METRIC

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PERFORMANCE SPECIFICATION

LUBRICATING OIL, AIRCRAFT TURBINE ENGINE, SYNTHETIC BASE, NATO CODE NUMBER O-156

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

1. SCOPE

1.1 Scope. This specification covers three 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 Number O-156.

1.2 Classification. The lubricating oil classed as follows:

Class	Type of Oil
STD	Standard (Non-Corrosion Inhibiting)
C/I	Corrosion Inhibiting
HTS	High Thermal Stability

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: Commander, Naval Air Warfare Center Aircraft Division Code 414100 B120-3, Highway 547, Lakehurst, NJ 08733-5100, by using the self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

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 listed in the issue of the Department of Defense Index of Specifications and Standards (DoDISS) and supplement thereto, cited in the solicitation (see 6.2).

SPECIFICATIONS

DEPARTMENT OF DEFENSE

MIL-L-7808	-	Lubricating Oil, Aircraft Turbine Engine, Synthetic Base
MIL-T-9046	-	Titanium and Titanium Alloy, Sheet, Strip, and Plate
DOD-L-85734	-	Lubricating Oil, Helicopter Transmission System, Synthetic Base

STANDARDS

FEDERAL

FED-STD-313	-	Material Safety Data, Transportation Data and Disposal Data for Hazardous Materials Furnished to Government Activities
FED-STD-791	-	Lubricant, Liquid Fuel, and Related Products; Methods of Testing

(Unless otherwise indicated, copies of federal and military specifications, standards, and handbooks are available from the Standardization Documents Order Desk, Bldg. 4D, 700 Robins Avenue, 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 are those cited in the solicitation (see 6.2).

DEPARTMENT OF DEFENSE TECHNICAL MANUALS

DEPARTMENT OF THE NAVY

NAVAIR 17-15BF-62 - Fluid Analysis Spectrometer, Type A/E35U-3, Operation Instructions and Maintenance Instructions

(Application for copies should be addressed to the Navy Inventory Point, Code 03334 (Publications/Forms Branch), 700 Robbins Avenue, Philadelphia, PA 19111-5098. Their customer service telephone is (215) 697-5632).

CODE OF FEDERAL REGULATIONS

DEPARTMENT OF LABOR

29 CFR 1910.1200 - Occupational Safety and Health Standards - Hazard Communications

(Application for copies should be addressed to the Superintendent of Documents, Government Printing Office, Washington, DC 20402.)

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 the documents which are DoD adopted are those listed in the issue of the DoDISS cited in the solicitation. Unless otherwise specified, the issues of documents not listed in the DoDISS are the issues of the documents cited in the solicitation (see 6.2).

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI-Z129.1 - American National Standard for the Precautionary Labeling of Hazardous Industrial Chemicals (DoD Adopted)

(Application for copies of ANSI-Z129.1 should be addressed to the American National Standards Institute, Inc., 1430 Broadway, New York, NY 10018.)

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM-D92 - Flash and Fire Points by Cleveland Open Cup, Standard Test Method for (DoD Adopted)
ASTM-D97 - Pour Point of Petroleum Oils, Standard Test Method for (DoD Adopted)
ASTM-D445 - Kinematic Viscosity of Transparent and Opaque Liquids (and the Calculation of Dynamic Viscosity), Standard Test Method for (DoD Adopted)

ASTM-D892 - Foaming Characteristics of Lubricating Oils, Standard Test Method for (DoD Adopted)
ASTM-D972 - Evaporation Loss of Lubricating Greases and Oils, Standard Test Method for (DoD Adopted)
ASTM-D1748 - Rust Protection by Metal Preservatives in the Humidity Cabinet, Standard Test Method for (DoD Adopted)
ASTM-D2532 - Viscosity and Viscosity Change After Standing at Low Temperature of Aircraft Turbine Lubricants, Standard Test Method for (DoD Adopted)
ASTM-D2603 - Sonic Shear Stability of Polymer-Containing Oils, Standard Test Method for (DoD Adopted)
ASTM-D4057 - Manual Sampling of Petroleum and Petroleum Products, Standard Practice for (DoD Adopted)
ASTM-D4177 - Automatic Sampling of Petroleum and Petroleum Products, Standard Practice for (DoD Adopted)
ASTM-E1 - ASTM Thermometers, Standard Specification for (DoD Adopted)

(Application for copies ASTM documents should be addressed to the American Society for Testing and Materials, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959.)

