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AEROSPACE STANDARD

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Superseding AS5780A

Specification for Aero and Aero-Derived Gas Turbine Engine Lubricants

RATIONALE

AS5780A, issued in 2005, is now due for revision. The changes made to this document reflect the consensus of opinion of SAE E-34 committee and reflects the further development and understanding of test methods and data.

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 D, Section D.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 shall take precedence.

2.2 Other Applicable References

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

2.3 Definitions

STANDARD PERFORMANCE CAPABILITY CLASS (SPC): Lubricant intended for normal 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.

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http://www.sae.org/technical/standards/AS5780B

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, and known or suspected carcinogens, 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 requirements 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

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TABLE 1 - PHYSICAL PROPERTIES

Property	Test Method	Limits
		SPC and HPC
Viscosity, mm^2/s @:		
100 °C	ASTM D445/IP71	4.9 to 5.4
40 °C	ASTM D445/IP71	23.0 min
-40 °C	ASTM D445/IP71 or ASTM D2532	13 000 max
Viscosity Stability, 72 hours @ -40 °C, % Change	ASTM D2532	6 max
Pour Point, °C	ASTM D97/IP15 or ASTM D5950	-54 max
Flash Point, °C	ASTM D92/IP36	246 min
Evaporation, 6.5 hours @ 204 °C, wt %	ASTM D972	10 max
Foaming Tendency, Sequence I, II, III, mL	ASTM D892/IP146	25/0 max (1)
Shear Stability, % Viscosity change @ 40 °C	ASTM D2603 (2)	4 max

NOTES:

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

2. ASTM D2603 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.

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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 Ash: 1 max (1) No undissolved water	Sed: 10 max Ash: 1 max (1) No undissolved water
Lubricant Compatibility: Sediment, mg/L Turbidity	FED STAN 791, Method 3403 Mod (2) / Def Stan 05-50 (Part 61) Method 24 See Note (3)	10 max None	10 max None
Elastomer Compatibility, AMS3217/4, 72 hours at 204 °C, % swell	FED-STD-791, Method 3604	5 min 25 max	5 min 25 max
Elastomer Compatibility (5), % 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 19.5 / 22 max 16.5 / 16.0 max N/A	 11 / 15 max 12 / 20 max 19 / 19.5 max 14.5 / 14.5 max 2 / 2 max
Trace Metals, mg/L	See Note (4)	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

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NOTES:

1. If the total sediment does not exceed 1 mg/L, the ash content requirement shall be waived.
2. FED STAN 791, Method 3403 shall be modified in accordance with Appendix C.
3. The E34 Qualified Products Group (QPG) should be contacted for the current list of required reference oil brands
4. 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.
5. Embrittlement shall be determined as a Report only item in Appendix A

TABLE 3 - STABILITY PROPERTIES

Property	Test Method	Limits	
		SPC	HPC
Oxidation & Corrosion Stability, 72 hours @ 175 °C	FED-STD-791, Method 5308 mod or ASTM D4636 Alt Proc 2 mod See Notes (1&2)		
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 max	±0.2 max
Silver		±0.2 max	±0.2 max
Aluminum		±0.2 max	±0.2 max
Magnesium		±0.2 max	±0.2 max
Copper		±0.4 max	±0.4 max
Oxidation & Corrosion Stability, 72 hours @ 204 °C	FED-STD-791, Method 5308 mod or ASTM D4636 Alt Proc 2 mod See Notes (1&2)		
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 max	±0.2 max
Silver		±0.2 max	±0.2 max
Aluminum		±0.2 max	±0.2 max
Magnesium		±0.2 max	±0.2 max
Copper		±0.4 max	±0.4 max
Oxidation & Corrosion Stability, 72 hours @ 218 °C	FED-STD-791, Method 5308 mod or ASTM D4636 Alt Proc 2 mod See Notes (1&2)		
Viscosity Change, %		120 max	60 max
TAN Change, mg KOH/g		15 max	10 max
Sediment, mg/100 mL		50 max	25 max
Metal Wt. Change, mg/cm^2			
Steel		±0.2 max	±0.2 max
Silver		±0.2 max	±0.2 max
Aluminum		±0.2 max	±0.2 max
Titanium (two test pieces)		±0.2 max	±0.2 max
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

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TABLE 3 - STABILITY PROPERTIES (CONTINUED)

Property	Test Method	Limits	
		SPC	HPC
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		190 min	205 min
Z Temperature, °C		190 min	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

NOTES:

1. The FED-STD-791, Method 5308 procedure or ASTM D4636 Alternative Procedure 2 may be used and shall be modified as stated in Appendix B. Duplicate tests required for qualification.

