INCH-POUND
MIL-L-22851D
1 December 1990
Superseding
MIL-L-22851C
2 January 1979

MILITARY SPECIFICATION

LUBRICATING OIL, AIRCRAFT PISTON ENGINE (ASHLESS DISPERSANT)

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

1. SCOPE

1.1 Scope. This specification establishes the requirements for lubricating oils containing ashless dispersant additives to be used in four stroke cycle, reciprocating piston aircraft engines.

1.2 Classification. The lubricating oils shall be furnished in the following grades:

SAE Grade	Military Grade	Commercial Grade	NATO Code Number
30	none	65	none
40	Type III	80	O-123
50	none	100	none
60	Type II	120	O-128
Multi-Grade	none	none	none

Note: The Military Grade designations are being phased-out in favor of the NATO Code Numbers. Commercial Grade designations are being replaced by the SAE Grade classifications.

2. APPLICABLE DOCUMENTS

2.1 Government documents.

2.1.1 Specifications and standards. The following specifications and standards form a part of this specification to the extent specified herein. Unless otherwise specified, the

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: Naval Air Systems Command, AIR-5363, Washington, DC 20361-5360, by using the Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

issues of these documents shall be 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

MILITARY

MIL-L-6082	Lubricating Oil, Aircraft Piston Engine (Non-Dispersant Mineral Oil.

STANDARDS

FEDERAL

FED-STD-313	Material Safety Data Sheets, Preparation and the Submission of.
FED-STD-791	Lubricants, Liquid Fuels and Related Products; Methods of Testing.

MILITARY

MIL-STD-105	Sampling procedures and Tables for Inspection by Attributes.
MIL-STD-290	Packaging, Packing and Marking of Petroleum and Related Products.

(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.)

2.1.2 Other Government publications. The following other Government publications form a part of this specification to the extent specified herein. Unless otherwise specified, the issues shall be those in effect on the date of the solicitation.

NAVAL AIR SYSTEMS COMMAND

NAVAIR 17-15-BF-62	- Fluid Analysis Spectrometer, Type A/E 35U-3, Operation Instructions and Maintenance Instructions.

(Application for copies should be addressed to the Naval Air Technical Services Facilities, 700 Robbins Avenue, Philadelphia, PA 19111-5098.)

(Copies of specifications, standards, other Government documents and publications required by contractors in connection with specific acquisition functions should be obtained from the contracting activity or as directed by the contracting activity.)

2.2 Non-Government publications. The following documents form a part of this specification to the extent specified herein. Unless otherwise specified, the issues of the documents which are DOD adopted shall be those listed in the issue of the DODISS specified in the solicitation. Unless otherwise specified, the issues of documents not listed in the DODISS shall be the issue of the nongovernment documents which is current on the date of the solicitation (see 6.2).

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM D 92	-	Flash and Fire Points by Cleveland Open Cup.
ASTM D 94	-	Saponification Number of Petroleum Products.
ASTM D 97	-	Pour Point of Petroleum Oils.
ASTM D 129	-	Sulfur in Petroleum Products (General Bomb Method).
ASTM D 130	-	Detection of Copper Corrosion from Petroleum Products by the Copper Strip Tarnish Test.
ASTM D 189	-	Conradson Carbon Residue of Petroleum Products.
ASTM D 287	-	API Gravity of Crude Petroleum and Petroleum Products (Hydrometer Method).
ASTM D 445	-	Kinematic Viscosity of Transparent and Opaque Liquids (and the Calculation of Dynamic Viscosity).
ASTM D 482	-	Ash from Petroleum Products.
ASTM D 664	-	Neutralization Number by Potentiometric Titration.
ASTM D 892	-	Foaming Characteristics of Lubricating Oils
ASTM D 1552	-	Sulfur in Petroleum Products (High-Temperature Method).
ASTM D 2270	-	Calculating Viscosity Index from Kinematic Viscosity at 40 and 100°C.
ASTM D 2273	-	Trace Sediment in Lubricating Oils.
ASTM D 2602	-	Apparent Viscosity of Engine Oils at Low Temperature Using the Cold-Cranking Simulator.
ASTM D 2622	-	Sulfur in Petroleum Products (X-Ray Spectrographic Method).
ASTM D 4057	-	Manual Sampling of Petroleum and Petroleum Products
ASTM D 4177	-	Automatic Sampling of Petroleum and Petroleum Products
ASTM D 4530	-	Micro Carbon Residue of Petroleum Products.
ASTM D 4624	-	Measuring Apparent Viscosity by Capillary Viscometer at High Temperature and High Shear Rates.
ASTM D 4683	-	Measuring Viscosity at High Temperature and High Shear Rate by Tapered Bearing Simulator.
ASTM D 4741	-	Measuring Viscosity at High Temperature and High Shear Rate by Tapered-Plug Viscometer.
ASTM STP 509A	-	Single Cylinder Engine Tests, Part IV

(Application for copies should be addressed to the American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103-1137.)

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI Z129.1 American National Standard for the Precautionary Labeling of Hazardous Industrial Chemicals.

(Application for copies should be addressed to the American National Standards Institute, 1430 Broadway, New York, NY 10018.)

SOCIETY OF AUTOMOTIVE ENGINEERS, INC.

SAE Standard, "Engine Oil Viscosity Classification - SAE J300."

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

2.3 Order of Precedence. In the event of a conflict between the text of this specification and the references cited herein (except for associated detail specifications, specification sheets or MS standards), the text of this specification takes precedence. Nothing in this specification, however, shall supersede applicable laws and regulations unless a specific exemption has been obtained.

3. REQUIREMENTS

3.1 Qualification. The lubricating oils furnished under this specification shall be products which are authorized by the qualifying activity for listing on the applicable qualified products list at the time for opening of bids (see 4.3 and 6.2.2). Detailed information on the procedures to be followed when submitting a candidate lubricating oil are available from the Naval Air Systems Command, AIR-53632, Washington DC 20361. Each qualification approval is effective for four years from the date on which it is originally granted. A four year extension of a qualification approval may be granted by the qualifying activity. Interim qualification approval will be granted upon the successful completion of all specification requirements with the exception of the 12 month storage stability test.

3.1.1 Read-Across Approvals. Complete chemical and physical property test results shall be submitted for each grade of oil for which qualification is requested. L-38 tests shall be performed on the lightest and heaviest single grade oils to be blended from the same basestock materials (neutral and bright stock). All single grade oils blended from the same basestock materials and meeting SAE viscosity classification standards between the two tested products will be granted qualification approval based on similarity. The 150 hour engine test will be run on an SAE 50 grade oil unless the use of another grade is acceptable to the approving agency. The flight test will be run on the appropriate single grade(s) for the environmental conditions encountered. Read-across approvals will only be granted to different grades of oil which are composed of varying percentages of the same base stocks blended with identical additive packages (adjustments in VI improver and pour point depressant concentration will be permitted). No read-across approvals will be granted to multi-grade oils.

3.1.2 Requalification. Requalification shall be required in the event any change is made in the source or composition of the lubricant, the ingredients used, the manufacturing processes, or the plant location.

3.2 Materials. The lubricating oils shall be derived from petroleum fractions, synthetically prepared compounds or a combination of the two types of products compounded with such functional additives as dispersants, oxidation inhibitors, viscosity index improvers, and pour point depressants necessary to meet specified requirements. Only ashless type additives shall be used. No re-refined constituent materials shall be used. Crude source(s) and the types of processing used in the manufacture of the base stocks shall be identified in accordance with Appendix A. Exceptions to these requirements shall be directed to the Naval Air Systems Command (NAVAIR) for consideration.

3.3 Chemical and physical properties. Chemical and physical properties of the blended base stocks without additives shall conform to the requirements of Table I. The finished lubricating oil shall conform to the physical and chemical property requirements specified in Table II.

3.4 Sulfur. The sulfur content of the oil shall not exceed the value shown for each grade in Table II. For quality conformance inspection, the sulfur content shall be within ±0.15% mass of the qualification value or within a 0.3% mass range selected by the manufacturer to bracket the qualification value.

3.5 API Gravity. The American Petroleum Institute (API) gravity of the oil shall be determined but not limited on qualification inspection. For quality conformance inspection, the gravity shall be within ±0.7 °API of the qualification value, or within a 1.4 °API range selected by the manufacturer to bracket the qualification value.

3.6 Carbon Residue. The carbon residue of the oil shall not exceed the limits specified in Table II. For quality conformance inspection, the carbon residue shall be within ±0.2% mass from the value determined on the qualification sample, or within a 0.4% mass range selected by the manufacturer to bracket the qualification value.

3.7 Workmanship. The lubricating oil shall be an uncloudy, homogeneous blend when examined visually by transmitted light. It shall exhibit no separation or fallout of the additive package. Any jelly-like substance or very viscous material observed in the bottom of the container will be considered evidence of additive fallout.

