MILITARY SPECIFICATION

LUBRICATING OIL, AIRCRAFT TURBINE ENGINE, POLYPHENYL ETHER BASE

This specification is approved for use by the Department of the Air Force and is available for use by all Departments and Agencies of the Department of Defense

1. SCOPE

1.1 This specification covers the requirements for one grade of aircraft gas turbine engine lubricating oil.

2. APPLICABLE DOCUMENTS

2.1 The following documents, of the issue in effect on date of invitation for bids or request for proposal, form a part of this specification to the extent specified herein.

SPECIFICATIONS

Federal

AA-S-698	Steel, Sheet and Strip, Low Carbon
QQ-A-250/4	Aluminum Alloy 2024, Plate and Sheet
PPP-C-1337	Containers, Composite: (Steel Drum with Polyethylene Insert)

Military

MIL-S-13282	Silver and Silver Alloy
MIL-L-27502	Lubricating Oil, Aircraft Turbine Engine, Ester Base

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: ASD/ENESS, Wright-Patterson Air Force Base, ohio 45433 by using the self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

FSC-9150

STANDARDS

Federal

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

Military

MIL-STD-105	Sampling Procedures and Tables for Inspection by Attribute
MIL-STD-147	Palletized and containerized unit loads 40 inch X 48 inch Pallets, Skids, Runners, or Pallet Type Base
MIL-STD-290	Packaging, Packing, and Marking of Petroleum and Related Products

(Copies of specification, standards, drawings, and publications required by contractors in conjunction with specific procurement functions should be obtained from the procuring activity or as directed by the contracting officer.)

2.2 Other publications. The following documents form a part of this specification to the extent herein. Unless otherwise indicated, the issue in effect on date of invitation for bid or request for proposal shall apply.

Society of Automotive Engineers

AMS 4908	Titanium, Alloy Sheet and Strip, 8Mn Annealed
AMS 5544	Alloy Sheet, Strip, and Plate, Corrosion and Heat Resistant, Nickel Base - 19.5Cr - 13.5Co - 4.3Mo - 3.0Ti - 14Al, Consumable Electrode or Vacuum Induction Melted, Annealed
AMS 6260	Steel Bars, Forgings, and Tubing, 1.2Cr - 3.25Ni - 0.12Mo (0.07 - 0.13) (SAE 9310)
AMS 6475	Steel Bars, Forgings, and Tubing, Nitriding 1.1Cr - 3.5Ni - 0.25Mo - 1.25Al (0.21 - 0.26C)
AMS 6490	Steel Bars, Forgings, and Tubing, 4.-Cr -4.25Mo - 1.0V (0.77 - 0.85C), Premium Bearing Quality, Consumable Electrode Vacuum Melted

(Application for copies should be addressed to the Society of Automotive Engineers, Incorporated, Two Pennsylvania Plaza, New York, New York 10001.)

American Society for Testing and Materials

ASTM D92	Flash and Fire Points by Cleveland Open Cup
ASTM D97	Pour Point
ASTM D270	Sampling Petroleum and Petroleum Products
ASTM D445	Viscosity of Transparent and Opaque Liquids (Kinematic and Dynamic Viscosities)
ASTM D664	Neutralization Number by Potentiometric Titration
ASTM D892	Foaming Characteristics of Lubricating Oils
ASTM D972	Evaporation Loss of Lubricating Greases and Oils
ASTM D1218	Refractive Index and Refractive Dispersion of Hydrocarbon Liquids
ASTM D1298	Test for Density, Specific Gravity, or API Gravity of Crude Petroleum and Liquid Petroleum Products by Hydrometer Method
ASTM D1947	Load-Carrying Capacity of Fluid Gear Lubricants
ASTM D2155	Autoignition Temperature of Liquid Petroleum Products
ASTM D2273	Trace Sediment in Lubricating Oils
ASTM D2532	Viscosity and Viscosity Change after Standing at -65°F (-53.9°C) of Aircraft Turbine Lubricants
ASTM D2766	Test for Specific Heat of Liquids and Solids
ASTM E100	Standard Specification for ASTM Hydrometers

(Application for copies should be addressed to the American Society for Testing and Materials, 1916 Race Street, Philadelphia, Pennsylvania 19103.)

3. REQUIREMENTS

3.1 Qualification. The lubricating oil furnished under this specification shall be a product which has been tested, and passed the qualification tests specified herein, and has been listed on or approved for listing on the applicable Qualified Product List (QPL).

