SAE Aerospace
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AEROSPACE STANDARD

SAE AS5780

REV. A

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Superseding AS5780

(R) Specification for Aero and Aero-Derived Gas Turbine Engine Lubricants

1. SCOPE:

This specification defines basic physical, chemical, and performance limits for 5 cSt grades of gas turbine engine lubricating oils used in aero and aero-derived marine and industrial applications, along with standard test methods and requirements for laboratories performing them. It also defines the quality control requirements to assure batch conformance and materials traceability, and the procedures to manage and communicate changes in oil formulation and brand. This specification invokes the Performance Review Institute (PRI) product qualification process. Requests for submittal information may be made to the PRI at the address in Appendix C, referencing this specification. Products qualified to this specification are listed on a Qualified Products List (QPL) managed by the PRI. Additional tests and evaluations may be required by individual equipment builders before an oil is approved for use in their equipment. Approval and/or certification for use of a specific gas turbine oil in aero and aero-derived marine and industrial applications is the responsibility of the individual equipment builders and/or governmental authorities and is not implied by compliance with or qualification to this specification.

2. REFERENCES:

2.1 Applicable Documents:

The publications referred to in this specification are listed in Appendix C, Section C.1. Reference in this specification to any related document means the edition and all amendments current at the date of use of that document. In the event of a conflict between the text of this document and references cited herein, the text of this document takes precedence.

2.2 Other Applicable References:

Other applicable references are listed in Appendix C, Section C.2 for information purposes only.

TO PLACE A DOCUMENT ORDER:
Tel: 877-606-7323 (inside USA and Canada)
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2.3 Definitions:

STANDARD PERFORMANCE CAPABILITY CLASS (SPC): Lubricant intended for less demanding service.

HIGH PERFORMANCE CAPABILITY CLASS (HPC): Lubricant intended for more demanding service in which engine operating conditions and/or service durations require higher thermal capability.

BATCH: The volume of basestock, additive or finished lubricant receiving final certification analysis and testing.

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 Original Equipment Manufacturers (OEMs) and Government Agencies. The QPMC has mandated a QPG for Aerospace Gas Turbine Oils.

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

QUALIFICATION REFERENCE NUMBER (QRN): A unique reference number assigned by the QPG to each formulation qualified to this specification.

3. COMPOSITION:

The composition of gas turbine oils used in aero and aero-derived marine and industrial applications shall be based on polyol ester base-stock chemistry. Other base-stock chemistries may be considered for qualification at the discretion of the QPG.

Additives containing barium or organic compounds of titanium are prohibited. If a tricresyl phosphate (TCP) additive is used, the TCP additive shall not contain more than 0.2% by weight of ortho cresol containing isomers of tricresyl phosphate.

All chemical ingredients contained in aviation turbine lubricants must comply with all legal, environmental, toxicological and regulatory requirements of the countries in which the products are manufactured and sold. A Materials Safety Data Sheet (MSDS) or other equivalent document shall be available to cover these regulatory requirements.

4. TESTS REQUIREMENTS:

The test requirements in this section are a mandatory requirement for the initial qualification of turbine engine oils to this specification. These requirements are primarily aimed at civil aero and aero-derived marine and industrial applications, but that does not preclude their use for military applications where considered desirable. All tests must be conducted by laboratories approved for the purpose in accordance with Section 5. The tests are grouped into the following property categories:

- Physical Properties
- Chemical Properties
- Stability Properties
- Deposition Properties
- Tribological Properties

TABLE 1 - Physical Properties

Property	Test Method	Limits
		SPC and HPC
Viscosity, mm^2/s @:		
100 °C	ASTM D 445 or IP71	4.9 to 5.4
40 °C	ASTM D 445 or IP71	23.0 min.
-40 °C	ASTM D 445 or IP71	13,000 max.
Viscosity Stability, 72 hours @ -40 °C, % Change	ASTM D 2532	6 max.
Pour Point, °C	ASTM D 97/IP15	-54 max.
Flash Point, °C	ASTM D 92/IP36	246 min.
Evaporation, 6.5 hours @ 204 °C, wt %	ASTM D 972	10 max.
Foaming Tendency, Sequence I, II, III, mL	ASTM D 892/IP146	25/0 max. (1)
Shear Stability, % Viscosity change @ 40 °C	ASTM D 2603 (2)	4 max.

