



U.S. Department
of Transportation
**Federal Aviation
Administration**

Advisory Circular

Subject: Approval of Propulsion Fuels,
Additives, and Lubricating Oils

Date: 6/30/14

AC No: 20-24D

Initiated by: AIR-20

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 guidance on fuel and lubricating oil specifications and standards, and on propulsion fuel and/or lubricating oil certification plans. This AC 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. The FAA (Federal Aviation Administration) will consider other methods an applicant may present to demonstrate compliance. Terms such as “should,” “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. This material does not change, create any additional, authorize changes in, or permit deviations from existing regulatory requirements.

3. Cancellation. AC 20-24C, Approval of Propulsion Fuels and Lubricating Oils, dated July 29, 2011, 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 (see appendices 2 and 3 of this AC for additional applicable regulations):

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

- b. Section 23.1521(d), Fuel grade or designation.
- c. Section 23.1522, Auxiliary power unit limitations.
- d. Section 23.1583(b)(1), Operating limitations.
- 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.
- l. Appendix G23.3(a)(4), Instructions for continued airworthiness, servicing information.
- m. Appendix H25.3(a)(4), Instructions for continued airworthiness, servicing information.
- n. Appendix A27.3(a)(4), Instructions for continued airworthiness, servicing information.
- o. Appendix A29.3(a)(4), Instructions for continued airworthiness, servicing information.

5. References and Related Reading.

a. FAA Guidance.

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

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

(3) AC 23.1521-1B, "Type Certification of Automobile Gasoline in Part 23 Airplanes with Reciprocating Engines," dated March 2, 1995.

(4) AC 23.1521-2, Change 1, "Type Certification of Oxygenates and Oxygenated Gasoline Fuels in Part 23 Airplanes with Reciprocating Engines," dated April 24, 1996.

(5) AC 33.47-1, "Detonation Testing in Reciprocating Aircraft Engines," dated June 27, 1988.

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

b. Industry Guidance.

(1) 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."

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

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

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

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

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

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

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

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

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

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

(12) CRC Report No. 635, "Handbook Of Aviation Fuel Properties," 2004 Third Edition, Coordinating Research Council, Inc.

(13) Defence Standard 91-86, “Turbine Fuel, Aviation Kerosine Type: High Flash Type, Containing Fuel System Icing Inhibitor,” issued by the United Kingdom (U.K.) Ministry of Defence.

(14) Defence Standard 91-87, “Turbine Fuel, Aviation Kerosine Type, Containing Fuel System Icing Inhibitor,” issued by the U.K. Ministry of Defence.

(15) 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.”

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

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

(18) 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).

(19) MIL-HDBK-510-1, “Department of Defense Handbook, Aerospace Fuels Certification,” dated November 13, 2008.

(20) RTCA Document No. (RTCA/DO)-160G, “Environmental Conditions and Test Procedures for Airborne Equipment,” dated December 8, 2010.

(21) SAE International Surface Vehicle Standard J1899, “Lubricating Oil, Aircraft Piston Engine (Ashless Dispersant).”

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

(23) SAE International Aerospace Standard AS5780, “Specification for Aero and Aero Derived Gas Turbine Engine Lubricants.”

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 fair consideration of all comments, and each objector is advised of the disposition of his or her objection(s) and the reasons why. In addition, consensus body members may change their votes after reviewing the comments.

b. Fuel or Oil Grade or Designation. A descriptive term used to identify a fuel or oil that meets certain performance requirements and other characteristics defined in an industry, governmental, or military specification.

c. 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.

d. Voluntary Consensus Standards Bodies. Domestic or international organizations that 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.

e. Independent Specifications. Specifications that are developed and issued by an independent organization, company, or individual that are not sanctioned, issued, or approved by a government, military, or industry voluntary consensus-based organization.

