

NOT-MEASUREMENT SENSITIVE

MIL-PRF-21260E

31 July 1998

SUPERSEDING

MIL-L-21260D

29 April 1988

PERFORMANCE SPECIFICATION

LUBRICATING OIL, INTERNAL COMBUSTION ENGINE,
PRESERVATIVE BREAK-IN

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

1. SCOPE

1.1 Scope. This performance specification covers engine oils suitable for preservation, break-in, and lubrication of reciprocating internal combustion engines of both spark-ignition and compression-ignition types, and of power transmission fluid applications in equipment used in combat/tactical service (see 6.1, 6.7 and 6.9).

1.2 Classification. The lubricating oils are of the following SAE viscosity grades (see 6.2 and 6.3):

<u>Viscosity Grade</u>	<u>Military Symbol</u>	<u>NATO Code</u>
SAE 10W	PE-10	C-640
SAE 30	PE-30	C-642
SAE 40	PE-40	----
SAE 15W-40	PE-15/40	----

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: U.S. Army Tank-automotive and Armaments Command, ATTN: AMSTA-TR-E/BLUE, Warren, MI 48397-5000, by using the Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document, or by letter.

AMSC N/A

FSC 9150

DISTRIBUTION STATEMENT A. Approved for public release; distribution is unlimited.

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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 requirement documents cited in sections 3 and 4 of this specification, whether or not they are listed.

2.2 Government documents.

2.2.1 Specifications, standards, and handbooks. The following specifications, standards, and handbooks 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-PRF-2104 | - Lubricating Oil, Internal Combustion Engine, Combat/Tactical Service. |
| MIL-PRF-46167 | - Lubricating Oil, Internal Combustion Engine, Arctic. |

STANDARDS

FEDERAL

- | | |
|-------------|---|
| FED-STD-791 | - Lubricants, Liquid Fuels and Related Products; Methods of Testing, or Equivalent (See 4.3.1). |
|-------------|---|

(Unless otherwise indicated, copies of the above specifications, standards, and handbooks are available from the Standardization Document Order Desk, 700 Robbins Avenue, Building 4D, Philadelphia, PA 19111-5094.)

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

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U.S. DEPARTEMENT OF LABOR (DOL)

OSHA 29 CFR 1910.1200 - Hazard Communication; Interpretation Regarding Lubricating Oils.

(Copies of the Code of Federal Regulations (CFR) are available from the Superintendent of Documents, U.S. 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 SOCIETY FOR TESTING AND MATERIALS (ASTM)

- | | |
|------|--|
| D92 | - Standard Test Method for Flash and Fire Points by Cleveland Open Cup. |
| D94 | - Standard Test Method for Saponification Number of Petroleum Products (DoD Adopted). |
| D97 | - Standard Test Method for Pour Point of Petroleum Oils (DoD Adopted). |
| D129 | - Standard Test Method for Sulfur in Petroleum Products (General Bomb Method) (DoD Adopted). |
| D130 | - Standard Test Method for Detection of Copper Corrosion from Petroleum Products, by the Copper Strip Tarnish Test (DoD Adopted). |
| D287 | - Standard Test Method for API Gravity of Crude Petroleum and Petroleum Products (Hydrometer Method) (DoD Adopted). |
| D445 | - Standard Test Method for Kinematic Viscosity of Transparent and Opaque Liquids (and the Calculation of Dynamic Viscosity) (DoD Adopted). |
| D524 | - Standard Test Method for Ramsbottom Carbon Residue of Petroleum Products (DoD Adopted). |
| D664 | - Standard Test Method for Neutralization Number by Potentiometric Titration (DoD Adopted). |
| D808 | - Standard Test Method for Chlorine in New and Used Petroleum Products (Bomb Method) (DoD Adopted). |
| D874 | - Standard Test Method for Sulfated Ash from Lubricating Oils and Additives (DoD Adopted). |

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- D892 - Standard Test Method for Foaming Characteristics of Lubricating Oils (DoD Adopted).
- D1091 - Standard Test Method for Phosphorus in Lubricating Oils and Additives (DoD Adopted).
- D1317 - Standard Test Method for Chlorine in New and Used Lubricants (Sodium Alcoholate Method).
- D1500 - Standard Test Method for ASTM Color of Petroleum Products (ASTM Color Scale) (DoD Adopted).
- D1552 - Standard Test Method for Sulfur in Petroleum Products (High-Temperature Method) (DoD Adopted).
- D2270 - Standard Practice for Calculating Viscosity Index from Kinematic Viscosity at 40 and 100°C (DoD Adopted).
- D2622 - Standard Test Method for Sulfur in Petroleum Products (X-Ray Spectrographic Method) (DoD Adopted).
- D2887 - Standard Test Method for Boiling Range Distribution of Petroleum Fractions by Gas Chromatography (DoD Adopted).
- D2896 - Standard Test Method for Base Number of Petroleum Products by Potentiometric Perchloric Acid Titration.
- D3228 - Standard Test Method for Total Nitrogen in Lubricating Oils and Fuel Oils by Modified Kjeldahl Method (DoD Adopted).
- D4047 - Standard Test Method for Phosphorus in Lubricating Oils and Additives by Quinoline Phosphomolybdate Method (DoD Adopted).
- D4057 - Standard Test Method for Manual Sampling of Petroleum and Petroleum Products (DoD Adopted).
- D4177 - Standard Test Method for Automatic Sampling of Petroleum and Petroleum Products (DoD Adopted).
- D4294 - Standard Test Method for Sulfur in Petroleum Products by Non-Dispersive X-Ray Fluorescence Spectrometry (DoD Adopted).
- D4624 - Standard Test Method for Measuring Apparent Viscosity by Capillary Viscometer at High Temperature and High-Shear Rates (DoD Adopted).
- D4628 - Standard Test Method for Analysis of Barium, Calcium, Magnesium, and Zinc in Unused Lubricating Oils by Atomic Absorption Spectrometry (DoD Adopted).