NOTES:

1. Volume after aeration/Volume after 1 minute settling.

2. ASTM D 2603 should be conducted with the following modifications:

Calibrate the instrument to achieve 11.5% ± 0.5% viscosity loss to a 30 ml sample of ASTM Reference Fluid A when irradiated for 5 minutes. Using the same power setting, irradiate a 30 ml sample of the turbine lubricant for 30 minutes.

TABLE 2 - Chemical Properties

Property	Test Method	Limits	
		SPC	HPC
TAN, mg KOH/g	ARP5088	1.0 max.	1.0 max.
Sediment/Ash, mg/L	FED-STD-791, Method 3010	Sed: 10 max.	Sed: 10 max.
		Ash: 1 max. (1)	Ash: 1 max. (1)
		No undissolved water	No undissolved water
Lubricant Compatibility: Sediment, mg/L Turbidity	FED STAN 791, Method 3403 Mod (2) / Def Stan 05-50 (Part 61) Method 24	10 max. None	10 max. None
Elastomer Compatibility, AMS 3217/4, 72 hours at 204 °C, % swell	FED-STD-791, Method 3604	5 min. 25 max.	5 min. 25 max.
Elastomer Compatibility, % weight change after 24/120 hours: Fluorocarbon @ 200 °C LCS Fluorocarbon @ 200 °C Nitrile @ 130 °C Silicone @ 175 °C Perfluoroelastomer @ 200 °C	Def Stan 05-50 (Part 61) Method 22	10/15 max. 10/20 max. Report Report N/A	11/15 max. 12/20 max. Report Report Report

TABLE 2 (Continued)

Property	Test Method	Limits	
		SPC	HPC
Trace Metals, mg/L	See Note (3)	Al, 2 max.	Al, 2 max.
		Fe, 2 max.	Fe, 2 max.
		Cr, 2 max.	Cr, 2 max.
		Ag, 1 max.	Ag, 1 max.
		Cu, 1 max.	Cu, 1 max.
		Sn, 4 max.	Sn, 4 max.
		Mg, 2 max.	Mg, 2 max.
		Ni, 2 max.	Ni, 2 max.
		Ti, 2 max.	Ti, 2 max.
		Si, 10 max.	Si, 10 max.
		Pb, 2 max.	Pb, 2 max.
		Mo, 3 max.	Mo, 3 max.
		Zn, 2 max.	Zn, 2 max.

NOTES:

1. If the total sediment does not exceed 1 mg/L, the ash content requirement shall be waived.

2. Per 4.4.1 of MIL-PRF-23699F.

3. The trace metal content of the oil shall be determined by a facility which meets the requirements of Section 5 of this specification. Appropriate spectrometric calibration standards, covering the concentration ranges of interest should be utilized.

