



SURFACE VEHICLE STANDARD

J1899™

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Superseding J1899 OCT2020

(R) Lubricating Oil, Aircraft Piston Engine (Ashless Dispersant)

RATIONALE

This revision introduces the E-38 Qualified Products Group as the qualifying activity for this specification. This revision allows the interchanging of new raw crude sources input materials proposed for manufacturer base stocks and updates the qualification formulation reporting and qualification testing requirements. The 150-hour engine test was revised to allow the incorporation of two Original Equipment Manufacturer (OEM) engines, which will improve the ability to qualify new oil formulations. This revision eliminates the 500-hour flight test in lieu of a second 150-hour engine test with the former being logistically unsupportable and the latter thought to be a more severe requirement for oil qualification than a 500-hour flight test.

1. SCOPE

This SAE Standard establishes the requirements for lubricating oils containing ashless dispersant additives to be used in four-stroke cycle, reciprocating piston aircraft engines. This document covers the same lubricating oil requirements as the former military specification MIL-L-22851. Users should consult their airframe or engine manufacturer's manuals for the latest listing of acceptable lubricants.

Compliance with this specification must be accomplished in accordance with the Performance Review Institute (PRI) product qualification process as described in the documents referenced in 2.1.3. Requests for submittal information may be made to the PRI at the address shown in 2.1.3, referencing this specification. Products qualified to this specification are listed on a Qualified Products List (QPL) managed by the PRI. Approval and/or certification for use of a specific piston engine oil in aero applications is the responsibility of the individual equipment builders and/or governmental authorities and may be accomplished by compliance with or qualification to this specification.

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1.1 Classification

The lubricating oils shall be furnished in the following grades as in Table 1:

Table 1 - Viscosity grade comparison table

SAE Grade	Military Grade	Commercial Grade	NATO Code Number
30	None	65	None
40	Type III	80	0-123
50	None	100	None
60	Type II	120	0-128
Multi-grade	None	None	None

NOTE: The military grade designations are being phased-out in favor of the NATO code numbers. Commercial grade designations are being replaced by the SAE grade classifications.

2. REFERENCES

2.1 Applicable Documents

The following publications form a part of this specification to the extent specified herein. Unless otherwise indicated, the latest issue of SAE publications shall apply.

2.1.1 United States Government Documents

2.1.1.1 Military Specifications and Standards

Copies of federal and military specifications, standards, and handbooks are available from the Document Automation and Production Service (DAPS), Building 4/D, 700 Robbins Avenue, Philadelphia, PA 19111-5094, Tel: 215-697-6257, <https://quicksearch.dla.mil/>.

MIL-L-22851 Lubricating Oil, Aircraft Piston Engine (Ashless Dispersant), canceled Nov. 1995

FED-STD-791 Lubricants, Liquid Fuels and Related Products; Methods of Testing

2.1.1.2 Civil Government Standards

Available from NIST, www.nist.gov

NIST Handbook 130 Uniform Laws and Regulations in the Areas of Legal Metrology and Fuel Quality

2.1.2 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or +1 724-776-4970 (outside USA), www.sae.org.

AMS3217/1 Test Slabs, Acrylonitrile Butadiene (NBR-H), Medium-High Acrylonitrile, 65 - 75

AMS3217/4 Test Slabs, Fluoroelastomer (FKM), 65 - 75

AMS3217/5 Test Slabs, Fluorosilicone (FVQM), 55 - 65

SAE J300 Engine Oil Viscosity Classification

SAE J1787 Measurement of the Total Ash Content of Aviation Piston Engine Oils by a Calculation Method

2.1.3 PRI Publications

Available from Performance Review Institute, 161 Thorn Hill Road, Warrendale, PA 15086-7527, Tel: 724-772-1616, www.p-r-i.org.

c-fm-12	Mark of Conformity and Program Name
PD2000	PRI-QPL Program Requirements
OP 2007	QPL Operating Procedure, QPG Operation

2.1.4 ASTM Publications

Available from ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959, Tel: 610-832-9585, www.astm.org

ASTM D92	Standard Test Method for Flash and Fire Points by Cleveland Open Cup Tester
ASTM D93	Standard Test Methods for Flash Point by Pensky-Martens Closed Cup Tester
ASTM D97	Standard Test Method for Pour Point of Petroleum Products
ASTM D129	Standard Test Method for Sulfur in Petroleum Products (General High Pressure Decomposition Device Method) (Use last revision dated 2018)
ASTM D130	Standard Test Method for Corrosiveness to Copper from Petroleum Products by Copper Strip Test
ASTM D445	Standard Test Method for Kinematic Viscosity of Transparent and Opaque Liquids (and Calculation of Dynamic Viscosity)
ASTM D482	Standard Test Method for Ash from Petroleum Products
ASTM D664	Standard Test Method for Acid Number of Petroleum Products by Potentiometric Titration
ASTM D892	Standard Test Method for Foaming Characteristics of Lubricating Oils
ASTM D1298	Standard Test Method for Density, Relative Density, or API Gravity of Crude Petroleum and Liquid Petroleum Products by Hydrometer Method
ASTM D1552	Standard Test Method for Sulfur in Petroleum Products by High Temperature Combustion and Infrared (IR) Detection or Thermal Conductivity Detection (TCD)
ASTM D2270	Standard Practice for Calculating Viscosity Index from Kinematic Viscosity at 40 °C and 100 °C
ASTM D2273	Standard Test Method for Trace Sediment in Lubricating Oils (Use last revision dated 2016)
ASTM D2622	Sulfur in Petroleum Products (Wavelength Dispersive X-ray Fluorescence Spectrometry)
ASTM D4052	Standard Test Method for Density, Relative Density, and API Gravity of Liquids by Digital Density Meter
ASTM D4683	Standard Test Method for Measuring Viscosity of New and Used Engine Oils at High Shear Rate and High Temperature by Tapered Bearing Simulator Viscometer at 150 °C
ASTM D4684	Standard Test Method for Determination of Yield Stress and Apparent Viscosity of Engine Oils at Low Temperature