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- D4629 - Standard Test Method for Standard Test Method for Trace Nitrogen in Liquid Petroleum Hydrocarbons by Syringe/Inlet Oxidative Combustion and Chemiluminescence Detection (DoD Adopted).
- D4683 - Standard Test Method for Measuring Viscosity at High Temperature and High Shear Rate by Tapered Bearing Simulator (DoD Adopted).
- D4684 - Standard Test Method for Determination of Yield Stress and Apparent Viscosity of Engine Oils at Low Temperature (DoD Adopted).
- D4739 - Standard Test Method for Base Number Determination by Potentiometric Titration.
- D4741 - Standard Test Method for Measuring Viscosity at High Temperature and High Shear Rate by Tapered-Plug Viscometer (DoD Adopted).
- D4927 - Standard Test Method for Elemental Analysis of Lubricants and Additive Components - Barium, Calcium, Phosphorus, Sulfur, and Zinc by Wavelength-Dispersive X-Ray Fluorescence Spectroscopy (DoD Adopted).
- D4951 - Standard Test Method for Determination of Additive Elements in Lubricating Oils by Inductively Coupled Plasma Atomic Emission Spectrometry (DoD Adopted).
- D5119 - Evaluation of Automotive Engine Oils in the CRC L-38 Spark-Ignition Engine.
- D5185 - Determination of Additive Elements, Wear Metals and Contaminants in Used Lubricating Oils by Inductively-Coupled Plasma Atomic Emission Spectrometry.
- D5480 - Standard Test Method for Motor Oil Volatility by Gas Chromatography.
- D5533 - Evaluation of Automotive Engine Oils in the Sequence IIIE, Spark-ignition Engine.
- D5862 - Standard Test Method for the Evaluation of Engines Oils in the Two-Stroke Turbo-Supercharged 6V92TA Diesel Engine.
- D5966 - Standard Test Method for the Roller Follower Wear Test.
- D6082 - Standard Test Method for High Temperature Foaming Characteristics of Lubricating Oils.

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ASTM Adjunct Publications

Adjunct No. 12-401300-00 - Copper Strip Corrosion Standard.

ASTM Special Publication (STP) 315H

Caterpillar 1N Test Procedures
Caterpillar 1M-PC Test Procedure
HEUI Engine Oil Aeration Test

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

ALLISON TRANSMISSION DIVISION (ATD)

C-4 Fluid Specification (TES-228).

(Application for copies should be addressed to EG&G Stationary Testing, Attn: ATF/Specialty Lab (C-4), 5904 Bandera Road, San Antonio, TX 78283-1993.)

CATERPILLAR INC., ENGINE DIVISION (CAT.)

Caterpillar TO-4, Fluid Requirements, VC 70.

(Application for copies should be addressed to Caterpillar, Component Development, Technical Center - G, P.O. Box 1875, Peoria, IL 61656-1875)

MACK TRUCK INCORPORATED

T-8 Fluid Specification

(Application for copies should be addressed to Mack Truck Inc., 1999 Pennsylvania Ave., Hagerstown, MD 21740.)

SOCIETY OF AUTOMOTIVE ENGINEERS, INC. (SAE)

SAE J300 - Engine Oil Viscosity Classification.
SAE J183 - Engine Oil Performance and Engine Service
Classification (Other than "Energy Conserving").

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

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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 engine 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 4.1.1 and 6.4).

3.2 Design, materials, and manufacturing processes. Unless otherwise specified herein, the design, materials, and manufacturing process selection is the prerogative of the contractor as long as all articles submitted to the government fully meet the operating, interface, support and ownership, and operating environment requirements specified.

3.2.1 Recycled, recovered, or environmentally preferable materials. Recycled, recovered, or environmentally preferable materials should be used to the maximum extent possible provided that the material meets or exceeds the operational and maintenance requirements, and promotes economically advantageous life cycle costs.

3.3 Operating requirements. The engine lubricating oil shall meet all the operating requirements as specified in 3.3.1 through 3.3.10.

3.3.1 Finished oil properties. The values, after the application of tolerances (see 4.1.1.1), shall not exceed the maximum (max.) or fall below the minimum (min.) limits as specified in table I.

TABLE I. Finished oil properties.

Property	SAE Grade 10W	SAE Grade 30	SAE Grade 40	SAE Grade 15W-40
Kinematic viscosity, Centistoke (cSt):				
@ 100 degrees Celsius (°C)				
min.	5.6	9.34	12.5	12.5
max.	< 7.4	< 12.5	< 16.3	< 16.3
@ 40 °C <u>1</u> /	X	X	X	X

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TABLE I. Finished oil properties - Continued.