TABLE 3 - Stability Properties

Property	Test Method	Limits	
		SPC	HPC
Oxidation & Corrosion Stability, 72 hours @ 175 °C	FED-STD-791, Method 5308 mod (1)		
Viscosity Change, %		-5 to +15	0 to +10
TAN Change, mg KOH/g		2.0 max.	1.0 max.
Sediment, mg/100 mL		50 max.	25 max.
Metal Wt. Change, mg/cm^2			
Steel		±0.2	±0.2
Silver		±0.2	±0.2
Aluminum		±0.2	±0.2
Magnesium		±0.2	±0.2
Copper		±0.4	±0.4
Oxidation & Corrosion Stability, 72 hours @ 204 °C	FED-STD-791, Method 5308 mod (1)		
Viscosity Change, %		-5 to +25	0 to +22.5
TAN Change, mg KOH/g		3.0 max.	2.0 max.
Sediment, mg/100 mL		50 max.	25 max.
Metal Wt. Change, mg/cm^2			
Steel		±0.2	±0.2
Silver		±0.2	±0.2
Aluminum		±0.2	±0.2
Magnesium		±0.2	±0.2
Copper		±0.4	±0.4
Oxidation & Corrosion Stability, 72 hours @ 218 °C	FED-STD-791, Method 5308 mod (1)		
Viscosity Change, %		Report	Report
TAN Change, mg KOH/g		Report	Report
Sediment, mg/100 mL		50 max.	25 max.
Metal Wt. Change, mg/cm^2			
Steel		±0.2	±0.2
Silver		±0.2	±0.2
Aluminum		±0.2	±0.2
Titanium (two test pieces)		±0.2	±0.2

TABLE 3 (Continued)

Property	Test Method	Limits	
		SPC	HPC
Thermal Stability & Corrosivity, 96 hours @ 274 °C	FED-STD-791, Method 3411		
Viscosity Change, %		±5.0 max.	±5.0 max.
TAN Change, mg KOH/g		6.0 max.	6.0 max.
Metal Wt. Change, mg/cm^2		±4.0 max.	±4.0 max.
Oxidative Stability	Def Stan 05-50 (Part 61) Method 9		
Temperature Parameters @ 192 hours			
E temperature, °C		185 min.	190 min.
A Temperature, °C		190 min.	190 min.
V Temperature, °C		185 min.	190 min.
B Temperature, °C		Report	205 min.
Z Temperature, °C		Report	210 min.
Effective Life @ 200 °C			
Volatilization loss, hours		90 min.	N/A
Acidity increase, hours		100 min.	N/A
Viscosity increase, hours		60 min.	N/A
Insolubles increase, hours		225 min.	N/A
Effective Life @ 250 °C			
Volatilization loss, hours		3 min.	4.9 min.
Acidity increase, hours		0.5 min.	1.4 min.
Viscosity increase, hours		1.0 min.	1.9 min.
Insolubles increase, hours		20 min.	22 min.

1. The FED-STD-791, Method 5308 procedure shall be modified as stated in Appendix B.

TABLE 4 - Deposition Properties

Property	Test Method	Limits	
		SPC	HPC
ERDCO Bearing Rig,	Fed Std 791 Method 3410, severity 1.5 (1)		
Demerits		80 max.	40 max.
Deposits, g		3.0 max.	1.5 max.
Oil Consumption, ml		2000 max.	4000 max.
Viscosity @ 40 °C Increase, %		-5 min. 30 max.	0 min. 35 max.
TAN Increase, mg KOH/g		2.0 max.	2.0 max.
HLPS Dynamic Coking @ 375 °C	ARP5996		
@ 20 hours, Deposit, mg		Report	0.4 max.
@ 40 hours, Deposit, mg		N/A	0.6 max.

1. Test duration is 100 hours for SPC oils and 200 hours for HPC oils.

TABLE 5 - Tribological Properties

Property	Test Method	Limits
		SPC and HPC
Load Carrying Capability	FED-STD-791, Method 6508 (1)	See Note 2
Load Carrying Capability, Load Stage	AIR4978 Appendix E, WAM	15 min.

1. Standard reference oil may be obtained from: Fuels and Lubricants Division, Attn: J. T. Shimski, Bldg. 2360, Naval Warfare Center Aircraft Division, 22229 Elmer Road, Unit 4, Patuxent River, MD 20670.

2. The average of six determinations for each class of the oil shall not be less than 102% of the reference oil (Hercolube A) when tested in accordance with FED-STD791, Method 6508, “Load Carrying Ability of Lubricating Oils (Ryder Gear Machine)”. All six determinations shall be made on the same machine. The reference oil average rating used to obtain the relative ratings shall also be reported.