2. ASTM D4636 main procedure glassware configuration (i.e., with multi-port head) to be allowed as an acceptable alternative.

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TABLE 4 - DEPOSITION PROPERTIES

Property	Test Method	Limits	
		SPC	HPC
ERDCO Bearing Rig,	Fed Std 791 Method 3410, severity 1.5 (1)		
Overall Deposit Demerit Rating		80 max	40 max
Filter 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		4.0 max	0.4 max
@ 40 hours, Deposit, mg		N/A	0.6 max

NOTES:

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 - Ryder Gear	FED-STD-791, Method 6508 (1)	See Note 2

NOTES:

1. Standard reference oil may be obtained from: Fuels and Lubricants Division, 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.

6. QUALITY CONTROL

The following tests shall be conducted on each batch of turbine oil prior to 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 in accordance with PRI documents PD2000 and PD2001. 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.

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TABLE 6 - QUALITY CONTROL SPECIFICATIONS

Property	Test Method	Limits	
		SPC and HPC	
Viscosity, mm^2/s @:			
-40 °C	ASTM D445/IP71 or ASTM D2532	13 000 max	
40 °C	ASTM D445/IP71	23.0 min	
Pour Point, °C	ASTM D97/IP15 or ASTM D5950	-54 max	
Flash Point, °C	ASTM D92/IP36	246 min	
T.A.N., mgKOH/g	ARP5088	1.0 max	
Foaming Tendency, Sequence I, II, III, mL	ASTM D892/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/Ash, mg/L	FED-STD-791, Method 3010	Sed: 10 max	
		Ash: 1 max (5)	
		No undissolved water	
Oxidation & Corrosion Stability, 72 hours @ 204 °C	FED-STD-791, Method 5308 mod or ASTM D4636 Alt Proc 2 mod (2&3)	Per Table 3	
Trace Metals		Per Table 2	
		SPC	HPC
HLPS Dynamic Coking, 20 hours @ 375 °C, mg	ARP5996 (4)	5.0 max (6)	0.6 max (6)

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NOTES:

1. Volume after aeration/Volume after 1 minute settling.
2. The FED-STD-791, Method 5308 procedure or ASTM D4636 Alternative Procedure 2 may be used and shall be modified as stated in Appendix B.
3. ASTM D4636 main procedure glassware configuration (i.e., with multi-port head) to be allowed as an acceptable alternative
4. Alternative tests may be acceptable at the discretion of the QPG.
5. If the total sediment does not exceed 1 mg/L, the ash content requirement shall be waived.
6. The limit applied for quality control is higher than that applied in Table 4 for qualification. Qualification data is usually derived from multiple tests whereas it is often only practical to conduct a single test for batch quality control purposes.

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.

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.

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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 Thorn Hill 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 A 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, including technical revisions. Change bars and (R) are not used in original publications, nor in documents that contain editorial changes only.

