METRIC

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PERFORMANCE SPECIFICATION

LUBRICATING OIL, AIRCRAFT TURBINE ENGINE, SYNTHETIC BASE, NATO CODE NUMBERS: O-152, O-154, O-156, and O-167

This specification is approved for use by all Departments and Agencies of the Department of Defense.

1. SCOPE

1.1 Scope. This specification covers four classes of gas turbine engine lubricating oils, primarily used for aircraft engines, which have a nominal viscosity of 5 centistokes at 100 °C and which are typically made with neopentyl polyol ester base stocks. This oil is identified by NATO Code Numbers O-152, O-154, O-156, and O-167.

1.2 Classification. The lubricating oil is furnished in the following classes as specified:

Class	Type of Oil	NATO Code
C/I	Corrosion Inhibiting	O-152
HTS	High Thermal Stability	O-154
STD	Standard (Non-Corrosion Inhibiting)	O-156
EE	Enhanced Ester	O-167

Comments, suggestions, or questions on this document should be addressed to: Commander, Naval Air Warfare Center Aircraft Division, Code 4L8000B120-3, Highway 547, Lakehurst, NJ 08733-5100 or emailed to michael.sikora@navy.mil. Since contact information can change, you may want to verify the currency of this address information using the ASSIST Online database at https://assist.dla.mil.

AMSC N/A FSC 9150

2. APPLICABLE DOCUMENTS

2.1 General. The documents listed in this section are specified in sections 3 and 4 of this specification. This section does not include documents cited in other sections of this specification or recommended for additional information or as examples. While every effort has been made to ensure the completeness of this list, document users are cautioned that they must meet all specified requirements cited in sections 3 and 4 of this specification, whether or not they are listed.

2.2 Government documents.

2.2.1 Specifications and standards. The following specifications and standards form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

FEDERAL STANDARD

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

DEPARTMENT OF DEFENSE SPECIFICATIONS

MIL-PRF-7808	-	Lubricating Oil, Aircraft Turbine Engine, Synthetic Base
MIL-DTL-85694	-	Spectrometric Oil Standards
DOD-PRF-85734	-	Lubricating Oil, Helicopter Transmission System, Synthetic Base
SD-6	-	Provisions Governing Qualification, Qualified Products Lists and Qualified Manufacturers Lists

(Copies of these documents are available online at http://quicksearch.dla.mil or https://assist.dla.mil or from the Standardization Document Order Desk, 700 Robbins Avenue, Building 4D, Philadelphia, PA 19111-5094.)

2.2.2 Other Government documents, drawings, and publications. The following other Government documents, drawings, and publications form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.)

DEPARTMENT OF DEFENSE TECHNICAL MANUAL

DEPARTMENT OF THE NAVY

NAVAIR 17-15-50.2 - Joint Oil Analysis Program Manual Volume II, Spectrometer and Physical Test Laboratory Operating Requirements and Procedures.

(Application for copies are available from Naval Air Systems Command, Navy Oil Analysis Program, 22229 Elmer Road, Building 2360, Unit 4, Patuxent River, MD 20670-1534.)

2.3 Non-Government publications. The following documents form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

ASTM INTERNATIONAL

ASTM D92 - Standard Test Method for Flash and Fire Points by Cleveland Open Cup Tester
ASTM D97 - Standard Test Method for Pour Point of Petroleum Products
ASTM D445 - Standard Test Method for Kinematic Viscosity of Transparent and Opaque Liquids (and Calculation of Dynamic Viscosity)
ASTM D471 - Standard Test Method for Rubber Property-Effect of Liquids
ASTM D892 - Standard Test Method for Foaming Characteristics of Lubricating Oils
ASTM D972 - Standard Test Method for Evaporation Loss of Lubricating Greases and Oils
ASTM D1748 - Standard Test Method for Rust Protection by Metal Preservatives in the Humidity Cabinet
ASTM D2532 - Standard Test Method for Viscosity and Viscosity Change After Standing at Low Temperature of Aircraft Turbine Lubricants
ASTM D2603 - Standard Test Method for Sonic Shear Stability of Polymer-Containing Oils
ASTM D4057 - Standard Practice for Manual Sampling of Petroleum and Petroleum Products
ASTM D4177 - Standard Practice for Automatic Sampling of Petroleum and Petroleum Products
ASTM D4636 - Standard Test Method for Corrosiveness and Oxidation Stability of Hydraulic Oils, Aircraft Turbine Engine Lubricants, and Other Highly Refined Oils
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 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 D6595 - Standard Test Method for Determination of Wear Metals and Contaminants in Used Lubricating Oils or Used Hydraulic Fluids by Rotating Disc Electrode Atomic Emission Spectrometry

(Copies of these documents are available from www.astm.org or ASTM International,100 Barr Harbor Drive, West Conshohocken, PA 19428-2959.)

AMERICAN SOCIETY FOR QUALITY (ASQ)

ANSI/ASQ Z1.4 - Sampling Procedures and Tables for Inspection by Attributes

(Copies of this document are available from www.asq.org or the American Society for Quality, 600 Plankinton Avenue, Milwaukee, WI 53203.)

NATIONAL TOXICOLOGY PROGRAM

Annual Report on Carcinogens

(Copies of this document are available from http://ntp.niehs.nih.gov or the National Toxicology Program, P.O. Box 12233, Research Triangle Park, NC 27709.)

SAE INTERNATIONAL

AEROSPACE MATERIAL SPECIFICATIONS (AMS)

SAE AMS3085 Fluid, Reference for Testing AS5780 HPC Class (Polyol) Resistant Material
SAE AMS3217/1 - Test Slabs, Acrylonitrile Butadiene (NBR-H), Medium-High Acrylonitrile, 65-75
SAE AMS3217/4 - Test Slabs, Fluoroelastomer (FKM), 65-75
SAE AMS3217/5 - Test Slabs, Fluorosilicone (FVMQ) 55-65
SAE AMS7276 - Rubber: Fluorocarbon (FKM) High-Temperature-Fluid Resistant Low Compression Set For Seals In Fuel Systems and Specific Engine Oil Systems
SAE AMS R 83485 - Rubber, Fluorocarbon Elastomer, Improved Performance at Low Temperatures
SAE AMS4900 - Titanium Sheet, Strip, and Plate Commercially Pure Annealed, 55 ksi (379 MPa) Yield Strength

AEROSPACE RECOMMENDED PRACTICE (ARP)

SAE ARP5088	-	Test Method for the Determination of Total Acidity in Polyol Ester and Diester Gas Turbine Lubricants by Automatic Potentiometric Titration
SAE ARP6166	-	Minisimulator Method
SAE ARP6179	-	Evaluation of Gas Turbine Engine Lubricant Compatibility with Elastomer O-Rings

(Copies of these documents are available from http://www.sae.org or from the Society of Automotive Engineers International, 400 Commonwealth Drive, Warrendale, PA 15096-0001.)