ASTM D4741	Standard Test Method for Measuring Viscosity at High Temperature and High Shear Rate by Tapered-Plug Viscometer
ASTM D4927	Standard Test Methods for Elemental Analysis of Lubricant and Additive Components - Barium, Calcium, Phosphorus, Sulfur, and Zinc by Wavelength-Dispersive X-Ray Fluorescence Spectroscopy
ASTM D4951	Standard Test Method for Determination of Additive Elements in Lubricating Oils by Inductively Coupled Plasma Atomic Emission Spectrometry
ASTM D5185	Standard Test Method for Multielement Determination of Used and Unused Lubricating Oils and Base Oils by Inductively Coupled Plasma Atomic Emission Spectrometry (ICP-AES)
ASTM D5293	Standard Test Method for Apparent Viscosity of Engine Oils and Base Stocks Between -10 °C and -35 °C Using Cold-Cranking Simulator
ASTM D5481	Standard Test Method for Measuring Apparent Viscosity at High-Temperature and High-Shear Rate by Multicell Capillary Viscometer
ASTM D5949	Standard Test Method for Pour Point of Petroleum Products (Automatic Pressure Pulsing Method)
ASTM D5950	Standard Test Method for Pour Point of Petroleum Products (Automatic Tilt Method)
ASTM D5985	Standard Test Method for Pour Point of Petroleum Products (Rotational Method)
ASTM D6709	Standard Test Method for Evaluation of Automotive Engine Oils in the Sequence VIII Spark-Ignition Engine (CLR Oil Test Engine)
ASTM D6922	Standard Test Method for Determination of Homogeneity and Miscibility in Automotive Engine Oils

2.1.5 American Petroleum Institute Publications

Available from: API, 200 Massachusetts Avenue NW, Suite 1100, Washington, D.C. 20001-5571, www.API.org.

API 1509, Annex E API Base Oil Interchangeability Guidelines For Passenger Car Engine Oils and Diesel Engine Oils

2.1.6 United Nations Publications

Available from United Nations Economic Commission for Europe, Palais des Nations, CH-1211, Geneva 10, Switzerland, Tel: +41-0-22-917-12-34, www.unece.org.

ST/SG/AC.10/30 Globalized Harmonized System of Classification and Labelling of Chemicals (GHS), Appendix D
Safety Data Sheets

2.1.7 Order of Precedence

In the event of a conflict between the text of this specification and the references cited herein, the text of this specification takes precedence. Nothing in this specification, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

3. DEFINITIONS

PERFORMANCE REVIEW INSTITUTE (PRI): An SAE affiliate with the objectives of providing global, unbiased, independent manufacturing process and product assessments and certification services.

QUALIFIED PRODUCTS GROUP (QPG): A mandated body designated by the PRI Qualified Product Management Council (QPMC) in accordance with PRI PD2000. This body is responsible for assessing whether a manufacturer's products comply with the relevant standards. The Mandated Body is known as a Qualified Products Group (QPG) and is composed of members from the OEMs and Government Agencies. The QPMC has mandated a QPG for Aerospace Piston Engine Oils.

QUALIFIED PRODUCTS LIST (QPL): A list of products qualified by the QPG to this specification and issued by the PRI.

4. REQUIREMENTS

4.1 Qualification

Qualification to this specification must be accomplished in accordance with the PRI product qualification process as described in the documents referenced in 2.1.3 (refer to OP 2007). The lubricating oils furnished under this specification shall be products that have been evaluated under the PRI product qualification process and that have been found to meet the applicable specification requirements by the QPG. Products qualified to this specification are listed on a QPL managed by the PRI.

Commercial products sold under this document must meet all of the requirements of Sections 4 and 5 of this document. Approval and/or certification for use of a specific piston engine oil in aero applications is the responsibility of the individual equipment builders and/or governmental authorities and may be accomplished by compliance with or qualification to this specification. Individual products acceptance lists for commercial aviation piston engine oils will be maintained by each of the original aircraft engine manufacturers.

Qualification samples and the corresponding test results must be retained by the oil manufacturer for a period of at least 3 years.

4.1.1 Read-Across Approvals

4.1.1.1 Single Viscosity Grade Oils

Read-across approvals for single viscosity grade oils will only be granted to different grades of oil that are composed of varying percentages of the same base stocks blended with identical additive packages (adjustments in Viscosity Index improver and pour point depressant concentration will be permitted). Complete chemical and physical property test results shall be submitted for each grade of oil for which qualification is requested.

Single cylinder engine tests shall be performed on the lightest and heaviest single grade oils to be blended from the same base-stock materials (neutral and bright stock). All single grade oils blended from the same base-stock materials and meeting SAE viscosity classification standards between the two tested products will be granted qualification approval based on similarity.