5. 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 required by PRI Program Document 2104.

6. QUALITY CONTROL:

The following tests shall be conducted on each batch of turbine oil prior to packaging and shipping. The batch number and AS5780 qualification reference number (QRN) 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 AS5780. That batch shall not therefore be marked or delivered as compliant with AS5780.

Immediate notification to the PRI is mandatory where any recall of finished product is deemed necessary. 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 (AS5780) and the Qualification Reference Number (QRN) as well as 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 6 - Quality Control Specifications

Property	Test Method	Limits	
		SPC and HPC	
Viscosity, mm^2/s @:			
-40 °C	ASTM D 445/IP71	13,000 max.	
40 °C	ASTM D 445/IP71	23.0 min.	
Pour Point, °C	ASTM D 97/IP15	-54 max.	
Flash Point, °C	ASTM D 92/IP36	246 min.	
T.A.N., mgKOH/g	ARP5088	1.0 max.	
Foaming Tendency, Sequence I, II, III, mL	ASTM D 892/IP146	25/0 max. (1)	
Thermal Stability & Corrosivity, 96 hours @ 274 °C	FED-STD-791, Method 3411		
Viscosity Change, %		±5.0 max.	
TAN Change, mg KOH/g		6.0 max.	
Metal Wt. Change, mg/cm^2		±4.0 max.	
Sediment, mg/L	FED-STD-791, Method 3010	10 max.	
Oxidation & Corrosion Stability, 72 hours @ 204 °C	FED-STD-791, Method 5308 mod (2)	Per Table 3	
Trace Metals		Per Table 2	
		SPC	HPC
HLPS Dynamic Coking, 20 hours @ 375 °C, mg	ARP5996 (3)	Report	0.6 max.

NOTES:

1. Volume after aeration/Volume after 1 minute settling.
2. The FED-STD-791, Method 5308 procedure shall be modified as stated in Appendix B.
3. Alternative tests may be acceptable at the discretion of the QPG.

7. MANUFACTURING TOLERANCES:

Turbine engine oils for aero and aero-derived marine and industrial applications are to be manufactured, blended, handled, and packaged in a manner that assures consistent composition, performance and quality.

Additives shall be of the same composition and manufactured at the same plants and by the same methods as those used in the qualified formulation. Additive treat rates for each manufactured batch shall not vary from those specified in Table 7.

TABLE 7 - Additive Batch Concentration Tolerances

Nominal Composition of the Approved Material, %wt	Range as Percentage of the Nominal Value
>2	± 5
<2	±10
<0.1	±20

Basestocks shall be of the same composition and manufactured at the same plants and by the same methods as those used in the qualified formulation. Incidental cross contamination by neopentyl polyol esters other than those used in the original qualification, but suitable by nature and quality for use in aviation turbine oil applications, shall not exceed 1.0% by weight.

Finished Turbine engine oils shall be of the same composition and manufactured at the same plants and by the same methods as those used in the qualified formulation.

8. TRACEABILITY:

All basestocks and additives used in the manufacture of each batch of turbine engine oil must have specifications suitable to assure their consistency and fitness for use, and be traceable to the specific batch numbers used by their manufacturer. Basestock and additive data, including the manufacturer's name, batch number, and specification analyses, must be maintained by the turbine engine oil manufacturer for a period not less than 5 years from the date of manufacture of the turbine engine lubricant made therefrom.

All finished batches of turbine engine oils must be traceable to the specific batch numbers used by their manufacturer. Turbine engine oil data, including the QRN, manufacturer's name, batch number, specification analyses, and a representative sample of not less than one case (24 x U.S. quart cans or equivalent volume), must be maintained by the turbine engine oil manufacturer for a period not less than three years from the date of manufacture of the turbine engine lubricant. Certificates of analysis for finished batches of oil shall show the relevant QRN.