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2.4 Order of precedence. Unless otherwise noted herein or in the contract, in the event of a conflict between the text of this document and the references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

3. REQUIREMENTS

3.1 Qualification. The lubricating oil furnished under this specification shall be products that are authorized by the qualifying activity for listing on the applicable qualified products list before contract award (see 4.2, 6.3, 6.4, and 6.5).

3.2 Materials. The composition of the lubricating oil is not limited; however, materials containing barium, organic compounds of titanium, and known or suspected human carcinogens (as defined by the National Toxicology Program's Annual Report on Carcinogens) are prohibited. Recycled basestocks are permitted; however, each batch shall be fully tested in accordance with the qualification requirements of this specification. If a tricresyl phosphate (TCP) additive is used, the TCP additive shall not contain more than 0.2 percent by weight of ortho cresol containing isomers of tricresyl phosphate. The manufacturer may be required to submit certification of conformance to this section (see 6.2).

3.2.1 Acid assay. The acid components, in mole percent, of the finished oil submitted as the qualification test sample, and reported on batch conformance reports, shall be determined in accordance with FED-STD-791, method 3500 or other equivalent gas chromatography methods. The manufacturer may then select a range of 10 mole-percent for each acid component to bracket the values measured on the qualification sample by the qualifying laboratory. The major acid components (10 mole-percent or greater) of production lots of oil shall fall within the stated range for each acid. The minor acid components shall not exceed 10 total mole-percent in bulk lots.

a. Alternate methods may be used if approved by the qualifying activity; however, only FED-STD-791, method 3500, shall be used for referee tests.

3.3 Chemical and physical requirements. All classifications of the lubricating oil shall conform to the requirements specified in table I.

TABLE I. Physical, chemical, and performance requirements.

Characteristic	Requirement	Test Method	Reference Paragraph
Acid assay	Report	FED-STD-791, Method 3500	3.2.1
Viscosity, mm^2/s (cSt) at -40 °C , maximum Percent change after 72 hours at -40 °C, maximum	13,000 ±6	ASTM D2532	 4.4.1
Viscosity, mm^2/s (cSt), at 100 °C at 40 °C, minimum	 4.90 - 5.40 23.0	ASTM D445	
Flash point, minimum	246 °C	ASTM D92	
Pour point, maximum	-54 °C	ASTM D97 or ASTM D5950 ASTM D5985 ASTM D5949	
Total acid number, mg KOH/g, maximum STD, C/I, HTS classes EE class	 1.00 0.75	SAE ARP5088	
Evaporation loss, percent by weight, 6.5 hours at 204 °C, maximum	 10	ASTM D972	4.4.2
Foaming, foam volume, mL, maximum 5 minutes aeration at 24 °C 1 minute settling at 24 °C 5 minutes aeration at 93.5 °C 1 minute settling at 93.5 °C 5 minutes aeration at 24 °C (after test at 93.5 °C, above) 1 minute settling at 24 °C	 25 nil 25 nil 25 nil	ASTM D892	

TABLE I. Physical, chemical, and performance requirements - Continued.

Characteristic	Requirement	Test Method	Reference Paragraph
Rubber compatibility Rubber swell, percent increase SAE AMS3217/1, 72 hours at 70 °C SAE AMS3217/4, 72 hours at 204 °C Standard silicone rubber, 96 hours at 121 °C Tensile strength loss, percent, max Standard silicone rubber, 96 hours at 121 °C	 5 - 25 5 - 25 5 - 25 30	FED-STD-791 Method 3604 Method 3433	4.4.3 and 4.4.3.1
Expanded Rubber Compatibility SAE AMS3217/5, 72 hours at 150 °C Rubber swell, percent increase Tensile strength loss, percent, max Elongation loss, percent, max Hardness loss, max	EE Class only 2 - 25 50 50 20	ASTM D471	4.4.4 and 4.4.4.1
Fluorocarbon SAE AMS7276 Suspended o-rings: 70 hours at 175 °C Tensile strength loss, percent, max Elongation loss, percent, max Mass increase, percent, max Rubber swell, percent increase Hardness loss, percent, max	EE Class only 30 20 9 5 - 17 20	SAE ARP6179	4.4.4 and 4.4.4.2
Fluorocarbon SAE AMS7276 Compressed o-rings: 480 hrs at 175 °C Compression set, percent, max	EE Class only 40	SAE ARP6179	4.4.4 and 4.4.4.2
Fluorocarbon SAE AMS-R-83485 Suspended/Compressed o-rings: 480 hours at 175 °C Tensile strength loss, percent, max Elongation loss, percent, max Mass increase, percent, max Rubber swell, percent increase Hardness loss, percent, max Compression set, percent, max	EE Class only 40 20 10 5 - 25 35 30	SAE ARP6179	4.4.4 and 4.4.4.3
Compatibility Turbidity Sediment, mg/l, maximum	Compatible None 20	FED-STD-791 Method 3403	4.4.5
Low temperature Storage Stability, 6 weeks at -18 °C	No crystallization, separation or gelling.		4.4.6
Stability Testing of First Production Run	Meet conformance inspection		4.4.7

TABLE I. Physical, chemical, and performance requirements - Continued.

Characteristic	Requirement	Test Method	Reference Paragraph
Thermal stability and corrosivity at 274 °C		FED-STD-791, Method 3411	4.4.8
Viscosity change, maximum	5.0 percent		
Total acid number change, mg KOH/g, maximum	6.0		
Weight of metal change, maximum	+/- 4.0 mg/cm^2		
Sediment		FED-STD-791, Method 3010	4.4.9
Visual undissolved water	none		
Sediment through 1.2 micron filter, maximum	10 mg/l		
Total ash content, maximum	1 mg/l		
Shear stability, viscosity loss at 40 °C, maximum	4 percent	ASTM D2603	4.4.10
Trace metal content by RDE-AES, ppm (mg/kg), maximum		ASTM D6595	4.4.11
Aluminum (Al)	2		
Iron (Fe)	2		
Chromium (Cr)	2		
Silver (Ag)	1		
Copper (Cu)	1		
Tin (Sn)	11		
Magnesium (Mg)	2		
Nickel (Ni)	2		
Titanium (Ti)	2		
Silicon (Si)	10		
Zinc (Zn)	2		
Lead (Pb)	2		
Molybdenum (Mo)	3		
Boron (B)	2		
Trace metal content ICP-AES, ppm (mg/kg), maximum		ASTM D5185	4.4.11
Aluminum (Al)	2		
Iron (Fe)	2		
Chromium (Cr)	2		
Silver (Ag)	1		
Copper (Cu)	1		
Tin (Sn)	4		
Magnesium (Mg)	2		
Nickel (Ni)	2		
Titanium (Ti)	2		
Silicon (Si)	10		
Zinc (Zn)	2		
Lead (Pb)	2		
Molybdenum (Mo)	3		
Boron (B)	2		

TABLE I. Physical, chemical, and performance requirements - Continued.