AMERICAN SOCIETY FOR QUALITY CONTROL (ASQC)

ASQC-Z1.4 - Sampling Procedures and Tables for Inspection by Attributes (DoD Adopted)

(Application for copies of ASQC-Z1.4 should be addressed to the American Society for Quality Control, P.O. Box 3005, 611 East Wisconsin Avenue, Milwaukee, WI 53201-4606.)

NATIONAL TOXICOLOGY PROGRAM

Annual Report on Carcinogens

(Application for copies should be addressed to the Annual Report on Carcinogens, National Toxicology Program, PO Box 12233, Research Triangle Park, NC 27709.)

SOCIETY FOR AUTOMOTIVE ENGINEERS (SAE)
AEROSPACE MATERIAL SPECIFICATIONS (AMS)

SAE-AMS3217/1 - Test Slabs, Acrylonitrile butadiene (NBR-H), Medium-High Acrylonitrile, 65-75 (DoD Adopted)
SAE-AMS3217/4 - Test Slabs, Fluoroelastomer (FKM), 65-75 (DoD Adopted)

AEROSPACE RECOMMENDED PRACTICE (ARP)

SAE-ARP4249 - Bearing Corrosion Test Method

SAE-ARP5088 - Test Method for the Determination of Total Acidity in Polyol Ester and Diester Gas Turbine Engine Lubricants by Automatic Potentiometric Titration

(Application for copies of SAE documents should be addressed to the Society of Automotive Engineers, 400 Commonwealth Drive, Warrendale, PA 15096-0001.)

(Non-Government standards and other publications are normally available from the organizations that prepare or distribute the documents. These documents also may be available in or through libraries or other informational services.)

2.4 Order of precedence. 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 and 6.3).

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 must be fully tested in accordance with the qualification requirements of this specification. If a tricresyl phosphate (TCP) additive is used, it shall not contain more than one (1) percent of the ortho-isomer of tricresyl phosphate. The manufacturer may be required to submit certification of conformance to this paragraph (see 6.2).

3.2.1 Acid assay. The acid components, in mole-percent, of the finished oil submitted as the qualification test sample shall be determined in accordance with FED-STD-791, method 3500, "Monobasic Acid Components of Synthetic Ester Lubricants by Gas Chromatography." 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 bulk lots (see 6.7) of oil shall fall within the stated range for each acid. The minor acid components shall not exceed 10 mole-percent in bulk lots.

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

TABLE I. Physical, chemical, and performance requirements.

Characteristic	Requirement	Test method	
		ASTM or SAE	FED-STD-791
Acid assay	Report (see 3.2.1)	—	3500 1/
Viscosity, cSt, at -40°C (-40°F), maximum	13,000	ASTM-D2532	—
Percent change after 72 hours at -40°C (-40°F), maximum 2/	±6		
Viscosity, cSt, at 100°C (212°F)	4.90 - 5.40	ASTM-D445	—
at 40°C (104°F), minimum	23.0		
Flash point, minimum	246°C (475°F)	ASTM-D92	—
Pour point, maximum	-54°C (-65°F)	ASTM-D97	—
Total acid number, maximum	1.00	SAE-ARP5088	—
Evaporation loss, percent by weight, 6.5 hours at 204°C (400°F), maximum 3/	10	ASTM-D972	—
Foaming, foam volume, ml, maximum 4/		ASTM-D892	—
5 minutes aeration at 24°C (75°F)	25		
1 minute settling at 24°C (75°F)	none		
5 minutes aeration at 93.5°C (200°F)	25		
1 minute settling at 93.5°C (200°F)	none		
5 minutes aeration at 24°C (75°F) (after test at 93.5°C, above)	25		
1 minute settling at 24°C (75°F)	none		
Rubber compatibility		—	3604 and 3433 5/
Rubber swell, percent			
SAE-AMS3217/1, 72 hours at 70°C (158°F)	5 - 25		
SAE-AMS3217/4, 72 hours at 204°C (400°F)	5 - 25		
Standard silicone rubber, 96 hours at 121°C (250°F)	5 - 25		
Tensile strength loss of standard silicone rubber, percent, maximum	30		
Compatibility	Compatible	—	3403 6/
Turbidity	None		
Sediment, mg/l, maximum	20		

TABLE I. Physical, chemical, and performance requirements, continued.