3.1.1 Requalification. Before any change is made in the manufacturing, blending, or packaging site; quality, composition, or source of ingredients; or source of supply of the lubricating oil, the contractor must notify the qualifying activity (see 6.3) to determine if requalification is required.

3.2 Composition. The composition of this lubricating oil is not limited except that the basestock shall be essentially bis (phenoxyphenoxy) benzene.

3.3 Trace element content. The trace element content of the lubricating oil shall be determined in accordance with 4.8.1. The trace element content shall be reported for each of the following listed elements and shall not exceed the content limit:

ELEMENT	CONTENT LIMIT (PPM, MAX.)
Iron (Fe)	2
Silver (Ag)	1
Aluminum (Al)	3
Chromium (Cr)	3
Copper (Cu)	1
Magnesium (Mg)	1
Nickel (Ni)	2
Silicon (Si)	1
Titanium (Ti)	1
Tin (Sn)	200 min, 400 max

3.4 Performance Characteristics. The performance of the lubricating oil shall conform to the requirements listed in Table I and Section 3 when tested in accordance with the applicable test method specified therein. Requirements contained herein are not subject to corrections for test tolerances. If multiple determinations are made, results falling within repeatibility and reproducibility tolerances may be averaged.

TABLE I

PERFORMANCE CHARACTERISTICS

Properties	Requirements		Test Methods ASTM	Footnotes
Refractive Index at 25°C (77°F)	1.6284 min; 1.6324 max.		D-1218	
Trace Sediment, Ml/200 Ml of Oil	0 005 max.		D-2273	1
Neutralization Number	0.05 max.		D-664	2
Specific Gravity at 100°F/60°F	1.180 min, 1.200 max.		D-1298	3
Viscosity at 260°C (500°F), cs	1.0 min.		D-445	4
Viscosity at 98.9°C (210°F), cs	12.5 min.		D-445	
Viscosity at 37.8°C (100°F), cs	330 min, 375 max.		D-445	
Viscosity at -51°C (-60°F), cs (35% by weight diluent)				
at 35 minutes	17,000 max.		D-2532	5
at 3 hours	17,000 max.		D-2532	5
Pour Point, °C	+5 max.		D-97	
Flash Point, °C	275 min.		D-92	
Autoignition Temperature, °C	610 min.		D-2155	
Evaporation Loss, at 300°C (572°F), Percent	35 max		D-972	6
at 260°C (500°F), Percent	15 max.		D-972	6
Specific Heat, @			D-2766	7
260°C (500°F)	45 min.			
160°C (320°F)	.40 min.			
60°C (140°F)	.35 min.			
Foaming Characteristics at	Foam Volume, Ml, at the end of.		D-892	8
	5 min. aeration	10 minute settling period		
24°C (75°F)	625 max.	550		
93°C (200°F)	250 max.	none		
24°C (after test at 93°C)	625 max.	550		

TABLE I
FOOTNOTES

1. Reagent grade trichloroethylene diluent shall be substituted for ASTM precipitation naphtha. Report total ml sediment per 200 ml of oil instead of average ml sediment per 100 ml of oil.

2. Titrate to a pH 11 end point.

3. Use ASTM 114H-62 hydrometer.

4. Viscometer shall be in accordance with ASTM D-445. Test conditions will be specified by the activity responsible for qualification (see 6.3).

5. Diluent shall be reagent grade trichloroethylene.

6. Use a 6 hour test period, ambient atmospheric pressure, and a bath temperature controlled within ±2°C of test temperature. Air Temperature shall be maintained within ±2°C of bath temperature, using a preheater if necessary.

7. Values may be calculated from an equation of specific heat vs. temperature derived from minimum of five determinations of enthalpy change made over the specified temperature range. These shall include determinations of enthalpy change made at elevated temperatures within ±20°C (±36°F) of each of the three required test temperatures.

8. Report foam collapse period in seconds. Complete foam collapse is adjudged to be that point at which no more than a single row of bubbles remain around the cylinder wall and the air inlet tube. If this ring of bubbles around the cylinder wall contains segments having two or more layers of bubbles and the difference in height of the foam in the ring is not greater then 10 ml, complete foam collapse is adjudged to be that point at which a break occurs in the ring of bubbles without subsequent reforming of the ring.