Characteristic	Requirement		Test Method	Reference Paragraph
	STD and C/I Classes	HTS and EE Classes		
Corrosion and oxidative stability a) 72 hours at 175 °C Viscosity, percent change Total acid number change, mg KOH/g, maximum Metal weight change, mg/cm^2, maximum Steel Silver (Ag) Aluminum (Al) Magnesium (Mg) Copper (Cu) Titanium (Ti) Sludge content (filtered through 10 µm), mg/100 mL of oil, maximum	 -5 to +15 2.0 ±0.2 ±0.2 ±0.2 ±0.2 ±0.4 --- 50	 0 to +10 1.0 ±0.2 ±0.2 ±0.2 ±0.2 ±0.4 --- 25	ASTM D4636, Alternate Procedure 2	4.4.12
Corrosion and oxidative stability b) 72 hours at 204 °C Viscosity, percent change Total acid number change, mg KOH/g, maximum Metal weight change, mg/cm^2, maximum Steel Silver (Ag) Aluminum (Al) Magnesium (Mg) Copper (Cu) Titanium (Ti) Sludge content, (filtered through 10 µm), mg/100 mL oil, maximum	 -5 to +25 3.0 ±0.2 ±0.2 ±0.2 ±0.2 ±0.4 --- 50	 0 to +22.5 2.0 ±0.2 ±0.2 ±0.2 ±0.2 ±0.4 --- 25	ASTM D4636, Alternate Procedure 2	4.4.12

TABLE I. Physical, chemical, and performance requirements - Continued.

Characteristic	Requirement		Test Method	Reference Paragraph
	STD and C/I Classes	HTS and EE Classes		
Corrosion and oxidative stability			ASTM D4636, Alternate Procedure 2	4.4.12
c) 72 hours at 218 °C				
Viscosity, percent change	120	60 max		
Total acid number change, mg KOH/g, maximum	15	10 max		
Metal weight change, mg/cm^2, maximum				
Steel	±0.2	±0.2		
Silver (Ag)	±0.2	±0.2		
Aluminum (Al)	±0.2	±0.2		
Magnesium (Mg)	---	---		
Copper (Cu)	---	---		
Titanium (Ti)	±0.2	±0.2		
Sludge content (filtered through 10 µm), mg/100 mL oil, maximum	50	25		

3.4 Bench performance requirements. Bench performance requirements shall be as specified in table II.

TABLE II. Bench performance requirements.

Characteristic	Requirement				Test Method
	STD	C/I	HTS	EE	
Gear load carrying ability, Relative Rating as % Herco A – average of 6 determinations, minimum	102%	102%	102%	110%	FED-STD-791, Method 6508 (Reference paragraph 4.4.13)
Bearing deposits					FED-STD-791, Method 3410 (Reference paragraph 4.4.14)
High Temperature Bearing Test,					
Total Test Time, hours	100	100	200	200	
Total Demerit Rating, maximum:	80	80	40	40	
Oil Consumption (mL) , maximum:	2000	2000	4000	4000	
Filter Deposits (g) , maximum:	3.0	3.0	1.5	1.5	
Viscosity, percent change	-5 to 30	-5 to 30	0 to 35	0 to 35	
Total acid number change, mg KOH/g, maximum	2	2	2	2	
Minisimulator Test,					SAE-ARP6166 (Reference paragraph 4.4.15)
Total Test Time, hours	N.A.	N.A.	N.A.	100	
Total Demerit Rating, maximum:	N.A.	N.A.	N.A.	45	
Oil Consumption (mL) , maximum:	N.A.	N.A.	N.A.	250	
Viscosity, percent change	N.A.	N.A.	N.A.	0 to 25	
Total acid number change, mg KOH/g, maximum	N.A.	N.A.	N.A.	2	
Bearing corrosion, percentage of test samples with no corrosion on raceway, minimum	N.A.	50%	N.A.	N.A.	Appendix A 4.4.16)

3.5 Full-scale performance requirements.

3.5.1 Turboshaft engine. The oils shall be tested in a full-scale turboshaft engine in accordance with 4.4.17 to evaluate its serviceability and to ensure that engine components are compatible with the lubricating oil. The post-test condition of the engine shall not indicate excessive or unusual deposits, wear or corrosion which are attributed to the test oil.

3.5.2 Service evaluation. The oil shall be rated as satisfactory after the model engine evaluation and flight evaluation tests specified in 4.4.18.

3.6 Toxicity. The lubricating oil shall have no adverse effect on the health of personnel when used for its intended purpose (see 6.8).

4. VERIFICATION

4.1 Classification of inspections. The inspection requirements specified herein shall be classified as follows:

a. Qualification inspection (see 4.2).
b. Conformance inspection (see 4.3).

4.2 Qualification inspection. Qualification inspection shall consist of testing to all the requirements specified in this specification. When required by the qualification activity, additional evaluations (engine and flight test service evaluation) may be required on candidate formulations.

4.2.1 Qualification process. The general outline of the qualification process (see 6.3) is described in SD-6.

4.2.2 Requalification. Requalification shall be required when any change is made in source of manufacture, purity, or composition of the lubricating oil base stocks or additives. A minor change in the oil formulation may be made without requalification testing, but only after notification to, and approval by, the qualification activity. Two specific requalification categories are reblend and rebrand, outlined in 4.2.2.1 and 4.2.2.2.

4.2.2.1 Reblend lubricating oil. A reblend lubricating oil is an original qualified product, as specified in 4.2, in which one or more ingredients have been blended by a manufacturer other than the manufacturer of the original formulation. A sample of the reblended lubricating oil shall be subjected to the qualification tests (see 4.2). The engine performance requirements (see 3.5.1) may be waived, at the discretion of the qualification activity, if the other test results indicate equivalence to the original formulation. Reblend approvals are initiated by the process specified in 6.3.

4.2.2.2 Rebrand lubricating oil qualification. A rebrand lubricating oil is a lubricating oil which has successfully passed the qualification tests (see 4.2) and is manufactured by the original formulator at the original manufacturing site but is packaged/distributed using a second party identifying trade name. Rebrand approvals are initiated by the process specified in 6.3.