3.8 Storage Stability.

3.8.1 Fourteen Day Storage Test. When stored as specified in paragraph 4.5.1.1, the oil shall show no separation.

TABLE I
CHEMICAL AND PHYSICAL PROPERTY REQUIREMENTS
FOR BLENDED BASE STOCK
(without additives)

Characteristic	Limit					Test Method
SAE Grade	30	40	50	60	Multi-Grade	
Carbon Residue, Mass % Max	0.6	0.6	1.2	1.2	0.6	ASTM D 189 ASTM D 4530
Sulfur, Mass % Max	0.6	0.8	1.0	1.2	0.6	ASTM D 129 ASTM D 1552 ASTM D 2622
	All Grades					
Viscosity Index, Min	85					ASTM D 2270
Viscosity, cSt, @ 100°C, @ 40°C	report report					ASTM D 445
Total Acid Number, mg KOH/g, Max 1/	0.10					ASTM D 664
Saponification Number, Max 2/	0.5					ASTM D 94

Note: 1/ Titrate to a pH 11 end point.
2/ Petroleum basestocks only.

3.8.2 Twelve Month Storage Test. When stored as specified in paragraph 4.5.1.2, the oil shall show no separation.

3.9 Bench performance requirements (L-38 engine test). The fully formulated oil shall meet the requirements of Table III when tested in the L-38 engine in accordance with ASTM STP 509A, Part IV. The test shall be run with the oil gallery temperature controlled at 135 ±1°C (275 ±2°F).

3.10 Engine Test. All candidate lubricating oils shall demonstrate satisfactory performance in a 150 hour engine performance test run on a Textron Lycoming TIO-540-J2BD engine in accordance with Appendix B. Results of this engine test shall be acceptable to the qualifying activity. For read-across approvals, only one engine test is required as defined in paragraph 3.1.1.

TABLE II
CHEMICAL AND PHYSICAL PROPERTY REQUIREMENTS
FOR FINISHED LUBRICANT

Characteristic / SAE Grade	30	40	50	60	Multi-Grade	Test Method
Viscosity, cSt, @ 100°C, Min	9.3	12.5	16.3	21.9	1/	ASTM D 445
@ 100°C, Less than	12.5	16.3	21.9	26.1	1/	
Viscosity Index, Min	100	100	95	95	100	ASTM D 2270
Flash Point, °C, Min	220	225	243	243	220	ASTM D 92
Pour Point, °C, Max	-24	-22	-18	-18	report	ASTM D 97
Viscosity, Low Temp., Cold Crank Sim., cP, Min	-	-	-	-	1/	SAE J300
	All Grades					
Viscosity, High Temp., High Shear, at 150°C, cP, Min	3.3					ASTM D 4683, ASTM D 4741, ASTM D 4624
Carbon Residue, Mass %	Report					ASTM D 189, ASTM D 4530
Sulfur, Mass %	Report					ASTM D 129, ASTM D 1552, ASTM D 2622
Viscosity, cSt, @ 40°C	Report					ASTM D 445
Total Acid Number, mg KOH/g, Max 2/	1.0					ASTM D 664
Density, °API	Report					ASTM D 287
Ash Content, Mass %, Max	0.006					ASTM D 482
Trace Sediment, ml/100ml Oil, Max	0.005					ASTM D 2273
Copper Strip Corrosion, Max Rating						ASTM D 130
3 hrs @ 100°C	1					
3 hrs @ 204°C	3					

Table II (Continued)

Characteristic	Limit	Test Method
SAE Grade	All Grades	
Foaming Tendency/Stability		ASTM D 892
Seq. I		
Aerated Vol., ml, Max	50	
Vol. after 10 min, ml, Max	0	
Seq. II		
Aerated Vol., ml, Max	50	
Vol. after 10 min, ml, Max	0	
Seq. III		
Aerated Vol., ml, Max	50	
Vol. after 10 min, ml, Max	0	
Compatibility with other oils	pass	FTM 791 Method 3403
Elastomer Compatibility 3/		FTM 791 Method 3604
% swelling, acceptable range: after 72 hours		
Material — Test Temp.		
AMS-3217/1 — 70°C (158°F)	-5 to +5	
AMS-3217/4 — 150°C (302°F)	-5 to +5	
AMS-3217/5 — 150°C (302°F)	-5 to +5	
US Navy Silicone Rubber 121°C (250°F)	0 to +20	
Trace Metal Content, ppm, Max.		(See Paragraphs 4.5.2 and 6.3.c)
Iron (Fe)	5	
Silver (Ag)	2	
Aluminum (Al)	7	
Chromium (Cr)	5	
Copper (Cu)	3	
Magnesium (Mg)	3	
Nickel (Ni)	3	
Lead (Pb)	5	
Silicon (Si)	25	
Tin (Sn)	10	
Titanium (Ti)	2	
Molybdenum (Mo)	4	

Notes: 1/ Oil shall meet the viscosity requirements of SAE J300 for the designated grade

2/ Titrate to a pH 11 end point.

3/ The elastomer compatibility test shall be performed in accordance with Fed Test Method Std 791 Method 3604 with the following exception: the specific materials which shall be tested and the temperature at which the test is to be conducted are those listed in the above table.

TABLE III
L-38 ENGINE TEST REQUIREMENTS [1/]

Characteristic	Limit		Test Method
	Single Grade	Multi-Grade	
BEARING			
Bearing Weight Loss, Total, mg, Max	500	500	[2/]
USED OIL			
Viscosity, Stripped, % Change, Max, @ 40°C	-15 to +10	report	ASTM D 445
Viscosity, @ 100°C	-	[3/]	SAE J300
Total Acid Number, Change, Max [4/]	2.0	2.0	ASTM D 664

Note: [1/] L-38 engine test is to be run in accordance with ASTM STP 509A, Part IV with an oil gallery temperature of 135 ±1°C (275 ±2°F).
[2/] ASTM STP 509A, Part IV.
[3/] Shall remain in SAE J300 grade.
[4/] Titrate to a pH 11 end point.

3.10.1 Engine Test Exclusion. At the discretion of the qualifying activity, the engine test requirement may be waived. Manufacturers requesting this waiver shall provide sufficient data to the qualifying activity to either verify that the candidate oil formulation does not represent a significant change from an existing qualified formulation or demonstrate the performance of the oil in an equivalent manner.

3.11 Flight test. After satisfactory completion of the 150 hour engine test requirement, all candidate oils shall demonstrate satisfactory performance when flight tested as specified in Appendix C. Flight tests shall be performed in accordance with current FAA advisory material. If the terms of paragraph 3.10.1 apply, the flight test shall not be required.

3.12 Material Safety Data Sheets. When applying for qualification, the manufacturer shall submit to the qualifying activity Material Safety Data Sheets prepared in accordance with FED-STD-313 (see 6.5).

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for inspection. Unless otherwise specified in the contract or purchase order, the contractor is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified in the contract or purchase order, the contractor may use his own or any other facility 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.

4.1.1 Responsibility for compliance. All items shall meet all requirements of sections 3 and 5. The inspection set forth in this specification shall become a part of the contractor's overall inspection system or quality program. The absence of any inspection requirements in the specification shall not relieve the contractor of the responsibility of assuring that all products or supplies submitted to the Government for acceptance comply with all requirements of the contract. Sampling inspection, as part of manufacturing operations, is an acceptable practice to ascertain conformance to requirements, however, this does not authorize submission of known defective material, either indicated or actual, nor does it commit the Government to accept defective material.

4.2 Classification of inspections. The inspection requirements specified herein are classified as follows:

a. Qualification inspection (see 4.3).

b. Quality conformance inspection (see 4.4).

4.3 Qualification inspection. The qualification inspection shall consist of a review of and concurrence with the manufacturer's test results (see 4.3.2) by NAVAIR's field activity, the Naval Air Propulsion Center (NAPC). Additional testing of the qualification inspection sample shall be performed by NAPC to confirm compliance with the requirements of Tables I and II.

4.3.1 Qualification inspection sample. All qualification and NAPC testing shall be conducted on the same homogeneous batch of oil. In addition the qualification inspection test samples for testing by NAPC shall consist of a one gallon sample of each grade of blended base oil without additives and a ten gallon sample of each grade of the finished oil for which qualification approval is sought. Material Safety Data Sheets completed in accordance with FED-STD-313 shall also be included with the test samples. At the direction of the Naval Air Systems Command, AIR-5363, these samples should be forwarded to the Naval Air Propulsion Center, (PE33), 1440 Parkway Ave., Trenton, NJ 08628, and should be plainly identified by a securely attached durable tag or label marked with the following information:

QUALIFICATION INSPECTION SAMPLE
LUBRICATING OIL, AIRCRAFT PISTON ENGINE,
ASHLESS DISPERSANT

Type of sample: *(basestock or finished oil)*
Name of manufacturer_____
Product code number_____
Batch number_____
Date of manufacture_____
Submitted by *(name)* _____ on _____ *(date)* for qualification inspection in accordance with MIL-L-22851 under authorization of *(reference authorizing letter)* *(see 6.3)*.

4.3.2 Test results. The manufacturer shall present a certified copy of the test report to NAPC. The report shall contain complete test data showing the results of all tests required by this specification with the exception of the 12 month storage stability test and the trace metal content. Photographs of the test parts from the L-38 engine shall be included along with data on the test oil's viscosity and TAN at 0, 10, 20, 30, and 40 hours into the test. The test report shall also include complete formulation data, including the brand name and manufacturer of each of the additives used, the concentration of each additive in the finished oil, the percentages of neutral and bright stock, as well as the crude oil sources and type of processing used in the manufacture of these base stock components.