For single viscosity grade, the 150-hour engine test will be run on the lowest viscosity grade oil unless the use of another grade is acceptable to the E-38 QPG, after which the read-across approval will be applied to the other grades.

4.1.1.2 Multigrade Viscosity Oils

Read-across approvals will only be granted to different grades of oil that are composed of varying percentages of the same base stocks blended with identical additive packages (adjustments in Viscosity Index improver and pour point depressant concentration will be permitted). Complete chemical and physical property test results shall be submitted for each grade of oil for which qualification is requested.

Single cylinder engine tests shall be performed on the lightest (meaning lowest W grade and the lowest High-Shear Rate Viscosity as defined by SAE J300) and heaviest (meaning highest W grade and the highest High-Shear Rate Viscosity as defined by SAE J300) multigrade oils to be blended from the same base-stock materials (neutral and bright stock).

For multigrade oils, the read-across approvals will be granted for a one-step viscosity grade increase in multigrade oils (e.g., from 20W-50 to 25W-60) but not for a reduction in grade. When required, the 150-hour engine tests will be run on the lightest multigrade candidate when such read-across approval is requested.

4.1.2 Requalification

Requalification is used to maintain or improve the configuration management and quality control of the original product. Requalification shall be required when any reformulation or change is made in: source of manufacture, purity, origin, or composition of the lubricating oil base stock(s) or additives. Requalification is also required for any changes in the manufacturing process or plant locations of the finished product, its additives, or base stock(s).

No changes shall be made unless approved by the E-38 QPG. When a manufacturer or authorized distributor fails to comply or demonstrates an inability to comply with requalification requirements, the E-38 QPG will remove the products from the electronic QPL.

When applicable, each manufacturer shall provide evidence to the E-38 QPG outside of the AEO format (e.g., a Certificate of Analysis or similar) that confirms the interchanging of their new raw crude sources input materials proposed for their base stocks demonstrates the same (or improved) holistic performance as the original raw crude sources used in the original base stock. Equivalency of base-stock materials can be shown through a variety of means, including but not limited to chemistry testing (bench, analytical), performance testing, statistical modeling, and chemical modeling.

4.2 Materials

The lubricating oils shall be derived from petroleum fractions, synthetically prepared compounds, or a combination of the two types of products. Lubricating oils may be compounded with such functional additives necessary to meet specified requirements such as:

- Dispersants
- Oxidation inhibitors
- Antifoam agents
- Viscosity index improvers
- Pour point depressants
- Anti-wear additive

When applying for qualification, refiners shall provide the following information about the crude oil and the processing used in the manufacture of each base stock blended into their product:

- Name of original base-stock refiner or processor.
- Location of refinery or processing plant by city and state (U.S.), province (Canada), and country.
- Definition of base-stock category per American Petroleum Institute Classification of Base Oils, API 1509, Annex E, subsection E.1.3.

Exceptions to these requirements shall be directed to the E-38 QPG. If re-refined materials are used, the manufacturer must demonstrate the consistency of the products to the qualifying activity.

4.3 Chemical and Physical Properties

The finished lubricating oil shall conform to the physical and property requirements specified in Tables 2A and 2B.

4.4 Sulfur

The sulfur content of the oil shall not exceed the value shown for each grade in Tables 2A and 2B. For quality conformance inspection, the sulfur content shall be within $\pm 0.15\%$ mass of the qualification value or within a 0.3% mass range selected by the manufacturer to bracket the qualification value.

4.5 API Gravity

The American Petroleum Institute (API) gravity of the oil shall be determined but not limited on qualification inspection. For quality conformance inspection, the gravity shall be within ± 1.0 degree API of the qualification value or within a 2.0 degree API range selected by the manufacturer to bracket the qualification value.

4.6 Workmanship

The lubricating oil shall be a homogeneous blend when examined visually at room temperature ($25^{\circ}\text{C} \pm 3^{\circ}\text{C}$) in a well-lighted room or daylight. It shall exhibit no separation or fallout of the additive package. Any jelly-like substance or very viscous material observed in the bottom of the container will be considered evidence of additive fallout.

4.7 Storage Stability

4.7.1 Fourteen-Day Storage Test

When stored as specified in 5.1.1.1, the oil shall show no separation.

4.7.2 Six-Month Storage Test

When stored as specified in 5.1.1.2, the oil shall show no separation.

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Table 2A - Chemical and physical property requirements for finished lubricant