4.2.3 Qualification inspection sample. The qualification test sample shall consist of 208 liters (55 gallons) of finished lubricating oil and 19 liters (5 gallons) of the base oil without additives. A minimum of 100 grams of each additive ingredient used in the manufacture of the qualification test sample shall be submitted prior to qualification (see 6.3.2).

4.3 Conformance inspection. Conformance inspection of production lots shall consist of all of the tests specified in table III. Failure of production lots to pass any of the conformance tests shall be cause for rejection of the lot.

TABLE III. Conformance tests.

Characteristic	Requirements	
	Reference Table	Additional Paragraphs
Acid assay	I	
Viscosity , mm^2/s (cSt), at 40 °C at 100 °C	I	
Flash point, °C	I	
Pour point, °C	I	
Total acid number, mg KOH/g , maximum	I	
Evaporation loss, percent by weight	I	
Foaming, foam volume, mL, maximum	I	
Thermal stability and corrosivity at 274 °C	I	
Sediment	I	
Trace metal content, ppm (mg/kg), maximum	I	
Corrosion and oxidative stability 72 hours at 204 °C	I	
Bearing deposits	II	4.4.19.1
Gear load carrying capacity	II	4.4.19.2
Bearing corrosion	II	4.4.19.3

4.3.1 Manufacturing tolerances. 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.

4.3.1.1 Additives. 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 IV.

TABLE IV. Additive batch concentration tolerances.

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

4.3.1.2 Basestocks. 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 percent by weight.

4.3.2 Government lot acceptance. In accordance with the contract, Government lot acceptance testing is required.

4.3.2.1 First production lot samples. Stability testing on the first production run will be performed as outlined in 4.4.7. A sample of five cases of 1 quart containers (120 containers) of material from the first production lot supplied to the procuring agency after qualification.

4.3.2.2 Production lot samples. In accordance with the contract, samples from every production lot will be supplied to the procuring activity.

4.3.2.3 Production lot shipping address: Production lot samples (see 4.3.2.1 and 4.3.2.2) shall be shipped to Naval Air Station, Hazmart Building 2385, Sample (AIR 4.4.2), 22680 Hammond Road, Patuxent River, MD 20670.

4.3.3 Sampling and inspection of oil. Each bulk lot (see 6.9) of material shall be sampled at random in accordance with ASTM D4057 or ASTM D4177 for the conformance inspection tests (see table III). Inspections shall meet or exceed requirements specified in the government contract or order.

4.3.3.1 Conformance test inspection report. The conformance inspection report (see 6.2) on each lot of oil shall be provided via electronic means or mailed to the following address: ATTN: Naval Air Systems Command, AIR 4.4.2.2, Propulsion Lubricants Team, 22229 Elmer Road, Building 2360, Unit 4, Patuxent River, MD 20670-1534.

4.3.4 Examination of filled containers. A random sample of filled containers from each packaged lot (see 6.9), taken in accordance with ASQ-Z1.4, shall be examined with regard to fill, closure, sealing and leakage.

4.4 Test methods. All tests shall be performed in accordance with tables I, II, and III.

4.4.1 Low temperature viscosity. For the purposes of determining the percent viscosity change, the initial viscosity shall be determined 35 ±1 minutes after the viscometer is placed in the bath maintained at -40 ±1.05 °C and again at 72 hours ±5 minutes after completion of initial viscosity.

4.4.2 Evaporation loss. Bath temperature shall be maintained at 204 ±1°C, for the 6.5 hour test period. Air temperature shall be maintained at 204 ±1°C, using a pre-heater, if necessary.

4.4.3 Rubber compatibility. Standard elastomer stocks shall conform to SAE AMS3217/1, SAE AMS3217/4, SAE AMS3217/5, SAE AMS7276, and SAE AMS R 83485.

4.4.3.1 Rubber swell. SAE AMS3217/1 and SAE AMS3217/4 shall be tested in accordance with FED-STD-791, method 3604. Standard Silicone Rubber shall be tested in accordance with FED-STD-791, method 3433.

4.4.4 Expanded rubber compatibility. The expanded rubber compatibility tests performed using ASTM D471 and SAE ARP6179 test methods are only required for the EE class.

4.4.4.1 SAE AMS3217/5 rubber compatibility. ASTM D471 modified procedure uses eight specimens, four cut using ASTM Die C (for tensile strength, elongation, and hardness properties) and four cut to 50 by 25 mm (for swell property). All eight specimens shall be suspended using stainless steel hangers submerged in 900 mL of oil in a sealed quart glass jar (a screw on lid lined with aluminum foil may be used). Aging shall be performed in an oven as stated in ASTM D471 with the single glass jar replacing the multiple test tube arrangement. Eight control specimens shall be used for baseline tensile strength, elongation, and hardness measurements.

4.4.4.2 SAE AMS7276 rubber compatibility. SAE AMS7276 shall be tested in duplicate with the EE candidate oil along with a single Reference Oil 300 (RO300 as in accordance with SAE AMS 3085) test and a single MIL-PRF-23699 STD class test; thus, a total of four cell assemblies per SAE ARP6179 are needed for one EE class qualification test. The results are invalid if either the RO300 or the STD tests fail any of their respective elastomer property limits. The limits for the RO300 control oil for suspended testing are tensile strength loss: 30 percent minimum, swell increase: 22 percent minimum, and hardness loss: 24 percent minimum. The limits for the STD control oil for suspended testing are tensile strength loss: 25 percent maximum, swell increase: 17 percent maximum, and hardness loss: 20 percent maximum. The limits for the compressed tests for RO300 and STD control oils are a compression set loss of 45 percent minimum and 35 percent maximum, respectively. The combined average of the duplicate tests for the candidate EE oil shall be reported along with the average of the RO300 and STD class oil tests for each of the listed properties. A single batch of SAE AMS7276 material has been set aside for this testing at the qualification laboratory as suggested in SAE ARP6179.

4.4.4.3 SAE AMS R 83485 Rubber Compatibility. SAE AMS R 83485 shall be tested in duplicate with the EE candidate oil per SAE ARP6179. The combined average of the duplicate tests for the candidate EE oil shall be reported.

4.4.5 Compatibility. The compatibility test shall be performed in accordance with FED-STD-791, method 3403 with the following exception: 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 l68 hour oven period, the test flasks shall be stored in the dark at room temperature 24 ±5 °C for 21 days before visual inspection for turbidity. Sediment shall be determined in accordance with FED-STD-791, method 3010. If the amount of sediment collected after the exposure period is greater than the limit specified in table I additional testing may be performed on the mixture to determine that its performance meets the requirements of this specification. The additional testing may include all of the tests specified in this specification. Referee lubricating oils shall consist of selected oils qualified under this specification, MIL-PRF-7808 and DOD-PRF-85734.