4.4 Quality Conformance Inspection. Quality conformance inspection shall consist of all the tests in Table II with the exception of the compatibility tests with elastomers and with other oils. Oil manufacturers shall retain a copy of each batch test report in their files for at least three years. A copy of the test report on each batch of oil produced for the U.S. government shall be forwarded to Naval Air Propulsion Center, Code PE33, P.O. Box 7176, Trenton, NJ 08628.

4.4.1 Lot formation.

4.4.1.1 Bulk lot. A bulk lot is considered as an indefinite quantity of homogenous mixture of material 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.

4.4.1.2 Packaged lot. A packaged lot is considered as an indefinite number of 208 liter (55 gallon) drums or smaller unit packages of identical size and type 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.

4.4.2 Sampling.

4.4.2.1 Sampling for verification of product quality. Each bulk and packaged lot of material shall be sampled at random in accordance with ASTM D 4057 or ASTM D 4177 for verification of product quality as specified in 4.4.

4.4.2.2 Sampling for examination of filled containers. Each packaged lot of containers shall be sampled in accordance with MIL-STD-105, Inspection Level I, for leakage, fill, closure and preparation for shipment (packaging, packing, marking) in accordance with Section 5.

4.4.2.3 Sampling for examination of sedimentation of filled and sealed containers. Samples of filled and sealed 0.95 liter (one-quart) containers shall be taken at such periodic intervals as to be representative of each day of operation. The number of samples to be taken each day shall be in accordance with MIL-STD-105, Inspection Level S-2, when tested against the sedimentation requirement of Table II.

4.4.3 Inspection.

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

4.4.3.2 Examination of filled containers. Examine samples taken in accordance with 4.4.2.2 for compliance with MIL-STD-290 with regard to fill, closure, sealing, leakage, packaging, packing, and marking requirements. Reject any container having one or more defects or under the required fill. If the number of defective or unfilled containers exceeds the acceptance number for the appropriate plan of MIL-STD-105, reject the lot represented by the sample.

4.5 Test methods. Tests shall be performed in accordance with the applicable methods listed in Tables I, II, III and Appendices B and C.

4.5.1 Storage Stability.

4.5.1.1 Fourteen-day storage test. A clean, capped or stoppered 1 quart glass bottle shall be half filled with test oil and stored on alternate days ±1 hour at 5 ±1°C (40 ±2°F) and -18 ±1°C (0 ±2°F) by daily transferring from one cold box to another. Examine the sample for evidence of additive separation immediately after removal from the 5°C storage. Note optical clarity and invert the bottles to see if deposits adhere to the bottom. Also slowly pour 10-15 ml. of cold oil over the lip of the bottle and observe carefully any unevenness in fluid texture. Deposits or suspended material may be present even though the sample is optically clear, because of similar refractive indices. The test cycle shall be repeated for 14 days except for weekend periods where the sample may remain at one temperature condition for up to 72 continuous hours.

4.5.1.2 Twelve-month storage test. A 1-gallon sample shall be stored in a clean, capped or stoppered wide-mouth glass container for a period of 12 months at 25 ±3°C (77 ±5°F) away from light. At the end of the storage period the oil shall then be examined visually for separation of components.

4.5.2 Trace metal content. The trace metal content of the oil shall be determined with an atomic emission (A/E 35U-3) spectrometer. Using Joint Oil Analysis Program spectrometric calibration standards, the spectrometer shall be standardized in accordance with 4-32, 4-33, 4-46, and 4-47 of NAVAIR 17-15-BF-62 publication. Immediately after standardizing the spectrometer, five determinations for trace metal content shall be determined on the oil. The average of the five determinations shall be reported. Samples requiring trace metal content determinations may be sent to: Oil Analysis Laboratory, Metrology Engineering Division, Naval Aviation Depot (Code-433), Naval Air Station, Pensacola, FL 32508.

5. PACKAGING (For Military Procurements)

5.1 Preservation and packing. The lubricating oil shall be preserved and packed in accordance with MIL-STD-290. The type and size of the containers and the level of preservation and packing shall be as specified by the acquiring activity.

5.2 Marking. All unit, intermediate, and shipping containers shall be marked in accordance with MIL-STD-290. All unit and intermediate packs of toxic and hazardous chemicals and materials shall also be labeled in accordance with the applicable laws, statutes, regulations or ordinances, including Federal, State, and Municipal requirements. In addition, unit or intermediate containers, including unit containers that serve as shipping containers, such as pails and drums, shall be marked with the applicable precautionary information detailed in ANSI Z129.1.

6. NOTES

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

6.1 Intended use. The lubricating oil covered by this specification is intended for use in four cycle piston aircraft engines.

6.2 Military Procurements.

6.2.1 Ordering data.

6.2.1.1 Acquisition requirements. Procurement documents should specify the following:

a. Title, number and date of this specification.

b. Grade of lubricating oil required (see 1.2).

c. Type and size of containers required (see 5.1).

d. Level preservation and packing required (see 5.1).

e. Quantity desired.

f. Submittal of test results (see 4.4).

6.2.2 Qualification. With respect to products requiring qualification, awards shall be made only for the products which are, at the time set for opening of bids, qualified for inclusion in applicable Qualified Products List 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 purchase orders for the products covered by this specification. The activity responsible for the Qualified Products List is Commander, Naval Air Systems Command, AIR-5363, Department of the Navy, Washington, DC 20361, and information pertaining to qualification of products may be obtained from that activity.

6.2.3 International standardization agreement. Certain provisions of this specification are the subject of an international standardization agreement with NATO (STANAG 1135). When amendment, revision, or cancellation of this specification is proposed which will affect or violate the international agreement concerned, the preparing activity shall take

appropriate reconciliation action through international standardization channels, including departmental standardization offices, if required.

6.3 Commercial products. Commercial products sold under this specification must meet all of the requirements of sections 3 and 4 of this document with the following exceptions:

a. Qualification samples and qualification/production test results do not have to be submitted to NAPC but must be retained by the manufacturer for a period of at least three years.

b. Individual product acceptance lists for commercial aviation piston engine oils shall be maintained by each of the original aircraft engine manufacturers.

c. The suppliers may use alternate method and laboratory for determining trace metal content.

In addition, commercial products do not have to meet the packaging requirements of section 5 above.

6.4 Marginal indicia. The margins of this specification have not been marked with asterisks due to the large number of changes.

6.5 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 paragraph 4 of FED-STD-313.

APPENDIX A

BASE STOCK CRUDE OIL SOURCE AND PROCESSING DESCRIPTIONS

When applying for qualification, refiners shall provide the following information about the crude oil and the processing used in the manufacture of each base stock blended into their product:

a. Name of original base stock refiner or processor.

b. Location of refinery or processing plant, by city and state (U.S.), province (Canada), or country.

c. General crude source shall be identified as follows:

ACI	-	Alaskan Cook Inlet
ANS	-	Alaskan North Slope
DE	-	Diester (Including Manufacturing Source)
GE	-	Germany
MC	-	Mid Continent
ME	-	Middle East
MW	-	Mid West
MX	-	Mexican
NA	-	North Africa
NS	-	North Sea
PA	-	Pennsylvania
PAO	-	Polyalpha olefin (Including Manufacturing Source)
PE	-	Polyol Ester (Including Manufacturing Source)
VEN	-	Venezuelan
WC	-	West Coast
WCA	-	Western Canada
WT	-	West Texas
OC	-	Other (Please provide brief description)

d. General crude refining processes (nonsynthetics only) shall be defined as follows:

SD	-	Straight Distillation
VD	-	Vacuum Distillation
SR	-	Solvent Refining
MH	-	Mild Hydrogenation
SH	-	Severe Hydrogenation
HP	-	Hydrocracked
OP	-	Other (Please provide brief description)

APPENDIX B

ENGINE TEST REQUIREMENTS FOR MILITARY SPECIFICATION MIL-L-22851 AVIATION PISTON ENGINE LUBRICANT

References (Latest Applicable Publication Applies)

(a) Military Specification MIL-L-22851, Lubricating Oil, Aircraft Piston Engine (Ashless Dispersant).

(b) Federal Aviation Administration, Federal Air Regulation Part 33.49 Endurance test, Subpart D Block Test, Reciprocating Aircraft Engines.

(c) Overhaul Manual, Textron Lycoming Direct Drive Engine, Publication Number 60294-7.

(d) Operator's Manual, Textron Lycoming TIO-540 Series Aircraft Engines, Publication Number 60287-23.

(e) Parts Catalog, Textron Lycoming TI0-540-J2BD Engine, Publication Number PC315.

(f) Overhaul Manual For Aircraft Systems Turbochargers, Publication Number TP20-0128.

(g) Service Table of Limits and Torque Value Recommendations, Textron Lycoming, Publication Number SSP1776.

(h) Overhaul Manual For Aircraft System Valves and Controllers, Publication Numbers TP20-0129

(i) Federal Aviation Administration, Federal Air Regulation Part 33.57 Endurance test, Subpart D Block Test, Reciprocating Aircraft Engines.

Enclosures

(1) TIO-540-J2BD Engine Instrumentation Data (Tables B-I and B-II)

(2) Figures B-1 and B-2

1. Objective. To conduct an engine test that will evaluate the quality of aviation piston engine oils (described in reference(a)) prior to being subjected to flight test evaluations.