3.5. Corrosion and oxidation stability. The lubricating oil shall be tested in accordance with 4.8.2 and shall meet the following requirements:

Test Temperature	48 Hour Post Test Oil Properties		48 Hour Metal Weight Change, Mg/Cm^2, Max.					
	Change in Viscosity at 37.8°C (100°F)	Change in Neutralization Number	Al	Ag	Fe	M-50	WSP	Ti
320°C (608°F)	-5% to +25%	0.20 max.	±.2	±.2	±.2	±.2	±.2	±.2

3.6 Deposition characteristics

3.6.1 Bearing deposition. The lubricating oil shall be tested in accordance with 4.8.3 at a test-oil sump temperature of 300°C (572°F) and a test bearing temperature of 360°C (680°F). The test-oil in temperature should be not less than 295°C (563°F) and the test-oil return temperature should not be less than 280°C (536°F). Test results must include reporting data on all determinations conducted. The average overall deposit demerit ratings shall not exceed 60. The weight of filter deposits shall not exceed 2 5 grams and the total oil consumption shall not exceed 1440 ml. The viscosity of the lubricating oil shall not have changed more than 25 percent from the original viscosity at 37.8°C (100°F), and the change in neutralization number shall not be greater than 0.20 during test and at the end of the test period. The metal specimen weight change at the end of the test period shall be not greater than ±0.2 mg/cm^2 from the before test weight for each metal specimen. In addition, the following shall be reported.

a. Bearing stabilization temperature
b. Major item deposit demerits
c. Major item colored photographs

3.7 Lubrication characteristics

3.7.1 Gear load carrying ability at 74°C (165°F). The gear load carrying ability of the lubricating oil shall be determined in accordance with 4.8.4.1 and shall meet the below listed requirements.

a. Qualification test requirement: The lubricating oil shall be subjected to six determinations. The average percentage of the six relative rating determinations shall be multiplied by the reference oil specified average value of 2900 ppi and the resulting load carrying ability shall be equal to or greater than 1920 ppi.

b. Quality conformance test requirement: The lubricating oil shall be subjected to a minimum of two and a maximum of six determinations. Test results must include reporting data on all determinations conducted. The average percentage of the relative rating determinations shall be multiplied by the reference oil specified average value of 2900 ppi and the resulting load carrying ability shall be equal to or greater than the following values:

Number of Determinations	Load Carrying Ability (Avg % Relative Rating x 2900 ppi)
2	2160 min
4	2000 min
6	1920 min

3.7.2 Gear load carrying ability at 220°C (428°F). The gear load carrying ability of the lubricating oil shall be determined in accordance with 4.8.4.2 and shall meet the below listed requirement.

a. Qualification test requirement. The lubricating oil shall be subjected to six determinations. The average value of the six determinations shall be equal to or greater than 960 ppi. The reference oil C average (eight determinations) rating shall be reported.

3.8 Compatibility

3.8.1 Compatibility, turbidity. The lubricating oil shall be tested in accordance with 4.8.5 and shall be compatible with each of the lubricating oils currently approved under this specification. At the end of the test period, mixtures shall not be turbid and the volume of sediment shall not exceed 0.005 Ml per 200 Ml of oil.

3.9 Workmanship. The finished lubricating oil shall be transparent, uniform in appearance, and shall be essentially free from cloudiness, suspended matter or other adulterations, when examined visually by transmitted light.

4. QUALITY ASSURANCE PROVISIONS

4.1 Unless otherwise specified in the contract, the contractor is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified in the contract, the contractor may use his own or any other facilities suitable for the performance of the inspection requirements specified herein, unless disapproved by the Government. The Government reserves the right to perform any of the inspections set forth in the specification where such inspections are deemed necessary to assure supplies and services conform to prescribed requirements.

4.2 Classification of tests. The inspection and testing of lubricating oil shall be classified as:

a. Qualification tests (4.6)
b. Quality conformance tests (4.7)

4.3 Definitions

4.3 1 Bulk lot. A bulk lot is defined as an indefinite quantity of a 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.

4.3.2 Packaged lot. A packaged lot is defined as an indefinite number of 55 gallon drums or smaller unit packages of identical size and type offered for acceptance and filled with a homogeneous mixture of material from one isolated container, or 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.

4.4 Sampling

4.4.1 Sampling for verification of product quality. Each bulk lot of material shall be sampled at random in accordance with ASTM Method D270 for verification of the product quality tests for 4.7.

