing TC or STC, those new fuels or oils were also identified by ASTM or SAE industry-based consensus grade designations or specifications. As with the original showing, applicants then showed that the product's airworthiness certification basis remained intact. After the showing, the FAA identified the fuel or oil grade, designation, or specification, as an operating limitation.

c. The FAA has also historically recognized the MIL-STD process and the controls in place in governmental bodies. Accordingly, the FAA has accepted their grades, designations, and specifications as sufficient to meet its regulatory needs related to identifying fuels and oils as operating limitations on a TCDS.

d. FAA continues to accept this historical approach to identifying new fuels and oils through a consensus-based industry organization, or governmental, or military standard. And after the proper regulatory showing, the identified fuel or oil can be identified as an operating limitation on a type certificate.

(1) Accordingly, fuels identified by an ASTM International aviation fuel specification, governmental or military specification, or other industry-based consensus organization specification, are identified in sufficient detail to meet the FAA's needs related to identifying a fuel by grade, designation, or specification on a TC, amended TC, or STC.

(2) Oils identified by an SAE International oil standard or a brand name that meets an SAE International standard, governmental or military specification, or other industry based consensus organization specification, are identified in sufficient detail to meet the FAA's needs related to identifying an oil by grade or specification on a TC, amended TC, or STC.

e. Applicants proposing a fuel or oil for a product should first contact the Engine and Propeller Directorate (E&PD) and provide proof that an industry voluntary consensus, governmental, or military organization has issued the standard or specification they propose for addition to a TC, or as an STC. The applicant should then coordinate with the cognizant aircraft certification office(s) (ACOs) and Directorate(s) to develop compliance plans and conduct the engine, airplane or APU certification programs. The applicant may proceed with the certification program with a preliminary version of the industry consensus-based, military, or governmental specification, but must substantiate that the tested fuel or oil meets the final, issued version of the specification before final issuance of the FAA design approval.

f. Once the applicant successfully completes the compliance plan, the proposed fuel or oil, as identified by specification, grade, or designation, may be included as an operating limitation on the product TCDS. It will of course also be identified in the operating and installation instructions, flight manuals, and other service documents. Further, a successful completion of the compliance plan means an applicant successfully demonstrates that the product when operated on the proposed fuel or oil continues to meet the certification requirements of the specific engine, APU, and aircraft (e.g., 14 CFR parts 21, 23, 25, 27, 29, 33 and 35, TSO C77, etc.).

8. Aviation Fuel.

a. Historically Accepted Aviation Fuel Specifications.

(1) The primary specification for Jet A and Jet A-1 turbine engine aviation fuel is ASTM International Standard D1655, “Standard Specification for Aviation Turbine Fuels.” This specification describes acceptable materials for producing turbine engine fuel, required properties that the fuel must meet, and test methods to measure those properties. The oversight of this specification is performed by ASTM International Subcommittee D.02.J on Aviation Fuels.

(2) U.S. Military fuel specifications. The following are examples of military aviation fuel specifications. These specifications are operating limitations on some U.S. products:

(a) MIL-DTL-83133, Detail Specification, Turbine Fuel, Aviation Kerosene Type, JP-8, and JP-8+100 issued by the U.S. Department of Defense (DOD).

(b) MIL-DTL-5624, Detail Specification, Turbine Fuel, Aviation, Grades JP-4 and JP-5, issued by the U.S. DOD.

(3) Turbine engine international fuel specifications. The following are examples of international aviation fuel specifications. These specifications are operating limitations on some U.S. products:

(a) Defence Standards 91-91, “Turbine Fuel, Aviation Kerosene Type, Jet A-1” and 91-87, “Turbine Fuel, Aviation Kerosine Type, Containing Fuel System Icing Inhibitor” issued by the United Kingdom (U.K.) Ministry of Defence. These standards are produced for the Defence Fuels and Lubricants Committee in collaboration with the U.K. Aviation Fuels Committee (AFC).

(b) CAN/CGSB-3.23, “Aviation Turbine Fuel, Kerosene Type” which includes grades Jet A and Jet A-1, and CGSB 3.24: “Aviation Turbine Fuel (Military Grades JP-5 and JP-8)” issued by the Canadian General Standards Board.

(c) GOST 10227, “Jet Fuels Specification,” including grades TS-1 and RT, issued by the Russia State Standard Committee. These are the predominant fuels used in Russia, the Commonwealth of Independent States, and some East European countries.

(d) “No. 3 Jet Fuel,” according to GB6537, issued by China’s National Technology Supervisory Bureau. This describes the fuel predominately offered at major international airports in China.

(4) Reciprocating Spark Ignition (SI) fuel specification(s). ASTM International Standard D910, “Standard Specification for Aviation Gasolines,” is the primary specification for reciprocating SI engine aviation fuel. This specification describes acceptable materials for producing leaded aviation gasoline, required properties that the fuel must meet, and test methods to measure those properties. The ASTM International Subcommittee D.02.J on Aviation Fuels oversees this industry specification. Other specifications for reciprocating SI engine aviation fuel include:

(a) ASTM International Standard D6227, “Standard Specification for Grade UL82 and UL87 Unleaded Aviation Gasoline.”

(b) ASTM International Standard D7547, “Standard Specification for Unleaded Aviation Gasoline.”

(c) ASTM D7592, “Standard Specification for Specification for Grade 94 Unleaded Aviation Gasoline Certification and Test Fuel.”

(d) Defence Standard 91-90, “Gasoline, Aviation: Grades 80/87, 100/130 and 100/130 Low Lead,” issued by the U.K. Ministry of Defence. This standard is produced for the Defence Fuels and Lubricants Committee in collaboration with the U.K. AFC.

(e) Russian GOST 1012-72 “Aviation petrols - Specifications” issued by the Russia State Standard Committee.

(f) GB/T1787-79(88) issued by China’s National Technology Supervisory Bureau.

b. Operating Limitations for Aviation Fuel.

(1) Operating limitations are part of the type design for each certificated product. The following regulations are some of the regulations that apply to fuel operating limitations:

(a) Engine operating limitations for fuel are required by § 33.7(b)(2) (reciprocating engine) and § 33.7(c)(2) (turbine engine).

(b) Airplane operating limitations for fuel are required by § 23.1521(d) (Normal category) and § 25.1521(b)(2) and (c)(2) (Transport category).