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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. If a report item forms part of a larger test matrix where limits are applied to the other parameters, the non-limited reporting items have been left in the main body of the specification. For instance a report requirement for TAN change in FTM 791 5308 was left in the main body of the specification because 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)	Report	Report
Viscosity, mm^2/s @ 200 °C	ASTM D341	Report	Report
Viscosity Index	ASTM D2270 (2)	Report	Report
Pressure - Viscosity Coefficient	ARP6157 (Draft) (3)	Report	Report
Density, kg/m^3	ASTM D4052 (4)	Report	Report
Heat Capacity joules/kg °C	ASTM E1269 (5)	Report	Report
Thermal Conductivity by DSC	ASTM D2717 (6)	Report	Report
Electrical Conductivity	ASTM D2624 (7)	Report	Report
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 (8)	No shrinkage (8)
160 °C		No shrinkage (8)	No shrinkage (8)
Hydrolytic Stability @ 90 °C	Def Stan 05-50 (Part 61), Method 6	Report	Report
Vapor Phase Coking @ 371 °C, Tube Deposit, mg	ARP5921 (Draft)	Report	Report
High Temperature Deposition, Tube Deposit rating, 15 hours, Oil in temp 163 °C	HTDT		
Tube deposit, wt		Report	Report
Tube deposit rating		Report	Report
Viscosity increase, %		Report	Report
TAN increase, mgKOH/g		Report	Report
Filter deposits, g		Report	Report
ALTE, Mild wear, WSD @ 20 kg ball load, mm	ARP6255	Report	Report
ALTE, Severe Wear, Ball Load @ 1.5 mm WSD, kg	ARP6255	Report	Report

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TABLE A1 - TESTS REQUIRING ONLY “REPORT” (CONTINUED)

Property	Test Method	Guidance	
		SPC	HPC
Thermal Ageing, 550 hours at 150 °C and 180 °C (9)	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
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	P&W Pressurised vessel test method	120 max	120 max
WAM Load Carrying Capability, Load Stage	ARP6156(Draft)	Report	Report
Elastomer Compatibility, Embrittlement, days to failure	Def Stan 05-50 (Part 61) Method 22		
Fluorocarbon @ 200 °C		Report	Report
LCS Fluorocarbon @ 200 °C		Report	Report
Nitrile @ 130 °C		Report	Report
Silicone @ 175 °C		Report	Report
Perfluoroelastomer @ 200 °C		Report	Report

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NOTES:

1. Alternate methods may be applicable but FED-STD-791, Method 3500, shall be used as the reference method.
2. ASTM D2270 may be used to determine the slope within the normal temperature range to 175 °C.
3. Pressure viscosity measurements to be determined at 40 °C, 70 °C, 100 °C, 130 °C, and 150 °C.
4. Density to be determined at 15 °C, 40 °C, and 70 °C.
5. Heat Capacity shall be determined at 15, 40, 100, 150 and 200 °C.
6. Thermal conductivity values to be determined at 40 °C, 100 °C, 150 °C, and 200 °C.

7. Electrical conductivity measurements shall be performed at 20 °C and 80 °C.

8. 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.

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

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APPENDIX B - CORROSIVENESS AND OXIDATION STABILITY

B.1 The corrosion and oxidation stability test shall be performed in accordance with either:

FED-STD-791, Method 5308, “Corrosiveness and Oxidation Stability of Light Oils (Metal Squares),”

Or

ASTM D4636, “Corrosiveness and Oxidation Stability of Hydraulic Oils, Aircraft Turbine Engine Lubricants, and Other Highly Refined Oils, Alternative Procedure 2.

Whichever of the above procedures is used it shall be modified as follows:

B.1.1 Three separate tests, each conducted for 72 hours, shall be conducted with bath temperatures of 175 °C ± 2.5 °C, 204 °C ± 2.5 °C, and 218 °C ± 2.5 °C.

B.1.2 A liquid-medium or fluidized sand bath heating apparatus may be used in place of an aluminum block heater.

B.1.3 An electrolytic-grade, silver test square shall be substituted for the cadmium plated steel test square. In the 218 °C test, substitute titanium conforming to AMS-T-9046, type 1, composition C in place of the copper and magnesium. Stainless steel or nickel-chrome wire may be used to tie the metal coupons together at all test conditions. The weight loss for titanium shall be reported as the average of the two squares. The condenser water temperature shall be maintained at 18 °C ± 2.5 °C.

B.1.4 The total acid number shall be determined in accordance with ARP5088.

B.2 The post-test sludge content shall be determined as follows:

B.2.1 Decant oil from the test tube through a pre-weighed 10.0 micron polytetrafluoro-ethylene (Teflon) filter (Militec LCWP 047-00 or equivalent) and measure filtrate volume.