4.4.2 Sampling for examination of filled containers. Each packaged lot of containers shall be sampled in accordance with MIL-STD-105, Inspection Level I, Acceptable Quality Level (AQL) 2.5 percent defective, and examined for leakage, fill, closure, and preparation for shipment (packaging, packing, marking) in compliance with MIL-STD-290.

4.5 Inspection of material. Inspection shall be in accordance with Method 9601 of FED-STD 791.

4.6 Qualification tests

4.6.1 Original formulation lubricating oil.

4.6.1.1 Qualification letter of request. The manufacturer shall forward a letter to the activity responsible for qualification (see 6.3) before the test sample is supplied. The letter shall contain the following:

a. Request for authorization to submit test sample for qualification.

b. Identification of the manufacturing site of the specific batch of test sample to be submitted.

c. Certified test report containing data on the specific batch of test sample to be submitted showing results of the test specified herein, except trace element content, viscosity at 260°C (500°F) and compatibility which shall be conducted by the activity responsible for qualification (6.3).

4.6.1.2 Qualification Test Sample. The qualification test sample, selected from a single lot, shall consist of 20 gallons packaged in 5-gallon polyethylene line containers. In addition, 5-gallons of the base oil blend (without additives), one quart of each basestock blend ingredient (without additives), and a minimum of 100 grams of each additive ingredient used in the manufacture of the qualification test sample shall be submitted. Each lubricant ingredient submitted shall be from the same batch used in the preparation of qualification test sample.

4.6.1.3 Formulation data. Complete formulation data shall be furnished to the qualifying activity. This data shall include chemical composition (I.U.P.A.C. nomenclature and structural diagrams of each ingredient), the percentages of each ingredient, the manufacturer and trade name of each ingredient, and where available, the purity of each ingredient and the approximate percent of each basestock isomer.

4.6.2 Tests. Tests to determine conformance to the requirements of this specification shall be conducted in accordance with the test methods specified in Table I and paragraph 4.8.

4.6.2.1 Additional tests. At the time of qualification, the right is reserved to subject the oil to such additional tests as are considered necessary to assure the serviceability of the material.

4.6.3.2 Test priority. Tests conducted by the qualifying activity will be accomplished in order of technical priority.

4.7 Quality conformance tests. Tests of individual lots which will serve as a basis for government acceptance shall consist of all requirements specified in Section 3 except the autoignition temperature test, the viscosity test at 260°C (500°F), the viscosity test at -51°C (-60°F), evaporation loss at 300°C (572°F), the specific heat test, the bearing deposition test, gear load carrying ability at 220°C (428°F) and the compatibility test.

4.7.1 In addition, a representative sample of oil not exceeding 450 ml taken immediately after thoroughly shaking (mechanically) a filled and closed 5-gallon container must conform to the trace sediment requirement. Samples shall be taken at periodic intervals so as to be representative of each days production. The number of samples taken each day shall be in accordance with MIL-STD-105 at Inspection Level S-3, Acceptable Quality Level (AQL) is 2.5 percent defective.

4.7.2 Rejection and retest. Lubricating oils which have been rejected may be reworked to correct the defects, and resubmitted for acceptance. Before resubmitting, full particulars concerning previous rejection and the action taken to correct the defects found in the original sample shall be furnished the inspector. Lubricating oil rejected after retest shall not be resubmitted without the specific approval of the procuring activity. Failure of production lots to pass the quality conformance tests shall be cause for removal from the Qualified Products List.

4.7.3 Reporting. A copy of the quality conformance test report on each lot shall be forwarded to the qualifying activity. (see 6.3).

4.8 Test Methods. Qualification and quality conformance requirements required by ection 3 shall be conducted in accordance with the applicable test methods listed in Table I and paragraphs 4.8.1 through 4.8.5.

4.8.1 Trace element content. The trace element content of the oil shall be determined by the Air Force Aerospace Fuels Laboratory with an atomic emission spectrometer. Immediately after standardizing the spectrometer, the oil sample shall be analyzed a minimum of five times and the average of each metal reported.