Characteristic	Requirement		Test method	
			ASTM or SAE	FED-STD-791
Storage stability Low temperature, 6 weeks at -18°C (0°F)	No crystallization, separation or gelling.		—	7/
Qualification sample Stored for three years at -40 to +60°C (-40 to +140°F)	Conform to 3.3 and 3.4. 9/		—	8/
First production qualification sample Stored for 12 months at 24° ±5°C (75° ±10°F)	Pass the conformance inspection. 9/		—	8/
Thermal stability and corrosivity at 274°C (525°F)				3411
Viscosity change, maximum 10/	5.0 percent		—	
Total acid number change from original, maximum	6.0		—	
Weight of metal change, maximum	4.0 mg/cm^2		—	
Sediment 11/			—	3010
Visual undissolved water	none			
Sediment through 1.2 micron filter, maximum 12/	10 mg/l			
Total ash content, maximum	1 mg/l			
Shear stability, viscosity loss at 40°C (104°F), maximum	4 percent		ASTM-D2603 13/	—
Trace metal content, parts per million (ppm), maximum			14/	—
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			
	STD and C/I classes	HTS Class		

TABLE I. Physical, chemical, and performance requirements, continued.

Characteristic	Requirement		Test method	
			ASTM or SAE	FED-STD-791
Corrosion and oxidative stability			—	5308 15/
a) 72 hours at 175°C (347°F)				
Viscosity, percent change 10/	-5 to +15	0 to +10		
Total acid number change, maximum 15/	2.0	1.0		
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)	±0.2	±0.2		
Copper (Cu)	±0.4	±0.4		
Titanium (Ti)	—	—		
Sludge content (filtered through 10 µm), mg/100 ml of oil, maximum	50	25		
Corrosion and oxidative stability			—	5308 15/
b) 72 hours at 204°C (400°F)				
Viscosity, percent change 10/	-5 to +25	0 to +22.5		
Total acid number change, maximum 15/	3.0	2.0		
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)	±0.2	±0.2		
Copper (Cu)	±0.4	±0.4		
Titanium (Ti)	—	—		
Sludge content, (filtered through 10 µm), mg/100 ml oil, maximum	50	25		
	STD and C/I Classes	HTS Class		

TABLE I. Physical, chemical, and performance requirements, continued.

Characteristic	Requirement		Test method	
			ASTM or SAE	FED-STD-791
Corrosion and oxidative stability			—	5308 15/
c) 72 hours at 218 °C (425 °F)				
Viscosity, percent change 10/	Report	Report		
Total acid number change, maximum 15/	Report	Report		
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		

1/ Alternate methods may be used if acceptable to the qualifying activity; however, only FED-STD-791, method 3500, "Monobasic Acid Components of Synthetic Ester Lubricants by Gas Chromatography," shall be used for referee tests.

2/ 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.

3/ Bath temperature shall be maintained at 204°C ±1°C (400°F ±2°F), and 6.5 hour test period. ASTM-E1, Thermometer 80F shall be used. Air temperature shall be maintained at 204°C ±1°C (400°F ±2°F), using a preheater, if necessary.

4/ Complete foam collapse is that point at which no more than a single row of bubbles remain around the cylinder wall and 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 than 10 milliliters (ml), complete foam collapse is the point at which a break occurs in the ring of bubbles without subsequent reforming of the ring.

5/ SAE-AMS3217/1 and SAE-AMS3217/4 shall be tested in accordance with FED-STD-791, method 3604, "Swelling of Synthetic Rubber by Aircraft Turbine Lubricants." Standard Silicone Rubber shall be tested in accordance with FED-STD-791, method 3433, "Compatibility of Synthetic Aircraft Turbine Lubricants with Silicone Rubber."

6/ See paragraph 4.4.1 for test method details.

7/ See paragraph 4.4.2 for test method.

8/ See paragraph 4.4.3 for test method.

9/ Tentative qualification approval will be given to products meeting all other tests of the qualification inspection (see 4.2). Final qualification approval will be awarded upon successful completion of the extended storage stability tests. Failure to pass the extended storage stability tests is cause for withdrawal of qualification approval (see 4.4.3).

10/ Compared with viscosity of new oil samples tested at 40°C (104°F).

11/ Sediment measurement may be made using a silver membrane filter.

12/ If the total sediment does not exceed 1 mg/l, the ash content does not need to be determined.