2. Introduction.

a. Qualified oils under Specification MIL-L-22851 are synthetic or petroleum base lubricating oil blends containing additives to impart oxidative stability and dispersant

properties. Laboratory and bench tests are performed under reference (a) to determine the chemical and physical properties of the lubricants.

b. Flight evaluations are also performed according to reference (a) to determine the oil's performance under actual engine operating conditions.

c. This directive identifies the equipment, procedure and requirements for a full scale piston engine test to evaluate aviation engine lubricating oils.

3. Approach.

a. The engine used in this test is the Textron Lycoming TI0-540-J2BD or an equivalent model with the approval of NAVAIR. It shall be run in the 150 hour endurance test described in reference (b) along with the amendments described herein. Prior to the engine test, the engine is to be assembled using original manufacturer parts. All the critical parts are to be measured during the initial build up. These dimensions shall be compared with the respective post test engine dimensions to determine the amount of wear which has occurred. Engine hardware shall also be visually inspected after the test and the presence of carbonaceous deposits shall be described and recorded.

b. Lubricant properties shall be examined periodically throughout the test to determine oil degradation.

c. All measured items shall meet the requirements contained herein.

4. Equipment.

a. Engine.

(1) The TI0-540-J2BD engine is manufactured by Textron Lycoming, Williamsport Division, Textron Inc., Williamsport, Pennsylvania. It is an internal combustion, air cooled, turbocharged piston engine.

(2) It is equipped with a continuous flow type fuel injection system and shall run on aviation grade gasoline with a minimum octane rating of 100LL.

(3) The engine is a six cylinder opposed design with a displacement of 8873.6 cu. cm.(541.5 cu in.). At maximum power it shall develop 350 Horsepower at sea level through critical altitude (15,000 feet).

(4) The engine is provided with a wet sump oil system having a capacity of 11.36 liters (12 quarts.)

(5) Accessories supplied with the engine are the fuel pump, the starter and the alternator. Two additional accessory drives are supplied on this model engine and need not be loaded during the test.

b. Test Stand. The test stand shall consist of an aircraft type dynafocal engine mounting system, Piper model number O1272-2, identical to that used on the Piper

PA31-350 (Manufactured by Piper Aircraft Corp. Vero Beach, Fla.) or equivalent. This system shall then be attached to a suitable test bed.

c. Power Absorber.

(1) This engine drives a propeller directly off the engine crankshaft. For this test setup a flight propeller shall be used to absorb engine power. The propeller shall be a three blade variable pitch type, Hartzell model number HC3YR-2UF/FC8468-6R manufactured by Hartzell Propeller Inc. Piqua, Ohio or equivalent representative propeller in a fixed position. Used in conjunction with this propeller shall be the Hartzell propeller governor model number F624Z or equivalent. This propeller and governor are similar to those used on the Piper PA31-350.

(2) With this type of installation auxiliary air may be required to cool the engine to the specified limits. The flight propeller alone may not provide sufficient cooling air to the engine in a test cell environment.

(3) Alternate means of absorbing engine power, e.g. club propellers or dynamometers are acceptable for this test method.

d. Instrumentation.

(1) The test location shall be equipped with the necessary instrumentation and associated hardware to record the required data. The minimum required instrumentation are listed in Table B-I. Also listed are the ranges and the limits of these parameters. The system shall acquire data from thermocouples, pressure taps, flow meters and tachometer. The instrumentation system shall be equipped with suitable alarms and controls to permit safe operation.

(2) Data shall be recorded periodically throughout the entire test. This includes the break-in, pre and post test calibration, and oil consumption runs along with the endurance test run. The data shall be recorded either by hand or by data acquisition system.

e. Fuel. All testing shall be conducted using grade 100LL aviation fuel manufactured to ASTM D 910 Standards.

f. The test installation shall incorporate a suitably sized air-oil separator connected to the oil breather exit of the engine.

5. Location. The engine test shall be conducted by a testing source approved by NAPC. To become an approved source, an operator shall complete an engine test per reference (b) on a MIL-L-22851, Grade SAE 50 oil, and provide the test results to NAPC for review and approval. To remain listed as an approved testing source, an operator shall be recertified as required by NAPC.

6. Procedure.

a. Introduction.

(1) The engine shall be run using the power settings outlined in reference (b). The test shall run for a total of 150 hours. A daily engine log shall be maintained summarizing all the daily activities.

(2) Prior to performing the 150 hour endurance test a break-in, an oil consumption run and a pretest calibration run shall be performed. The time spent on these sequences shall not be included as part of the 150 hours of test time. All non-test time accumulated during the 150 hour endurance test plus the pre and post test run time and any miscellaneous running should not exceed 20 hours. All miscellaneous running time shall be documented.

(3) After 150 hours of testing has been completed the engine shall be subjected to a post test calibration run. At this time any change in engine performance which has occurred during the test shall be determined and recorded.

(4) Prior to starting any sequence (break-in, pre and post test calibration,and oil consumption runs) the engine shall be run at a low power setting to allow the oil to reach a temperature of 140°F as recommended in section 9 of reference (c). The start-up, warm-up and ground check procedures outlined in reference (d) shall be used at the beginning of any run listed in this procedure. This shall also be done at the start of each cycle of the endurance run and at start-up after the engine has been shut down (e.g. shut down for maintenance, etc.). This warm-up time shall not be included in the 150 hour endurance test time.

(5) At the end of any sequence or cycle or in the event of a premature shut down, the engine shall be stopped according to the shut down procedure in reference (d). The only time this procedure may be omitted is if the engine shall sustain serious damage if it is run, even at an idle condition, for any length of time (e.g. complete loss of oil or oil pressure, etc.).

(6) For all engine running procedures listed below, the engine speed shall be maintained within ± 3 percent of the specified values and the manifold pressure within ± 0.5 inches of Hg. The test cell environment shall stay at ambient conditions.

(7) For all sequences run prior to the actual endurance test, an oil filter shall be used in the oil system . At the completion of the pre-test calibration run this filter shall be replaced with a new oil filter.

b. Break-in Run.

(1) The engine shall be run for a 3 hour break-in period according to the procedure outline below. This sequence shall be run at ambient pressure with the mixture setting adjusted to full rich. Record the data once at each power setting. The oil used during this run shall be a MIL-L-6082.

(2) The break-in run shall be conducted as follows:

a. 0.25 hours at 1200 RPM.
b. 0.25 hours at 1500 RPM.
c. 0.25 hours at 1720 RPM.
d. 0.25 hours at 1900 RPM.
e. 0.33 hours at 2050 RPM.
f. 0.33 hours at 2170 RPM with a manifold pressure of 32 in. of Hg.
g. 0.33 hours at 2290 RPM with a manifold pressure of 36 in. of Hg.
h. 0.33 hours at 2390 RPM with a manifold pressure of 38 in. of Hg.
i. 0.33 hours at 2490 RPM with a manifold pressure of 41 in. of Hg.
j. 0.33 hours at 2575 RPM with a manifold pressure of 43 in. of Hg.
k. Adjust the turbocharger density controller as per Lycoming Service Instruction Number 1187.
l. Shut down the engine according to the shut down procedure in reference (d).

During the break-in run, the engine temperatures, pressures, and speeds shall remain within the normal operating limits specified by the manufacturer for the power setting selected. If a fixed pitch (club propeller) type of power absorber is used, the break-in run manifold pressure for condition j. shall be met. For all other conditions the test profile manifold pressure shall be monitored but not controlled.

(3) Drain the used break-in oil from the engine, oil lines and oil cooler. Remove the oil filter and replace it with a new one. Fill the crankcase with a clean charge of the candidate oil and proceed to the oil consumption run.

c. Oil Consumption Run.

(1) This sequence shall be run for two hours at maximum continuous power and speed (2575 rpm with a manifold pressure of 43 in. of Hg), at sea level pressure, and have an oil temperature of 93 ± 6°C (200 ± 10°F). During this run record data every 15 minutes. After the engine has been shut down and the oil has drained down into the engine sump (approximately one-half hour), add enough test oil to bring the level to the full mark. Determine the oil consumption from the amount of oil added and record this quantity. The oil consumption shall not exceed 0.95 liters per hour (1.0 quart per hour), if this value is exceeded the engine shall be rejected for testing.

(2) Drain the used oil from the engine, oil lines and the oil cooler. Fill the engine with a clean charge of candidate oil to flush out any residual break-in lubricant. Proceed to the pretest calibration run.

d. Pretest Calibration Run.

(1) Prior to endurance testing a calibration run shall be conducted. The engine shall not be used if its performance does not meet the required power settings listed in paragraph 6d (3). With the data obtained from the calibration run described below, construct a propeller load curve for the engine to be used in testing. This propeller load curve shall also be used as a record of the engine's performance prior to running the endurance test.

(2) The pretest calibration run shall be conducted using three different power settings. Each of these settings shall be held for a minimum of 10 minutes and the data shall be recorded when all the parameters have stabilized. The engine speed, manifold pressure, and fuel mixture shall be held constant for each power level.

(3) The propeller pitch stops shall be set according to the propeller manufacturer's recommendations or as necessary to achieve an engine speed of 2575 RPM and a manifold pressure of 40 inches of Hg. This shall enable the engine to run at all the settings listed below with the propeller blades at the fixed pitch position. Run the engine at the speeds indicated below and record the manifold achieved. Construct a propeller load curve using the manifold pressures achieved at these engine speeds.