4.4.6 Low temperature storage. Three one quart samples of oil shall be stored in a cold chamber maintained at -18 ±2.5 °C for 6 weeks. At the end of the storage period, the oil shall be visually inspected for evidence of crystallization, additive separation, and gelling.

4.4.7 Stability testing of first production run. Five cases of one quart containers (120 containers) from the first production batch of the tentatively qualified oil procured for U.S. government use (original qualification, reblend, or rebrand) shall be stored at a temperature of not lower than -40 °C and not greater than 60 °C for l2 months. At the end of the l2 month storage period the samples shall be examined for conformance to the inspection requirements of conformance inspection (see 4.3).

4.4.7.1 Tentative qualification approval. Tentative qualification approval is given to products meeting the qualification inspection (see 4.2). Final qualification approval shall be awarded upon successful completion of the stability testing of first production run. Failure to pass this test shall be cause for withdrawal of approval.

4.4.8 Thermal stability and corrosivity. Post test oil viscosity sample shall be compared with viscosity of new oil samples tested at 40 °C. Post test oil total acid number is compared to the total acid number of the new oil sample. The viscosity shall be determined in accordance with ASTM D445. The total acid number shall be determined in accordance with SAE ARP5088.

4.4.9 Sediment. Sediment measurement may be made using a silver membrane filter. If the total sediment does not exceed 1 mg/l, the ash content does not need to be determined.

4.4.10 Shear stability. Use an irradiation period of 30 minutes on a 30 mL oil sample at a power setting which causes 11.5 ±0.5 percent viscosity loss to a 30 mL sample of ASTM Reference Fluid, when irradiated for five minutes. ASTM Reference Fluid A is a petroleum oil

containing a polymer capable of being broken down by turbulence at high rates of shear; typical viscosities are 10.7 mm^2/s (cSt) at 100 °C and 57 mm^2/s (cSt) at 40 °C. ASTM Reference Fluid A may be obtained from vendors listed in the ASTM D2603 method.

4.4.11 Trace metal content. The trace metal content of the oil for qualification testing shall be determined both with a Rotating Disc Electrode - Atomic Emission Spectrometer (RDE-AES) and Inductively Coupled Plasma - Atomic Emission Spectrometer (ICP-AES) spectrometer.

4.4.11.1 Spectrometer standardization. The spectrometer shall be standardized and correlated in accordance with the JOAP Program Manual, NAVAIR 17-15-50.2 using MIL-DTL-85694 standards. Immediately after standardizing the spectrometer, five determinations of the oil for trace metal content shall be performed. The average of the five determinations shall be reported. Samples requiring trace metal content determinations may be sent to: Naval Air Station, Hazmart Building 2385, Sample (AIR 4.4.6) – NOAP, 22680 Hammond Road, Patuxent River, MD 20670.

4.4.11.2 ICP adjustments. In accordance with ASTM D5185, modifications that allow for the adjustments in the dilution of the sample are allowed to accurately measure 2 ppm (mg/kg) of metals in the ICP-AES spectrometer.

4.4.11.3 Trace metal conformance testing option. Trace metal content for conformance testing (table III) can be tested using either RDE-AES spectrometer or ICP-AES spectrometer for the same elements outlined in table I.

4.4.12 Corrosion and oxidation stability. The corrosion and oxidation stability test shall be performed in accordance with ASTM D4636, Alternate Procedure 2, with the following modifications:

a. Duplicate tests shall be run at three separate tests temperatures, each conducted for a 72 hour-duration, at the bath or block temperatures of: 175 ±2.5 °C, 204 ±2.5 °C, and 218 ±2.5 °C. The individual results shall be reported.
b. A suitable liquid medium or fluidized sand bath heating apparatus may be used in lieu of an aluminum block heater.
c. After the sample tube has been in a liquid heating medium (or aluminum block) for 15 minutes, connect the dry air supply, adjust the air flow rate, and begin the test time.
d. An electrolytic grade silver test square shall be substituted for the cadmium plated steel square; in the 218 °C test, substitute titanium conforming to SAE AMS4900 (or equivalent), for copper and magnesium; stainless steel or nickel-chrome wire may be used to tie the metal coupons together at all test conditions.
e. Post test oil viscosity sample is compared with viscosity of new oil samples tested at 40 °C . Post test oil total acid number is compared to the total acid number of the new oil sample. The total acid number shall be determined in accordance with SAE ARP5088.
f. The glassware from FED-STD-791, method 5308 can be used.

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

g. Decant oil from the test tube through a preweighed l0.0 micron polytetrafluouroethylene filter (Militec LCWP 047-00 or equivalent) and measure filtrate volume.
h. Set filtrate aside for viscosity and acid number tests.
i. Remove all sludge from test equipment with rubber policeman, wash equipment and filtered sludge with petroleum ether, oven dry sludge sample, and weigh and compute sludge weight per 100 mL of oil.
j. 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, n-heptane, or hexane shall be used in place of 1,1,1-trichloroethane (O-T-620).

4.4.13 Gear load carrying ability. The average of six determinations for STD, C/I, and HTS classes of oil shall be not less than 102 percent of the reference oil (Hercolube A, see 4.4.13.1) when tested in accordance with FED-STD-791, method 6508 and table II. The average of six determinations for EE class of oil shall not be less than 110 percent of the reference oil. 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. Only the Ryder gear machines having a reference oil average rating of 2,100-2,600 lb/in. after eight determinations are acceptable.

4.4.13.1 Source for standard reference oil for Ryder Gear Test (table II). Standard reference oil may be obtained from the Naval Air Systems Command, AIR 4.4.2.2, Propulsion Lubricants Team, 22229 Elmer Road, Building 2360, Unit 4, Patuxent River, MD 20670-1534.

4.4.14 Bearing deposits.

a. Post test oil viscosity sample is compared with viscosity of new oil samples tested at 40 °C. Post test oil total acid number is compared to the total acid number of the new oil sample. The viscosity shall be determined in accordance with ASTM D445. The total acid number shall be determined in accordance with SAE ARP5088.

4.4.14.1 Classes STD and C/I. The qualification sample will be evaluated in a 100 hour test in accordance with table II (FED-STD-791, Method 3410, severity level 1-1/2).

4.4.14.2 Classes HTS and EE. The qualification sample will be evaluated in a 200 hour test in accordance with table II (FED-STD-791, Method 3410, severity level 1-1/2).