7. Background.

a. 14 CFR requires that type certificate (TC) applicants identify the fuel and oil grade, designation, and/or specifications that are used in their products during certification. Once compliance with the airworthiness certification regulations is demonstrated, the grade, designation, and/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 comply with the AFM or RFM. Operators must use only those fuels and oils listed in the AFM and RFM. The operating limitations, therefore, must be precise ensuring the fuel and oil is controlled enabling the engine and aircraft to continue to meet their airworthiness certification basis during service.

b. Historically, the FAA used the voluntary consensus standards from ASTM or SAE to identify fuel and oil grades, designations, brand name designations, or specifications to be identified on a TCDS. Applicants demonstrated that the product (for example, the engine or airplane) operated as designed over its complete operating range using the proposed fuel or oil. Applicants demonstrated this during a TC, amended TC, supplemental TC (STC), or amended STC (ASTC) program. Once demonstrated, the FAA issued the TC, amended TC, STC, or ASTC with the fuel or oil identified as an operating limitation. Thereafter, when applicants proposed adding new fuels or oils to an existing TC or STC, those new fuels or oils were also identified by grade designations, brand name designations, and/or ASTM or SAE industry-based consensus specifications. As with the original demonstration, applicants then demonstrated that

the aircraft or engine complied with the certification basis. See appendices of this AC for a list (not all-inclusive list) of regulations. After the demonstration, the FAA identified the new fuel or oil grade, designation, or specification, as an operating limitation.

c. Historically, the FAA recognized the MIL-STD process and the controls in place by the U.S. military. Accordingly, the FAA has accepted their grades, designations, and/or specifications as sufficient to meet its regulatory needs related to identifying fuels and oils as operating limitations on a TCDS.

d. The FAA continues to accept this historical approach in identifying new fuels and oils through a consensus-based industry organization, governmental, or military standard. After the proper regulatory demonstration, the fuel or oil can be identified as an operating limitation on a TC.

(1) Accordingly, fuels identified by an ASTM, governmental or military specification, or other industry-based consensus organization specification, are considered to be identified in sufficient detail to be accepted by the FAA as fuel operating limitations on a TC, amended TC, STC, or ASTC.

(2) Oils identified by an SAE oil standard or a brand name that meets an SAE standard, governmental or military specification, or other industry-based consensus organization specification, are considered to be identified in sufficient detail to be accepted by the FAA as oil operating limitations on a TC, amended TC, STC, or ASTC.

e. The FAA will also accept fuels identified by independent specifications, provided the specification meets the criteria specified in paragraph 8.e. of this AC.

f. Applicants proposing to add a fuel to a product's TC, or as an STC, should first contact the FAA and provide either:

(1) An industry voluntary consensus, governmental, or military organization standard or specification they intend to use, or

(2) An independent specification that meets the criteria specified in paragraph 8.e. of this AC that they intend to use.

g. Applicants proposing an oil for a product should first contact the FAA and provide the industry voluntary consensus, governmental, or military organization standard or specification they propose to add to a TC, STC, or ASTC.

h. The applicant should then coordinate with the FAA 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 submitted specification, but must substantiate that the tested fuel or oil meets the final issued version of the specification before the FAA issues the final design approval.

i. Once the applicant successfully completes the demonstration of compliance, the proposed fuel, as identified by specification number, and any other information necessary to define the fuel, may be included as an operating limitation on the product's TCDS by the FAA. For example, the fuel could be identified by specification number and octane requirement or grade. Oil could be identified by a specification number, or any other information necessary, such as brand name or grade. These operating limitations will also be identified by the applicant 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 with the proposed fuel or oil, continues to meet the certification requirements of the specific engine, APU, and aircraft, for example, 14 CFR parts 21, 23, 25, 27, 29, 33 and 35, technical standard order (TSO), TSO-C77, etc.

(1) Approved fuels are described in the operating limitations (located in the TCDS and AFM, or STC and aircraft flight manual supplement (AFMS), whichever is applicable), engine installation and operating instructions, and the engine and aircraft maintenance manuals in a manner consistent with the examples below:

(a) Jet A or Jet A1, meeting ASTM D1655.

(b) Grade 100LL, meeting ASTM D910.

(2) Approved oils are described in the operating limitations (located in the TCDS and AFM, or STC and AFMS, whichever is applicable), engine installation and operating instructions, and the engine and aircraft maintenance manuals in a manner consistent with the example below:

(a) Aeroshell Oil W 15W-50, meeting SAE International Standard, SAE J1899.

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.

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

(a) Defence Standards 91-91, “Turbine Fuel, Aviation Kerosine 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 U.K.’s Defence Fuels and Lubricants Committee (DFLC) in collaboration with the 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 F-34 and F-44),” issued by the Canadian General Standards Board (CGSB).

(c) GOST (Gosudarstvennyy Standart) 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 Eastern European countries.