(4) The following instrument settings shall be used for the pretest calibration run:

a. All power levels below shall be run with the fuel mixture at the settings specified in Figure B-1.
b. 2575 RPM at 40 inches of Hg. manifold pressure.
c. 2400 RPM and record manifold pressure
d. 2200 RPM and record manifold pressure
e. Shut down the engine according to the shut down procedure in reference (d).

(5) If an alternate power absorber is used, a similar propeller load curve shall be constructed to measure engine power. The alternate device selected shall allow the engine to operate at the speeds and manifold pressures specified by the manufacturer for the ambient conditions present. These values and limits are contained in reference (d). If the engine's performance does not meet the minimum acceptable limits, it will not be considered acceptable for use.

(6) Drain the used oil from the engine, oil lines and the oil cooler. Replace the slave oil filter with a new test oil filter. Install a fresh charge of test oil and proceed to the endurance test.

e. FAR 33.49 Endurance Test.

(1) The test procedure listed below is that as described in reference (b). The test consists of seven portions for which the engine is run at various power settings. The total test duration is 150 hours as indicated in Table B-II.

(2) Use Figure B-2 as a guideline to set the manifold pressure and engine speed to achieve the desired power settings. Figure B-1 shows the recommended fuel mixture setting for the desired engine speed and horsepower. Holding the engine speed and the manifold pressure constant, adjust the fuel mixture as necessary to obtain the setting shown in Figure B-1. The fuel flow shall remain within the specified limits shown in Figure B-2.

(3) During 50 hours of the endurance test at least one cylinder shall be operated at or above the limiting cylinder head temperature, 260°C (500°F). The other cylinders shall not be lower than 28°C (50°F) below the limiting cylinder head temperature. This 50

hours of test time shall be conducted with the engine set at maximum continuous power and speed. For test method consistency this phase shall take place during the last 50 hours of testing at the maximum continuous power setting. Start at test portion 4 cycle 7, as given in paragraph 6e (4).

(4) The 50 hours of test time mentioned above shall also be run with the oil inlet temperature maintained within ±3°C (±5°F) of the limiting oil inlet temperature, 118°C (245°F). Adjust the cooling equipment for the engine as necessary to achieve this temperature. If it is necessary the oil lines and sump may be insulated. The remainder of the test shall be conducted with the oil inlet temperature at 104°C ±3°C (220°F ±5°F).

(5) The test procedure shall be run as follows with a minimum of one-half hour separation between cycles. The delay between cycles is to permit evaluation of the lubricants resistance to the formation of carbonaceous materials during static hot soak conditions. Test data is to be recorded once during the last 5 minutes of each power setting in portion 1. In portions 2 through 7 record the data at approximately 15 minute intervals during each power setting. Allow the engine to run for at least 10 minutes after a setting change (in portions 2 through 7) before taking an instrument reading.

Portion 1 - 30 hours (10 cycles)

Each test cycle shall include the .16 hour (10 minutes) sequence listed below repeated 18 times in a three hour period:

a. 0.08 hours at rated maximum continuous power with maximum continuous speed (350 horsepower at 2575 RPM).
b. 0.08 hours at economy cruise (210 horsepower at 2200 RPM).

Portion 2 - 20 Hours (4 cycles)

Each test cycle is 5.0 hours run as follows:

a. 2.5 hours at rated maximum continuous power with maximum continuous speed (350 horsepower at 2575 RPM).
b. 2.5 hours at maximum best economy cruising power (210 horsepower at 2200 RPM).

Portion 3 - 20 Hours (10 cycles)

Each test cycle is 2.0 hours run as follows:

a. 1.5 hours at rated maximum continuous power with maximum continuous speed (350 horsepower at 2575 RPM).
b. 0.5 hours at 75 percent maximum continuous power with 91 percent maximum continuous speed (263 horsepower at 2340 RPM).

Portion 4 - 20 hours (10 cycles)

Each test cycle is 2.0 hours run as follows:

a. 1.5 hours at rated maximum continuous power with maximum continuous speed (350 horsepower at 2575 RPM).

b. 0.5 hours at 70 percent maximum continuous power with 89 percent maximum continuous speed (245 horsepower at 2290 RPM).

Portion 5 - 20 Hours (10 cycles)

Each test cycle is 2.0 hours run as follows:
a. 1.5 hours at rated maximum continuous power with maximum continuous speed (350 horsepower at 2575 RPM).
b. 0.5 hours at 65 percent maximum continuous power with 87 percent maximum continuous speed (228 horsepower at 2240 RPM).

Portion 6 - 20 Hours (10 cycles)

Each test cycle is 2.0 hours run as follows:
a. 1.5 hours at rated maximum continuous power with maximum continuous speed (350 horsepower at 2575 RPM).
b. 0.5 hours at 60 percent maximum continuous power with 84.5 percent maximum continuous speed (210 horsepower at 2180 RPM).

Portion 7 - 20 Hours (10 cycles)

Each test cycle is 2.0 hours run as follows:
a. 1.5 hours at rated maximum continuous power with maximum continuous speed (350 horsepower at 2575 RPM).
b. 0.5 hours at 50 percent maximum continuous power with 79.5 percent maximum continuous speed (175 horsepower at 2050 RPM).

(5) Proceed to the post test calibration run.

f. Post Test Calibration Run. This sequence shall be conducted after the endurance test has been completed. The data obtained here shall be compared to the pretest calibration data to determine the loss of engine performance due to the endurance test. The procedure performed shall use the same method as that employed in the pretest calibration run (paragraph 6d). Changes in performance will be displayed by the differences in the manifold pressures needed to achieve a specified engine speed in the pre and post test calibration runs.

g. Oil Sampling.

(1) Oil samples shall be taken from the sampling valve (paragraph 6h (7)) on the engine crankcase within 10 minutes after the engine is shut down. The samples shall be taken every 25 test hours or at the end of the next cycle nearest the 25 hour interval (unless otherwise specified). When taking oil samples drain 50 ml of oil into a clean beaker to clear the sample line then take a clean sample bottle and draw the required sample amount. Return the original 50 ml of oil to the oil sump.

(2) Draw a 100 ml sample of the lubricant for laboratory analysis. This analysis shall consist of viscosity at 40°C (104°F) and 100°C (212°F) (per ASTM D445), total acid

number determination (per ASTM 664, titrate to a pH of 11) and trace metal content determination (by spectrometric oil analysis).

(3) Identify the oil sample with the test number, engine model number, engine serial number, oil time, engine time, test portion and cycle number, oil code number, and the date drawn.

(4) The oil samples are to be taken before any make-up oil is added to the oil sump.

h. Engine Assembly.

(1) The engine is to be built up according to the assembly procedure outlined in references (d) and (e). Engine parts are to be replaced as recommended in reference (c) during the engine overhaul. Certain parts shall be replaced that are not listed in reference (c). This is to be done for the purpose of rating consistency. These parts are as follows: pistons, valves, and valve guides, piston pin plugs, camshaft, valve lifters, spark plugs and the turbocharger. The turbocharger may be reconditioned as long as it meets with the manufacturer's specifications for new equipment (reference (f)) and is fitted with a new bearing. A preassembly hydraulic leak down test shall be performed on each lifter unit and the data recorded.

(2) The cylinders are to be measured and replaced if they are not within manufacture's specifications. The cylinders to be used shall be nitrided. The piston ring gap shall be at the service maximum (reference (g)).

(3) The turbocharger shall be sent to the manufacture or to an overhaul facility approved by the manufacturer for inspection and overhaul. It shall be installed on the engine according to the procedures listed in reference (f) and (h).

(4) The engine crankshaft bearings shall be weighed prior to being installed in the engine. The bearings shall be clean, dry and free of any grease, oil or preservative before weighing. Do not handle clean unweighed bearings with bare hands. Wear clean rubber gloves (e.g. surgical gloves) or use a clean pair of tweezers to handle the bearings. Weigh bearings on a scale with an accuracy of 0.001 g. Record the weight of each bearing and the position where it is installed in the engine.

(5) Prior to each engine assembly specific engine parts are to be measured and their dimensions recorded. These same parts shall be measured after the test has been completed and compared to the original dimensions. This comparison shall be used to determine the amount of wear that has occurred during the test. Reference (g) lists all the required items to be measured prior to overhaul, with their respective dimensions and clearances. Some of these parts are of particular importance in determining the outcome of the test. The dimensions of these items and the items listed in reference (g) shall be recorded upon assembly of the engine for comparison with post test dimensions. Listed below are the critical items to be measured:

a. Crankshaft journals, main and rod
b. Bearings, main and rod inside diameter

c. Tappet bore, case inside diameter
d. Tappet body, outside diameter
e. Tappet plunger assembly and body
f. Camshaft journal and bore
g. Connecting rod bushing, inside diameter
h. Piston pin hole in piston, inside diameter
i. Piston pin, outside diameter
j. Piston ring and piston, side clearance, all rings
k. Piston ring, gap, all rings
l. Piston pin plug hole in piston, inside diameter
m. Piston pin plug, outside diameter
n. Piston, outside diameter, lands and skirts
o. Cylinder barrel bore at 2,4 and 6 inch stations as measured from the bottom of the cylinder.
p. Valve stem, intake and exhaust, outside diameter (3 places) and length
q. Valve guide, intake and exhaust, inside diameter (3 places)
r. Valve rocker shaft, outside diameter
s. Valve rocker bushing, intake and exhaust, inside diameter
t. Oil pump impeller, diameter and side clearance
u. Accessory drive bushings, inside diameters
v. Accessory drive journals, outside diameters

(6) If a constant speed propeller is used, the condition of its oil wetted parts shall be document prior to use. The propeller shall be inspected and assembled as described in the manufacturer's overhaul manuals.