4.4.15 Minisimulator test. The enhanced ester qualification sample after a 100-hour minisimulator test (SAE ARP6166) shall perform in accordance with table II.

a. Post test oil viscosity sample is compared with viscosity of new oil samples tested at 40 °C. Post test oil total acid number is compared to the total acid number of the new

oil sample. The viscosity shall be determined in accordance with ASTM D445. The total acid number shall be determined in accordance with SAE ARP5088.

4.4.16 Bearing corrosion (class C/I only). The candidate oil shall successfully pass three series of bearing corrosion tests:

a. The first series of tests shall be conducted on the candidate oil as received (new oil) with a minimum of 18 of 36 bearing raceways being free from corrosion;
b. The second series shall be conducted on the post-test filtrate from the 204 °C. Corrosion and oxidation stability test (stressed oil) (see table I) with a minimum of three of six bearing raceways being free from corrosion.
c. The third series shall be run on the used oil from the turboshaft engine test (see 4.4.17) with a minimum of three of six bearing raceways being free from corrosion.
d. Any batch of bearing corrosion tests shall also include one pass and one fail reference oil test bearing for quality control purposes.

4.4.17 Turboshaft engine. The oil shall be subjected to an accelerated endurance test in a turboshaft engine for a period sufficient to determine its performance characteristics. Engine components shall be inspected for defects upon completion of the endurance test run. Any defects found in the components of the engine which are serviced by the oil shall be cause for disqualification. Engine test conditions and test period shall be specified by the activity responsible for qualification (see 4.2).

4.4.18 Service evaluation. When candidate lubricants that were the result of unique or unusual formulation or manufacturing technologies are submitted for qualification testing, the qualification activity (see 4.2) may require additional engine and flight test evaluations. The additional evaluations shall be conducted by the qualifying activity, or its designated representative, and shall consist of the following:

a. Model type test. A 150-hour, test cell operated, evaluation shall be conducted on a minimum of two different models of aviation gas turbine engines used by the U.S. Military.

b. Flight evaluation. A 2000-hour flight evaluation shall be conducted in a Government owned aircraft having the same engine model as used in the Model type test, above.

4.4.18.1 Evaluation criteria. The rating criteria for both the model type test and the flight evaluation will be reported as satisfactory or unsatisfactory. The satisfactory rating is contingent upon the successful completion of the test duration without a lubricant-related discrepancy and the satisfactory condition of the lubricant-wetted parts upon post-test engine disassembly and inspection. The post-test condition of the candidate lubricant shall be free of deleterious features.

4.4.19 Conformance inspection testing methods. The following information is in support of the conformance testing required in table III.

4.4.19.1 Bearing deposits conformance testing. The bearing deposit test (see table II) shall be performed on the first three full-scale production lots of each qualified lubricating oil supplied to the procuring activity.

4.4.19.2 Ryder gear load carrying capacity conformance testing. The Ryder Gear test (see table II) shall be performed on the first ten full-scale production lots of each newly qualified Class C/I and EE lubricating oil supplied to the procuring activity. Additional requirements for performing the Ryder Gear test on subsequent production batches may be specified in the procurement contracts. Additional load carrying test methods may be deemed suitable for qualification of management of change issues at the discretion of the qualifying activity. The products shall meet the conformance test requirements as stated in 4.4.19.2.1 and 4.4.19.2.2.

4.4.19.2.1 Class C/I products criteria. Class C/I products shall meet one of the following criteria:

a. greater than or equal to 112 percent of the Herco A reference fluid value if measured by two determinations.
b. greater than or equal to 106 percent of the Herco A reference fluid value if measured by four determinations.
c. greater than or equal to 102 percent of the Herco A reference fluid value if measured by six determinations.

4.4.19.2.2 Class EE products criteria. Class EE products shall meet the following criteria:

a. greater than or equal to 110 percent of the Herco A reference fluid value as measured by six determinations.

4.4.19.3 Bearing corrosion conformance inspection procedures. The bearing corrosion test shall be performed on all production batches of Class C/I lubricant supplied, except as noted in 4.4.19.3.1. Each production batch of the oil shall successfully pass one series of bearing corrosion tests (see table II) on the new oil. This series shall consist of nine candidate specimens and one each of the pass and fail reference oils (see 4.4.16).

4.4.19.3.1 Corrosion additive. Confirmation of the presence of the corrosion additive may be conducted using a quantitative laboratory analytical method of analysis approved by the qualifying activity. Confirmation of the specified additive package by such approved methods may be substituted for a bearing corrosion test to satisfy the quality conformance test requirement.

5. PACKAGING

5.1 Packaging. For acquisition purposes, the packaging requirements shall be as specified in the contract or order (see 6.2). When packaging of materiel is to be performed by DoD or in-house contractor personnel, these personnel need to contact the responsible packaging activity to ascertain packaging requirements. Packaging requirements are maintained by the Inventory Control Point's packaging activity within the Military Service or Defense Agency, or within the military service's system commands. Packaging data retrieval is available from the managing Military Department's or Defense Agency's automated packaging files, CD-ROM products, or by contacting the responsible packaging activity.

6. NOTES

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

6.1 Intended use. These lubricating oils are intended for use in gas turbine engines and gear boxes for air, sea, and ground mobility equipment. These oils are designed for operation within the approximate bulk oil temperature range of -40 to 204 °C. The STD class oil is intended for use in normal performance turbo equipment where concerns about ferrous material (gears and bearings) corrosion induced from extended periods of downtime in a moist environment is not a concern. The C/I class oil is intended for applications where corrosion inhibition is desired. The HTS class is for use in hot running engine designs where evidence of oil coking and/or oil degradation is noted. The EE class is intended for applications needing improved fluorocarbon (SAE AMS7276) compatibility as well as better load carrying capability. All the lubricant classifications are not intended for use in gas turbine systems containing silicone and fluorosilicone seals which operate at elevated temperatures. All the lubricant classifications are interchangeable and fully compatible with each other; however, mixing across classifications will diminish the added benefits provided by the C/I, HTS, or EE oils and the mixture will revert to the STD level of performance. Reference NAVAIRINST 10350.4 for more information about application of these oils.

6.2 Acquisition requirements. Acquisition documents should specify the following:

a. Title, number, and date of this specification.
b. Class (STD, C/I, HTS or EE) desired (see 1.2).
c. Quantity required
d. If certification of conformance to material prohibitions is required (see 3.2).
e. Submittal of conformance test results (see 4.3.3.1).
f. Packaging requirements (see 5.1).

6.3 Qualification process. Clarification information concerning submitting a test sample to the Naval Air System Command for qualification to MIL-PRF-23699 follows.

