

METRIC

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 SUPERSEDING
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MILITARY SPECIFICATION

LUBRICATING OIL, INTERNAL COMBUSTION ENGINE, TACTICAL SERVICE

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

1. SCOPE

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

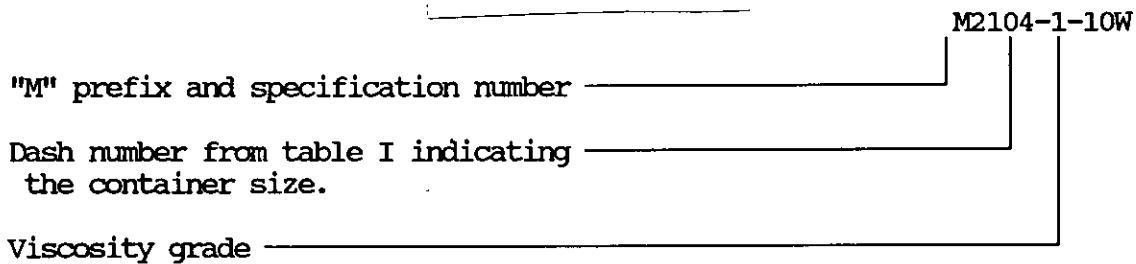
1.2 Classification. The lubricating oils shall be of the following viscosity grades (see 6.2):

<u>Viscosity Grade</u>	<u>Military Symbol</u>	<u>NATO Code</u>
Grade 10W	OE/HDO-10	O-237
Grade 30	OE/HDO-30	O-238
Grade 40	OE/HDO-40	---
Grade 15W-40	OE/HDO-15/40	O-1236

1.3 Military part number. Engine oils furnished under this specification shall be identified by a military part number consisting of; a "M" prefix and specification number, a single digit "Dash Number" taken from table I which indicates the container size, and the viscosity grade of the lubricant. The military part number for grade 10W lubricant to be furnished in 1-pint containers is shown in the following example:

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: USA Belvoir Research, Development, and Engineering Center, ATTN: STRBE-TSE, Fort Belvoir, VA 22060-5606 by using the self-addressed Standardization Document improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.
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TABLE I. Dash number designations for use in military part numbers.

Dash number	Container size
1	1-pint
2	1-quart
3	1-gallon
4	5-gallon pail
5	55-gallon drum
6	bulk

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 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.

SPECIFICATIONS

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- MIL-L-21260 - Lubricating Oil, Internal Combustion Engine, Preservative and Break-In.
- MIL-L-46152 - Lubricating Oil, Internal Combustion Engine, Administrative Service.
- MIL-L-46167 - Lubricating Oil, Internal Combustion Engine, Arctic.

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.

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- MIL-STD-105 - Sampling Procedures and Tables for Inspection by Attributes.
 MIL-STD-290 - Packaging of Petroleum and Related Products.

2.1.2 Other Government documents. The following other Government document forms 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.

U.S. DEPARTMENT OF LABOR (DOL)

OSHA 29 CFR 1900.1200 - Hazard Communication; Interpretation Regarding Lubricating Oils.

(Guideline CPL 2-2.38 may be obtained from OSHA Publication Office, Room S-4203, 200 Constitution Avenue, NW, Washington, DC 20210.)

2.2 Other 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 non-Government documents which is current on the date of the solicitation.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

- D 92 - Flash and Fire Points by Cleveland Open Cup.
 D 94 - Saponification Number of Petroleum Products.
 D 97 - Pour Point of Petroleum Oils.
 D 129 - Sulfur in Petroleum Products by the Bomb Method.
 D 287 - API Gravity of Crude Petroleum and Petroleum Products (Hydrometer Method).
 D 445 - Viscosity of Transparent and Opaque Liquids (Kinematic and Dynamic Viscosities).
 D 524 - Ramsbottom Carbon Residue of Petroleum Products.
 D 664 - Test for Neutralization Number by Potentiometric Titration.
 D 808 - Chlorine in New and Used Petroleum Products (Bomb Method).
 D 874 - Sulfated Ash from Lubricating Oils and Additives.
 D 892 - Foaming Characteristics of Lubricating Oils.
 D 1091 - Phosphorus in Lubricating Oils and Additives.
 D 1317 - Chlorine in New and Used Lubricants (Sodium Alcoholate Method).
 D 1500 - ASTM Color of Petroleum Products (ASTM Color Scale).
 D 1552 - Sulfur in Petroleum Products (High Temperature Method).
 D 2270 - Calculating Viscosity Index from Kinematic Viscosity at 40 and 100 °C.
 D 2622 - Sulfur in Petroleum Products (X-ray Spectrographic Method).
 D 2887 - Boiling Range Distribution of Petroleum Fractions by Gas Chromatography.
 D 2896 - Total Base Number of Petroleum Products by Potentiometric Perchloric Acid Titration.
 D 3228 - Total Nitrogen in Lubricating Oils by Modified Kjeldahl Method.
 D 4047 - Phosphorus in Lubricating Oils and Additives by Quinoline Phosphomolybdate Method.