Property	SAE Grade 10W	SAE Grade 30	SAE Grade 40	SAE Grade 15W-40
Viscosity apparent, Centipoise (cP) @ °C				
min.	3500 @ -25	----	----	3500 @ -20
max.	3500 @ -20	----	----	3500 @ -15
Kinematic viscosity, Centistokes (cSt)				
@ 100 °C min.	5.6	9.3	12.5	12.5
max.	<7.4	<12.5	<16.3	<16.3
@ 40 °C	X	X	X	X
Pumpability, 30 000 cP, max. @temperature, °C	-25	----	----	-20
High-temperature/high-shear viscosity, min.	2.9	X	X	3.7
Viscosity index, min. <u>1/</u>	X	80	80	X
Pour point, °C, max.	-30	-18	-15	-23
Stable pour point, °C, max.	-30	----	----	-23
Flash point, °C, min.	205	220	225	215
Evaporative loss, percent (%) <u>2/</u>	18	----	----	15
Other properties:				
Gravity	X	X	X	X
Carbon residue	X	X	X	X
Sulfur	X	X	X	X
Sulfated ash	X	X	X	X
Total acid number (TAN)	X	X	X	X
Total base number (TBN)	X	X	X	X
Phosphorus	X	X	X	X
Nitrogen	X	X	X	X
Metallic components	X	X	X	X
Chlorine	X	X	X	X
Color	X	X	X	X
Boiling range	X	X	X	X

1/ Limits for the values marked by “X” cannot be established, as they differ from brand of oil to another for the same grade. These values are influenced by the source of the base stock, the identities and quantities of additives, etc. During qualification, test values shall be determined which are characteristics of a particular product and which can serve thereafter to identify the product.

2/ The indicated limits apply when ASTM D5480 is used.

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3.3.2 Foaming. The oil shall not produce foam which will cause inadequate lubrication, cavitation, overflow loss of lubricant, mechanical failure, or any other detrimental effect that compromises performance.

3.3.3 Oxidation and wear protection characteristics. The oils shall protect internal loaded engine components against excessive wear and oxidation.

3.3.4 Soot protection. The oils shall protect internal loaded diesel engine components against excessive wear caused by the presence of soot.

3.3.5 Ring-sticking, wear, and accumulation of deposits. The oils shall prevent the sticking of piston rings and port clogging, and shall minimize the wear of cylinders, rings, and loaded engine components such as cam followers, valve rocker arms, rocker arm shafts, and the oil pump and fuel injection pump drive gears.

3.3.6 Friction retention characteristics and wear. The oils shall maintain a stable coefficient of friction and shall minimize distress and wear during use in power shift transmissions and other cooled friction compartments, or hydraulic systems such as steering and disconnect clutches.

3.3.7 Seal compatibility. The oils shall minimize the deterioration of seal and friction materials.

3.3.8 Dispersancy characteristics. The oil shall minimize engine deposits and increased oil viscosity by ensuring the stable dispersement of soot, produced during diesel combustion, in the lubricating oil.

3.3.9 Corrosion. The oils shall meet the requirements as specified in 3.3.9.1 through 3.3.9.3.

3.3.9.1 Bearing corrosion. The oils shall not corrode copper-lead alloy bearings.

3.3.9.2 Metal corrosion. The oils shall not corrode metals.

3.3.9.3 Acid neutralization. The oils shall neutralize the corrosive effects of acid.

3.3.10 Shear stability. SAE 15W-40 grade oil shall demonstrate shear stability.

3.4 Interface requirements. The oils shall be compatible with oils previously qualified under MIL-PRF-2104, MIL-PRF-21260, and MIL-PRF-46167.

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3.5 Support and ownership requirements. The oils shall meet all support and ownership requirements as specified in 3.5.1 through 3.5.2.

3.5.1 Homogeneity. The oils shall be and shall remain homogeneous.

3.5.2 Hazardous materials. The oils shall not contain carcinogenic or potentially carcinogenic constituents as defined under the Hazard Communication Standard 29 CFR 1910.1200.

3.6 Operating environment requirements. The oil shall operate under the environmental conditions as specified in 3.6.1 and 3.6.2.

3.6.1 Humidity. The oils shall provide resistance to the deleterious effects of corrosion under conditions of high humidity.

3.6.2 Salt water. The oils shall provide resistance to the deleterious effects of corrosion in an aqueous salt environment.

4. VERIFICATION

4.1 Classification of inspections. Inspection requirements specified herein are classified as follows:

- a. Qualification inspection (see 4.1.1).
- b. Conformance inspection (see 4.1.2).

4.1.1 Qualification inspection. Qualification inspection shall consist of all the verifications listed in table II and shall be in accordance with acceptable tolerances (see 4.1.1.1).

4.1.1.1 Tolerances. Acceptable tolerances for values or limits in 3.3.1 through 3.3.10 shall be as specified by the qualifying activity (see 6.2 and 6.4).

Table II. Verification methods.