(d) GB 6537, “No. 3 Jet Fuel,” issued by China’s National Technology Supervisory Bureau. This specification 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. Other specifications for reciprocating SI engine aviation fuel include:

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

(b) ASTM 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 U.K.’s DFCL in collaboration with the 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 certificate for each certificated product. The following 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), and §§ 25.1521(b)(2) and (c)(2) (transport category).

(c) APU operating limitations for fuel are required by § 23.1522, § 25.1522, and § 29.1522.

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

c. ASTM Aviation Fuel Specifications as Operating Limitations for Aviation Fuel.

(1) The FAA has determined that ASTM aviation fuel specifications are acceptable specifications, and may be identified as operating limitations for fuel. The root number of the ASTM fuel specification (e.g., D1655; except as noted in paragraph 8.c.(2)(c) of this AC) and any other information necessary to define the fuel, such as octane requirement or grade used to successfully complete the compliance demonstration, will be listed in the engine and aircraft TCDS. Manufacturers will also list the specifications in the documents referenced in the TCDS. For STC projects, the fuel specification root number (except as noted in paragraph 8.c.(2)(c) of this AC) and any other information necessary to define the fuel, such as octane requirement or grade, 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, allowing for adequate reference as an operating limitation.

(2) Special Considerations Applicable to ASTM Aviation Fuel Specifications.

(a) Minor Revisions to ASTM Aviation Fuel Specifications. Revisions to fuel specifications that are not significant enough to impact the suitability of the fuel for its intended use are incorporated as minor revisions under the existing specification root number. Each minor revision of the specification is then identified by a new suffix number, which is typically issued on an annual basis. These minor revisions consist of editorial changes, wording clarifications, or changes in criteria, materials, or processes. These changes are not extensive enough to require the issuance of a new specification.

1 Operating limitations that specify an ASTM fuel specification root number only does not require an amendment to that approval when minor revisions are incorporated into that ASTM fuel specification.

2 Operating limitations that specify an ASTM fuel specification root number and suffix number do require an amendment to that approval when minor revisions are incorporated into that ASTM fuel specification (see paragraph 8.c.(2)(c) of this AC).

(b) Synthetic Jet Fuels. ASTM 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 has issued two standards intended to facilitate the evaluation of synthetic jet fuel produced from non-conventional sources, and the integration of these fuels into the existing supply system and onto existing aircraft.

1 ASTM D4054, “Standard Practice for 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. The D4054 evaluation is conducted for both new fuels and revisions to existing fuel properties to verify that the resulting fuel is suitable for aviation use, based on its performance characteristics and chemical compositions. 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 D7566, “Aviation Turbine Fuel Containing Synthesized Hydrocarbons.” This specification defines criteria for synthetic jet 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 type is incorporated in D7566 and current specified operating limitations are adequate to accommodate 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 in which the scope does not include aircraft engines, or does not explicitly include the intended type of aircraft or aircraft engine. The ASTM subcommittee that is responsible for these specifications will not consider the suitability of the fuel for use on aircraft or aircraft engines. In this case, the impact of minor revisions (see paragraph 8(b)(3)(a) of this AC) to the fuel specification, on the fuel’s suitability for aircraft and aircraft engines, must be evaluated by the applicant. The operating limitation must reference

both the specification root number and the issue suffix number or revision level to allow for the evaluation and approval of each minor revision. 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 D4814, “Standard Specification for Automotive SI Engine Fuel.”

2 ASTM D4806, “Standard Specification for Denatured Fuel Ethanol for Blending with Gasolines for Use as Automotive Spark-Ignition Engine Fuel.”

3 D1655 for 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 specifically 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 is listed as D1655-10 for a project initiated in CY 2010.

(d) Aviation Fuel Sub-Grades. ASTM International aviation fuel specifications may specify certain fuel grades that are subsets of existing grades. These sub-grades meet all of the performance requirements of other existing grades, but specify a narrower range or more stringent criteria for some of those properties. For example, in ASTM International specification D910, grade 100VLL is identical to grade 100LL in all aspects, except that the maximum lead content is reduced by about 19%. Because the specification criteria for 100LL lead content is expressed as only a maximum value, the lower maximum of 100VLL will always meet 100LL’s specification requirements. Also, in ASTM International specification D1655, grade Jet A-1 is identical to grade Jet A, except that Jet A-1 specifies a lower freezing point (-47°C) than Jet A (-40°C). Because the freezing point is specified as a maximum criterion, Jet A-1 will always meet the specification requirements of Jet A.