Characteristic (Limits) SAE Grade	30	40	50	60	Multigrade	Test Method
Viscosity, mm ² /s (cSt), @ 100 °C, Min	9.3	12.5	16.3	21.9	(1)	ASTM D445
@ 100 °C, Less than	12.5	16.3	21.9	26.1	(1)	
Viscosity Index, Min	95	95	95	95	100	ASTM D2270-2016
Flash Point, °C, Min	220	225	243	243	220	ASTM D92
Flash Point, °C	report	report	report	report	report	ASTM D93
Pour Point, °C, Max	-24	-22	-18	-18	--	ASTM D97, ASTM D5949, ASTM D5950, ASTM D5985
Sulfur, Mass %, Max	0.6	0.8	1.0	1.2	0.6	ASTM D129-2018, ASTM D1552, ASTM D2622, ASTM D4951, ASTM D5185
Viscosity, Low Temp, Pumping	--	--	--	--	(1)	ASTM D4684
Viscosity, Low Temp, Cold Crank Sim., cP, Min	--	--	--	--	(1)	ASTM D5293
Viscosity, High Temp, High Shear, at 150 °C, cP, Min	2.9	3.7	3.7	3.7	(1)	ASTM D4683, ASTM D4741, ASTM D5481
All Grades						
Viscosity, mm ² /s (cSt), @ 40 °C			report			ASTM D445
Acid Number, mg KOH/g, Max ⁽²⁾			1.0			ASTM D664
Density, @ 15 °C, g/mL			report			ASTM D4052
Gravity, @ 60 °F, °API ⁽³⁾			report			ASTM D1298, ASTM D4052
Ash Content, ⁽⁴⁾ Mass %, Max			0.011			ASTM D482, SAE J1787
Trace Sediment, mL/100 mL Oil, Max			0.005			ASTM D2273
Copper Strip Corrosion, ⁽⁵⁾ Max Rating						ASTM D130
3 hours @ 100 °C			1			
3 hours @ 204 °C			3			
Foaming Tendency/Stability Seq. I						ASTM D892
Aerated Vol., mL, Max			50			
Vol. after 10 minutes, mL, Max			0			
Seq. II						
Aerated Vol., mL, Max			50			
Vol. after 10 minutes, mL, Max			0			
Seq. III						
Aerated Vol., mL, Max			50			
Vol. after 10 minutes, mL, Max			0			

⁽¹⁾ Oil shall meet the viscosity requirements of SAE J300 for the designated grade.

⁽²⁾ Titrate to a pH 11 end point.

⁽³⁾ API gravity may be computed from the relative density measured by ASTM D4052.

⁽⁴⁾ ASTM D482 is required for qualification. Either ASTM D482 or SAE J1787 may be used for quality assurance testing.

⁽⁵⁾ Conduct the test in accordance with ASTM D130 but at the temperature specified.

Table 2B - Chemical and physical property requirements for finished lubricant

Characteristic (Limits) SAE Grade		All Grades	Test Method
Compatibility with other oils ⁽¹⁾		pass	ASTM D6922
Elastomer Compatibility ⁽²⁾ % swelling, acceptable range: after 72 hours			FED-STD-791 Method 3604
Material	Test Temp		
AMS3217/1	70 °C (158 °F)	-5 to +10	
AMS3217/4	150 °C (302 °F)	-5 to +5	
AMS3217/5	150 °C (302 °F)	-5 to +5	
U.S. Navy			
Silicone Rubber	121 °C (250 °F)	0 to +20	
Trace Metal Content, ppm, Max			ASTM D5185
Iron (Fe)		5	
Silver (Ag)		2	
Aluminum (Al)		7	
Chromium (Cr)		5	
Copper (Cu)		3	
Magnesium (Mg)		3	
Nickel (Ni)		3	
Lead (Pb)		5	
Silicon (Si)		25	
Tin (Sn)		10	
Titanium (Ti)		2	
Zinc (Zn)		10	
Molybdenum (Mo)		4	

(1) The E-38 Qualified Products Group (QPG) should be contacted for the current list of required reference oil brands.

(2) The elastomer compatibility test shall be performed in accordance with Fed Test Method Std 791 Method 3604 with the following exception: The specific materials which shall be tested and the temperature at which the test is to be conducted are those listed in this table.

4.8 Performance Requirements

4.8.1 Single Cylinder Engine Test

- 4.8.1.1 The fully formulated oil shall meet the requirements of Table 3 when tested in the Sequence VIII spark-ignition engine test run in accordance with ASTM D6709, except as modified herein. The test shall be run with the oil galley temperature controlled at 135 °C ± 1 °C (275 °F ± 2 °F).

Table 3 - Sequence VIII engine test requirements at 40 hours (end of test)⁽¹⁾

End of Test Characteristic	Limit Single Grade	Limit Multigrade	Test Method
Bearing			
Bearing Weight Loss (Uncorrected), Total, mg, Max	500	500	ASTM D6709
Used Oil			
Viscosity, % Change, Max @ 40 °C ⁽²⁾	-15 to +10	≤ +10	ASTM D445
Viscosity, @ 100 °C	--	⁽³⁾	ASTM D445
Acid Number, Change, Max ⁽⁴⁾	2.0	2.0	ASTM D664

⁽¹⁾ The engine test is to be run in accordance with ASTM D6709 with an oil galley temperature of 135 °C ± 1 °C (275 °F ± 2 °F).

⁽²⁾ Viscosity change of the 40-hour sample shall be as shown for the specified grade.

⁽³⁾ Stripped viscosity of the 10-hour sample shall remain in original SAE grade.

⁽⁴⁾ Titrate to a pH 11 end point.

- 4.8.1.2 The test fuel shall be Soltrol 10 plus 0.779 to 0.806 mL/L (2.95 to 3.05 mL/U.S. gallon) tetraethyllead (TEL) in place of the KA24E unleaded fuel. The air-to-fuel ratio is to be 14.0:1 as calculated by exhaust gas analysis (refer to ASTM D6709, section 7.6).