Title	Requirements	Verification	Title	Requirements	Verification
Operating requirements	3.3	4.3.3	Metal corrosion	3.3.9.2	4.3.3.9.2
Finished oil requirements	3.3.1	4.3.3.1	Acid neutralization	3.3.9.3	4.3.3.9.3
Foaming	3.3.2	4.3.3.2	Shear stability	3.3.10	4.3.3.10
Oxidation/wear protection	3.3.3	4.3.3.3	Interface requirements	3.4	4.3.4
Soot protection	3.3.4	4.3.3.4	Support and ownership requirements	3.5	4.3.5
Ring sticking/wear	3.3.5	4.3.3.5			
Friction retention/wear	3.3.6	4.3.3.6	Homogeneity	3.5.1	4.3.5.1

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Table II. Verification methods - Continued.

Title	Requirements	Verification	Title	Requirements	Verification
Seal compatibility	3.3.7	4.3.3.7	Hazardous materials	3.5.2	4.3.5.2
Dispersancy	3.3.8	4.3.3.8	Operating environment requirements	3.6	4.3.6
Corrosion	3.3.9	4.3.3.9		Humidity	3.6.1
Bearing corrosion	3.3.9.1	4.3.3.9.1	Salt water	3.6.2	4.3.6.2

4.1.2 Conformance inspection. The engine lubricating oil supplied under contract shall have the same base stocks and additive components, at the appropriate concentrations, as when qualified. Unless otherwise specified (see 6.2, 6.5, and 6.5.1), the finished oil properties and the foaming characteristics shall be tested as specified in table II to insure that purchased oils are of the same composition and quality as the respective qualification samples, and to identify the products. The results obtained shall fall within the tolerances/specific values determined at the time of qualification (see 4.1.1.1).

4.2 Sampling. Samples from bulk or packaged lots (see 6.8), shall be taken for testing in accordance with ASTM D4057 or D4177, as appropriate.

4.3 Verification methods. The types of verification methods included in this section are visual inspection, measurement, sample tests, full-scale demonstration tests, simulation, modeling, engineering evaluation, component properties analysis, and similarity to previously approved or previous qualified designs.

4.3.1 Verification alternatives. The manufacturer may propose alternative test methods, techniques, or equipment, including the application of statistical process control, tool control, or cost effective sampling procedures, to verify performance. See the contract for alternatives that replace verification required by this specification.

4.3.2 Inspection conditions. Tests may be conducted, in any sequence, in any plant or laboratory approved by the qualifying activity (see 6.2 and 6.4).

4.3.3 Operating requirements verification. Complete each test under 4.3.3.

4.3.3.1 Finished oil property verifications. Use the test methods as specified in table III to determine that finished oil properties are as specified.

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Table III. Finished oil property test methods.

Property	Test methods		
	FED-STD-791 or equivalent (see 4.3.1)	ASTM	SAE
Viscosity, kinematic Viscosity, apparent High temperature/shear Viscosity index Pour point Stable pour point <u>1/</u> Pumpability Flash point Evaporative loss <u>2/</u> <u>3/</u> Gravity, API Carbon residue TAN TBN Phosphorus Sulfur <u>4/</u> Nitrogen Sulfated ash Metallic components	203	D445 D4683, D4624, D4741 D2270 D97 D4684 D92 D5480, D5800 D287 D524 D664 D2896, D4739 D1091, D4047, D4951, D5185 D129, D1552, D2622, D4294, D4297, D4951, D5185 D3228, D4629 D874 D4628, D4927, D4951, D5185	J300, appendix A

1/ Test is only required for SAE grades 10W and 15W-40 oils.

2/ ASTM D5480 is the preferred method.

3/ After being cooled down to its pour point, the oil shall regain its homogeneity on standing at a temperature not more than 6°C above the pour point. However, it should not exceed the indicated limits.

4/ ASTM D1552 is the preferred method. ASTM D4294 is only for use with base stock.

4.3.3.2 Foaming test. All grades of oil shall be subject to the following tests and shall exhibit the correlative results:

- a. Initial test. Test oils in accordance with sequence I of ASTM D892. Not more than 10 milliliters (mL) of foam shall remain immediately following the end of the 5 minute blowing period. No foam shall remain at the end of the 10 minute settling period.
- b. Intermediate test. Test oils in accordance with sequence II of ASTM D892. Not more than 20 milliliters (mL) of foam shall remain immediately following the end of the 5 minute blowing period. No foam shall remain at the end of the 10 minute settling period. Option A is not allowed.

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- c. Final test. Repeat procedures under initial test.
- d. High temperature engine oil aeration test (ASTM D 6092). Test oil in accordance with ASTM D6082. Not more than 50 mL of foam shall remain immediately following the end of the blowing period. No foam shall remain at the end of the 1-minute settling period.