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- D 4057 - Manual Sampling of Petroleum and Petroleum Products.
- D 4294 - Sulfur in Petroleum Products by Non-Dispersive X-Ray Fluorescence Spectrometry.
- D 4628 - Analysis of Barium, Calcium, Magnesium and Zinc in Unused Lubricating Oils by Atomic Absorption Spectrometry.
- D 4683 - Measuring Viscosity at High Temperature and High Shear Rate by Tapered Bearing Simulator.
- D 4684 - Test Method for Determination of Yield Stress and Apparent Viscosity of Engine Oils at Low Temperature.
- D 4736 - Standard Test Method for Evaluating Friction Retention Characteristics of Oils used in Oil Cooled Bronze faced Friction Clutches.

ASTM Special Technical Publication (STP) 315H.

- Engine Test Sequence IID.
- Engine Test Sequence IIIIE.
- Engine Test Sequence VE.

ASTM Special Technical Publication (STP) 509A.

- Caterpillar 1G2 Test Method
- Labeco L-38 Test Procedure

(Application for copies of all ASTM test methods should be addressed to the American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103.)

ALLISON TRANSMISSION DIVISION (ATD)

C-3 Fluid Specification.

(Application for copies should be addressed to Allison Transmission Division, P.O. Box 894, Indianapolis, IN 46206.)

SOCIETY OF AUTOMOTIVE ENGINEERS (SAE)

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

(Application for copies should be addressed to SAE, 400 Commonwealth Drive, Warrendale, PA 15096.)

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

2.3 Order of precedence. In the event of a conflict between the text of this specification and the references cited herein, the text of this specification shall take precedence. Nothing in this specification, however, shall supersede applicable laws and regulations unless a specific exemption has been obtained.

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3. REQUIREMENTS

3.1 Qualification. Engine lubricating oils furnished under this specification shall be products which are qualified for listing on the applicable qualified products list at the time set for opening of bids (see 4.5.1 and 6.4). The qualifying activity (see 6.4) may waive complete qualification testing or may require only partial qualification testing of grade 40 oil if the contractor states in a written affidavit that the product has been formulated with base stocks, refining treatment, and additives the same as those used in the formulation of grade 30 oil qualified under this specification.

3.1.1 Qualification period. Each viscosity grade of oil which satisfies all the requirements of this specification shall be qualified for a period not exceeding four years from the date of its original qualification. The qualification period for each grade 40 oil qualified in accordance with 3.1 shall not exceed that of the grade 30 used in the qualification procedure. When the qualification period has expired, or whenever there is a change in the base stock, in the refining treatment or in the additives used in the formulation, each product must be requalified if the contractor wishes to maintain the formulation as a qualified product and be eligible to bid on government solicitations for this material.

3.1.2 Tolerances. The engine lubricating oil supplied under contract shall be identical, within permissible tolerances assigned by the qualifying activity for the properties listed in 3.5, to the product receiving qualification. The values resulting after the application of tolerances shall not exceed the maximum nor fall below the minimum limits specified herein (see table II and 3.4.1 through 3.4.9).

3.1.3 Pour-point depressant. No changes shall be made in either the type or concentration of the pour-point depressant after qualification testing and approval unless:

- a. The oil is retested for conformity to the pour-point, stable pour point, borderline pumping temperature and all viscosities (see table II).
- b. The qualifying activity (see 6.4) is informed of the proposed change(s) and of the retesting.
- c. The qualifying activity approves the proposed change(s) in writing.

3.1.4 Material Safety Data Sheets. When applying for qualification, the manufacturer shall submit to the qualifying activity (see 6.4) Material Safety Data Sheets prepared in accordance with FED-STD-313. When FED-STD-313 is at variance with the CFR, 29 CFR 1910.1200 shall take precedence, modify and supplement FED-STD-313.

3.2 Materials. The engine lubricating oils shall be derived from petroleum fractions, synthetically prepared compounds or a combination of the two types of products. They may be virgin or re-refined stocks or a combination thereof. The stocks shall be compounded with such functional additives (detergents, dispersants, oxidation inhibitors, corrosion inhibitors, etc.) as are necessary to meet the specified requirements. The contractor shall certify that no carcinogenic or potentially carcinogenic constituents are present as defined

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under the Hazard Communication Standard (29 CFR 1910.1200). Certification of this effect shall be made available to the contracting officer or the contracting officer's designated representative.

3.2.1 Toxic products and formulations. The engine lubricating oil shall have no adverse effect on the health of personnel when used for its intended purpose. Questions pertinent to this effect shall be referred by the contracting activity to the appropriate departmental medical service who will act as an advisor to the contracting agency.

3.3 Physical and chemical requirements.

3.3.1 Requirements for finished oil. The oils shall conform to the requirements specified in table II and 3.4.1 through 3.4.9.

3.3.2 Requirements for base stock. A 180 mL sample of each base stock component used in formulating the finished oil, accompanied by the following property data, shall be submitted to the qualifying activity (see 6.4) at the time of qualification. Annually thereafter a 180 mL production sample of each base stock component used in formulating the finished oil, accompanied by the aforementioned property data, shall be submitted to the qualifying activity.