1 Sub-grades such as Grade 100VLL or Jet A-1 are acceptable for use on those aircraft and engines that are approved to operate with other grades that encompass all of the specification criteria of the sub-grade, unless otherwise prohibited by the TC/STC holder. The TC/STC holder may communicate the acceptability of sub-grades to operators via routine service information documents.

2 If TC/STC holders choose to add sub-grades to existing operating limitations in aircraft flight manuals, pilot operating instructions, or TCDSs that specify other grades that encompass all of the specification criteria of the sub-grade, they may substantiate their showing of compliance to the applicable aircraft or engine airworthiness standards by submittal of the subject ASTM International aviation fuel specification(s). If the sub-grade is added to the operating limitations, then aircraft placards, operating, maintenance, and other service documents must also be revised to specify the sub-grade.

d. Other Governmental, Military or Industry Voluntary Consensus-Based Standards, or Specifications as Operating Limitations for Aviation Fuel. 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.

e. Independent Specifications as Operating Limitations for Aviation Fuel.

(1) The FAA has determined that independent fuel specifications may be acceptable for definition of aviation fuel operating limitations if they provide an equivalent level of property, performance, and quality control as governmental, military, or industry voluntary consensus-based standards.

(2) The intent of this guidance is to provide an acceptable level of property, performance, and quality control for fuels produced to independent specifications. Fuels used for certification compliance testing must meet all of the requirements of the independent specification.

(3) Fuel Production Requirements. Independent specifications must include criteria to ensure that fuels produced to these specifications are controlled in a manner consistent with the fuel used during the certification testing. Production processes and facilities, quality control systems, manufacturing processes, materials and feedstocks, additives, and test methods must all be consistent with the fuel used for certification testing. Production traceability and control of non-compliant or contaminated fuel batches must be provided to allow for continued operational safety planning.

(4) Additives. Additives permitted for use in fuels identified by independent specifications must be sufficiently specified to limit the variability of additive chemical composition. The independent specification must provide a means for detecting the presence of any additive permitted for use in the fuel defined by the specification.

(5) Fuel Properties and Compositional Definition. Independent specifications must specify a very narrow range of composition and properties to minimize the variability of performance of fuels produced to the specification.

(6) Trace Materials. Criteria to limit trace materials, such as trace organics, non-metals, and metals, must be established based on the feedstock and process characteristics. Test methods must be specified to measure trace materials.

(7) Test Methods. Test methods must be specified for each criterion used to measure the properties of the fuel. The reproducibility and repeatability of each specified test method must be defined, and must be valid for the specific chemistry of the fuel. A referee test method must be specified if more than one test method is defined for a particular criterion. Only those test methods used during the certification compliance program may be listed in the specification.

(8) Test Laboratories. The specification must define the accreditation requirements for laboratories used to conduct test methods specified in the specification.

(9) Transfer. Independent specifications must specify requirements to measure and document fuel properties at each transfer of ownership, storage facility, and transportation mode.

(10) Change Control. A change to any of the requirements included in the specification will be subject to FAA design change oversight and approval. Independent specifications must be listed in the operating limitations in the TCDS and AFM/RFM, and must provide a means for change tracking, i.e., a revision number.

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

(1) 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 are not limited to, those regulations listed in appendices 2 and 3 of this AC.

(2) Applicants must present either an issued industry consensus-based, governmental or military fuel specification as specified in paragraphs 8.c and 8.d of this AC, or an independent specification that meets the criteria specified in paragraph 8.e. of this AC, and a compliance plan to the FAA.

(3) An applicant's compliance plan must 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 with the FAA are recommended to ensure the plan is developed with minimal delay.

(4) An applicant's compliance plan must address the effects of mixing the proposed new aviation fuel with other existing types of aviation fuel, for example, mixing 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.

(5) New 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.

(6) 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 adding an aviation fuel specification as an operating limitation. Additional guidance on some airworthiness standards follows in appendix 3. The following is not all-inclusive and is provided as a recommended starting point only. Applicants should obtain guidance from the FAA on the regulations with which they will need to show compliance.

(a) To ensure the operating limitation for the new fuel is acceptable (refer to § 33.7 and paragraph 5.b.(4) of TSO-C77b), applicants must show that the new fuel is compatible with existing fuels, additives, and oils specified in the operating limitations and instructions for continued airworthiness (ICA). If applicable, compatibility data generated during the ASTM fuel specification development may be used.