(c) APU operating limitations for fuel are required by § 25.1522.

(d) Rotorcraft operating limitations for fuel are required by § 27.1521(d) (Normal category) and § 29.1521(d) (Transport category).

(2) The FAA has determined that ASTM International aviation fuel specifications are acceptable specifications and may be identified as operating limitations for fuel. When ASTM fuel specifications are specified, the root number of the ASTM fuel specification (e.g., D1655) and the fuel types or grades used in successfully completing the compliance demonstration, will be listed in the engine and aircraft TCDS. Manufacturers will also list them in the documents referenced in the TCDS. For STC projects, the fuel specification root number and fuel types or grades will be listed in the limitations section of the STC. When applicants present a fuel specification from another industry based consensus organization or a governmental or military specification, they should present sufficient information regarding how the specification is identified to permit adequate reference as an operating limitation.

(3) Special Considerations.

(a) Minor Revisions. Fuel specifications are often revised, changing criteria, materials, or processes. These changes are typically not extensive enough to require a new specification; rather, they are incorporated into the existing specification as new suffix numbers.

(b) Drop-In Jet Fuels. ASTM Standard D1655, “Standard Specification for Aviation Turbine Fuels,” defines specification criteria for conventional jet fuel. This specification requires that the jet fuel be produced from conventional raw materials, such as petroleum, tar sands, or shale oil. However, new processing techniques are emerging that will allow jet fuel to be produced from other raw materials, such as biomass, natural gas, or coal. ASTM International has issued two standards intended to facilitate the evaluation of jet fuel produced from non-conventional sources and the integration of these fuels into the existing supply system and onto existing aircraft.

1 ASTM International Standard Practice D4054, "Guideline for the Qualification and Approval of New Aviation Turbine Fuels and Fuel Additives," provides a procedure for evaluating new jet fuels or significant modifications to existing fuels to determine if the new fuel is suitable for aviation use. Seemingly minor changes to specification properties or criteria may result in changes in a fuel's performance, but the laboratory, rig, and engine tests specified in D4054 are sufficient to fully evaluate the fit for purpose or suitability of new fuels with engine and airframe fuel systems. D4054 evaluation is conducted for both new fuels and revisions to existing fuel properties to verify that the resulting fuel is fit for purpose for aviation use. If the new or revised fuel is found to possess performance characteristics and chemical compositions essentially identical to conventional jet fuel, then it is called a "drop-in fuel." The U.S. DOD has developed a similar document, MIL-HDBK-510-1, for the evaluation of fuels to be used on military aircraft.

2 ASTM issued ASTM Standard Specification D7566, "Aviation Turbine Fuel Containing Synthesized Hydrocarbons," for drop-in fuels that have been qualified to ASTM D4054. Because D7566 fuels meet or exceed the requirements of D1655 fuels, both of these specifications are cross-referenced to allow D7566 fuels to be redesignated as D1655 fuels. A redesignated fuel can move seamlessly through the ground distribution infrastructure without separate tracking. The redesignated fuel can also be used in aircraft without amending the operating limitations of those aircraft.

3 If the fuel is a drop-in fuel and the currently specified operating limitations are adequate to accommodate the fuel, as in D7566 or D1655 fuels, then further FAA testing is not required.

4 TC/STC holders do not need to revise aviation fuel operating limitations to use D7566 fuels that have been redesignated to D1655 fuels, if the existing operating limitations include D1655 fuels.

(c) ASTM Non-Applicable Fuel Specifications. Non-applicable ASTM fuel specifications are those ASTM specifications for which the scope does not include aircraft engines, or does not explicitly include the intended type of aircraft or aircraft engine. For these special cases, the operating limitation needs to reference both the specification root number and the issue suffix number or revision level. TC/STC holders must apply for a TC/STC amendment each time the revision number changes. Non-applicable ASTM fuel specifications that have been approved as operating limitations are listed below.

1 ASTM International Standard D4814, "Standard Specification for Automotive Spark Ignition Engine Fuel." For example, the operating limitation is listed as D4814-10 for a certification project initiated in calendar year (CY) 2010.

2 ASTM International Standard D4806, Standard Specification for Denatured Fuel Ethanol for Blending with Gasolines for Use as Automotive Spark-

Ignition Engine Fuel. For example, the operating limitation is listed as D4806-10 for a certification project initiated in CY 2010.

(d) Aircraft Diesel Engines Using Jet Fuel. Reciprocating compression ignition engines (diesel engines) are typically designed to operate on aviation turbine fuel due to the wide availability of this fuel at airports. The ASTM specification for aviation turbine fuel is D1655. This is a non-applicable specification for diesel engines because the specification scope does not include aviation diesel engines. Therefore, the operating limitation needs to reference both the specification root number and the issue suffix number or revision level. This will require the TC/STC holder to apply for a TC/STC amendment each time the revision number changes. For example, the operating limitation should be listed as D1655-10 for a project initiated in CY 2010.

(e) Other governmental military or industry voluntary consensus-based standards, designations, or specifications. If an applicant proposes to specify an aviation fuel identified by another governmental, military or industry voluntary consensus-based standard, designation, or specification, then the applicant should present sufficient information to show that the specification provides an equivalent level of property, performance, and quality control.

c. Operating Limitations for Aviation Fuel: Certification Compliance Plans.

(1) The E&PD is the FAA's technical focal point for aviation fuel. The E&PD will coordinate with the cognizant directorate and the assigned ACO to identify the applicable airworthiness certification requirements. Applicable airworthiness requirements are those FAA aircraft, aircraft engine, or APU regulatory standards for which showing compliance is contingent on fuel properties and product performance using the fuel. Applicable regulations may include, but not be limited to, those regulations listed in appendices 2 and 3.

(2) Applicants should present an issued industry consensus-based, governmental or military fuel specification to the assigned ACO and work with that ACO to develop a compliance plan. The E&PD will oversee the compliance plan development conducted by the ACO, applicant, and other cognizant directorate (if applicable).

(3) The certification project may be initiated with a preliminary version of the industry consensus-based, military or governmental fuel specification. However, FAA design approval and issuance of the STC or amended TC will not occur until the fuel used during the certification testing is shown to meet the criteria of the final, issued specification when that specification is issued.

(4) An applicant's compliance plan should address all applicable airworthiness certification standards, some of which are discussed below. Sound testing techniques and thorough data analysis should be well documented in the compliance plan. Accordingly, close contact and frequent coordination are recommended to ensure the plan is developed with minimal delay.