4.8.1.3 The test need not be conducted using an ASTM Test Monitoring Center (TMC) calibrated test stand and power section (refer to ASTM D6709, section 10). In place of TMC reference oils, a substitute aviation piston engine reference oil shall be used to validate test operation for individually authorized qualification programs as follows:

4.8.1.3.1 A separate aviation reference oil test shall be conducted one test prior to performing a candidate lubricant test. The oil used in the reference test shall be determined by the E-38 QPG based on discussions with the candidate oil supplier. The reference lubricant shall be a retained sample of an originally qualified product (or a recent production batch of the manufacturer's qualified lubricant) conforming to the SAE Standard for which candidate approval is sought. The results obtained with the reference oil must be reported to the E-38 QPG immediately following completion of the reference test and before conducting the candidate oil test. The results obtained with the reference oil must correlate with the ASTM D5119 or ASTM D6709 data previously obtained on that approved formulation.

4.8.1.3.2 Laboratory operators should be aware of the impact of conducting non-standard Sequence VIII tests on their TMC calibration status (refer to ASTM D6709, section 10.1.3.3).

4.8.1.4 The final lab test report shall be the same format as that used for the normal ASTM D6709 test, section 13, but shall also include the following supplemental report items for Aviation Piston Engine Oil approval:

- Viscosity at 40 °C and 100 °C on the 20-hour, 30-hour, and 40-hour oil samples.
- Stripped viscosity (per ASTM D6709, Annex A14) at 40 °C on the 40-hour oil sample for single grade products.
- Stripped viscosity (per ASTM D6709, Annex A14) at both 40 °C and 100 °C on the 10-hour and 40-hour oil samples for multigrade products.
- Acid number per ASTM D664 on the new oil, 10-hour, 20-hour, 30-hour, and 40-hour oil samples.
- Post-test photographs of the bearing (top and bottom halves) and of the piston skirts (thrust and non-thrust) sides.

4.8.2 Engine Test

All candidate lubricating oils shall demonstrate satisfactory performance in two 150-hour engine endurance tests run on engine models identified and operated as specified in Appendix A. One engine shall be from the list of approved Lycoming Engines models and the other from the list of approved Continental Aerospace Technologies models. Results of these engine tests shall be acceptable to the E-38 QPG. For read-across approvals, only one pair of engine tests are required as described and defined in 4.1.1.

4.8.2.1 Engine Test Exclusion

At the discretion of the E-38 QPG, this engine test requirement may be waived. Manufacturers requesting this waiver shall provide sufficient data to the E-38 QPG to either verify that the candidate oil formulation does not represent a significant change from an existing qualified formulation or demonstrate the performance of the oil in an equivalent manner.

4.9 Material Safety Data Sheets

When applying for qualification, the manufacturer shall submit to the E-38 QPG Safety Data Sheets prepared in accordance with ST/SG/AC.10/30, Globalized Harmonized System of Classification and Labelling of Chemicals (GHS), Appendix D Safety Data Sheets

5. QUALITY CONTROL

The Table 4 tests shall be conducted on each batch of piston engine oil prior to shipping. The batch number shall be displayed on all certificates of analysis. A batch that fails to pass any of the requirements of this section shall be deemed not to comply with the requirements of SAE J1899. Therefore, that batch shall not be marked or delivered as compliant with SAE J1899.

Immediate notification to the PRI is mandatory where any recall of finished product is deemed necessary in accordance with PD2000. This must include the name and contact information of the person(s) with whom the PRI can communicate pertinent details and verification. It also needs to reference the specification number (SAE J1899) and the affected batch number(s). A description of the nature and the magnitude of the problem, list of the users thought to be affected, and potential consequences to the user would be desirable.

Table 4 - Quality assurance test requirements for finished lubricant

Characteristic (Limits), SAE Grade	30	40	50	60	Multigrade	Test Method
Viscosity, mm ² /s (cSt),						ASTM D445
@ 100 °C, Min	9.3	12.5	16.3	21.9	(1)	
@ 100 °C, Less than	12.5	16.3	21.9	26.1	(1)	
Viscosity Index, Min	95	95	95	95	100	ASTM D2270
Flash Point, °C Min	220	225	243	243	220	ASTM D92
Sulfur, Mass % Max ⁽²⁾	0.6	0.8	1.0	1.2	0.6	ASTM D129, ASTM D1552, ASTM D2622, ASTM D4951, ASTM D5185
Pour Point, °C Max	-24	-22	-18	-18	--	ASTM D97, ASTM D5949, ASTM D5950, ASTM D5985
Viscosity, Low Temp, Cold Crank Sim.	--	--	--	--	(1)	ASTM D5293
All Grades						
Viscosity, mm ² /s (cSt), @ 40 °C			Report			ASTM D445
Acid Number, mg KOH/g, Max ⁽³⁾			1.0			ASTM D664
Density @ 15 °C, g/mL			Report			ASTM D4052
Gravity @ 60 °F, °API ⁽⁴⁾			Report			ASTM D1298, ASTM D4052
Ash Content ⁽⁵⁾ Mass % Max			0.011			ASTM D482, SAE J1787
Trace Sediment, mL/100 mL Oil, Max			0.005			ASTM D2273
Copper Strip Corrosion, Max Rating, 3 hours @ 100 °C			1			ASTM D130
Foaming Tendency/Stability, Seq. 2						ASTM D892
Aerated Volume, mL, max			50			
Volume after 10 minutes, mL, max			0			
Trace Metal Content, ppm, Max						ASTM D5185
Iron (Fe)			5			
Silver (Ag)			2			
Aluminum (Al)			7			
Chromium (Cr)			5			
Copper (Cu)			3			
Magnesium (Mg)			3			
Nickel (Ni)			3			
Lead (Pb)			5			
Silicon (Si)			25			
Tin (Sn)			10			
Titanium (Ti)			2			
Zinc (Zn)			10			
Molybdenum (Mo)			4			

(1) Oil shall meet the viscosity requirements of SAE J300 for the designated grade.