13/ 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 A, 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 the Rohm and Haas Company, Research Laboratories, Spring House, PA 19477.
14/ See paragraph 4.4.6 for test method details.
15/ See paragraph 4.4.4 for test method details.

3.4 Bench performance requirements. Bench performance requirements shall be as specified in table II and 3.4.1 through 3.4.3.

TABLE II. Bench performance requirements.

Requirement	Limit			Test method		
	STD	C/I	HTS	FED-STD-791	SAE	ASTM
Gear load carrying ability	1/	1/	1/	6508 2/	—	—
Bearing deposits	3/	3/	4/	3410, severity level 1-½	—	—
Bearing corrosion (class C/I only)	—	5/	—	—	SAE-ARP4249 6/	ASTM-D1748 6/

1/ See 3.4.1.
2/ Only the Ryder gear machines having a reference oil average rating of 2,100-2,600 lb./in. after eight determinations are acceptable.
3/ See 3.4.2.1.
4/ See 3.4.2.2.
5/ See 3.4.3
6/ SAE-ARP4249 is required for qualification testing. ASTM-D1748 is an alternate test method for conformance testing (see 4.4.7.1).

3.4.1 Gear load carrying ability. The average of six determinations for each class of the oil shall be not less than 102 percent of the reference oil (Hercolube A, see 6.2.1) when tested in accordance with FED-STD-791, 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.

3.4.2 Bearing deposits.

3.4.2.1 Classes STD and C/I. The overall deposit demerit rating shall be less than 80 after a 100 hour bearing test in accordance with FED-STD-791, Method 3410, "High Temperature Deposit and Oil Degradation Characteristics of Aviation Turbine Oils," severity level 1-½. The weight of filter deposits shall not exceed 3 grams and the total oil consumption shall not exceed 2,000 ml. The viscosity of the lubricating oil shall not have changed more than –5 to +30 percent from the original viscosity at 40°C (104°F) and the change in total acid number shall not exceed 2.0 mg KOH/g, during test and at the end of the 100 hour test period.

3.4.2.2 Class HTS. The overall deposit demerit rating shall not exceed 20 after a 100 hour bearing test in accordance with FED-STD-791, Method 3410, severity level 1-½. The weight of filter deposits shall not exceed 1.5 grams and the total oil consumption shall not exceed 2,000 ml. The viscosity of the lubricating oil shall not have changed more than -0 to +20 percent from the original viscosity at 40°C (104°F) and the change in total acid number shall not exceed 1.5 mg KOH/g, during test and at the end of the 100 hour test period.

3.4.3 Bearing corrosion (class C/I only). A minimum of fifteen of the twenty candidate test specimens from each series shall be free of corrosion at the end of testing in accordance with 4.4.7.

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 4.4.5 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 of 4.4.8.

3.6 Toxicity. The lubricating oil shall have no adverse effect on the health of personnel when used for its intended purpose. Questions pertinent to this effect shall be referred by the contracting activity to the appropriate departmental medical service who will act as its advisor. Material safety data sheets (MSDS) must be prepared and submitted in accordance with FED-STD-313 (see 6.6).

4. VERIFICATION

4.1 Classification of inspections. The inspection and testing of lubricating oil 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 section 3. When required by the qualification activity, additional evaluations (engine and flight test service evaluation) may be required on candidate formulations. The extended storage stability tests (see 4.4.3) will be performed after the candidate product has passed all other qualification tests. Tentative qualification approval may be granted to products undergoing the extended storage stability tests. Upon successful completion of the extended storage stability test, full qualification approval will be granted. Failure to pass the extended storage stability tests is cause for withdrawal of qualification approval.

4.2.1 Requalification. Requalification shall be required when any reformulation or 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 (see 6.3).

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

Table III. Conformance tests.

Characteristic	Test method		
	Test paragraph	FED-STD-791	ASTM or SAE
Acid assay (see table I and 3.2.1)	—	3500	—
Viscosity (see table I) at 40°C (104°F) at 100°C (212°F)	— —	— —	 ASTM-D445 ASTM-D445
Flash point, °C (see table I)	—	—	ASTM-D92
Pour point, (see table I)	—	—	ASTM-D97
Total acid number, (see table I)	—	—	SAE-ARP5088
Evaporation loss, (see table I)	—	—	ASTM-D972
Foaming, foam volume (see table I)	—	—	ASTM-D892
Thermal stability and corrosivity at 274°C (525°F) (see table I)	—	3411	—
Sediment (see table I)	—	3010	—
Corrosion and oxidative stability, 72 hours at 204°C (400°F) (see table I)	4.4.4	5308	—
Trace metal content (see table I)	4.4.6	—	—
Bearing corrosion (class C/I only)	4.4.7.1 and 4.4.7.1.1	—	
Bearing deposits 1/	See table II	—	—
Gear load carrying ability (class C/I only)	See table II	6508 2/	—

1/ The bearing deposit test shall be performed on the first three full-scale production lots of each qualified lubricating oil supplied to the procuring activity. Additional requirements

for performing the bearing test on production batches may be specified in the procurement contracts.