(7) In order to reduce the possibility of oil loss during sample acquisition, the crankcase drain plug should be replaced with an appropriate sampling valve.

(8) After the break-in run is completed perform a compression check on each cylinder. Record the cylinder pressure for comparison with the post test compression check.

i. Servicing and Maintenance

(1) The oil level should be checked after each cycle and not allowed to drop below 9.46 liters (10 quarts). Add test oil as necessary to keep the system full (11.36 liters, 12 quarts). An oil test log shall be maintained by recording the amount of oil added to or removed from the engine during the test. This data shall be used for the determination of engine oil consumption.

(2) After 75 hours of testing the used test oil shall be drained from the engine, oil lines and oil cooler. This shall be performed in portion 4 between cycles 3 and 4 of the endurance test. The amount of oil drained shall be recorded on the oil test log. Allow sufficient time for the oil to completely drain from the engine (approximately one-half hour). Store the oil in a sealable metal container and mark the container as per paragraph 6g (3). Remove the oil filter and replace it with a new one. The filter is to be opened, inspected, photographed, its condition recorded and the element retained for later examination. Any oil removed with the filter housing shall be measured and the amount recorded on the oil test log. The engine shall be recharged to the 11.36 liters (12 quarts)

level with new test oil which shall be used for the remainder of the test. The spark plugs shall be inspected, cleaned and regapped if necessary, at 75 hours of test time.

(3) Maintenance during the test shall be allowed as long as it is in accordance with reference (i) and it shall be reported in the test log.

(4) Prior to engine disassembly a post test cylinder compression check shall be performed.

j. Disassembly. After the post test calibration run is completed remove and disassemble the engine as per reference (c). Take care not to disturb any carbonaceous deposits that have formed during the test.

7. Inspection Requirements.

a. Introduction. After the engine has been disassembled, it shall be inspected. The engine's moving and respective stationary parts shall be measured to determine the amount of wear that has occurred throughout the test. The oil wetted areas in the engine shall be visually examined to determine the amount and the type of carbonaceous deposits that have formed. Color photographs of lubricant wetted areas, as designated by NAPC, shall be taken prior to engine cleaning. Disassembly and inspection of the engine shall be witnessed by an NAPC designated representative.

b. Deposit Inspection.

(1) Visual. The oil wetted surfaces in the engine shall be visually inspected for carbonaceous deposits at the end of the test. These deposits shall be rated according to their type and severity (e.g. light varnish, medium carbon, heavy sludge, etc.). All the inspections and ratings shall be reviewed by NAPC. A comparison shall be made between the relative rated areas in the test engine and the engine from the reference test. With this method if any of the areas have more severe deposits than those found in the reference test, the oil may be rejected for qualification under the MIL-L-22851 specification. Ratings shall be conducted according to the Coordinating Research Council manuals and procedures. Photographs shall be taken of all post test lubricant wetted areas prior to cleaning to insure a pictorial documentation of the deposits. Photographs and deposit ratings of the reference oil are available from the cognizant activity.

(2) Measurements. The side clearance and end gap of each piston ring shall be measured prior to part cleaning. The exhaust and intake valve guides shall also be measured prior to cleaning to determine the amount of deposits that may be present. A post-test hydraulic leak down check shall be performed on each lifter unit and the results compared to pretest results.

c. Post-Cleaning Dimensional Inspection.

(1) Following disassembly and parts cleaning all the engine parts that had been measured before the test shall now be measured as part of the post test inspection. These parts shall be cleaned in accordance with section 3 of reference (c). The parts shall be measured by the same methods used during the engine assembly (paragraph 6h (5)) and the

measurements recorded. This procedure shall insure that the relative dimensions are measured consistently. All the components shall be within the manufacturer's maximum and minimum dimensions and clearances or below the service maximums, where applicable (reference (g)).

(2) The engine bearings shall be weighed after the test to determine the amount of metal loss during the test. Using the same procedure in paragraph 6h (4) determine the weight of each bearing and record it with the respective pretest weight. Insure that the bearings are thoroughly cleaned prior to weighing. This includes all carbonaceous deposits that may have formed during the test. From this determine the weight loss of each bearing.

(3) All nonconforming measurements shall be highlighted with an asterisk (*). Following the measurement table a summary of the discrepant parts, if any, shall be provided identifying the part by number, nomenclature and the nature of the failure (e.g. worn beyond service limits).

d. Propeller Inspection. After the completion of the post test calibration run the propeller shall be removed and disassembled as necessary for rating all the oil wetted areas. Any abnormal deposits shall be cause for rejecting the candidate oil for qualification under MIL-L-22851. Propeller disassembly and inspection shall be carried out using the manufacturer's overhaul instructions. The condition of the oil wetted parts shall be described as noted in paragraph 7.b.

e. Turbocharger Inspection. As part of the engine inspection the oil wetted areas of the turbocharger shall be rated for deposits. The bearing and shaft shall be checked for excessive wear by dimensional measurement. Any abnormal deposits or wear may be cause for rejecting the candidate oil for qualification under MIL-L-22851. Turbocharger disassembly and inspection shall be carried out using the manufacturer's overhaul instructions. The condition of the oil wetted parts shall be described as noted in paragraph 7.b.

f. Oil Degradation.

(1) The oil properties shall be examined throughout the test to determine the amount of degradation that has occurred. The change in physical and chemical properties of the oil (determined by the methods described in paragraph 6g (2)) shall be recorded. The engine test facility is responsible for reporting the lubricant analysis. The analysis shall be conducted by a certified laboratory or other facility as approved by the cognizant activity. The test report shall include a table of the data acquired and computations of the percent viscosity change and total acid number change. The table shall start with the new oil (zero time) and proceed through the 25 hour incremental samples to the test completion.

(2) After removal of the 100 ml samples for laboratory analysis, one gallon of the remaining oil drained at 75 hours and one gallon taken at test completion shall be shipped, post paid, to the Naval Air Propulsion Center, 1440 Parkway Ave, Trenton, N.J. 08628, Attn. PE33. The oil shall be held for additional analysis.

8. Report Requirements. After the completion of the engine inspection one copy of the test report shall be submitted to the Naval Air Propulsion Center within sixty (60) days. The report shall contain the following information as a minimum:

a. Identification of the candidate oil
b. Test summary
c. Oil consumption log
d. Used oil analysis
e. Dimensional inspection tables
f. Deposit inspection records and photographs
g. Daily engine test log
h. Copy of data sheets
i. Propeller condition report
j. Turbocharger condition report

9. Miscellaneous.

a. NAPC Contact. In the event that any problems occur during testing contact:

Supervisor, Fluid Sciences Division
Naval Air Propulsion Center
Fluid Science Division, PE33
P.O. box 7176
Trenton, N.J. 08628

b. Federal Aviation Administration Approval. If concurrent Federal Aviation Administration (FAA) approval is desired, the applicant shall make suitable arrangements with the appropriate FAA regional office. Coordination of the testing with Federal Aviation Administration requirements is encouraged.

TABLE B-I
TIO-540-J2BD ENGINE INSTRUMENTATION DATA 1/

Parameter	I.D. Tags	Range	Limit
Temperature (°F)			
Oil, In (gallery)	TIS	0-400	245 Max 2/
Oil, Out (to cooler)	TOO	0-500	Record
Air, Compressor Inlet	TAI	0-200	32-104
Air, Compressor Outlet	TATE	0-500	400 Max
Air, Test Cell	TATC	0-200	32-104
Exhaust Gas, Tubocharger Inlet	TETI	0-2000	1650 Max
Cylinder Head (at each Cyl.)	TCH (1-6)	0-800	500 Max
Fuel Inlet	TFI	0-200	100 Max
Pressure			
Oil, Engine Gallery	POEG	0-200	55-95 2/, 3/
Oil, Pump Exit Engine (PSIG)	POPE	0-300	Record 2/
Oil, Filter Outlet (PSIG)	POFO	0-200	Record 4/
Air, Dry Manifold, Std. Location (in. Hg)	PAM	0-100	49.0 Max 2/
Air, Barometric, Test Cell (in. Hg)	PBTC	0-40	Record 5/
Fuel, at Engine Fuel Pump Inlet (PSIG)	PFUP	0-200	-2 to +65
Flow			
Fuel (lbs./hr.)	FF	0-300	250 Max
Speed (RPM)			
Engine	ERPM	0-4000	2575 Max
Other			
Test Time, hours	TET	0-200	150
Test Time, hours	TOT	0-200	

Notes: 1/ The test instrumentation shall be calibrated before each test so as to insure that reported data shall have static accuracy within the following limits:
- Temperature within 2°F
- Pressure within 2%
- Flow within 0.2%
- Speed within 0.2%

2/ Measured at the location specified in reference (d).

3/ Values stated are for normal operation after engine warm up. The minimum idle pressure is 25 psig and the maximum warm up pressure is 115 psig.

4/ The oil filter outlet pressure should not drop more than 18 psi below the oil pump exit pressure.

5/ Barometric pressure.