(b) To ensure the operating limitation for the new fuel is acceptable (refer to § 33.7 and paragraph 5.b.(4) of TSO-C77b), applicants must show that the new fuel exhibits acceptable storage stability. Fuel performance related to such items as gum formation, potential gums, water reaction, microbial contamination, and fuel stability over time must be evaluated to determine the impact on fuel performance over long-duration storage.

(c) Fuel composition can significantly affect material properties and durability (refer to §§ 33.15, 33.53, and 33.91, and TSO-C77b, appendix 1, section 4.2). Applicants should demonstrate materials compatibility of the fuel-wetted materials, including elastomers, seals, and metallic components. This can be accomplished with a combination of soak testing and component testing (for example, in accordance with RTCA DO-160C), or by other methods the applicant proposes, and should become part of the applicant's compliance plan. In some cases, materials compatibility data generated during development of the ASTM fuel specification may be used. This may require testing of both used and unused non-metallic parts, such as elastomers and seals, if using the fuel on engines previously operated with other types of fuel.

(d) 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, material responses or effects, and others should be evaluated by test or analysis. The applicant must substantiate that any time-between-overhaul (TBO) established for the engine, or the existing engine's TBO, whichever is applicable, is valid with the new fuel. This may require analysis or testing to show compliance with §§ 33.15, 33.19, 33.49, and 33.87 (refer to §§ 33.15, 33.19, 33.49, and 33.87 and TSO-C77b, appendix 1, sections 4.2, 4.3 and 6.3).

(e) Applicants should evaluate engine-cooling requirements since different fuels may change combustion characteristics and thereby impact cooling requirements. This is particularly important for reciprocating engines where fuel characteristics can affect cylinder temperatures (refer to § 33.21 and TSO-C77b, appendix 1, section 5.7).

(f) The engine fuel system must 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 (refer to § 33.51). For SI reciprocating engine fuels, carburetor icing and vapor lock tendencies should be evaluated (refer to §§ 33.35, 33.67, and TSO-C77b, appendix 1, section 5.5).

(g) Avoiding engine detonation and demonstrating acceptable detonation margins are critical requirements for SI 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 must be approved by the FAA (refer to § 33.47 and see AC 33.47-1).

(h) Compression Ignition (CI) reciprocating engines require fuel with an acceptable cetane number to ensure stable combustion across the entire operating envelope. These engines typically specify Jet A fuel as the aviation fuel operating limitation. The ASTM specification for Jet A fuel, D1655, does not specify a minimum cetane number. Therefore, CI engines must demonstrate operability at the minimum expected (worst case) cetane number of Jet A fuel (refer to § 33.51).

(i) Fuel composition and properties can significantly affect the ability to support combustion at certain points in the engine-operating envelope. Applicants must therefore evaluate engine operability with the new fuel at all operating and atmospheric conditions approved for the engine. Engine starting, acceleration, deceleration, and steady-state operation must be evaluated by test or analysis for all approved operating conditions (refer to §§ 33.51, 33.89, and TSO-C77b, appendix 1, section 4.4).

(j) The applicant must identify any changes to the ICA, including, but not limited to, safety precautions, fluid compatibility, changes to placards, changes to service intervals, and changes to maintenance practices (refer to § 33.4).

(7) Applicable Regulations for Airplanes and Rotorcraft. For a list of regulations that may apply to projects adding a new aviation fuel as an operating limitation, see appendix 2 and appendix 3, of this AC. Additional guidance on airworthiness standards follows in paragraphs (7)(a) through (g) below. The following is not all-inclusive and is only provided as a recommended starting point. Applicants must obtain guidance from the FAA on the regulations they will need to show compliance.

(a) Applicants must evaluate the effect of differences in fuel properties, such as density on aircraft weight, center of gravity, and aircraft structure (refer to §§ 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 must evaluate the effect of differences in fuel properties, such as density, energy content, and combustion characteristics on aircraft performance (refer to §§ 23.53, 23.69, 23.77, 25.105, 25.117, 25.119, 25.121, 27.51, 27.65, 27.67, 29.51, 29.65, and 29.67).

(c) Applicants must demonstrate materials compatibility of the fuel wetted materials, including elastomers, seals, metallic components, fuel bladders, and fuel tanks. This can be done with a combination of soak testing and component testing (refer to §§ 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 using the fuel on aircraft previously operated with other types of fuel.