4.8.2 Corrosion and oxidation stability test. The oil shall be evaluated in the corrosion and oxidation stability test in accordance with Method 5307 of FED-STD 791 at the conditions specified below

The test duration shall be 48 hours at 10 liters/hr dry air-flow with no intermediate 10-ml samples withdrawn. The test temperature shall be 320°C (608°F) and the metal specimens shall be:

Bottom	Aluminum (QQ-A-250/4, T3 or T4)
	Silver (MIL-S-13282, Grade A)
	Mild Steel (AA-S-698, Grade 1009, cold rolled, condition No. 4 or 5)
	M-50 steel (AMS 6490)
	Waspaloy (AMS 5544)
Top	Titanium (AMS 4908)

4.8.3 Bearing deposition test. The oil shall be evaluated in the bearing deposition test in accordance with the test method defined in Appendix 1A of MIL-L-27502, except that the metal specimens shall be as follows:

Aluminum (QQ-A-250/4, T3 or T4)
Silver (MIL-S-13282, Grade A)
Mild Steel (AA-S-698, Grade 1009, cold rolled, condition No. 4 or 5)
M-50 Steel (AMS 6490)
Waspaloy (AMS 5544)
Titanium (AMS 4908)

Suitable insulation should be appropriately applied to achieve the required test-oil in temperature and the test-oil return temperature.

4.8.4 Gear load carrying tests

4.8.4.1 Load-carrying capacity at 74°C (165°F) shall be determined in accordance with ASTM D 1947 using AMS 6260 test gears. Only those gear machines having a reference oil average (eight determinations) rating within the range of 2,500 to 3,300 ppi are acceptable.

4.8.4.2 Load-carrying capacity at 220°C (428°F) shall be determined under the below test conditions using the WADD High Temperature Gear Machine conducted in accordance with the test procedure described in Appendix 1B of MIL-L-27502.

Gear Material: AMS6475* (Nitralloy N)
Gear Temperature: 220 ± 3°C (428 ± 5°F)
Test Oil-in Temperature: 205 ± 3°C (401 ± 5°F)
Support Oil-in Temperature: 74 ± 3°C (165 ± 5°F)

Only those gear machines having a reference oil C average (eight determinations at 74°C (165°F) using AMS6260 test gears) rating within the range of 2500 to 3300 ppi are acceptable.

*Gears shall be finished machined including gear tooth profile grinding after nitriding.

4.8.5 Compatibility. The compatibility test shall be conducted in accordance with Method No. 3403 of FED-STD- 791 with the following additional procedure: Upon completion of the 168 hour oven period, the test flasks shall be stored in the dark and room temperature 25°C ± 5 (77°F ± 9°F), for 21 days before visual inspection for turbidity and centrifuging. Centrifuge tubes having a small scale division of 0.005 ml or less shall be used. (DeLaval centrifuge tube, Part Nr. 14209, or equivalent, is acceptable.)

5. Packaging

5.1 Packing. The lubricant shall be furnished in 5-gallon containers conforming to type II, class 1 of PPP-C-1337.

5.2 Unitized Loads. When specified (see 6.2), the 5-gallon containers shall be unitized in accordance with MIL-STD-147, load type IV.

5.3 Marking. Container marking shall conform to the requirements of MIL-STD-290. The identification and address marking shall conform to the markings required for the 5-gallon pail in MIL-STD-290.

6. NOTES

6.1 Intended use. This lubricating oil is intended for use in specific models for aircraft turbine engines and power equipment requiring a polyphenyl ether base oil with a high temperature capabilility of +300°C (572°F). This oil is not suitable for use below +15°C (+59°F) without proper dilution.

6.2 Ordering data. Procurement documents should specify·

a. Title, number, and date of this specification.

b. Unitized loads, if desired.

c. Quantity desired.

6.3 Qualification. With respect to products requiring qualification, awards will be made only for such products as have, prior to the set time for opening of bids, been tested and approved for inclusion in the applicable Qualified Products List whether or not such products have actually been so listed by that date. The attention of the suppliers is called to this requirement, 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. The activity responsible for the approval of products for the Qualified Products List is the Air Force Aero Propulsion Laboratory (Attn: SFL), Wright-Patterson AFB, Ohio 45433, and information pertaining to qualification of products may be obtained from that activity.

6.4 Supplemental information concerning qualification and procurement of this material are contained in the Defense Standardization Program Document, SD-6, entitled Provisions Governing Qualification (Qualified Products List) dated 1 March 1967.

Custodians: Air Force - 11

Review Activities: Air Force - 68

Preparing Activity: Air Force - 11

Project Nr 9150-F476

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5 PROBLEM AREAS

a. Paragraph Number and Wording

b Recommended Wording

c Reason/Rationale for Recommendation

6 REMARKS

7a. NAME OF SUBMITTER *(Last, First, MI)* – Optional

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