6.3.1 Requesting qualification. At the initiation of the qualification process, prospective suppliers must forward a written request for such action to the Naval Air Systems Command. The activity responsible for qualification is the Naval Air Systems Command, ATTN: Naval Air Systems Command, AIR 4.4.2.2, Propulsion Lubricants Team, 22229 Elmer Road, Building 2360, Unit 4, Patuxent River, MD 20670-1534. Information pertaining to qualification of products may be obtained from that activity. This letter must contain general information on the proposed candidate material. The Naval Air Systems Command will respond in writing with a formal "letter of authorization" providing detailed instructions for the submission of product samples, cost of testing, and test data.

6.3.2 Qualification sample. Upon receiving authorization by the Naval Air Systems Command, qualification samples may be forwarded to the qualification activity, as detailed in the authorization letter. These samples will be tested in accordance with the letter of authorization. Each sample must be plainly identified by a securely attached, durable tag or label marked with the following information:

QUALIFICATION INSPECTION SAMPLE
LUBRICATING OIL, AIRCRAFT TURBINE ENGINE,
MIL-PRF-23699

Type of sample: *(basestock, additive, or finished oil)*
Classification of Oil: (STD, C/I, HTS or EE)
Name of manufacturer: _____
Product code number: _____
Batch number: _____
Date of manufacture: _____
Submitted by *(name)* on *(date)* for qualification inspection in accordance with MIL-PRF-23699 under authorization of *(reference authorizing letter, see 4.2)*.

6.3.3 Qualification inspection test report. The manufacturer must submit a certified test report to the qualification activity (see 4.2) before any qualification test sample is supplied. Each reformulation request must also include a certified test report. These reports should be submitted in electronic format and use the latest version of the SAE AS5780 Qualified Products Formulation Pro-forma and Qualification Report (see https://www.eauditnet.com/).

6.3.3.1 Qualification test report requirements. The test report must contain laboratory data performed by the submitter or independent lab showing the results of all tests required by this specification and product classification, with the exception of the tests for compatibility, low temperature storage, extended storage stability, bearing deposit test, gear load carrying ability, shear stability, and full scale engine tests.

6.3.4 Formulation data. The manufacturer must submit the complete formulation data (in hardcopy format) giving the chemical name of each ingredient, the percentage of

each ingredient, and the manufacturer and trade name of each ingredient. The manufacturer must use the latest version of the SAE AS5780 Qualified Products Formulation Pro-forma and Qualification Report (see https://www.eauditnet.com/). The manufacturer must also submit the MSDS of the candidate product and for each of the additive components used in the formulation.

6.4 Qualification. With respect to products requiring qualification, awards will be made only for the products which are, at the time of award of contract, qualified for inclusion in the Qualified Products List, QPL-23699, whether or not such products have actually been so listed by that date. The attention of the contractors is called to these requirements, and manufacturers are urged to arrange to have the products that they propose to offer to the Federal Government tested for qualification in order that they may be eligible to be awarded contracts or orders for the products covered by this specification. Information pertaining to qualification of products may be obtained from the Naval Air Systems Command, Attn: Naval Air Systems Command, AIR 4.4.2.2, Propulsion Lubricants Team, 22229 Elmer Road, Building 2360, Unit 4, Patuxent River, MD 20670-1534.

6.5 Qualified Products Database. Current oils qualified to this specification can be found in the Qualified Products Database (QPD) at https://assist.dla.mil. Manufacturers with oils qualified to this specification are required to update their CAGE code listing annually at https://www.sam.gov. Even if an oil formulation does not have any changes (as described in 4.2), manufacturers are required to recertify their products every two years.

6.6 Subject term (key word) listing.

Corrosion inhibition
High thermal stability
Lubricant

6.7 International standardization agreement implementation. This specification implements NATO STANAG 1135. When amendment, revision, or cancellation of this specification is proposed, the preparing activity must coordinate the action with the U.S. National Point of Contact for the international standardization agreement, as identified in the ASSIST database at https://assist.dla.mil.

6.8 Toxicity. Questions pertinent to this effect should be referred by the contracting activity to the appropriate departmental medical service who will act as its advisor.

6.8.1 Material Safety Data Sheets. Contracting officers will identify those activities requiring copies of completed Material Safety Data Sheets prepared in accordance with FED-STD-313. The pertinent Government mailing addresses for submission of data are listed in section 5 of FED-STD-313.

6.9 Definitions.

6.9.1 Bulk lot. A bulk lot is defined as an indefinite quantity of homogeneous mixture of material offered for acceptance in a single isolated container or manufactured by a single plant run (not exceeding 24 hours) through the same processing equipment, with no change in ingredient material.

6.9.2 Packaged lot. A packaged lot is defined as an indefinite number of 208 liter (55 gallon) drums or smaller unit packages of identical size and type offered for acceptance and filled with a homogeneous mixture of material manufactured by a single plant run (not exceeding 24 hours) through the same processing equipment, with no change in ingredient material.

6.10 Changes from previous issue. Marginal notations are not used in this revision to identify changes with respect to the previous issue due to the extent of the changes.

APPENDIX A

Method For Determining Corrosion Preventative Properties of Synthetic Gas Turbine Lubricants

A.1 SCOPE

A.1.1 This test method uses ASTM D1743 as a basis to determine the corrosion preventative properties of synthetic gas turbine lubricants using tapered roller bearings stored under wet conditions. This Appendix is a mandatory part of the specification. The information contained herein is intended for compliance.

A.2 APPLICABLE DOCUMENTS

ASTM INTERNATIONAL

ASTM D235	Mineral Spirits (Petroleum Spirits) (Hydrocarbon Dry Cleaning Solvent)
ASTM D1141	Standard Practice for the Preparation of Substitute Ocean Water
ASTM D1193	Standard Specification for Reagent Water
ASTM D1743	Standard Test Method for Determining Corrosion Preventative Properties of Lubricating Greases

A.3 TERMINOLOGY

A.3.1 Description of terms specific to this standard. Corrosion, n - the chemical or electrochemical reaction between a material, usually a metal, and its environment that produces a deterioration of the material and its properties

A.4 SUMMARY OF TEST METHOD

A.4.1 Summary. Clean, new bearings are immersed in an aviation gas turbine lubricant and rotated, so as to evenly distribute the lubricant over the bearing surfaces. The bearings are subsequently dipped in distilled water, then stored at 52 ±1ºC and 100 percent relative humidity. After a specified time period the bearings are cleaned and the races of the bearing cups are examined for evidence of corrosion.

A.5 SIGNIFICANCE AND USE

A.5.1 Significance and use. This test method differentiates the relative corrosion preventative capabilities of aviation gas turbine lubricants under the conditions of the test.