(d) Applicants must 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. Refer to §§ 23.901(d), 23.903, 23.903(d), 23.903(e), 23.903(f), 23.903(g), 23.939, 25.901(d), 25.903(a), 25.903(e), 25.903(f), 25.939, 27.903, 27.903(d), 27.939, 29.903, 29.903(e), 29.923(p), and 29.939.

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

(f) Applicants must show that the fuel is compatible with aircraft fuel system components, and that the fuel does not have any adverse effect on fuel system performance. This demonstration must 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 aviation 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 8f.(6)(c) 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 must also include an analysis of the effect of fuel properties, such as viscosity on fuel system pressure drop and fuel pump performance.

5 Refer to §§ 23.951, 23.955, 23.959, 23.969, 23.973(e)(f), 23.975, 23.979, 23.997, 23.1001, 23.1305, 23.1337, 25.951, 25.952, 25.955, 25.959, 25.969, 25.975, 25.979, 25.981, 25.997, 25.1001, 25.1305, 25.1337, 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.

(g) The applicant must identify any changes to the ICA, including, but not limited to, safety precautions, fluid compatibility, changes to placards, changes to service intervals, and changes to maintenance practices (refer to appendices G23.3, H25.3, A27.3, and A29.3).

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 (AS), SAE 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. SAE Technical Committee E-34, Propulsion Lubricants, maintains SAE AS5780. The SAE E-34 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, Lubricating Oil, Aircraft Piston Engine (Non-Dispersant Mineral Oil) and MIL-L-22851, Lubricating Oil, Aircraft Piston Engine (Ashless Dispersant) for conventional SI reciprocating engines. However, SAE International Surface Vehicle Standard J1899, "Lubricating Oil, Aircraft Piston Engine (Ashless Dispersant)," and SAE International Surface Vehicle Standard J1966, "Lubricating Oils, Aircraft Piston Engine (Non-Dispersant Mineral Oil)," replaced MIL-L-6082 and MIL-L-22851 as the primary standards for conventional SI reciprocating engine oil. SAE Standards J1899 and J1966 define physical, chemical, and performance limits for conventional SI 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 SI reciprocating engines. They also define quality control requirements to assure batch conformance and materials traceability. The SAE E-38 Aviation Piston Engine Fuels and Lubricants Committee maintains SAE Standards J1899 and J1966.

b. Operating Limitations for Lubricating Oil.

(1) FAA regulations require the Administrator to 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, brand name, and specifications for reciprocating and turbine engines.

(2) The FAA determined that SAE grade, 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 meet the 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 SI 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 SAE 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 if these changes have a significant potential to adversely impact the engine oil system. 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 re-identification, 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 aviation oil identified by another governmental, military, or industry voluntary consensus-based standard, or specification, then the applicant must 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) 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 FAA, the FAA will aid applicants as they develop their compliance plan.

(2) An applicant's compliance plan must address all applicable airworthiness certification standards, some of which are discussed paragraph 9.c(5) below. Sound testing techniques and thorough data analysis must also be well documented in the compliance plan. Accordingly, close contact and frequent coordination with the FAA are recommended to ensure the plan is developed with minimal delay.

(3) An applicant's compliance plan must 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 airplane or rotorcraft the engine is installed on continues 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 must include the applicable requirements and performance standards from the latest revision of TSO-C77.

(5) Applicable Regulations for Engines and APUs. For a list of regulations that may apply to oil projects, see appendix 2 of this AC, paragraphs 4, 5, and 6. Additional guidance on airworthiness standards follows in paragraphs 9.c(5)(a) through (d). The following list is not all-inclusive, and is provided as a recommended starting point only. Applicants must therefore, obtain from the FAA, guidance on regulations with which they will need to show compliance.

(a) Applicants must 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 done with any combination of engine test, rig test, and analysis based on prior service experience or testing. The applicant must substantiate that any time-between-overhaul (TBO) established for the engine, or the existing engine's TBO, whichever is applicable, is valid with the new oil. This may require analysis or testing to show compliance with §§ 33.15, 33.19, 33.49, and 33.87. Refer to §§ 33.15, 33.19, 33.49, and 33.87 and TSO-C77b, appendix 1, sections 4.2, 4.3, and 6.3.