8. (Continued):

Brand names under which turbine engine oils will be sold to users must be traceable to their formulations and qualification data through their QRNs. Qualification data for specific brand names shall be retained for a period of not less than five years after the retirement of the brand name. When a single brand name is used for multiple oil formulations, each formulation shall have a unique QRN. Analysis certificates must clearly show the appropriate QRN for the formulation used and the batch number of the product. All product containers shall show the batch number of the product.

9. QUALIFICATION:

Turbine engine oils satisfying all of the requirements of this specification may be qualified by the Qualified Product Group (QPG) and listed by brand name and QRN on a Qualified Products List (QPL). Qualification testing, review of test results, and recertification of qualification for QPL listing shall be in accordance with PRI documents PD2000, PD2001, PD2104 and the instructions from the PRI. Such qualification indicates only that the formulations satisfy this specification and does not imply suitability or approval for use in any applications. The QPG shall provide copies of the current Qualified Products List via the PRI web site assigned to the QPG. Certification Type Approvals will be required by equipment builders and government regulatory authorities before an oil may be used in civil aviation applications. In addition, equipment builders may require flight evaluations or controlled service use prior to granting approval for use in their equipment.

Development and manufacturing organizations submitting products for PRI qualification under this specification must comply with the quality system requirements for manufacturing organizations as stated in PD2104.

The QPG reserves the right to sample representative qualified oils from the field on an annual basis and analyze them to determine if any changes have occurred in composition or performance since qualification. Oil samples which demonstrate material change in composition or fail any requirements contained within this specification are subject to investigation by the QPG and can result in removal from the QPL and may be subjected to warranty and liability claims.

Recertification of qualification is required every 5 years. Recertification consists of a letter certifying that there have been no changes in the material ingredients, manufacturing processes or site of production since qualification and that the product meets all of the requirements of this specification.

NOTE: The responsible agency for the QPL is the Performance Review Institute, 161 Thornhill Road, Warrendale PA 15086-7527, Phone 724-772-1616, Fax 724-772-1699, website address www.pri.sae.org.

10. CHANGE MANAGEMENT:

The turbine engine oil manufacturer shall seek written commitment from the suppliers of the basestocks and additives that no changes in the manufacturing location, methods or procedures used to make the basestocks and/or additives, nor in the specifications to which the basestocks and/or additives are supplied, shall be made without prior written agreement of the turbine oil manufacturer.

Any changes related to turbine engine oils qualified under this specification shall require written notification to the QPG before the changed oil may be used in applications requiring AS5780 qualification. Examples of changes requiring notification are:

a. Changes in the oil formulation.

b. Changes in the composition of the basestocks.

c. Changes in the composition of the additives.

d. Changes in the source of first tier suppliers and/or manufacturing plant location for the basestocks, additives, or finished oil. Oil manufacturers shall demonstrate equivalent controls over second tier raw material suppliers.

e. Changes in the manufacturing process.

f. Changes in the brand name under which a formulation is marketed (including rebrands).

g. Business changes such as mergers, acquisitions by other companies, plant closings, and discontinuation of products.

Oils so changed shall be subject to full or partial requalification at the discretion of the QPG. The procedures governing this process shall be defined in PRI document PD2104.

11. NOTES:

11.1 The change bar (l) 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.

PREPARED BY
SAE COMMITTEE E-34, PROPULSION LUBRICANTS

APPENDIX A
REPORT ITEMS

A.1 This appendix lists tests that do not have associated specification limits at this time. The tests in Table A1 shall still be performed and the data submitted to the QPG as required for AS5780 qualification. The two main aims of this are; to provide performance data which is considered of significance by some engine OEMs; and to enable data on these tests to be accumulated so that appropriate specification limits can be proposed in the future. Where a report item forms part of a larger test matrix where limits are applied to other parameters, then this has been left in the main body of the specification. For instance a report requirement for TAN change in FTM 791 5308 where limits are applied to the accompanying metal weight changes.