(5) An applicant's compliance plan should also address the effects of mixing the proposed new aviation fuel with other existing types of aviation fuel, such as mixing of conventional Jet A fuel with synthetic Jet A fuel. Data generated during development of the industry consensus-based, governmental or military fuel specification may be used to support this task.

(6) Applicants must demonstrate that the engine and the airplane or rotorcraft in which the engine is installed continue to meet all certification standards when operating with the new fuel.

(7) New Technical Standard Order (TSO) APU approvals, or major changes or STCs to existing APU TSO approvals, that include a new fuel operating limitation should include the applicable requirements and performance standards from the latest revision of TSO C77 in the compliance plan.

(8) Applicable Regulations for Engines and APUs. See appendix 2 of this AC, paragraphs 1, 2, and 3 for a list of some regulations that may apply to projects to add an aviation fuel specification as an operating limitation. Additional guidance on some airworthiness standards follows. The following is by no means exclusive, and is provided as a recommended starting point only. Applicants should, therefore, obtain from the E&PD, as the FAA's fuel focal point, guidance on the regulations with which they will need to show compliance.

(a) Fuel composition can significantly affect material properties and durability (see §§ 33.15, 33.53, and 33.91). Applicants should demonstrate materials compatibility of the fuel-wetted materials, including elastomers, seals, and metallic components. This can be accomplished by a combination of soak testing and component testing or by other methods that the applicant proposes and which become part of the applicant's compliance plan. In some cases, materials compatibility data generated during the ASTM fuel specification development may be used. This may require testing of both used and unused non-metallic parts, such as elastomers and seals, if the fuel is to be used on engines previously operated with other types of fuel.

(b) Applicants should consider several factors when demonstrating that an engine operating with a new fuel does not result in an unsafe condition. For example, differences or changes in combustion characteristics such as temperature and pressure, deposit accumulation, octane demand, fuel lubricity, fuel vaporization, and materials responses or affects, and others, should be evaluated by test or analysis. Applicants who propose a longer, mature engine maintenance interval or Time Between Overhaul (TBO) for a new engine, or propose to maintain the intervals or TBO of an existing, mature engine, may need to perform a long duration engine test beyond that specified in §§ 33.49 or 33.87 to show compliance to §§ 33.15 and 33.19 (see §§ 33.15, 33.19, 33.49, and 33.87).

(c) Applicants should evaluate engine cooling requirements as different fuels may change combustion characteristics and thereby impact cooling requirements. This is particularly important for reciprocating engines where fuel characteristics can impact cylinder temperatures (see § 33.21).

(d) The engine fuel system should function properly with the proposed fuel throughout its complete operating range under all flight and atmospheric conditions. Fuel density, vaporization, and low temperature properties may affect fuel system performance under certain conditions (see § 33.51). For spark ignition reciprocating engine fuels, carburetor icing and vapor lock tendencies should be evaluated (see §§ 33.35 and 33.67).

(e) Avoiding engine detonation and demonstrating acceptable detonation margins are critical requirements for spark ignition reciprocating engines. A fuel must demonstrate adequate anti-knock margin under the worst-case operating conditions to prevent destructive detonation. Due to the variation in accuracy and responsiveness of detonation measurement systems, the detonation measurement test method the applicant intends to use should be approved by the FAA (see § 33.47 and AC 33.47-1).

(f) Fuel composition and properties can significantly affect the ability to support combustion at certain points in the engine operating envelope. Applicants should therefore evaluate engine operability with the new fuel for all operating and atmospheric conditions approved for the engine. Engine starting, acceleration, deceleration, and steady-state operation should be evaluated by test or analysis for all approved operating conditions (see §§ 33.51 and 33.89).

(9) Applicable Regulations for Airplanes and Rotorcraft. See appendix 3 of this AC, paragraph 1 for a list of some regulations that may apply to projects for adding a new aviation fuel as an operating limitation. Additional guidance on some airworthiness standards follows. The following is by no means exclusive and is provided as a recommended starting point only. Applicants should, therefore, obtain from the E&PD as the FAA's fuel focal point, and the appropriate airplane directorate, guidance on regulations with which they will need to show compliance.

(a) Applicants should evaluate the effect of differences in fuel properties such as density on aircraft weight and center of gravity and aircraft structure (see §§ 25.23, 25.25, 25.29, 23.23, 23.25, 23.29, 27.25, 27.27, 27.29, 29.25, 29.27, and 29.29).

(b) Applicants should evaluate the effect of differences in fuel properties, such as density, energy content and combustion characteristics, on aircraft performance (see §§ 25.105, 25.117, 25.119, 25.121, 23.53, 23.69, 23.77, 27.51, 27.65, 27.67, 29.51, 29.65, and 29.67).

(c) Applicants should demonstrate materials compatibility of the fuel wetted materials, including elastomers, seals, metallic components, fuel bladders, and fuel tanks. This can be done by a combination of soak testing and component testing (see

§§ 23.603, 25.603, 27.603, and 29.603). This may require testing of both used and unused non-metallic parts, such as elastomers and seals, if the fuel is to be used on aircraft previously operated with other types of fuel.

(d) Applicants should evaluate the effect of differences in fuel properties such as density, energy content and combustion characteristics on installed engine and APU performance, including in-flight restarting (see §§ 25.901(d), 25.903(a), 25.903(e), 25.903(f), 25.939, 23.901(d), 23.903, 23.903(d), 23.939, 27.903, 27.903(d), 27.939, 29.903, 29.903(e), 29.923(p), and 29.939).

(e) Fuel performance in high temperature conditions can be influenced by fuel properties such as vapor pressure, liquid/vapor ratio, and thermal conductivity. Applicants should therefore, evaluate fuel system hot weather and engine cooling performance when operating with the new fuel (see §§ 23.961, 25.961, 27.961, 29.961, 25.1041, 25.1043, 25.1045, 23.1041, 23.1043, 23.1045, 23.1047, 27.1041, 27.1043, 27.1045, 29.1041, 29.1043, 29.1045, 29.1047, and 29.1049).

(f) Applicants should show the fuel is compatible with the aircraft fuel system components and that the fuel does not have any adverse effect on fuel system performance. This demonstration should include an evaluation of fuel properties such as flash point or vapor pressure for their effect on the fuel in the fuel tank, including flammability.