4.3.3.2.1 HEUI engine oil aeration test. The HEUI engine oil aeration test shall be required only when a satisfactory high temperature engine oil aeration test is not available. Satisfactory performance shall be demonstrated when the oils exhibit test results meeting the following criteria:

	<u>% max.</u>
HEUI foam stability @ 20 hrs.	10

4.3.3.3 Oxidation and wear protection test. The oils shall be tested in accordance with ASTM D5533 and shall exhibit results (single or average) meeting the following criteria:

	<u>1 Test</u>	<u>2 Tests</u>	<u>3 Tests</u>
Average rating @ 64 hours			
Viscosity increase, hour to 375% average (avg.) min.	67.5	65.1	64.0
Oil ring land deposits, avg. min.	2.6	2.6	2.6
Piston skirt varnish, avg. min.	8.7	8.7	8.7
Sludge, avg. min.	9.0	9.0	9.0
Stuck rings, avg. min.	none	none	none
Stuck lifter, avg. max.	none	none	none
Scuffing and wear at 64 hours			
Cam or lifter scuffing	none	none	none
Cam plus lifter wear, micrometers (µm)			
avg. min.	64	64	64
avg. max.	145	145	145

4.3.3.4 Soot protection test. The oils shall be tested in accordance with ASTM D5966 and shall exhibit results meeting the following criteria:

	<u>1 Test</u>	<u>2 Tests</u>	<u>3 Tests</u>
Pin wear, µm avg. max.	11.4	12.4	12.7

4.3.3.5 Ring-sticking, wear, and accumulation of deposits tests. Test all oils as specified in 4.3.3.5.1 and 4.3.3.5.2. Only SAE grade 30, 40, and 15W-40 oils shall be tested as specified in 4.3.3.5.3.

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4.3.3.5.1 Four-stroke cycle diesel engine - low sulfur fuel. The oils shall be tested in accordance with Caterpillar 1N test procedure using low-sulfur fuel. (Only one test is required; however, the test limits are adjusted according to the number of tests submitted and equivalency to original limits.) The test results shall meet the following criteria:

	<u>1 Test</u>	<u>2 Tests</u>	<u>3 Tests</u>
Top groove filling, % avg. max.	20	23	25
WDN, demerits, avg. max.	286	311.7	323.0
Top land heavy carbon, % avg. max.	3	4	5
Oil consumption, grams per kilowatt hour (g/kW-h)	0.5	0.5	0.5
Scuffing, piston/rings/liners, avg. max.	none	none	none
Stuck rings, avg. max.	none	none	none

4.3.3.5.2 Four-stroke cycle diesel engine - higher sulfur fuel. The oils shall be tested in accordance with Caterpillar 1M-PC test procedure using high-sulfur fuel. (Only one test is required; however, when three or more tests are run, one test may be discarded and the average determined from the remaining test results). The test results shall meet the following criteria:

	<u>1 Test</u>
Top groove filling, % avg. max.	70
WDN, avg. max.	240
Ring side clearance loss, millimeter max.	0.013
Piston ring sticking	none
Scuffing, piston/rings/liners	none

4.3.3.5.3 Two-stroke cycle diesel engine. The oils shall be tested in accordance with ASTM D5862. (Only one test is required; however, if more than one test is run, the test limits are adjusted according to the number of tests run, maximum of three tests, and equivalency to original limits.) The test results shall meet the following criteria:

	<u>1 Test</u>	<u>2 Tests</u>	<u>3 Tests</u>
Average ring face distress, demerits (max.)			
Fire ring, avg.	0.33	0.34	0.36
Nos. 2 and 3 compression rings, avg.	0.28	0.29	0.30
Broken rings	none	none	none
Cylinder liner area			
Avg. liner distress, % area, avg. max.	60.0	63.5	65.0
Port plugging, % area, avg. max.			
Avg.	2	2	2
Single cylinder	5	5	5

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4.3.3.6 Friction retention and wear tests. Complete each test under 4.3.3.6. Friction retention and wear characteristics shall be required only for SAE grades 10W, 30, and 15W-40.

4.3.3.6.1 Slip time and torque test. The oils shall be tested in accordance with ATD C-4 fluid specification. The test results shall meet the following nominal criteria, as adjusted to accommodate slight changes in individual friction plate batches:

	Graphite	Paper
	<u>0 - 5500 cycles</u>	<u>0 - 10 000 cycles</u>
Slip time at cycles, seconds (s) max.	0.74	0.67
Mid-point coefficient, min.	0.097	0.080

4.3.3.6.2 Friction coefficient and wear. The oils shall be tested in accordance with Caterpillar VC 70 fluid requirements and shall meet the following criteria, as adjusted to accommodate slight changes in individual fluoroelastomer batches and performance of the reference oil:

	<u>Sequence 1220</u>	<u>Sequence FRRET</u>
Avg. dynamic coefficient, %	90 - 140	----
@ 3000 cycles	----	85 - 130
@ 8000 cycles	----	90 - 125
@ 15 000 cycles	----	90 - 125
@ 25 000 cycles	----	95 - 125
Avg. static coefficient, %	91 - 127	----
Disc wear, mm max.	0.04	----
Energy limit, %	25	----

4.3.3.7 Seal compatibility test. The oils shall be tested in accordance ATD C-4 and shall exhibit results meeting the following nominal criteria, as adjusted to accommodate slight changes in individual elastomer batches:

Buna N:	
Volume changes, %	0 to +5
Hardness change, points	0 ± 5
Polyacrylate:	
Volume changes, %	0 to +10
Hardness change, points	0 to +5
Silicone:	
Volume changes, %	0 to +5
Hardness change, points	0 to -10

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Fluoroelastomer:

Volume changes, %	0 to +4
Hardness change, points	-4 to +4

Ethyl Acrylic:

Volume changes, %	+12 to +28
Hardness change, points	-6 to -18

4.3.3.8 Dispersancy test. The oils shall be tested in accordance with the Mack T-8 fluid specification and shall exhibit test results meeting the following criteria:

	<u>1 Test</u>	<u>2 Tests</u>	<u>3 Tests</u>
Viscosity increase, cSt max. from min. corrected to 3.8 % Soot by TGA	11.5	12.5	13
Oil consumption grams/brake horsepower-hour (g/Bhp-h), max.	0.0005	0.0005	0.0005
Filter Plugging, differential pressure	138	138	138

4.3.3.9 Corrosion. Complete each test under 4.3.3.9.

4.3.3.9.1 Bearing corrosion. The oils shall be tested in accordance with ASTM D5119 and shall exhibit results meeting the following criteria:

	<u>1 Test</u>	<u>2 Tests</u>	<u>3 Tests</u>
Bearing weight loss, milligrams (mg), avg. max.	43.7	48.1	50.0

4.3.3.9.2 Metal corrosion test. The oils shall be tested in accordance with ASTM D130 and shall not exhibit copper strip discoloration in excess of ASTM No. 3 when compared to ASTM Copper Strip Corrosion Standard. The oils shall also be tested in accordance with method 5308 of FED-STD-791, or equivalent (see 4.3.1) and shall exhibit results meeting the following criteria:

Copper, parts per million (ppm) max.	20
Lead, ppm max.	60

4.3.3.9.3 Acid neutralization test. The following test procedure shall be performed. Clean and sand-blast three test panels which shall be of the material, design, and dimensions specified in 4.3.6.2.1. Handling each panel separately with forceps, immerse the panel completely for not more than one second in a 0.1 ± 0.01 % aqueous solution of hydrobromic acid. Within one second after removal from the acid solution, immerse the panel completely, with agitation, in a sample of the oil to be tested, maintained at a temperature of $25 \pm 3^\circ\text{C}$ and

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contained in a 500 mL tall-form beaker. Transfer the panel from the hydrobromic acid solution immediately, without draining the excess acid solution. Immerse the panel in the oil sample and remove it a total of 12 times in 60 s. Change the position of the tips for each immersion to assure access of the oil to all surfaces of the panel. Support the panels by inserting them in slots cut in the faces of cylindrical hardwood blocks, 54 mm in diameter and 25.4 mm in height. Each slot shall measure 3 mm deep and 2 mm wide. Allow the panels to stand in the air at $25 \pm 3^\circ\text{C}$ for a period of 4 hours. Following this 4 hour standing period, remove the remaining oil film from the panel with naphtha and examine the panel for the extent of corrosion. Corrosion, staining, or other attack occurring within 3 mm of any edge of the panel, or within 3 mm of the line of contact between the panel and the upper surface of the slot in the wooden block, shall not be considered for evaluation of the test results. A total of not more than three corrosion spots, none of which exceed 1 mm in length, width, or diameter, shall be evident on any of the test panels. There also shall be no evidence of staining or any other attack on any of the three test panels.

4.3.3.10 Shear stability test. SAE 15W-40 grade oil shall demonstrate shear stability when tested as follows:

- a. Weigh 25 grams of used oil, obtained every 10 hours of testing in accordance with ASTM D5119, and place sample into a 50mL three-necked round bottom flask equipped with a thermometer, gas inlet tube, stirrer, and distillation side arm.
- b. Heat the sample at $120 \pm 5^\circ\text{C}$ in a vacuum of 100 mm of mercury with a nitrogen sparge for 1 hour.
- c. Filter the stripped sample through a 0.5 micron filter pad.
- d. The kinematic viscosity of the filtered sample, determined at 100°C and in accordance with ASTM D445, shall be 13.0 cSt.

4.3.4 Interface requirements verification. The oil shall show no evidence of separation when tested against selected reference oils in accordance with method 3470 of FED-STD-791, or equivalent (see 4.3.1 and 6.6).

4.3.5 Support and ownership requirements. Complete each test under 4.3.5.

4.3.5.1 Homogeneity test. The oils shall show no evidence of separation or color change when tested in accordance with method 3470 of FED-STD-791, or equivalent (see 4.3.1).

4.3.5.2 Compatibility test. The oils shall show no evidence of separation when they are tested against selected reference oils in accordance with method 3470 of FED-STD-791, or equivalent (see 4.3.1 and 6.6).

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4.3.5.3 Hazardous materials test. Using one or more of the methods outlined in 4.3 and 4.3.1, verify the absence of hazardous materials.

4.3.6 Operating environment verifications. Complete each test under 4.3.6.

4.3.6.1 Humidity corrosion test. The corrosion protection properties of the oils shall be tested in a humidity cabinet for a min. of 32 days (720 hours) in accordance with method 5329 of FED-STD-791, or equivalent (see 4.3.1). Three test panels per method 5329 of FED-STD-791, or equivalent (see 4.3.1) shall be used. There shall be no more than three corrosion spots, none of which exceed 1 mm in length, width, or diameter.

4.3.6.2 Salt water immersion test. The corrosion protection properties of the oils shall be tested in salt water in accordance with 4.3.3.9.5.1 through 4.3.3.9.5.4.