(b) Applicants must also include in the ICA, if applicable, instructions for inspections, repair, and cleaning of turbine engine areas or components shown to be susceptible to carbon deposit build-up. These instructions must be derived by reviewing the oil system design accomplished during compliance with §§ 33.71, 33.19, and TSO-C77b, appendix 1, sections 5.4 and 4.3.

(c) 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 (refer to § 33.15 and TSO-C77b, appendix 1, section 4.2).

(d) The applicant must identify any changes to the ICA, including, but not limited to, safety precautions, fluid compatibility, changes to placards, changes to service intervals, and changes to maintenance practices (refer to § 33.4).

(6) Applicable Regulations for Airplanes and Rotorcraft. For a list of regulations that may be applicable for oil projects, see appendix 3 of this AC, paragraph 2. Additional guidance on airworthiness standards follow in paragraphs 9.c.(6)(a) through (c). The following list is not all-inclusive, and is provided as a recommended starting point only. Applicants must therefore, obtain from the appropriate directorate guidance on regulations with which they will need to show compliance.

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

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

(c) The applicant must identify any changes to the ICA, including, but not limited to, safety precautions, fluid compatibility, changes to placards, changes to service intervals, and changes to maintenance practices (refer to appendices G23.3, H25.3, A27.3 and A29.3).

10. Additives.

a. Additive Specification.

(1) Fuel additives that are incorporated into ASTM, governmental or military specification, or other industry-based consensus organization specification, are considered to be identified in sufficient detail to be accepted by the FAA under existing operating limitations on TCs, amended TCs, STCs, or ASTCs, provided there are no changes to those operating limitations.

(2) Oil additives that are incorporated into an SAE oil standard, or a brand name that meets an SAE standard, governmental or military specification, or other industry-based consensus organization specification, are considered to be identified in sufficient detail to be accepted by the FAA under existing operating limitations on TCs, amended TCs, STCs, or ASTCs provided there are no changes to those operating limitation.

(3) The FAA will accept fuel or oil additives that are not incorporated into fuel or oil specifications according to paragraph 10.a.(1) or (2) above, provided the additive is identified and controlled to a single compositional definition.

b. Additive Approval.

(1) For additives incorporated into an ASTM, SAE oil standard, or a brand name that meets an SAE standard, governmental or military specification, or other industry-based consensus organization specification:

(a) Further FAA testing or approval is not required if the current specified operating limitations are adequate to accommodate the fuel, or oil specification or standard. TC/STC holders do not need to revise aviation fuel operating limitations to use the additive.

(b) If the current specified operating limitations are not adequate to accommodate the fuel, or oil specification or standard, then a regulatory showing of compliance according to paragraph 8.f. or 9.c. of this AC, whichever applicable, is necessary to incorporate the fuel or oil as a new operating limitation on a TC or STC.

(2) For additives not incorporated into an ASTM, SAE oil standard, or a brand name that meets an SAE standard, governmental or military specification, or other industry-based consensus organization specification:

(a) If the FAA determines that a demonstration of compliance for each certificated product for which the additive is intended to be used on is necessary, then the applicant must follow the process described in paragraph 7.f. of this AC to add the additive to each product's TC or STC.

(b) In special cases, the FAA may determine that sufficient data is available to support a broad-based approval for use of the additive on an identifiable population of engines or aircraft. For example, an additive with an identical composition to an existing, approved additive may have extensive service experience on a specific category, or type of aircraft or engine. In this case, the FAA may conduct the evaluation and approval in accordance with § 21.8(d).

(c) For approvals conducted according to paragraphs (a) or (b) above, the showing of compliance must address the following:

1 It must be demonstrated that the additive does not have any adverse effects on the operation, performance, durability, or materials of the products intended for use.

2 It must be demonstrated that the additive does not have any adverse effects on the performance of the base fuel or oil that it is intended for use with.

3 It must be demonstrated that the additive is compatible with all other additives, or combination of all other additives, permitted for use in the base fuel or oil that the additive is intended for use with.

If you have any suggestions for improvements or changes, you may use the template provided at the end of this AC.



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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 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 Continental Motors, Inc. (CMI) 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 CMI and LE.

c. The NAWC’s procedure is captured in SAE 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 (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. The following provides an overview of each step.

a. Step 1: Preliminary Data and Ground Testing.