1 Fuel properties such as the dielectric/density relationship can change the gauging system function since some gauging systems do not have densitometers and are based on an assumed relationship for typical kerosene fuels.

2 Some fuel types can also cause corrosion and adversely affect material properties and durability of engine fuel system components as discussed in paragraph 8c.(8)(a) above.

3 Some fuel types can also have an affinity for water retention and icing, which could lead to stoppage of fuel flow or corrosion.

4 A comprehensive compliance plan should also include an analysis of the effect of fuel properties such as viscosity on fuel system pressure drop and fuel pump performance

5 See §§ 25.951, 25.952, 25.955, 25.959, 25.969, 25.975, 25.979, 25.981, 25.997, 25.1001, 25.1305, 25.1337, 23.951, 23.955, 23.959, 23.969, 23.973(e)(f), 23.975, 23.979, 23.997, 23.1001, 23.1305, 23.1337, 27.951, 27.955, 27.959, 27.965, 27.969, 27.997, 29.951, 29.955, 29.959, 29.969, 29.975, 29.979, 29.997, 29.1001, 29.1305, and 29.1337.

9. Lubricating Oil.

a. Historically Accepted Oil Standards.

(1) Commercial turbine engine type design holders traditionally used performance standard MIL-PRF-23699 to qualify engine oil. Today, SAE International Aerospace Standard AS5780, "Specification for Aero and Aero Derived Gas Turbine Engine Lubricants," replaces MIL-PRF-23699 for commercial turbine engines.

(2) SAE AS5780 defines physical, chemical, and performance limits for gas turbine engine oils along with standard test methods and requirements. It includes specialized laboratory and rig testing to determine if the oil is suitable for aircraft turbine engines. It also defines quality control requirements to ensure batch conformance and materials traceability, and it includes procedures to manage and communicate changes in oil formulation and brand.

(a) SAE AS5780 is maintained by SAE Technical Committee E-34, Propulsion Lubricants. The SAE E-34 Propulsion Lubricants committee addresses all facets of aerospace propulsion lubricants—development, maintenance, and in-service experience. This work includes lubricants used for gas turbine engines, aircraft gearboxes and accessories.

(3) Similarly, commercial and military engine type design holders used MIL-L-6082 (Non-Dispersant Mineral Oil) and MIL-L-22851 (Ashless Dispersant) for conventional spark ignition reciprocating engines. However, SAE Surface Vehicle Standard J1899, "Lubricating Oil, Aircraft Piston Engine (Ashless Dispersant)" and SAE Surface Vehicle Standard J1966, "Lubricating Oils, Aircraft Piston Engine (Non-Dispersant Mineral Oil)," replaced the military specifications as the primary standards for conventional spark ignition reciprocating engine oil. These specifications define physical, chemical, and performance limits for conventional spark ignition reciprocating engine oils along with standard test methods and requirements. They include specialized laboratory and rig testing to determine if the oil is suitable for aircraft conventional spark ignition reciprocating engines. They also define quality control requirements to assure batch conformance and materials traceability. SAE Standards J1899 and J1966 are maintained by the SAE Fuels and Lubricants Technical Committee 8 (TC-8) Aviation Piston Engine Lubricants.

b. Operating Limitations for Lubricating Oil.

(1) FAA regulations also require that the Administrator establish engine operating limitations related to oil. These operating limitations are also included in the engine TCDS for each type certificated design. Operating limitations for oil are related to oil grade or specifications for reciprocating and turbine engines.

(2) The FAA determined that SAE grade or specification known as an SAE standard, or oil formulation brand designation(s) based on SAE standards are acceptable to include as engine operating limitations related to oil. Once the compliance plan is successfully completed, the oil formulation brand designation or the standard number will

be listed in the engine TCDS or in manufacturers' documents referenced in the TCDS. For STC projects, the oil formulation brand designation or the standard number will be listed in the limitations section of the STC.

(3) Special Considerations.

(a) Oil Formulation Brand Name Designation. Turbine engines generally require lubricating oils that meet SAE AS5780 standard, but the operating limitation specified in the engine TC is most often listed as the brand name(s) of specific oil formulations. Similarly, conventional spark ignition piston engine lubricating oil typically meets SAE J1899 or J1966 standards with the operating limitations listed as brand name(s) of specific oil formulations. This is a more specific means of identification than simply referencing SAE AS5780, J1899 or J1966, and therefore, specifying the brand name is generally acceptable for establishing an operating limitation related to oil, as required by §§ 33.7(b)(3) and (c)(3). Specifying AS5780, J1899 or J1966 is also acceptable if the engine manufacturer has demonstrated that any oil with properties that fall within the range of criteria in the specification is acceptable for use in the subject engine.

(b) Changes to SAE Approved Oil Formulation. Oil manufacturers may change oil formulation, base stock composition, additive composition, or manufacturing plant location. SAE requires brand re-identification when these changes are shown to affect oil performance, as defined by AS5780. This brand re-identification will result in applicants requesting a change to the TC or STC to add the new brand as an operating limitation.

1 If SAE determines the change does not require a change to the brand name, then the specified operating limitation is still valid, and accordingly, no change to the TC or STC is required. This is because operating limitations relative to oil are typically defined in terms of the brand name.

2 If SAE determines the change requires a brand name reidentification, then the SAE industry oversight group generally evaluates the change in parallel with the engine manufacturer's FAA design change control process. The industry oversight group's report and associated evidence can be used to support the FAA's review process.

(c) Other governmental military or industry voluntary consensus-based standards or specifications. If an applicant proposes to specify an aviation oil identified by another governmental, military or industry voluntary consensus-based standard, or specification, then the applicant should present sufficient information to show that the oil grade, brand name or specification provides an equivalent level of property, performance, and quality control.

c. Operating Limitations for Oil: Certification Compliance Plans.

(1) The E&PD is the FAA's technical focal point for identifying the applicable airworthiness certification requirements involving aviation oil. Applicable airworthiness requirements are those FAA regulatory standards for which the showing of compliance is contingent on oil properties. Once applicants present the industry consensus-based, governmental, or military oil brand, standard, grade, or specification to the E&PD, the Directorate will aid applicants as they develop their compliance plan.