4.3.6.2.1 Test panels. Use three test panels of the composition specified in method 5329 of FED-STD-791, or equivalent (see 4.3.1). Each panel shall measure 76 x 51 x 1.6 mm and shall contain a hole 6.4 mm in diameter, whose center is on the mid-line of the panel, 6.4 mm from one of the 51 mm edges. All corners and edges of the panels shall be completely rounded.

4.3.6.2.2 Preparation of test panels. The test panels shall be cleaned and sand-blasted as specified in method 5329 of FED-STD-791, or equivalent (see 4.3.1). The panels shall then be immersed in the oil sample at $25 \pm 3^{\circ}\text{C}$ and gently agitated for one minute. The panels shall be suspended on glass hooks and the oil allowed to drain for 20 hours in a dust-free area maintained at $25 \pm 3^{\circ}\text{C}$, and a maximum relative humidity of 50 %.

4.3.6.2.3 Preparation of synthetic sea water. Synthetic sea water shall be prepared with a composition as specified in table IV. The pH of the salt solution shall be adjusted to a value between 8.0 and 8.2 by the addition of 5 % solution of sodium carbonate. If the salt solution is kept in stock, check the pH and adjust it before each test, if necessary, to the same value.

Table IV. Composition of synthetic sea water.

Ingredient	Grams per liter of solution
Magnesium chloride hexahydrate	11.0
Anhydrous calcium chloride	1.2
Anhydrous sodium sulfate	4.0
Sodium chloride	25.0

4.3.6.2.4 Procedure. The following test procedure shall be performed. Immerse each of the oil-coated test panels separately in a tall-form beaker containing synthetic sea water at $25 \pm 3^{\circ}\text{C}$ for 20 hours. Immerse the panels in a vertical position to a depth of 10 to 16 mm above the panel. Support the panels by inserting them in slots cut in the faces of cylindrical hardwood

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blocks, 54 mm in diameter and 25.4 mm in height. Each slot shall measure 3 mm deep and 2 mm wide. Precondition the blocks before initial use by immersing them for 48 hours in synthetic sea water at $25 \pm 3^{\circ}\text{C}$. Cover each beaker with a watch glass before the start of the 20 hour immersion period. After immersion, rinse with acetone, and finally rinse with aliphatic naphtha. Allow the panels to dry at $25 \pm 3^{\circ}\text{C}$ and inspect them immediately for corrosion spots. To differentiate between gray discoloration and rust, illuminate each panel with a 100 Watt “daylight” electric bulb and view its surface at an angle of 20 to 40 degrees ($^{\circ}$) with the plane of the panel. Corrosion occurring within 3 mm of any edge of the panel, within 3 mm of the edge of the hole in any panel, or within 6 mm of the line of contact of the panel and the upper surface of the slot in the support block shall be considered in the evaluation of the test results. A total of not more than three corrosion spots, none of which exceed one mm in length, width, or diameter, shall be evident on the test panels.

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 which may be helpful, but is not mandatory.)

6.1 Intended use. The SAE 10W grade oil is not to be used in high-output, two-cycle compression-ignition engines. The lubricating oils, except as mentioned above, covered by this specification are intended for the preservative, break-in and operational use until the first scheduled oil change of all spark-ignition and compression-ignition engines used in all types of military combat/tactical ground equipment and for the crankcase lubrication of two-cycle, four-cycle, high-speed, high-output, supercharged compression-ignition engines used in all ground equipment. The oils are also intended for the same application in power transmissions, hydraulic systems, and non-hypoid gear units of engineer/construction equipment, materials handling equipment and combat/tactical ground equipment. The lubricating oils covered by this specification meet service classifications API CG-4, CF of SAE J183 and are intended for all conditions of operational service, as defined by appropriate lubrication orders, when temperatures are above -25°C (see 6.7). This specification requires an oil formulation that is both versatile-used as engine oil, transmission fluid, and hydraulic fluid-and meets extreme

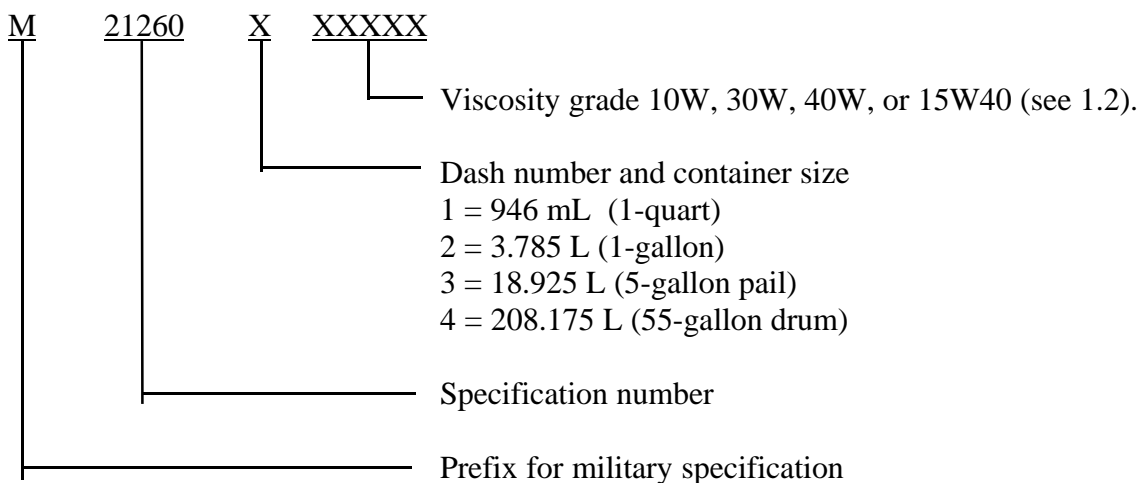
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operating environmental conditions for use in combat/tactical ground equipment. These requirements cannot be found in current industry standards and are not appropriate for other Government vehicles.