2/ The oil shall exceed one of the following ratings: a) two determinations, minimum of 112 percent; b) four determinations, minimum of 106 percent; or c) six determinations, minimum of 102 percent. The average value of all test results shall be reported, with a maximum of six determinations conducted.

4.3.1 Sampling and inspection. Each bulk lot (see 6.7) of material for conformance inspection shall be sampled at random in accordance with ASTM-D4057 or ASTM-D4177. Inspections shall be conducted in accordance with FED-STD-791, method 9601, "Inspection Requirements." 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, and one case of every production lot supplied to the procuring activity thereafter, shall be forwarded to the Naval Air Warfare Center Aircraft Division (Code 4.4.5, Bldg. 34), 1440 Parkway Avenue, Trenton, New Jersey 08628.

4.3.2 Examination of filled containers. A random sample of filled containers from each lot (see 6.7), taken in accordance with ASQC-Z1.4, shall be examined with regard to fill, closure, sealing and leakage. Reject any container having one or more defects or for being under the required fill. If the number of defective or underfilled containers exceeds the acceptance number for the appropriate sampling plan of ASQC-Z1.4, reject the lot represented by the sample.

4.3.3 Conformance test inspection report. A copy of the conformance inspection report on each lot of oil produced for US Government use shall be forwarded to the qualification activity (see 6.3).

4.4 Test methods. All tests shall be performed in accordance with tables I and II, and 4.4.1 through 4.4.8.

4.4.1 Compatibility. The compatibility test shall be performed in accordance with FED-STD-791, method 3403, "Compatibility of Turbine Lubricating Oils," with the exception that 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° ±5°C (75° ±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)." 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 in this specification. Referee lubricating oils shall consist of selected oils qualified under this specification, MIL-L-7808 and DOD-L-85734.

4.4.2 Low temperature storage stability. Three one quart samples of oil shall be stored in a cold chamber maintained at -18° ±2.5°C (0° ±5°F) for 6 weeks. At the end of the storage period the oil shall be visually inspected for evidence of crystallization, additive separation, and gelling.

4.4.3 Extended storage stability.

a. Qualification sample. Ten one gallon containers of the qualification sample shall be stored at -40 to +60°C (-40 to +140°F), for three years. If at any time during the storage period the lubricating oil fails to conform to 3.3 and 3.4, qualification approval will be withdrawn.
b. First production sample. Five cases of one quart containers (120 containers) from the first production batch of the tentatively qualified oil (original qualification, reblend, or rebrand) shall be stored at 24° ±5°C (75° ±10°F) for 12 months. At the end of the storage period, the lubricating oil shall be pass the conformance inspection (see 4.3).

4.4.4 Corrosion and oxidation stability. The corrosion and oxidation stability test shall be performed in accordance with FED-STD-791, method 5308, "Corrosiveness and Oxidation Stability of Light Oils (Metal Squares)," with the following modifications:

a. Three separate tests, each conducted for 72 hours, shall be conducted with bath temperatures of 175°±2.5°C (347° ±5°F), 204° ±2.5°C (400° ±5°F), and 218° ±2.5°C (425° ±5°F);
b. A liquid-medium or fluidized sand bath heating apparatus may be used in place of an aluminum block heater;
c. An electrolytic-grade, silver test square shall be substituted for the cadmium plated steel square; in the 218°C test, in place of copper and magnesium, substitute titanium conforming to MIL-T-9046, type I, composition C; 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; condenser water temperature shall be maintained at 18° ±2.5°C (65° ±5°F);
d. The total acid number shall be determined in accordance with SAE-ARP5088.

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

e. Decant oil from the test tube through a preweighed 10.0 micron polytetrafluoroethylene (Teflon) filter (Militec LCWP 047-00 or equivalent) and measure filtrate volume;
f. Set filtrate aside for viscosity and acid number tests;
g. 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.
h. 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).