(2) See 4.4 for conformance limit range.

(3) Titrate to a pH 11 end point.

(4) API gravity may be computed from the relative density measured by ASTM D4052; see 3.5 for conformance limit range.

(5) ASTM D482 is required for qualification. Either ASTM D482 or SAE J1787 may be used for quality assurance testing.

5.1 Test Methods

Tests shall be performed in accordance with the applicable methods listed in Tables 2A, 2B, 3, and 4 and Appendix A.

5.1.1 Storage Stability

5.1.1.1 Fourteen-Day Storage Test

A clean, capped, or stoppered 0.95-L (1-quart) glass bottle shall be half filled with test oil and stored on alternate days ± 1 hour at $5^{\circ}\text{C} \pm 1^{\circ}\text{C}$ ($40^{\circ}\text{F} \pm 2^{\circ}\text{F}$) and $-18^{\circ}\text{C} \pm 1^{\circ}\text{C}$ ($0^{\circ}\text{F} \pm 2^{\circ}\text{F}$) by daily transferring from one cold box to another. Examine the sample for evidence of additive separation immediately after removal from the 5°C storage. Note optical clarity and invert the bottles to see if deposits adhere to the bottom. Also, slowly pour 10 to 15 mL of cold oil over the lip of the bottle and observe carefully any unevenness in fluid texture. Deposits or suspended material may be present even though the sample is optically clear because of similar refractive indices. The test cycle shall be repeated for 14 days, except for weekend periods where the sample may remain at one temperature condition for up to 72 continuous hours.

5.1.1.2 Six-Month Storage Test

A 1-gallon sample of the test oil shall be stored in a clean, capped, or stopper wide-mouth glass container for a period of 6 months at $25^{\circ}\text{C} \pm 3^{\circ}\text{C}$ ($77^{\circ}\text{F} \pm 5^{\circ}\text{F}$) away from light. At the end of the storage period, the oil shall then be examined visually for separation of components.

6. LABORATORIES

The laboratories used to generate data in order to show compliance with this specification may belong to the supplier, the user, or an independent organization. However, all laboratories used to conduct tests under this specification must be approved under an accreditation scheme as per E-38 PRI requirements.

7. PACKAGING

Packaged products shall be labelled using NIST Handbook 130, Sequence IV.A, and use the PRI Mark of Conformity and Program Name document (c-fm-12).

8. NOTES

This section contains information of a general or explanatory nature that may be helpful but is not mandatory.

8.1 Intended Use

The lubricating oil covered by this specification is intended for use in four cycle piston aircraft engines and covers the same lubricating oil requirements as the former military specification MIL-L-22851. Users should consult their engine manufacturer's manuals for the latest listing of acceptable lubricants.

8.2 Revision Indicator

A change bar (I) located in the left margin is for the convenience of the user in locating areas where technical revisions, not editorial changes, have been made to the previous issue of this document. An (R) symbol to the left of the document title indicates a complete revision of the document, including technical revisions. Change bars and (R) are not used in original publications, nor in documents that contain editorial changes only.

APPENDIX A - ENGINE TEST REQUIREMENTS FOR SAE J1899/MIL-L-22851 AVIATION PISTON
ENGINE LUBRICANT

A.1 REFERENCES (LATEST APPLICABLE PUBLICATION APPLIES)

- a. SAE J1899, Lubricating Oil, Aircraft Piston Engine (Ashless Dispersant)
- b. Code of Federal Regulations (CFR) 14, Federal Air Regulation Part 33.49 Endurance Test, Subpart D Block Test, Reciprocating Aircraft Engines
- c. Code of Federal Regulations (CFR) 14, Federal Air Regulation Part 33.57 General Conduct of Block Tests
- d. Code of Federal Regulations (CFR) 14, Federal Air Regulations Part 33.45 Calibration Tests

A.2 ENCLOSURES

Table A1 Recommended Engine Instrumentation

A.3 APPROACH

Acceptable engine models for this test are Lycoming Engines models TIO-540-J2B, TIO-540-J2BD, LTIO-540-J2B, and LTIO-540-J2BD; and Continental Aerospace Technologies models TSIO-360-KB, TSIO-360-RB, TSIO-550-J, LTSIO-360-KB, and LTSIO-360-RB. They shall be run in the 150-hour endurance test described in reference (b) above along with the exceptions and amendments described herein.

1. The oil manufacturer will obtain approval for the engine test locations from the E-38 QPG prior to beginning the test. The E-38 QPG will review and approve each engine test plan for the corresponding test location.
2. Prior to the engine test, the engine is to be assembled using original manufacturer parts.
3. All the critical parts are to be measured during the initial buildup. These dimensions shall be compared with the respective post-test engine dimensions to determine the amount of wear that has occurred.
4. Engine hardware shall also be visually inspected after the test, and the presence of carbonaceous deposits shall be described and recorded.
5. The additional 50-hour turbocharger test requirements specified in reference (b) (sub-paragraph 33.49.e.iii) are not required.
6. The full test duration may be run at ambient pressure altitude in place of the critical altitude and 8000-foot pressure altitude requirement as required in reference (b) (sub-paragraph 33.49.e.1.ii).
7. It is not necessary to load each accessory drive and mounting attachment as required in reference (b).