(2) An applicant's compliance plan should address all applicable airworthiness certification standards, some of which are discussed below. Sound testing techniques and thorough data analysis should also be well documented in the compliance plan. Accordingly, close contact and frequent coordination are recommended to ensure the plan is developed with minimal delay.

(3) An applicant's compliance plan should also address the effects of mixing the proposed new oil with other types of oil, such as mixing a new brand with an existing brand. Data generated during the development of the industry consensus-based, military, or governmental oil specification may be used to support this task.

(4) Applicants using engine oil for airplane or rotorcraft systems must demonstrate that the engine and the airplane or rotorcraft in which the engine is installed continue to meet all certification standards. If a qualification project for a new operating limitation for oil for an APU is required for a new TSO, major change, or STC, then the compliance plan should include the applicable requirements and performance standards from the latest revision of TSO C77.

d. Applicable Regulations for Engines and APUs. See appendix 2 of this AC, paragraphs 4, 5, and 6 for a list of some of the regulations that may apply to oil projects. Additional guidance on some airworthiness standards follows. The following list is by no means exclusive, and is provided as a recommended starting point only. Applicants should therefore, obtain from the E&PD, as the FAA's lubricating oil focal point, guidance on regulations with which they will need to show compliance.

(1) Applicants should review the design of the turbine engine oil system and provide data that shows that the new turbine engine oil will not result in harmful build-up of carbon deposits for compliance with §§ 33.19 and 33.71. This can be accomplished by any combination of engine test, rig test, and analysis based on prior service experience or testing. Applicants who propose a longer, mature engine maintenance interval or TBO for a new turbine or reciprocating engine, or propose to maintain the TBO or other major maintenance interval of an existing, mature turbine or reciprocating engine, may need to perform a long duration engine test beyond that specified in §§ 33.49 or 33.87 to show compliance with §§ 33.15 and 33.19 (see §§ 33.19 33.39, and 33.71).

(2) Applicants should also include in the Instructions for Continued Airworthiness if applicable, instructions for inspections, repair, and cleaning of turbine

engine areas or components shown to be susceptible to carbon deposits build-up. These instructions should be derived from the review of the oil system design accomplished during compliance with § 33.71 and 33.19.

(3) If all oil-wetted materials on the specific engine model under review were not evaluated during the SAE qualification process, additional materials compatibility testing will be necessary (see § 33.15).

e. Applicable Regulations for Airplanes and Rotorcraft. See appendix 3 of this AC, paragraph 2 for a list of some of the regulations that may be applicable for oil projects. Additional guidance on some airworthiness standards follow. The following list is by no means exclusive, and is provided as a recommended starting point only. Applicants should therefore, obtain from the E&PD as the FAA's lubricating oil focal point, and the appropriate airplane directorate, guidance on regulations with which they will need to show compliance.

(1) Applicants should show that the oil is compatible with aircraft or propeller systems that use the oil (see §§ 25.901(d), 25.903, 25.903(f), 25.905, 25.943, 25.1011(b), 25.1019, 23.901(e), 23.901(f), 23.903(b)(2), 23.905(d), 23.909, 27.903, and 29.903).

(2) Applicants should show that the oil has no adverse effect on engine cooling (see §§ 25.1041, 25.1043, 25.1045, 23.1041, 23.1043, 23.1045, 23.1047, 27.1041, 27.1043, 27.1045, 29.1041, 29.1043, 29.1045, 29.1047, and 29.1049).

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APPENDIX 1

HORIZONTALLY OPPOSED RECIPROCATING ENGINE OIL APPROVALS: THE SAE J1899 PROGRAM

1. Introduction. This appendix provides guidance for oil qualification programs performed in accordance with SAE standard J1899, "Lubricating Oil, Aircraft Piston Engine (Ashless Dispersant)." This appendix provides guidance specific to SAE J1899 qualified piston engine lubricating oils. It applies only to Teledyne Continental Motors (TCM) and Lycoming Engines (LE) horizontally opposed reciprocating engines.

2. Background.

a. This appendix applies to a single engine model or a family of engine models if the applicant can show that the tested engine represents the most severe case. The costs associated with such a substantiation program are prohibitive for single reciprocating engine models; therefore, a broader applicability for lubricating oil approvals is required for these engines.

b. The Naval Air Warfare Center (NAWC) developed a standardized procedure to qualify a particular engine oil across engine models, based on similarities of materials and design operating parameters. Today, this procedure applies only to horizontally opposed reciprocating engines manufactured by TCM and LE.

c. The NAWC's procedure is captured in SAE standard J1899. It provides specific requirements for laboratory testing, engine bench testing, and engine flight testing. It represents an acceptable method of showing the FAA that applicable airworthiness certification standards are retained when the oil is used.

3. FAA Oversight of SAE J1899 Qualification Program. The SAE J1899 qualification program consists of: Step 1—all laboratory analysis and testing and engine endurance testing; and Step 2—flight testing of the oil using the specified engine model. The SAE technical team, comprised of the oil manufacturer, engine manufacturers, the FAA, and the U.S. Navy, oversees both steps. Under Step 1, applicants conduct sufficient testing and analysis to obtain an STC which approves the use of the oil for flight testing on designated TCM and LE engines in Step 2. Step 1 requires direct FAA participation. Step 2 relies on delegated oversight performed by the engine manufacturers under their design change approval system. An overview of each step is provided below.

a. <u>Step 1: Preliminary Data and Ground Testing</u>.

(1) The objective of this step is to provide proof of compliance to obtain a supplemental type certificate that authorizes flight testing of the LE and TCM engine models specified in SAE J1899. For this step, applicants should submit a compliance plan to the E&PD which identifies the applicable regulations from part 33 (or Civil Air

Regulation (CAR) 13). The applicant should also provide the FAA with analyses, data, test plans and test reports to demonstrate compliance with each regulation.

(2) The first step consists of providing all preliminary data, laboratory testing, and evaluation; the L-38 engine test; and the 150-hour engine endurance test of a Lycoming TIO-540 engine. The applicant must perform these tests in accordance with SAE J1899.

(3) The compliance plan should reference the applicable J1899 sections. The following table summarizes the relationship between J1899 and part 33; applicants can use it to aid in developing their compliance plan.