B.2.2 Set filtrate aside for viscosity and acid number tests.

B.2.3 Remove all sludge from the test equipment with a rubber policeman, wash the equipment and filtered sludge with petroleum ether, oven dry the sludge sample, weigh and calculate the sludge weight per 100 ml of oil.

B.2.4 Do not add the petroleum ether washings to the oil filtrate used for viscosity and acid number. Petroleum ether with a boiling range of 30 to 60 °C, or n-heptane shall be used in place of 1,1,1-trichloroethane (O-T-620) (FED-STD-791, Method 5308) and toluene (ASTM D4636).

NOTE: The glassware arrangement used for the ASTM D4636 main procedure (i.e., with female sample tube Figure 1, three-port sample tube head, Figure 2 and Allihn type condener, Figure 4) may be used as an acceptable alternative to the glassware stated in the above procedures. If this glassware arrangement is used the two unused ground glass ports shall have appropriately sized ground glass stoppers inserted into them to prevent loss of volatile material.

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APPENDIX C - LUBRICANT COMPATIBILITY

FED-STD-791, method 3403, “Compatibility of Turbine Lubricating Oils,” shall be modified as follows:

Petroleum ether, with a boiling range of 30 to 60 °C, n-heptane, or hexane, shall be used in place of 1,1,1-trichloroethane (O-T-620).

Upon completion of the 168 hour oven period, the test flasks shall be stored in the dark at room temperature 24 °C ± 5 °C (75 °F ± 10 °F) for 21 days before visual inspection for turbidity.

Sediment shall be determined in accordance with FED-STD-791, method 3010, “Solid Particle Contamination in Aircraft Turbine Engine Lubricants (Gravimetric Procedure).”

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APPENDIX D - REFERENCES

D.1 APPLICABLE DOCUMENTS

The following documents and publications are referred to in this specification. Methods issued by other standardization bodies that are equivalent to the methods listed in Table A are shown in brackets. However, the status of method equivalence should be checked before using anything other than the primary method. Unless otherwise stated, the most recent version of the method shall be used.

TABLE D1 - APPLICABLE DOCUMENTS

Designation	Title
ASTM	Annual Book of ASTM Standards Section 5, Petroleum Products, Lubricants, and Fossil Fuels
IP	Energy Institute - Standard Methods for Analysis and Testing of Petroleum and Related Products
ISO	International Organization for Standardization - International Standards on Petroleum Products
ASTM D97 (IP 15, ISO 3016,)	Determination of Pour Point
ASTM D92 (IP 36, ISO 2592)	Determination of Open Flash and Fire Point - Cleveland Method
ASTM D5950	Standard Test Method for Pour Point of Petroleum Products (Automatic Tilt Method)
ASTM D445 (IP 71, ISO 3104, BS 2000:Part 71)	Determination of Kinematic Viscosity and Calculation of Dynamic Viscosity
ASTM D341	Viscosity, mm^2/s @ 200°C
ASTM D892 (IP 146)	Determination of Foaming Characteristics of Lubricating Oils
ASTM D972	Evaporation Loss of Lubricating Greases and Oils
ASTM D2270 (IP226, ISO 2909)	Calculation of Viscosity Index from Kinematic Viscosity
ASTM D2532	Standard Test Method for Viscosity and Viscosity Change After Standing at Low Temperature of Aircraft Turbine Lubricants
ASTM D2603	Test Method for Sonic Shear Stability of Polymer-containing Oils
ASTM D2717	Standard Test Method for Thermal Conductivity of Liquids
ASTM D2624 (IP 274, ISO 6297)	Electrical Conductivity of Aviation and Distillate Fuels
ASTM D4052 (IP 365, ISO 12185)	Determination of Density - Oscillating U-Tube Method
ASTM D4636	Corrosiveness and Oxidation Stability of Hydraulic Oils, Aircraft Turbine Engine Lubricants, and Other Highly Refined Oils
ASTM E1269	Specific Heat Capacity by Differential Scanning Calorimetry
ISO 4259 (IP 367)	Method for Determination and Application of Precision Data in Relation to Methods of Test for Petroleum Products

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