NOTE: Engine tests using these specified engine models and run in strict compliance with reference (b) may be used to qualify a lubricant without these listed exceptions.

Lubricant properties shall be examined periodically throughout the test to determine oil degradation.

All measured items shall meet the requirements contained herein.

Table A1 - Recommended engine instrumentation

Function	Temperature (°F)	Pressure	Other
Air and Exhaust System			
Engine Room	X	In Hg	
Manifold	X	In Hg	
Air Turbo Compressor - in	X	In Hg	
Air Turbo Compressor - out (Deck)	X	In Hg	
Cylinder Head - each cylinder	X		
Exhaust Gas - each cylinder	X		
Turbo Turbine - in	X		
Turbo Turbine - out	X		
Oil System			
Engine Oil	X	psig	
Oil Cooler - in	X		
Oil Cooler - out	X		
Turbo Oil Bearing Supply - in		psig	
Turbo Wastegate Supply - in		psig	
Crankcase Breather		In H ₂ O	
Fuel System			
Engine Fuel Pump - in	X	psig	
Flow			pounds per hour
Fuel Injector Inlet		psig	
Fuel Nozzle Differential		psid	
Engine Operation			
Speed			RPM
Total Time			hours
Test Time			hours
Forced Cooling Hood Air	X	In H ₂ O	
Relative Humidity		%	
Vapor Pressure		In H ₂ O	

A.4 EQUIPMENT

a. Engine:

1. The engine used shall be one listed in paragraph A.3 of this appendix.

b. Test Stand: The test stand used shall be suitable to safely support the engine for the duration of the evaluation.

c. Power Absorber: An engine that is equipped with a propeller shaft must be fitted for the endurance test with an oil-controlled variable pitch propeller that thrust-loads the engine to the maximum thrust, which the engine is required to resist at each applicable operating condition specified in reference (b).

d. Instrumentation:

1. The test location shall be equipped with the necessary instrumentation and associated hardware to record the data required to satisfy the requirements of references (b), (c), and (d). The recommended minimum instrumentation is listed in Table A1.
2. Data shall be recorded periodically throughout the entire test. This includes the break-in, pretest and post-test calibration, and oil consumption runs along with the endurance test run. The data shall be recorded either by hand or by data acquisition system

e. Fuel: All testing shall be conducted using grade 100LL aviation fuel manufactured to ASTM D 910 Standards.

A.5 PROCEDURE

A.5.1 Introduction

- a. The engine shall be run using the power settings outlined in reference (b). The endurance test shall run for a total of 150 hours. A daily engine log shall be maintained summarizing all the daily activities.
- b. Prior to performing the 150-hour endurance test, a break-in, an oil consumption run, and a pretest calibration run shall be performed. The time spent on these sequences shall not be included as part of the 150 hours of test time. All non-test time accumulated during the 150-hour endurance test plus the pretest and post-test run time and any miscellaneous run time should be minimized to the greatest extent possible. All miscellaneous running time shall be documented.
- c. After 150 hours of endurance testing has been completed, the engine shall be subjected to a post-test calibration run. At this time, any change in engine performance that has occurred during the test shall be determined and recorded.
- d. Prior to starting any sequence (break-in, pretest and post-test calibration, and oil consumption runs), the engine shall be run at a lower power setting to allow the oil to reach a nominal temperature of 60 °C (140 °F) or as recommended in the applicable operator's manual. The start-up, warm-up, and ground-check procedures outlined in the operator's manual shall be used at the beginning of any run listed in this procedure. This shall also be done at the start of each cycle of the endurance run and at start-up after the engine has been shut down (e.g., shut down for maintenance, etc.). This warm-up time shall not be included in the 150-hour endurance test time.
- e. As a minimum, a total of 64 engine shutdowns are required to assess the potential for the formation of carbonaceous deposits in the cylinder/valve assembly and on the pistons using the shutdown procedure described in the applicable operator's manual. If the 64 shutdowns are not completed during the normal duration of the 150-hour test, they may be accomplished as a separate shutdown portion using the conditions described in A.5.5.d.8. The operating time accumulated on the engine during such special shutdown cycles shall not be counted as part of the 150-hour test and may be incorporated into the overall test program at the convenience of the operator. The only time this procedure may be omitted is if the engine shall sustain serious damage if it is run, even at an idle condition, for any length of time (e.g., complete loss of oil or oil pressure, etc.).
- f. For all engine running procedures listed below, the engine speed shall be maintained within $\pm 3\%$ of the specified values and the manifold pressure within ± 0.5 inch of Hg. The test cell environment shall stay at ambient conditions.

- g. For all sequences run prior to the actual endurance test, an oil filter shall be used in the oil system. At the completion of the oil consumption run, the filter shall be replaced with a new oil filter.
- h. Maintain all other engine parameters per the manufacturer's stated operating limits.

A.5.2 Break-In Run

The engine shall be run for a 3-hour break-in period according to the procedure as defined in A.5.2. This sequence shall be run at ambient pressure with the mixture setting adjusted to full rich. Record the data once at each power setting. The oil used during this run shall be an SAE J1899 or SAE J1966 product as specified in the manufacturer's pertinent manual or service instruction. If an SAE J1899 product is selected for break-in, it shall be per the manufacturer's approved lubricating oil list and shall not contain anti-wear additives such as tricresyl phosphate (TCP).