TABLE B-II
150 HOUR TEST OPERATING CONDITIONS, TIO-540-J2BD 1/

Test Period	Cumulative Time, Hrs.	Cycles/ Period	Cycle Time, Hrs.	BHR	RPM	Manifold Pressure 2/	Fuel Flow Lb./Hr.	Oil Temp. °F	Cyl. Head Temp. °F
1	0 to 30	10	0.08 0.08	350 210	2575 2200	43.0 record	240-250 86-90	140-245 140-245	350-475 350-475
2	30 to 50	4	2.5 2.5	350 210	2575 2200	43.0 record	240-250 86-90	215-225 215-225	350-475 350-475
3	50 to 70	10	1.5 0.5	350 263	2575 2340	43.0 record	240-250 130-135	215-225 140-245	350-475 350-475
4	70 to 90	10	1.5 0.5	350 245	2575 2290	43.0 record	240-250 120-125	235-245 140-245	500 Min 3/ 350-475
5	90 to 110	10	1.5 0.5	350 228	2575 2240	43.0 record	240-250 102-109	235-245 140-245	500 Min 3/ 350-475
6	110 to 130	10	1.5 0.5	350 210	2575 2180	43.0 record	240-250 86-90	235-245 140-245	500 Min 3/ 350-475
7	130 to 150	10	1.5 0.5	350 175	2575 2050	43.0 record	240-250 79-84	235-245 140-245	500 Min 3/ 350-475

Note: 1/ The engine is to be shutdown a minimum of 0.5 hours between each cycle.
2/ Measured at 60°F. For non-standard conditions, use power charts to set the manifold pressure to corrected values.
3/ Starting at cycle 7, the hottest cylinder head shall maintain a minimum temperature of 500°F. The temperature of the remaining cylinder heads shall be within 50°F of the hottest cylinder head for the remainder of the test at all maximum power conditions.

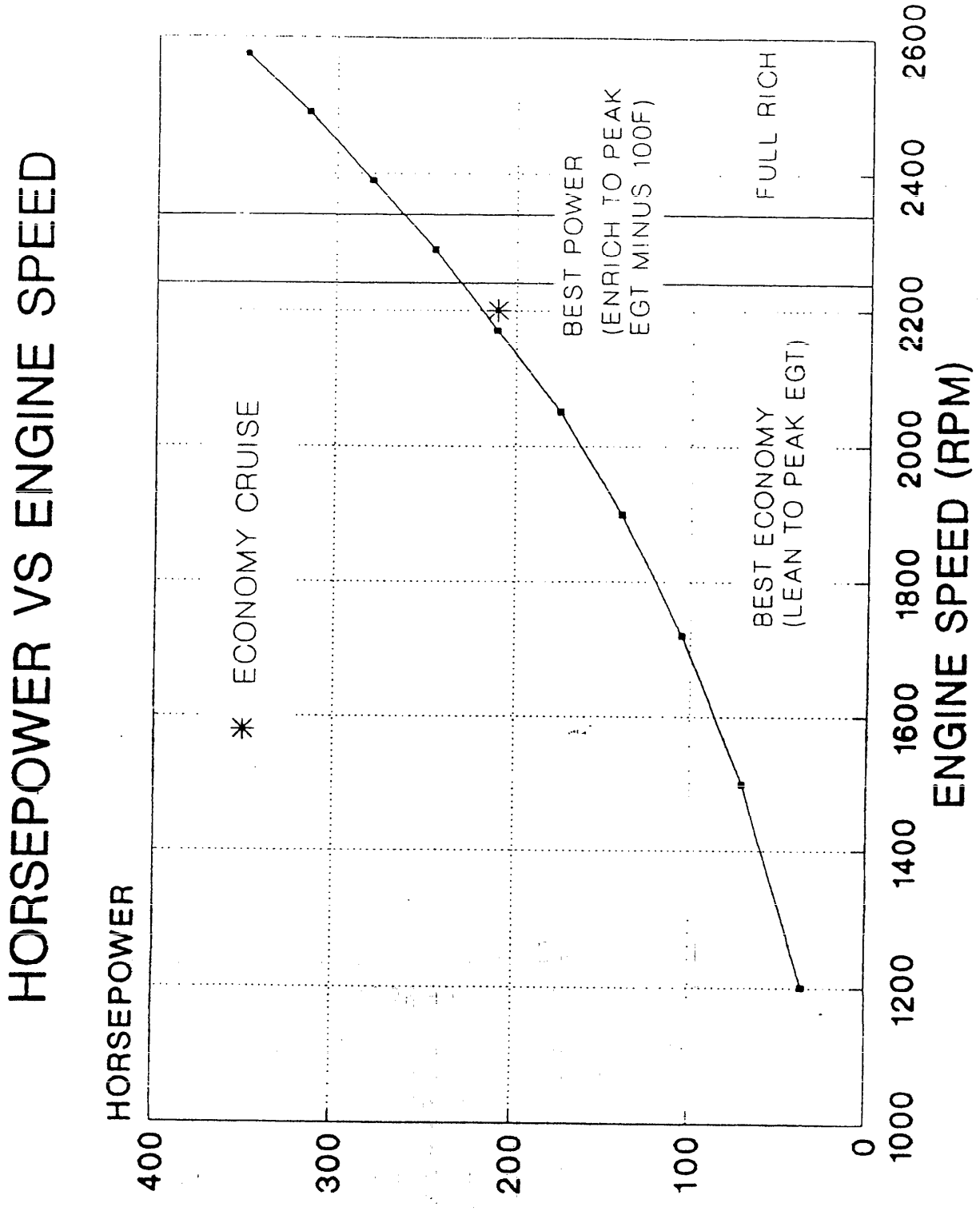
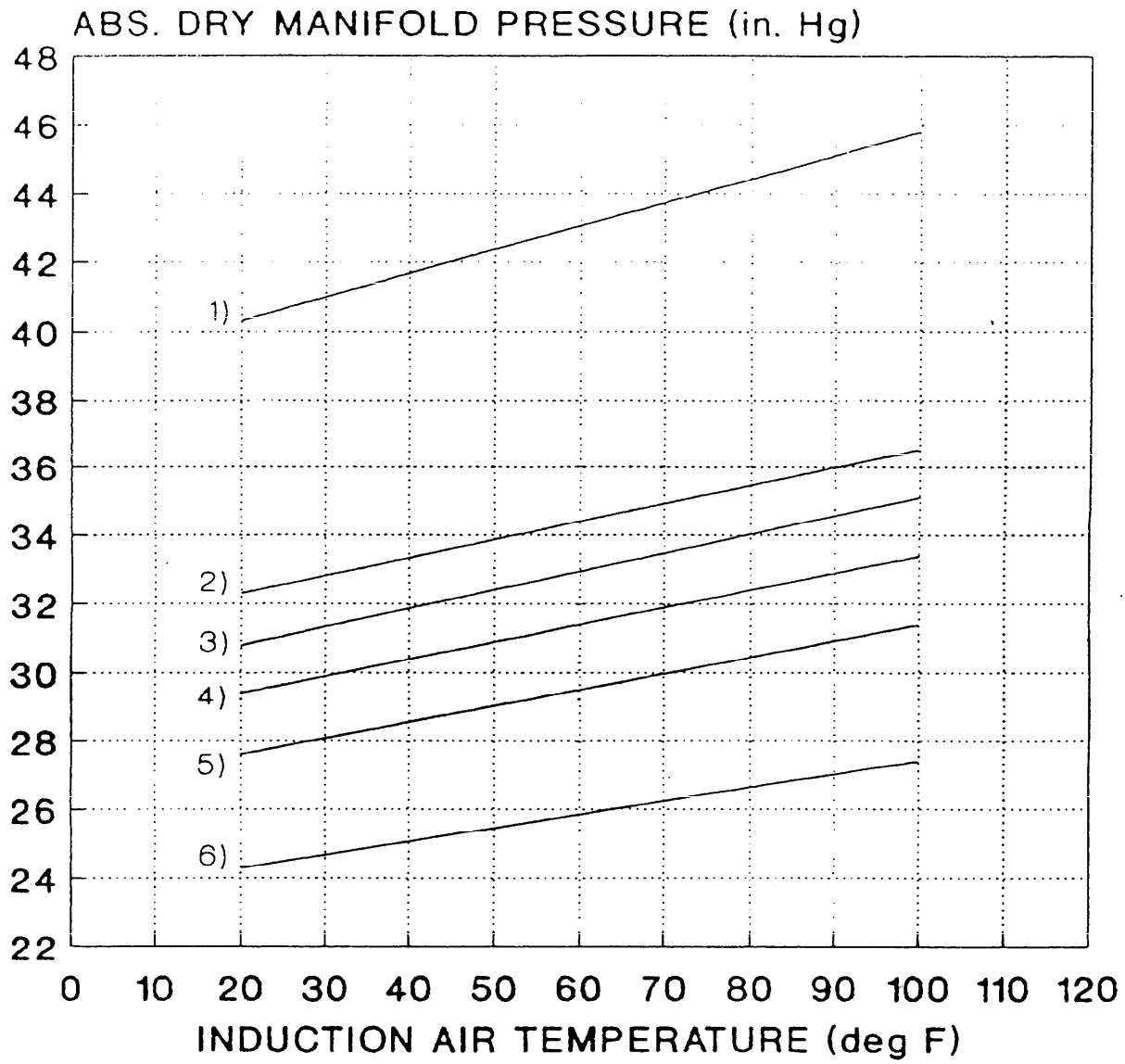


FIGURE B-1

POWER CHART AT SEA LEVEL



1) 2575 RPM 350 HP 240-250 #/HR FUEL FLOW
2) 2340 RPM 263 HP 130-135 #/HR FUEL FLOW
3) 2290 RPM 245 HP 120-125 #/HR FUEL FLOW
4) 2240 RPM 225 HP 102-109 #/HR FUEL FLOW
5) 2150 RPM 210 HP 95-101 #/HR FUEL FLOW
   2200 RPM 210 HP 86-90 #/HR FUEL FLOW
6) 2050 RPM 175 HP 79-84 #/HR FUEL FLOW

FIGURE B-2

APPENDIX C

FLIGHT EVALUATION REQUIREMENTS

1. Objective. Flight evaluations are to be conducted on all new formulations of MIL-L-22851 aviation piston engine oils to determine their acceptability for general use.