4.4.5 Turboshaft engine. The lubricating 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 6.3).

4.4.6 Trace metal content. The trace metal content of the lubricating oil shall be determined with an atomic emission spectrometer (A/E 35U-3 or FAS-2C). Using Joint Oil Analysis Program spectrometric calibration standards, the spectrometer shall be standardized in accordance with paragraphs 4-32, 4-33, 4-46 and 4-47 of NAVAIR 17-15BF-62. 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: Department of Defense, Technical Support Center, Joint Oil Analysis Program, Attn.: NOAP Lab, 296 Farrar Road, Suite B, Pensacola, FL 32508-5010.

4.4.7 Bearing corrosion (class C/I only). The bearing corrosion test shall be conducted in accordance with table II and the following:

a. The candidate oil must pass three series of the bearing corrosion test (see 3.4.3);
b. The first series of tests shall be conducted on the as received candidate oil (new oil);
c. The second series shall be conducted on the post test filtrate from the 204°C (400°F) Corrosion and oxidation stability test (stressed oil) (see table I).
d. The third series shall be run on the used oil from the turboshaft engine test (see 4.4.5).
e. Each series of tests shall consist of two test chambers, each containing ten candidate specimens and four each of the pass and fail reference oils..
f. Bearing corrosion conformance inspection shall be conducted in accordance with 4.4.7.1 and 4.4.7.1.1.

4.4.7.1 Conformance inspection procedures. Each bulk lot of the lubricating oil shall pass one series of bearing corrosion tests in accordance with 3.4.3 and table II. The series shall consist of two test chambers, each containing ten candidate specimens and four each of the pass and fail reference oils (see 3.4.3). ASTM-D1748 may be used as an alternate for SAE-ARP4249 during conformance testing. When ASTM-D1748 is used, the test shall be run for a 144 hour duration using five manually polished specimens (ten ratable surfaces). At the completion of the 144 hour test period, eight of the ten ratable surfaces must meet the pass criteria stated in the method.

4.4.7.1.1 Corrosion additive. Confirmation of the presence of the corrosion additive may be conducted using a quantitative analytical method approved by the qualifying activity (see 6.3). When approved, confirmation of the specified additive package may be substituted for SAE-ARP4249 or ASTM-D1748.

4.4.8 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 6.3) may require additional engine and flight test evaluations. The additional evaluations shall be conducted by the qualifying activity, or its designated representative, and will consist of the following:

a. Model type test. A 150 hour, test cell operated, evaluation will be conducted on a minimum of two different models of aviation gas turbine engines used by the US Military.
b. Flight evaluation. A 500 hour flight evaluation will be conducted in a Government owned aircraft having the same engine model as used in the Model type test, above.

4.4.8.1 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 must be free of features that would endanger safety of flight.

5. PACKAGING

5.1 Packaging. For acquisition purposes, the packaging requirements shall be as specified in the contract or order (see 6.2). When actual packaging of materiel is to be performed by DoD personnel, these personnel need to contact the responsible packaging activity to ascertain requisite packaging requirements. Packaging requirements are maintained by the Inventory Control Point's packaging activity within the Military Department or Defense Agency, or within the Military Department's System Command. 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 (-40 to 400°F). 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 inoperation 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. 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 or HTS oils and the mixture will revert to the STD level of performance.

6.2 Acquisition requirements. Acquisition documents should specify the following:

a. Title, number, and date of this specification, including any amendments.
b. Issue of DoDISS to be cited in the solicitation and, if required, the specific issue of individual documents referenced (see 2.2 and 2.3).
c. Class (STD, C/I or HTS) desired.
d. Quantity, type, and size of container required (see 5.1).
e. Any additional instructions for performing the bearing corrosion conformance inspection (see 4.4.7.1).
f. Submittal of conformance test results (see 4.3.4).
g. If certification of conformance to material prohibitions is required (see 3.2).

6.2.1 Source for standard reference oil for Ryder Gear Test (see 3.4.1 and table II). Standard reference oil may be obtained from the Naval Air Warfare Center Aircraft Division Code 4.4.5, Bldg. 34, Box 7176, Trenton, NJ 08628 or the qualification activity (see 6.3).