A.2 Where considered appropriate, guidance limits have been provided in the third column of Table A1. The guidance is based on current knowledge and is intended to assist the oil formulator in meeting OEM engine approval criteria that may be required once the lubricant has achieved AS5780 qualification. **The guidance limits shall not be used as criteria for assessing the suitability of the lubricant for AS5780 qualification while the test remains in this appendix.**

TABLE A1 - Tests Requiring Only "Report"

Property	Test Method	Guidance	
		SPC	HPC
Acid Assay, Mole %	FED-STD-791, Method 3500 (1)		
Viscosity, mm^2/s @ 200 °C	ASTM D 341		
Viscosity Index	ASTM D 2270 (2)		
Pressure - Viscosity Coefficient	Wedeven Method		
Density @ 15 °C, kg/m^3	ASTM D 4052		
Specific Heat joules/kg °C (3)	ASTM D 2766 or E 1269		
Thermal Conductivity	Holometrix (4)		
Electrical Conductivity	ASTM D 2624		
Elastomer Compatibility, Fluorocarbon, 1800 hours at:	Snecma Method		
100 °C, % swell		20 max.	20 max.
120 °C, %swell		20 max.	20 max.
140 °C		No shrinkage (5)	No shrinkage (5)
160 °C		No shrinkage (5)	No shrinkage (5)
Hydrolytic Stability @ 90 °C	Def Stan 05-50 (Part 61), Method 6		
Vapor Phase Coking @ 371 °C, Deposit, mg	ARP5921 (Draft) (6)		200 max.
High Temperature Deposition, Deposit, mg	Alcor HTDT		1.0 max.

TABLE A1 (Continued)

Severe wear Ball load @ 1.5 mm WSD, kg	AIR4978 Appendix B, ALTE severe wear procedure	38 min.	38 min.
Mild wear WSD @ 20 kg ball load, mm	AIR4978 Appendix B, ALTE mild wear procedure	1.30 max.	1.30 max.
Thermal Ageing, 550 hours at 150 °C and 180 °C (7)	Turbomeca method		
Anti-oxidant content, %:			
150 °C		Report	50 min.
180 °C		Report	15 min.
Density change, %			
150 °C		Report	0.5 max.
180 °C		Report	1.0 max.
Viscosity @ 40 °C change, %			
150 °C		10 max.	5 max.
180 °C		25 max.	15 max.
Viscosity @ 100 °C, change, %			
150 °C		8 max.	4 max.
180 °C		15 max.	10 max.
Acidity change, mg KOH/g			
150 °C		8 max.	2 max.
180 °C		15 max.	5 max.
Flash point change, °C			
150 °C		70 max.	25 max.
180 °C		85 max.	50 max.
Sediment, mg/100 ml			
150 °C		Report	2 max.
180 °C		Report	4 max.
Thermal Ageing, 72 hours at 225 °C	Turbomeca method		
Acidity change, mg KOH/g		N/A	20 max.
Flash point change, °C		N/A	100 max.
Particulate generation @ 125 psig, 329.5 °C (625 °F), 18 hours, mg	Pressurized bomb test method	120 max.	120 max.

1. Alternate methods may be applicable but FED-STD-791, Method 3500, shall be used as the reference method.

2. ASTM D 2270 may be used to determine the slope within the normal temperature range to 175 °C.

3. The method used shall be reported with the test results. Specific heat shall be determined at 15, 40, 100, 150 and 200 °C.

4. Alternative methods may be used provided the method used is also reported.

5. Determinations of % swell are conducted periodically throughout the test. The term, “no shrinkage”, shall be taken as meaning no reduction in the % swell of the test pieces as the test progresses.

6. New equipment is being commissioned. A round robin will be conducted prior to setting limits for this test.

7. Each of the degradation parameters should also be determined and reported after test durations of 150, 330, and 750 hours.