6.2 Acquisition requirements. Acquisition documents must specify the following:

- a. Title, number, and date of this specification.
- b. Grade of oil required (see 1.2).
- c. Issue of DoDISS to be cited in the solicitation, and if required, the specific issue of individual documents referenced (see 2.2.1 and 2.3).
- d. Specification of values and tolerances for finished oil requirements (see table I and 4.1.1.1).
- e. If conformance testing is other than as specified (see 4.1.2).
- f. Approved plants or laboratories for testing (see 4.3.2).
- g. Packaging requirements, quantity and PIN (see 5.1 and 6.3).

6.3 Part or identifying number (PIN) configuration. The PIN to be used for oils acquired to this specification are created as follows:



6.4 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 Qualified Products List QPL No. 21260 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. Information pertaining to qualification of products may be obtained from US Army Tank-automotive and Armaments Command, Warren, Michigan 48397-5000.

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6.5 Conformance testing. Affordable conformance inspection with confidence varies depending upon a number of procurement risk factors. Some of these factors include: Contractor past performance, government schedules and budget, product material and design maturity, manufacturing capital equipment and processes applied, the controlled uniformity of those processes, labor skill and training, and the uniformity of measuring processes and techniques. During the solicitation, contracting documents should indicate those tests desired from table II and their designated frequency based on a risk assessment for the procurement.

6.5.1 Other requirements for tolerances for conformance testing. Definite numerical values are not specified for certain of the physical and chemical properties listed in table I, and for which corresponding test methods are given in table III. Values of some properties vary from one brand of oil to another for the same grade. These values are influenced by the source of the base stock, the identities and quantities of additives, etc. Definite numerical values are not always functionally important except, for some properties, within specified maximum and minimum limits. It is not possible (or necessary) to assign restrictive values in the specification before the testing of qualification samples. During qualification, test values will be determined which are characteristics of a particular product and which can serve thereafter to identify the product. Using the results of qualification testing, the qualifying activity can set values, including permissible tolerances, for future conformance testing.

6.6 Reference oils. Reference oils for conducting compatibility tests are to be obtained from the SAE, 400 Commonwealth Drive, Warrendale, PA 15096.

6.7 Temperature range. Recommended ambient temperature ranges for specific grade oils are shown in table V.

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TABLE V. Recommended ambient temperature ranges for usage of engine oils.

EXPECTED TEMPERATURES														
° F	<-25	-25	0	15	25	40	50	60	70	80	90	100	110	120
° C	<-15	-15	-18	-10	-5	5	10	16	21	27	32	38	44	49

Note: For power transmission, hydraulic system and non-hypoid gear box applications, lubricants may be used at all temperature above the low temperature recommendation shown in table IV.

6.8 Definitions.

6.8.1 Bulk lot. An indefinite quantity of a homogeneous mixture of one grade of oil offered for acceptance in a single, isolated container; or manufactured in a single plant run (not exceeding 24 hours), through the same processing equipment, with no change in the ingredient materials.

6.8.2 Packaged lot. An indefinite number of 208.175 L (55 gallon drum) or smaller unit containers of identical size and type, offered for acceptance, and filled with a homogeneous mixture of one grade of oil from a single, isolated container; or filled with a homogeneous mixture of one grade of oil, manufactured in a single plant run (not exceeding 24 hours), through the same processing equipment, with no change in the ingredient materials.

6.9 Subject term (key word) listing.

Combat service	Tactical service
Compression-ignition	Viscosity
Corrosion inhibitor	
Foaming	
Power transmission fluid	
Spark-ignition	

6.10 International standardization agreement. Certain provisions of this specification are subject of international standardization agreement STANAGs 2845 and 1135. When amendment, revision, or cancellation of this specification is proposed which the international

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agreement concerned, the preparing activity will take appropriate reconciliation action through international standardization channels, including departmental standardization offices, to change the agreement or make other appropriate accommodations.

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

Custodians:

Army - AT
Navy - SH
Air Force - 68

Preparing Activity:

Army - AT

(Project 9150-0177)

Review Activities:

Army - AR, MI, SM
Navy - AS, MC, OS, SA, YD1
Air Force - 11, 99
DLA - GS

Industry Associations:

ASTM
SAE

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.
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3. The preparing activity must provide a reply within 30 days from receipt of the form.

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I RECOMMEND A CHANGE:

1. DOCUMENT NUMBER

MIL-PRF-21260E

2. DOCUMENT DATE (YYMDD)

980731

3. DOCUMENT TITLE

LUBRICATING OIL, INTERNAL COMBUSTION ENGINE, PRESERVATIVE BREAK-IN

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

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(2) AUTOVON
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c. ADDRESS *(Include Zip Code)*

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