6.3 Qualification. With respect to products requiring qualification, awards will be made only for products which are, at the time of award of contract, qualified for inclusion in the applicable Qualified Products List, QPL-23699, 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 purchase orders for the products covered by this specification. Information pertaining to qualification of products may be obtained from the Naval Air Warfare Center Aircraft Division, Code 4.4.5, 48256 Shaw Road, Bldg. 1461, Patuxent River, MD 20670.

6.3.1 Data. To initiate the qualification process, forward a written request, including general information on the proposed candidate material, to the above address. Written response to this will be a "letter of authorization," which will provide detailed instructions for the submission of product samples and test data. A test report, containing data showing the results of all tests required by this specification, with the exception of compatibility, low temperature storage, extended storage stability, bearing test, shear stability, and full scale engine tests must be submitted to the qualification activity prior submittal of the qualification test sample. The test report must include complete formulation data, including the chemical name, the manufacturer, the trade name, and the percentage of each ingredient. The mole-percent of each acid of the base ester must be provided (see 3.2.1). The MSDS of the candidate product and each additive used in the formulation must be included.

6.3.2 Sample. The qualification test sample consists 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 must

be submitted prior to qualification testing. Each sample is to 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 or HTS)
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 6.3)*.

6.3.3 Reblend lubricating oil qualification. 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. At the discretion of the qualification activity, the turboshaft engine performance test requirements (see 3.5.1 and 4.4.5) may be waived, if the other test results indicate equivalence to the original formulation. Candidates for reblend approval are required to undergo qualification inspection (see 4.2) and may be initiated by the process described in 6.3.

6.3.4 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 may be initiated by the process described in 6.3.

6.4 Subject term (key word) listing.

Lubricant
Corrosion inhibition
High thermal stability

6.5 International standardization agreement. Certain provisions of this specification are the subject of international standardization agreement NATO STANAG 1135, "Interchangability Chart of NATO Standardized Fuels, Lubricants and Associated Products." When amendment, revision, or cancellation of this specification is proposed which will modify the international agreement concerned, the preparing activity will take appropriate action through international standardization channels, including departmental standardization offices, to change the agreement or make other appropriate accommodations.

6.6 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.

6.7 Definitions.

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.

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.

6.8 Changes from previous issue. Asterisks (or vertical lines) are not used in this revision to identify changes with respect to the previous issue due to the extensiveness of the changes.

CONCLUDING MATERIAL

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

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

Preparing activity:
Navy - AS
(Project 9150-1180)

STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

INSTRUCTIONS

1. The preparing activity must complete blocks 1, 2, 3, and 8. In block 1, *both the document number and revision letter* should be given.
2. The submitter of this form must complete blocks 4, 5, 6, and 7.
3. The *preparing activity must provide a reply* within 30 days from receipt of the form.
   NOTE: This form may not be used to request copies of documents, nor to request waivers, or clarification of requirements on current contracts. Comments submitted on this form do not constitute or imply authorization to waive any portion of the referenced document(s) or to amend contractual requirements.

I RECOMMEND A CHANGE:	1. DOCUMENT NUMBER	2. DOCUMENT DATE (YYMMDD)
	MIL-PRF-23699F	21 May 1997

3. DOCUMENT TITLE

LUBRICATING OIL, AIRCRAFT TURBINE ENGINE, SYNTHETIC BASE, NATO CODE NUMBER O-156

4. NATURE OF CHANGE (*Identify paragraph number and include proposed rewrite, if possible. Attach extra sheets as needed.*)

5. REASON FOR RECOMMENDATION

6. SUBMITTER

a. NAME (*Last, First, Middle Initial*)	b. ORGANIZATION	
c. ADDRESS (*Include Zip Code*)	d. TELEPHONE (*Include Area Code*) (1) Commercial: (2) DSN: (If Applicable)	7. DATE SUBMITTED (YYMMDD)

8. PREPARING ACTIVITY

a. NAME COMMANDER NAVAL AIR WARFARE CENTER AIRCRAFT DIVISION	b. TELEPHONE NUMBER (*Include Area Code*) (1) Commercial: (908) 323-7488 (2) DSN: 624-7488
c. ADDRESS (*Include Zip Code*) CODE 4141000B120-3 HIGHWAY 547 LAKEHURST, NJ 08733-5100	IF YOU DO NOT RECEIVE A REPLY WITHIN 45 DAYS, CONTACT: Defense Quality and Standardization Office, 5203 Leesburg Pike, Suite 1403, Falls Church, VA 22041-3466 Telephone (703) 756-2340 DSN 289-2340.