Table A-1. Relationship between J1899 and Part 33

CFR Section	Subject	Comments	J1899 Reference
33.7	Engine operating limitations	Oil specification reference defined.	3.
33.15	Materials	Data from L-38 engine test, and any other laboratory data related to materials compatibility.	3.8.1
33.39	Lubrication system	Analyses and test data to confirm the lube system operates properly with the new oil.	3.
33.42	General (block tests)	Break-in, oil consumption, and pre-and post-test calibration runs, 150 hour endurance test.	3.8.2, appendix B
33.45	Calibration tests	Break-in, oil consumption, and pre-and post-test calibration runs.	3.8.2, B6.2, B6.3, B6.4, B6.6
33.49	Endurance test	150 hour endurance test.	3.8.2, B6.5
33.55	Teardown inspection	Post-test inspection requirements.	3.8.2, B7

For engines certified under CAR 13, applicants should reference the equivalent requirement from that regulation.

(4) Some differences exist between § 33.49 and the J1899 endurance test of section B6.5. For example, J1899 B6.5 does not require that the engine be operated at critical and 8000 ft. altitudes, as required by § 33.49(e)(1)(ii), and does not require that accessories be loaded, as required by § 33.49(a). Also, the turbo supercharger 50-hour test specified in § 33.49(e)(1)(iii) is not included in the J1899 test. However, the J1899

B6.5 test is acceptable to show that the engine oil or additive is acceptable for the limited flight test to be performed in Step 2.

(5) The 150-hour endurance test specified in J1899 B6.5 is considered an official FAA test and, therefore, subject to FAA certification test requirements. These include conformity of the test lubricant or additive, conformity of the test hardware and apparatus, and FAA testing oversight. Applicants should submit a test plan for approval, and the cognizant FAA ACO should issue a Test Inspection Authorization, prior to conducting the tests.

(6) Upon completion of the above requirements, the FAA will issue an STC to authorize flight testing of the specified LE and TCM engine models in accordance with appendix C of SAE J1899.

b. Step 2: Flight Testing.

(1) Flight evaluation is the second step, using the specified LE and TCM engine models, as described in SAE J1899, appendix C. In this step, the applicant should conduct a long duration flight test of 500 hours on both LE and TCM engines.

(2) The FAA has delegated oversight of these tests to the engine manufacturers under their design approval holder (DAH) authority. Test conformity and procedure requirements need only meet the engine manufacturer's requirements for a design change. Although the company designated engineering representative is responsible for FAA oversight, the FAA retains the authority to observe the testing or review the engine manufacturer's approval of the product, if necessary. The applicant should ensure that the engine manufacturer is participating in the evaluation of the oil and has access to sufficient data to assess the acceptability of the product.

(3) Step 2 allows the SAE technical team to complete the evaluation of the oil. Once completed, the team will determine if the oil should be added to the U.S. Navy's QPL. Engine manufacturer approval of the product is accomplished by reference to the QPL in LE and TCM service documents.

APPENDIX 2

APPLICABLE AIRWORTHINESS STANDARDS - ENGINES

The following sections from 14 CFR part 33 and TSO C77b may aid applicants in developing their compliance plans. This list is by no means all inclusive. Applicants should, therefore, work with their assigned ACOs and the E&PD to develop their individual compliance plans.

1. Fuel Approval for Turbine Engines.

§ 33.4 Instructions for Continued Airworthiness
§ 33.5 Instruction manual for installing and operating the engine
§ 33.7 Engine ratings and operating limitations
§ 33.15 Materials
§ 33.17 Fire prevention
§ 33.19 Durability
§ 33.21 Engine cooling
§ 33.28 Engine control systems
§ 33.65 Surge and stall characteristics
§ 33.67 Fuel system
§ 33.72 Hydraulic actuating systems
§ 33.73 Power or thrust response
§ 33.82 General
§ 33.85 Calibration tests
§ 33.87 Endurance test
§ 33.89 Operation test
§ 33.91 Engine component test
§ 33.93 Teardown inspection
§ 33.99 General conduct of block tests

2. Fuel Approval for APUs (from TSO C77b).

a. Paragraph 4. MARKING, subparagraph b.(2), “Fuel type and specification.”

b. Paragraph 5, DATA REQUIREMENTS, subparagraph (b), “TSO Technical Data.” including the following statements from this paragraph:

(1) “(4) A model specification that specifies the APU ratings and operating limitations established when demonstrating compliance with the requirements of this TSO.”

(2) “(5) Manual(s) that contain instructions for installing and operating the APU.”

(3) "(6) Manual(s) containing instructions for continued airworthiness of the APU."

c. Appendix 1 (Performance Standards). The following sections apply:

4.2 Materials
4.4 Operating characteristics
4.5 APU Control System
5.2 Fire prevention
5.5 Fuel system
5.7 Cooling
6.1 General (Block Tests)
6.2 Calibration tests
6.3 Endurance test
6.4 Teardown Inspection
6.9 Electronic Control Components

3. Fuel Approval for Reciprocating Engines.

§ 33.4 Instructions for Continued Airworthiness
§ 33.5 Instruction manual for installing and operating the engine
§ 33.7 Engine ratings and operating limitations
§ 33.15 Materials
§ 33.17 Fire prevention
§ 33.19 Durability
§ 33.21 Engine cooling
§ 33.28 Engine control systems
§ 33.35 Fuel and induction system
§ 33.43 Vibration test
§ 33.45 Calibration test
§ 33.47 Detonation test
§ 33.49 Endurance test
§ 33.51 Operation test
§ 33.53 Engine component test
§ 33.55 Teardown inspection
§ 33.57 General conduct of block tests

4. Oil Approval for Turbine Engines.

§ 33.4 Instructions for Continued Airworthiness
§ 33.5 Instruction manual for installing and operating the engine
§ 33.7 Engine ratings and operating limitations
§ 33.15 Materials
§ 33.17 Fire prevention

§ 33.19 Durability
§ 33.21 Engine cooling
§ 33.71 Lubrication system
§ 33.72 Hydraulic actuating systems
§ 33.82 General
§ 33.85 Calibration tests
§ 33.87 Endurance test
§ 33.91 Engine component test
§ 33.93 Teardown inspection
§ 33.99 General conduct of block tests

5. Oil Approval for APUs (from TSO C77b).

a. Paragraph 4. MARKING, subparagraph (b), including "(3) Lubricating oil type and specification."

b. Paragraph 5, DATA REQUIREMENTS, subparagraph (b), "TSO Technical Data," including the following statements from this paragraph:

(1) "(4) A model specification that specifies the APU ratings and operating limitations established when demonstrating compliance with the requirements of this TSO."