(1) The objective of this step is to provide proof of compliance to obtain an STC that authorizes flight testing of the LE and CMI engine models specified in SAE J1899. For this step, applicants must submit a compliance plan to the FAA that identifies the applicable regulations from part 33 (or CAR 13). The applicant must 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 an LE TIO-540 engine. The applicant must perform these tests in accordance with SAE J1899.

(3) The compliance plan must 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

(4) For engines certified under CAR 13, applicants must reference the equivalent requirement from that regulation.

(5) 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). In addition, the turbo supercharger 50-hour test specified in § 33.49(e)(1)(iii) is not included in the J1899 test. While the applicant must demonstrate compliance with each applicable FAA regulation, 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 below.

(6) 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 must submit a test plan for approval, and the responsible FAA aircraft certification office (ACO) must issue a Test Inspection Authorization, prior to conducting the tests.

(7) 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 CMI engine models, as described in SAE J1899, appendix C. In this step, the applicant must conduct a long-duration flight test of 500 hours on the specified LE and CMI engine(s).

(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 must 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 must be added to the U.S. Navy's Qualified Products List (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 not all-inclusive. Applicants must work with the FAA 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 not all-inclusive. Applicants must work with the FAA to develop their individual compliance plans.

1. Fuel.a. Transport Category Airplanes.

§ 25.21	Proof of compliance
§ 25.23	Load distribution limits
§ 25.25	Weight limits
§ 25.27	Center of gravity limits
§ 25.29	Empty weight and corresponding center of gravity
§ 25.101	General (Performance)
§ 25.105	Takeoff
§ 25.107	Takeoff speeds
§ 25.109	Accelerate-stop distance
§ 25.111	Takeoff path
§ 25.113	Takeoff distance and takeoff run
§ 25.115	Takeoff flight path
§ 25.117	Climb: general
§ 25.119	Landing climb: All-engines operating
§ 25.121	Climb: One-engine-inoperative
§ 25.123	En-route flight paths
§ 25.603	Materials
§ 25.833	Heaters
§ 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
§ 25.907	Propeller vibration and fatigue
§ 25.939	Turbine engine operating characteristics
§ 25.943	Negative acceleration
§ 25.945	Thrust or power augmentation system
§ 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
§ 25.963(b)	Fuel tanks: general

§ 25.967(e)	Fuel tank installations (Compatibility with coatings/materials used as secondary barriers)
§ 25.969	Fuel tank expansion space
§ 25.973	Fuel tank filler connection
§ 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
§ 25.1093(a), (c)	Induction system icing protection
§ 25.1123(a)	Exhaust piping
§ 25.1125(a)(1)	Exhaust heat exchangers
§ 25.1127(a)	Exhaust driven turbo-superchargers
§ 25.1301(a)	Function and installation
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§ 25.1522	Auxiliary power unit limitations
§ 25.1527	Ambient air temperature and operating altitude
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§ 25.1535	ETOPS approval
§ 25.1557(b)	Powerplant fluid filler openings
§ 25.1541	General (markings and placards)
§ 25.1549	Powerplant and auxiliary power unit instruments
§ 25.1553	Fuel quantity indicator
§ 25.1555(c)(2)	Control markings
§ 25.1557(b)(1)	Miscellaneous markings and placards
§ 25.1581	General (airplane flight manual)
§ 25.1583	Operating limitations
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§ 25.1587	Performance information
Appendix K25.1.4(a) Propulsion Systems Fuel System Design	

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
§ 23.65	Climb: All engines operating
§ 23.69	Enroute climb/descent
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§ 23.343	Design fuel loads
§ 23.601	General
§ 23.603	Materials
§ 23.633	Materials strength properties & design values
§ 23.863(b)(2)	Flammable fluid fire protection
§ 23.901(f)	Auxiliary power unit
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§ 23.939	Powerplant operating characteristics
§ 23.943	Negative acceleration
§ 23.951	General (fuel system)
§ 23.954	Fuel system lightning protection
§ 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
§ 23.967	Fuel tank installation
§ 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
§ 23.1123(a)	Exhaust system
§ 23.1125(a)(1)	Exhaust heat exchangers
§ 23.1301(a)	Function and installation
§ 23.1305	Powerplant instruments
§ 23.1337	Powerplant instruments installation
§ 23.1501	General
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§ 23.1557(c)	Powerplant fluid filler openings
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c. Normal Category Rotorcraft. (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
§ 27.1529	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. (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
§ 27.1529	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

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