The break-in run shall be conducted as follows:

1. 0.25 hour at 1200 rpm
2. 0.25 hour at 1500 rpm
3. 0.25 hour at 1700 rpm
4. 0.25 hour at 1900 rpm
5. 0.33 hour at 2050 rpm
6. 0.33 hour at 85% maximum continuous speed and 60% maximum continuous power
7. 0.33 hour at 90% maximum continuous speed and 70% maximum continuous power
8. 0.33 hour at 93% maximum continuous speed and 80% maximum continuous power
9. 0.33 hour at 97% maximum continuous speed and 90% maximum continuous power
10. 0.33 hour at 100% maximum continuous speed and 100% maximum continuous power
11. Shut down the engine according to the manufacturer's operator's manual.

During the break-in run, the engine temperatures, pressures, and speeds shall remain within the normal operating limits specified by the manufacturer for the power setting selected.

Drain the used break-in oil from the engine, oil lines, and oil cooler. Remove the oil filter and replace it with a new one and proceed to the oil consumption run.

A.5.3 Oil Consumption Run

- a. Weigh and record the amount of new test candidate oil added to the engine.
- b. The duration of the oil consumption run shall be that as specified in the engine manufacturer's applicable Overhaul, Maintenance, or Operator's manuals, Service Bulletins, or Instructions for such purpose. During the oil consumption run, the engine temperatures, pressures, and speeds shall remain within the normal operating limits specified by the manufacturer for the power setting selected.
- c. The engine shall be operated at $180^{\circ}\text{F} \pm 20^{\circ}\text{F}$ oil temperature.
- d. Drain and record the weight of post-test oil. If the oil consumption exceeds the maximum consumption limit outlined in the manufacturer's documents, follow the manufacturer's troubleshooting guidance and repeat the test.

A.5.4 Pretest Calibration Run

- a. Prior to endurance testing, a calibration run shall be conducted as required by reference (d). The engine shall not be used if its performance does not meet the required corrected power listed in the engine operator's manual.
- b. Drain the used oil from the engine, oil lines, and the oil cooler. Replace the slave oil filter with a new test oil filter. Install a fresh charge of test oil and proceed to the endurance test.

A.5.5 14 CFR § 33.49 Endurance Test

- a. The test procedure listed below is similar to that as described in reference (b). The test consists of seven portions for which the engine is run at various power settings.
- b. During 50 hours of the endurance test, at least one cylinder shall be operated at or above the limiting cylinder head temperature. The other cylinders shall not be lower than 28 °C (50 °F) below the limiting cylinder head temperature. This 50 hours of test time shall be conducted with the engine set at maximum continuous power and speed. For test method consistency, this phase shall take place during the second half (75 to 150 hours) of the endurance test. Start at test portion 4 cycle 7, as given in A.5.5.d, until 50 hours of hot condition test time is accrued.
- c. The 50 hours of test time mentioned above shall also be run with the engine oil gallery temperature maintained within ± 6 °C (± 10 °F) of the engine limiting oil temperature. Adjust the cooling equipment for the engine if necessary to achieve this temperature. If it is necessary, the oil lines and sump may be insulated. The remainder of the test shall be conducted with the oil inlet temperature of 104 °C $\pm$ 6 °C (220 °F $\pm$ 10 °F) for operating periods greater than 1-hour duration and within the range of 60 to 124 °C (140 to 255 °F) for periods less than 1 hour.
- d. The test procedure shall be run as follows with a minimum of 5 minutes separation between the engine shutdown of one cycle and the start of the next cycle. The 5-minute shutdown between cycles is required unless an additional shutdown assessment cycle is added to the test program in order to accomplish the required 64 shutdowns. The engine operating conditions required for the special shutdown cycles are described in A.5.5.d.8 below. As a minimum, test data is to be recorded once during the last 5 minutes of each power setting in portion 1. In portions 2 through 7, record the data at approximately 15-minute intervals during each power setting. Allow the engine to run for at least 10 minutes after a setting change (in portions 2 through 7) before taking an instrument reading. (All horsepower values are corrected to sea level standard day conditions at the stated speed.)
 1. Portion 1, 0 to 30 hours (10 cycles). Each test cycle shall include the 0.16-hour (10-minute) sequence as follows, repeated 18 times in a 3-hour period:
 - i. 0.08 hour (5 minutes) at maximum continuous power with maximum continuous speed
 - ii. 0.08 hour (5 minutes) at best economy cruising power or maximum recommended cruising power
 2. Portion 2, 30 to 50 hours (four cycles). Each test cycle is a 5-hour run as follows:
 - i. 2.5 hours at maximum continuous power with maximum continuous speed
 - ii. 2.5 hours at maximum best economy cruising power or maximum recommended cruising power
 3. Portion 3, 50 to 70 hours (10 cycles). Each test cycle is a 2-hour run as follows:
 - i. 1.5 hours at maximum continuous power with maximum continuous speed
 - ii. 0.5 hour at 75% maximum continuous power with 91% maximum continuous speed
 4. Portion 4, 70 to 90 hours (10 cycles). Each test cycle is a 2-hour run as follows:
 - i. 1.5 hours at maximum continuous power with maximum continuous speed
 - ii. 0.5 hours at 70% maximum continuous power with 89% maximum continuous speed