(2) "(5) Manual(s) that contain instructions for installing and operating the APU."

(3) "(6) Manual(s) containing instructions for continued airworthiness of the APU."

c. Appendix 1 (Performance Standards). The following sections apply:

4.2 Materials
4.4 Operating characteristics
4.7 Extreme attitude operation
5.2 Fire prevention
5.4 Lubrication system
5.7 Cooling
6.1 General (Block Tests)
6.2 Calibration tests
6.3 Endurance test
6.4 Teardown Inspection
6.9 Electronic Control Components

6. Oil Approval for Reciprocating Engines.

§ 33.4 Instructions for Continued Airworthiness
§ 33.5 Instruction manual for installing and operating the engine
§ 33.7 Engine ratings and operating limitations
§ 33.15 Materials
§ 33.17 Fire prevention
§ 33.19 Durability
§ 33.21 Engine cooling
§ 33.39 Lubrication system
§ 33.42 General
§ 33.45 Calibration tests
§ 33.49 Endurance test
§ 33.53 Engine component test
§ 33.55 Teardown inspection
§ 33.57 General conduct of block tests

APPENDIX 3

APPLICABLE AIRWORTHINESS STANDARDS – AIRPLANES AND ROTORCRAFT

The following sections from 14 CFR parts 23, 25, 27, or 29 may aid applicants in developing their compliance plans. This list is by no means all inclusive. Applicants should, therefore, work with their assigned ACOs, the E&PD, and cognizant directorate to develop their individual compliance plans.

1. Fuel.

a. Transport Category Airplanes.

§ 25.23	Load distribution limits
§ 25.25	Weight limits
§ 25.29	Empty weight and corresponding center of gravity
§ 25.105	Takeoff
§ 25.117	Climb: general
§ 25.119	Landing climb: All-engines operating
§ 25.121	Climb: One-engine-inoperative
§ 25.603	Materials
§ 25.863(b)(2)	Flammable Fluid Fire Protection
§ 25.901(d)	Auxiliary power unit
§ 25.903(a)	Engine type certificate.
§ 25.903(e)	Restart capability
§ 25.903(f)	Auxiliary power unit
§ 25.939	Turbine engine operating characteristics
§ 25.943	Negative acceleration
§ 25.951	General (fuel system)
§ 25.952	Fuel system analysis and test
§ 25.955	Fuel flow
§ 25.959	Unusable fuel supply
§ 25.961	Fuel system hot weather operation
§ 25.969	Fuel tank expansion space
§ 25.975	Fuel tank vents and carburetor vapor vents
§ 25.979	Pressure fueling system
§ 25.981	Fuel tank ignition prevention
§ 25.997	Fuel strainer or filter
§ 25.1001	Fuel jettisoning system
§ 25.1011(b)	General (oil system)
§ 25.1041	General (cooling)

§ 25.1043	Cooling tests
§ 25.1045	Cooling test procedures
§ 25.1305	Powerplant instruments
§ 25.1337	Powerplant instruments
§ 25.1521	Powerplant limitations
§ 25.1522	Auxiliary power unit limitations
§ 25.1529	Instructions for Continued Airworthiness
§ 25.1557(b)	Powerplant fluid filler openings
§ 25.1541	General (markings and placards)
§ 25.1581	General (airplane flight manual)
§ 25.1583	Operating limitations
§ 25.1585(e)(f)	Operating procedures

b. Normal, Utility, Acrobatic, and Commuter Category Airplanes.

§ 23.23	Load distribution limits
§ 23.25	Weight limits
§ 23.29	Empty weight and corresponding center of gravity
§ 23.53	Takeoff performance
§ 23.63	Climb: General
§ 23.69	Enroute climb/descent
§ 23.77	Balked landing
§ 23.343	Design fuel loads
§ 23.603	Materials
§ 23.863(b)(2)	Flammable fluid fire protection
§ 23.901(f)	Auxiliary power unit
§ 23.903	Engines
§ 23.939	Powerplant operating characteristics
§ 23.943	Negative acceleration
§ 23.951	General (fuel system)
§ 23.955	Fuel flow
§ 23.959	Unusable fuel supply
§ 23.961	Fuel system hot weather operation
§ 23.963	Fuel tanks: General
§ 23.965	Fuel tank tests
§ 23.969	Fuel tank expansion space
§ 23.973(e)(f)	Fuel tank filler connection
§ 23.975	Fuel tank vents and carburetor vapor vents
§ 23.979	Pressure fueling system
§ 23.993	Fuel system lines and fittings
§ 23.997	Fuel strainer or filter
§ 23.1001	Fuel jettisoning system
§ 23.1011	General (oil system)

§ 23.1041	General (cooling)
§ 23.1043	Cooling tests
§ 23.1045	Cooling test procedures for turbine powered airplanes
§ 23.1047	Cooling test procedures for reciprocating engine powered airplanes
§ 23.1305	Powerplant instruments
§ 23.1337	Powerplant instruments installation
§ 23.1501	General
§ 23.1521	Powerplant limitations
§ 23.1522	Auxiliary power unit limitations
§ 23.1529	Instructions for Continued Airworthiness
§ 23.1541	General (markings and placards)
§ 23.1549	Powerplant and auxiliary power unit instruments
§ 23.1557(c)	Powerplant fluid filler openings
§ 23.1581	General (airplane flight manual)
§ 23.1583	Operating limitations
§ 23.1585(i)	Operating procedures

c. Normal Category Rotorcraft. (Note: Additional requirements from appendix A to part 27 may apply for Category A approval of rotorcraft.)