2. Introduction.

a. The flight evaluation of candidate oils is the last step for the complete qualification of new products to the MIL-L-22851 specifications. Prior to entering this phase of the qualification process, candidate oils shall have met all the physical, chemical and bench test requirements of the specification. In addition, the candidate shall also have satisfactorily completed a 150 hour engine test.

b. In the flight evaluation, the lubricant is subjected to actual flight environments for a specified duration. During the program, lubricant samples are periodically analyzed for changes in physical and chemical composition. At the completion of the evaluation, key parts are measured and visually examined. Based on the results obtained, a determination is made on the acceptability of the candidate lubricant and a recommendation is forwarded to NAPC for action.

3. Approach. The flight evaluation is performed in nongovernment aircraft and is arranged for, and conducted by, the lubricant supplier. Prior to program initiation, the lubricant supplier shall provide an outline of the proposed evaluation to NAPC for approval. The outline shall, as a minimum, address all the criteria contained in this document. The periodic used oil analysis shall be provided. When engines have completed the specified operating intervals, the required inspections shall be witnessed by NAPC personnel or their appointed representatives.

4. Equipment.

a. Engines. The flight evaluation is to be conducted on a minimum of two turbocharged engines. One engine shall be from Textron-Lycoming and the other from Teledyne-Continental. Acceptable engine models are listed in Table C-I. The engines used should be new or freshly overhauled units. However, engines having less than 200 hours of total time since their last overhaul are acceptable.

b. Propellers. All engines used in the flight evaluation shall have oil-actuated variable pitch propellers. The propellers shall be in suitable condition to permit a performance assessment of the lubricant in the unit.

5. Procedure.

a. The lubricant supplier shall submit a general flight evaluation test plan, which includes the identification of the test location, to the Naval Air Propulsion Center for approval prior to initiating the program.

b. The lubricant supplier is responsible for insuring that, as a minimum, 500 hours are obtained on each of the required engines. A suitable number of evaluation engines should be included in the program to insure that the 500 flight hour requirements are met on at least one of each type of engine.

c. Oil consumption records and oil property data shall be maintained on all flight evaluation engines. The data is to be available throughout the evaluation period and is to be summarized at the completion of the test. One pint (approximately 475 milliliter) oil samples shall be obtained at 50 +/- five hour intervals. The oil samples shall be obtained before fresh oil is added to the engine and shall be taken within one half hour after engine shutdown. The oil samples shall be analyzed for viscosity at 100°C, and for total acid number per the methods listed in Table C-II of specification MIL-L-22851. The sample shall also be examined by spectrographic oil analysis for wear metal content.

d. Oil changes are to be conducted per the engine manufacturers recommendations unless otherwise approved by the NAPC. The oil filters shall be replaced and inspected as per paragraph 6e at each oil change

e. All normal engine maintenance records shall be documented and be available for review throughout the evaluation interval. The NAPC shall be notified if engines are added or removed from the program, or if there is a deviation from the original evaluation plan.

6. Inspection Requirements.

a. At the completion of the specified operational period the engine is to be disassembled to the degree required and inspected. The disassembly is to be witnessed by NAPC personnel or an appointed representative. Parts are to be measured using approved standard practices. Critical dimensions and acceptable tolerances and wear limits shall meet the requirements listed in the engine manufacturers overhaul information.

b. The disassembled parts are to be color photographed and their condition rated in accordance with the Coordinating Research Council rating manuals and procedures prior to cleaning and measurement. Any lubricant related deposit shall be photographed and recorded.

c. At the completion of the evaluation all cylinders shall be removed and inspected. The critical items to be inspected and measured are listed in Table C-II.

d. The variable pitch propeller shall be disassembled to the extent that the oil activated mechanisms and seals can be visually rated.

e. The oil filter elements and/or screens removed during the flight evaluation shall be visually examined for wear debris and carbonaceous material and their conditions recorded.

f. The periodic oil samples are to be identified with the aircraft model and registration number, engine model and serial number, engine total time, oil time, oil identification and date drawn. The periodically obtained oil samples shall be tested for

viscosity and total acid number per paragraph 5.c. and the values reported in table and graphic format.

g. Complete spectrographic wear metal analysis data shall be reported for each engine in the program. The used oil values obtained are for engine operational health monitoring and lubricant wear property information only. The data are not specifically limited, but are indicative of potential wear problems which may require additional engine disassembly and inspection.

h. A general description of the engine flight-use profile shall be provided in the final report. A daily log shall be maintained, containing as minimum, the duration and ambient temperature of each flight.

i. Any engine or propeller malfunctions which occur during the flight evaluation on the candidate lubricant, which may be lubricant related, shall be reported to the Naval Air Propulsion Center. The cause of the problem and corrective actions employed shall be included in the final report.

j. If any of the inspections or measurements are unusual or indicate incipient problems, further inspection may be required. At the discretion of the Naval Air Propulsion Center, a continuation of the flight evaluation may be required for a duration to be specified by them.

7. Report Requirements.

a. For each engine in the evaluation program a final report summarizing the results of the program shall be provided to the Naval Air Propulsion Center within sixty (60) days following the inspection. The report, as a minimum, shall contain information from paragraphs 6.a. through 6.j.

8. Miscellaneous.

a. Contacts. Questions on this requirement may be addressed to:

Supervisor, Fluid Sciences Division
Naval Air Propulsion Center
Fluid Science Division, PE33
P.O. Box 7176
Trenton, N.J. 08628
609-896-5840

or

Naval Air Systems Command
AIR-53632F
Washington, DC 20361-5360
202-692-2653

b. Federal Aviation Administration Approval. If concurrent Federal Aviation Administration (FAA) approval is desired, the applicant shall make suitable arrangements with the appropriate FAA regional office. Coordination of the testing with the FAA is encouraged.

TABLE C-I

Acceptable Engine Models

1. Textron Lycoming O-360 and O-540 series of engines
2. Teledyne Continental Motors O-360, O-470 and O-520 series

Note 1. All engines used shall be air cooled, have variable pitch propellers, and at least one engine from each manufacturer shall be turbocharged.

Note 2. Additional type aircraft engines may be added with concurrence of NAPC.

TABLE C-II

Inspection Requirements

Visual Descriptions

1. Crankcase general condition
2. Cylinders, valves and valve guides
3. Pistons and rings
4. Camshaft lobes and lifters
5. Propeller oil wetted components
6. Oil filter element and/or screens
7. Pushrod ends and overall condition
8. Connecting rod bearings and corresponding shafts
9. Cylinder head dome and valve seat area
10. Rocker box cover, cylinder top deck, rocker arms, armpins and valve springs

Measurements

1. Connecting rod bushing, crankshaft end, inside diameter
2. Connecting rod bushing, piston pin end, inside diameter
3. Crankshaft connecting rod journal, outside diameter
4. Piston pin, hole
5. Piston pin, diameter
6. Piston pin plug hole in piston, inside diameter (if used)
7. Piston pin plug, outside diameter
8. Piston ring side clearance (before and after cleaning)
9. Piston ring gap (before and after cleaning)
10. Piston diameter
11. Cylinder barrel bore
12. Valve stems, intake and exhaust, outside diameter
13. Valve guides, intake and exhaust, inside diameter, measured in three locations
14. Valve rocker arm shaft, intake and exhaust, outside diameter
15. Valve rocker bushings, intake and exhaust, inside diameter

NOTE: Other measurements and descriptions necessary to assess the performance of the candidate lubricant in the specific engine are to be added as required.

CONCLUDING MATERIAL

Custodians:
Army - MR
Air Force - 11

Review activities:
Army - AV, MR
DLA - PS

User activity:
Navy - MC

Preparing Activity:
Navy - AS

International interest:
(see 6.2.3)

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-L-22851D	901201

3. DOCUMENT TITLE
LUBRICATING OIL, AIRCRAFT PISTON ENGINE (ASHLESS DISPERSANT)

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) AUTOVON (If applicable)	7. DATE SUBMITTED (YYMMDD)

8. PREPARING ACTIVITY

a. NAME	b. TELEPHONE (Include Area Code)	
Naval Air Systems Command AIR-53632	(1) Commercial 202-692-2653.	(2) AUTOVON 222-2653
ADDRESS (Include Zip Code) Naval Air Systems Command AIR-53632	IF YOU DO NOT RECEIVE A REPLY WITHIN 45 DAYS, CONTACT: Defense Quality and Standardization Office	