A.6 APPARATUS

a. Timken bearings: Each bearing consists of 2 separate parts.

b. Bearing Cone: consisting of cone and roller assembly (Timken Part No. LM 11949)

c. Bearing Cup (Timken Part No. LM 11910)

d. Container, 237 cm^3 clear glass jar (85.7 mm high, 69.8 mm diameter) fitted with a lid containing a PTFE[1] liner. Note, the lids shall be replaced after 10 tests or earlier if it is apparent that the jar has not remained sealed throughout the test (see A.10).

e. Bearing Support, a glass adapter with a taper between the range of 14/35 to 19/38 is suitable.

f. Glass rod fitted with a rubber policeman.

g. Watch glass or alternative glassware that can withstand heating to 71 ºC in an oven (the size required will depend on the number of bearings being prepared).

h. Oven, air-circulating, capable of maintaining the temperatures 52 ±1ºC and 71 ±1ºC. (Note the oven should be dark inside and in an area essentially free of vibration.)

A.7 REAGENTS

a. Distilled Water (ASTM D1193 Type II reagent grade).

b. Isopropyl alcohol [2] (Reagent grade)

c. Solvent rinse solution:

Isopropyl alcohol	90%
Distilled Water	9%
Ammonium Hydroxide [3]	1% (Reagent Grade)

d. Stoddard Solvent[4], (as described in specification ASTM D235).

e. Synthetic seawater (as described in specification ASTM D1141, combined stock solution 1 and 2).

f. 50:50 mixture by volume of Isopropyl alcohol and Stoddard solvent

A.8 PREPARATION OF BEARINGS

A.8.1 Bearing examination. Examine the test bearings carefully and only select those that are entirely free of corrosion. During the bearing preparation handle the bearing with tongs. Care shall be taken to avoid touching the bearings with fingers.

A.8.2 Bearing cleaning procedure. The procedure below describes the use of heated solvents to clean the bearings. The solvents shall only be heated under a suitable fume extraction system.

a. Separate and wash the selected bearing thoroughly in hot (52 to 66 ºC) Stoddard solvent to remove rust preventative. To ensure complete removal of the rust preventative, subject the bearing to a second wash in Stoddard solvent heated to between 52 and 66 ºC.

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[1] Polytetrafluoroethylene
[2] Warning: Flammable
[3] Warning: Poison. Causes burns. Vapor extremely irritating. Can be fatal if swallowed. Harmful if inhaled.
[4] Warning: Combustible, Vapor Harmful.

b. Remove the bearing from the Stoddard solvent and immerse in solvent rinse solution at ambient temperature. This is to remove the Stoddard solvent and any fingerprints that are present.

c. Transfer the bearing from the ambient solvent rinse solution to fresh solvent rinse solution heated to between 66 ºC and 100 ºC.

d. Assemble the cup and cone on a bearing support (6.3 refers) and slowly rotate the bearing while immersed using the glass fitted with a rubber policeman.

e. Remove the bearing from the solvent rinse solution, separate the two components and place on a filter paper to drain.

f. Transfer the bearing to a watch glass (or alternative glassware) and place this in an oven set at 71 ±1ºC for 15 minutes to dry the bearing.

g. Remove the bearing from the oven and place it in a dessicator to cool for a minimum of 30 minutes.

h. When cooled re-examine the bearing to ensure the surfaces are still free of corrosion and the bearing can be turned freely. (Care should be taken not to spin the bearings once they have been prepared as this may damage the race.)

A.9 PROCEDURE

a. For each test, select bearings that are entirely free of corrosion. The bearings shall only be handled while wearing clean, oil resistant gloves.

b. Separate the bearing cup and cone and immerse both components in the test oil. Leave to stand for 10 minutes at ambient temperature.

c. Assemble the bearing cup and cone and place it on the glass support in such a manner that the weight of the cup will maintain contact between the races and rolling elements.

d. Hold the glass support and re-immerse the bearing in the test oil at ambient temperature, and slowly rotate the cup for 30 seconds using the glass rod fitted with a rubber policeman. Remove the glass support and bearing from the test oil and allow to drain for one minute.

e. After draining, completely immerse the glass support and bearing for 10 seconds in freshly boiled distilled water that has been allowed to cool to room temperature. Use a new supply of water for each bearing.

f. Add 5 mL of synthetic seawater to a glass jar (see A.6d). Transfer the bearing and glass support from the distilled water to the glass jar, allowing any water on the bearing to remain. Tighten the screw cap firmly and store the jar in a dark oven, located in an area essentially free of vibration, at 52 ±1 ºC for 48 hours.

A.10 RATING PROCEDURE

a. Upon completion of the storage period, remove the jars from the oven. Visually determine if any condensation is present in the sealed jars. If condensation is not present, then the PTFE liner of the lid should be considered suspect and the lid should be replaced.

b. Remove the bearing from the test jar. An audible hiss is often heard when the lid seal is broken which adds further confidence in the sealing ability of the lid.

c. Remove the bearing from the jar and separate the two components. Place the bearing cup in a 50:50 mixture by volume of isopropyl alcohol and Stoddard solvent. The solvent mixture can be heated to facilitate the removal of the oil, while observing the proper precautions for a flammable mixture. Agitate the cup vigorously to remove the oil.

d. Transfer the bearing cup from the solvent and allow to dry on clean filter paper.

e. Wipe the cup raceway with lint free paper, so as to remove any staining and repeat the rinsing using fresh solvent mixture if necessary to ensure all traces of the oil and stains are removed.

f. Examine the cup raceway for evidence of corrosion without the use of magnification using the IP 220 rating criteria as shown in Table A-I. Record the rating for each bearing.

TABLE A-I. Rating criteria.

Rating	Degree of Corrosion
0	No corrosion
1	No more than three small spots sufficient to be visible to the naked eye and less than 1 mm in diameter.
2	Small areas of corrosion covering up to 1% of the surface.
3	Areas of corrosion covering between 1% and 5% of the surface.
4	Areas of corrosion covering between 5% and 10% of the surface.
5	Areas of corrosion covering more than 10% of the surface

A.11 REPORT

A11.1 Test result report. Report the test result as the total count of bearings tested in the test oil, the number of bearings that were recorded for each rating category, the recorded rating of the pass and fail reference oil.

CONCLUDING MATERIAL

Custodians:
Army - AT
Navy - AS
Air Force - 11
DLA - GS

Preparing activity:
Navy - AS
(Project 9150-2013-007)

Review activities:
Army - AR, AV
Navy - SH
Air Force - 68

Industry associations:
NATO
` SAE, E-34 Committee

NOTE: The activities listed above were interested in this document as of the date of this document. Since organizations and responsibilities can change, you should verify the currency of the information above using the ASSIST Online database at https://assist.dla.mil.