§ 27.25	Weight limits
§ 27.27	Center of gravity limits
§ 27.29	Empty weight and corresponding center of gravity
§ 27.45	Performance (General)
§ 27.49	Performance at minimum operating speed
§ 27.51	Takeoff
§ 27.65	Climb: All-engines operating
§ 27.67	Climb: One-engine-inoperative
§ 27.75	Landing
§ 27.603	Materials
§ 27.863(b)(2)	Flammable fluid fire protection
§ 27.903	Engines
§ 27.903(d)	Restart capability
§ 27.939	Turbine engine operating characteristics
§ 27.951	General (fuel system)
§ 27.955	Fuel flow
§ 27.959	Unusable fuel supply
§ 27.961	Fuel system hot weather operation
§ 27.969	Fuel tank expansion space
§ 27.975	Fuel tank vents
§ 27.997	Fuel strainer or filter
§ 27.1011(b)	General (oil system)

§ 27.1041	General (cooling)
§ 27.1043	Cooling tests
§ 27.1045	Cooling test procedures
§ 27.1305	Powerplant instruments
§ 27.1337	Powerplant instruments
§ 27.1521	Powerplant limitations
§ 271529	Instructions for Continued Airworthiness
§ 27.1541	General (markings and placards)
§ 27.1557(c)	Miscellaneous markings and placards
§ 27.1581	General (rotorcraft flight manual)
§ 27.1583	Operating limitations
§ 27.1585(e)(f)	Operating procedures

d. Transport Category Rotorcraft.

§ 29.25	Weight limits
§ 29.27	Center of gravity limits
§ 29.29	Empty weight and corresponding center of gravity
§ 29.45	Performance (General)
§ 29.49	Performance at minimum operating speed
§ 29.51	Takeoff data: general
§ 29.53	Takeoff: Category A
§ 29.63	Takeoff: Category B
§ 29.65	Climb: All-engines operating
§ 29.67	Climb: One-engine-inoperative
§ 29.77	Landing decision point (LDP): Category A
§ 29.79	Landing: Category A
§ 29.83	Landing: Category B
§ 29.85	Landing: balked landing: Category A
§ 29.603	Materials
§ 29.863(b)(2)	Flammable Fluid Fire Protection
§ 29.901(c)(d)	Auxiliary power unit
§ 29.903	Engines
§ 29.903(e)	Restart capability
§ 29.923(p)	Rotor drive system and control mechanism tests
§ 29.939	Turbine engine operating characteristics
§ 29.951	General (fuel system)
§ 29.955	Fuel flow
§ 29.959	Unusable fuel supply
§ 29.961	Fuel system hot weather operation
§ 29.969	Fuel tank expansion space
§ 29.975	Fuel tank vents and carburetor vapor vents
§ 29.979	Pressure refueling

§ 29.997	Fuel strainer or filter
§ 29.1001	Fuel jettisoning system
§ 29.1011(b)	General (oil system)
§ 29.1041	General (cooling)
§ 29.1043	Cooling tests
§ 29.1045	Climb cooling test procedures
§ 29.1047	Takeoff cooling test procedures
§ 29.1049	Hover cooling test procedures
§ 29.1305	Powerplant instruments
§ 29.1337	Powerplant instruments
§ 29.1521	Powerplant limitations
§ 29.1522	Auxiliary power unit limitations
§ 29.1529	Instructions for Continued Airworthiness
§ 29.1541	General (markings and placards)
§ 29.1557(c)	Miscellaneous markings and placards
§ 29.1581	General (rotorcraft flight manual)
§ 29.1583	Operating limitations
§ 29.1585(e)(f)	Operating procedures
§ 29.1587	Performance information

2. Oil.

a. Transport Category Airplanes.

§ 25.863(b)(2)	Flammable fluid fire protection
§ 25.901(d)	Auxiliary power unit
§ 25.903	Engines
§ 25.903(f)	Auxiliary power unit
§ 25.905	Propellers
§ 25.943	Negative acceleration
§ 25.1011(b)	General (oil system)
§ 25.1019	Oil strainer or filter
§ 25.1041	General (cooling)
§ 25.1043	Cooling tests
§ 25.1045	Cooling test procedures
§ 25.1521	Powerplant limitations
§ 25.1522	Auxiliary power unit limitations
§ 25.1529	Instructions for Continued Airworthiness
§ 25.1541	General (markings and placards)
§ 25.1581	General (airplane flight manual)
§ 25.1583	Operating limitations

b. Normal, Utility, Acrobatic, and Commuter Category Airplanes.

§ 23.863(b)(2)	Flammable fluid fire protection
§ 23.901(f)	Auxiliary power unit
§ 23.903	Engines
§ 23.905	Propellers
§ 23.909	Turbocharger systems
§ 23.943	Negative acceleration
§ 23.1011(b)	General (oil system)
§ 23.1019	Oil strainer or filter
§ 23.1041	General (cooling)
§ 23.1043	Cooling tests
§ 23.1045	Cooling test procedures for turbine powered airplanes
§ 23.1047	Cooling test procedures for reciprocating engine powered airplanes
§ 23.1501	General
§ 23.1521	Powerplant limitations
§ 23.1522	Auxiliary power unit limitations
§ 23.1529	Instructions for Continued Airworthiness
§ 23.1541	General (markings and placards)
§ 23.1549	Powerplant and auxiliary power unit instruments
§ 23.1581	General (airplane flight manual)
§ 23.1583	Operating limitations

c. Normal Category Rotorcraft. (Note: Additional requirements from appendix A to part 27 may apply for Category A approval of rotorcraft.)

§ 27.863(b)(2)	Flammable fluid fire protection
§ 27.903	Engines
§ 27.923	Rotor drive system and control mechanism tests
§ 27.927	Additional tests
§ 27.1011(b)	General (oil system)
§ 27.1019	Oil strainer or filter
§ 27.1041	General (cooling)
§ 27.1043	Cooling tests
§ 27.1045	Cooling test procedures
§ 27.1521	Powerplant limitations
§ 271529	Instructions for Continued Airworthiness
§ 27.1541	General (markings and placards)
§ 27.1581	General (airplane flight manual)
§ 27.1583	Operating limitations

d. Transport Category Rotorcraft.

§ 29.863(b)(2)	Flammable fluid fire protection
§ 29.903	Engines
§ 29.901(c)(d)	Auxiliary power unit
§ 29.923	Rotor drive system and control mechanism tests
§ 29.927	Additional tests
§ 29.1011(b)	General (oil system)
§ 29.1019	Oil strainer or filter
§ 29.1041	General (cooling)
§ 29.1043	Cooling tests
§ 29.1045	Climb cooling test procedures
§ 29.1047	Takeoff cooling test procedures
§ 29.1049	Hover cooling test procedures
§ 29.1521	Powerplant limitations
§ 29.1522	Auxiliary power unit limitations
§ 29.1529	Instructions for Continued Airworthiness
§ 29.1541	General (markings and placards)
§ 29.1581	General (airplane flight manual)
§ 29.1583	Operating limitations