Viscosity
 at 100 °C, centistokes
 at 40 °C, centistokes
 Viscosity index
 Gravity, °API
 Pour-point, °C
 Carbon residue, mass%
 Sulfated ash, mass%
 Total acid number
 Saponification number
 Elemental content, mass %
 Nitrogen
 Chlorine
 Sulfur
 Color
 Boiling point distribution, °C
 @1%, 5%, 10%, 50%, and 90% points

3.4 Performance requirements. The oils shall conform to the respective requirements specified in 3.4.1 through 3.4.9.

3.4.1 Foaming. All grades of oil shall demonstrate the following foaming characteristics when they are tested in accordance with 4.6, table III (ASIM D 892).

- a. Initial test at 24 ±0.5 °C. Not more than 25 mL of foam shall remain immediately following end of the 5-minute blowing period. No foam shall remain at the end of the 10-minute settling period.
- b. Intermediate test at 93.5 ±0.5 °C. Not more than 150 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.

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- c. Final test at 24 ± 0.5 °C. Not more than 25 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.

3.4.2 Stability and compatibility.

3.4.2.1 Stability. The oils shall show no evidence of separation or color change when they are tested in accordance with 4.6, table III (method 3470 of FED-STD-791). A 180 mL sample of the finished lubricant used for this test shall be provided to the qualifying activity (see 6.4) at the time of qualification.

3.4.2.2 Compatibility. The oils shall be compatible with oils previously qualified under MIL-L-2104, MIL-L-46152, MIL-L-21260 and MIL-L-46167. The oils shall show no evidence of separation when they are tested against selected reference oils in accordance with 4.6, table III (method 3470 of FED-STD-791).

3.4.3 Moisture-corrosion characteristics. The oils shall prevent or minimize corrosion of ferrous-metal engine components in the presence of moisture inducted by low-temperature operating conditions. Satisfactory performance in this respect shall be demonstrated when the oils are tested and rated in accordance with 4.6, table III (Engine Test Sequence IID) and exhibit test results meeting the following criteria:

Average rust (min.)	8.1
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3.4.4 Wear protection characteristics. The oils shall protect internal loaded engine components against excessive wear. Satisfactory performance in this respect shall be demonstrated when the oils are tested and rated in accordance with 4.6, table III (Engine Test Sequence IIIE) and exhibit test results meeting the following criteria:

Scuffing and wear at 64 hrs.	
Cam or lifter scuffing	None
Cam plus lifter wear, μm	
Average (max.)	64
Maximum	178

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TABLE II. Finished oil requirements.

Property	Grade 10W	Grade 30	Grade 40	Grade 15W-40
Viscosity at 100 °C				
Kinematic, centistokes				
min.	5.6	9.3	12.5	12.5
max.	<7.4	<12.5	<16.3	<16.3
Viscosity at 40 °C ^{1/}				
Kinematic, centistokes	X	X	X	X
Viscosity @ Temperature ^{2/}				
apparent, centipoise @°C				
min.	3500@-25	---	---	3500@-20
max.	3500@-20	---	---	3500@-15
High temperature/high shear viscosity	---	---	---	X
Borderline pumping temperature, °C (max.)	-25	---	---	-20
Viscosity index, (min.)	X	75	X	X
Pour-point, °C, (max.)	-30	-18	-15	-23
Stable pour point, °C, (max.) ^{3/}	-30	---	---	-23
Flash point, °C, (min.)	205	220	225	215
Evaporative loss	X	---	---	X
Other properties ^{1/}				
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	X	X	X	X
Total base number	X	X	X	X
Phosphorus	X	X	X	X
Nitrogen	X	X	X	X
Metallic components	X	X	X	X

^{1/} Value shall be reported ("X" indicates report).

^{2/} Report the measured apparent viscosity for grade 10W and 15W-40 oils at the minimum and maximum temperatures.

^{3/} After being cooled below its pour point, the oil shall regain its homogeneity on standing at a temperature not more than 6 °C above the pour point.

3.4.5 Low-temperature deposits and wear. The oils shall minimize wear and the formation of undesirable deposits associated with intermittent, light-duty, low-temperature operating conditions. Satisfactory performance in this respect shall be demonstrated when the oils are tested and rated in accordance with 4.6, table III (Engine Test Sequence VE) and exhibit test results meeting the following criteria:

Average engine sludge (min.)	8.5
Average engine varnish (min.)	4.2

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Average piston skirt varnish (min.)	6.0
Average rocker cover sludge (min.)	6.5
Oil ring clogging, % (max.)	15
Oil screen clogging, % (max.)	23
Compression ring sticking (hot stuck)	None
Cam wear, μm	
Average (max.)	203
Maximum	457

3.4.6 Bearing corrosion and shear stability.

3.4.6.1 Bearing corrosion. The oils shall be non-corrosive to alloy bearings. Satisfactory performance in this respect shall be demonstrated when the oils are tested in accordance with 4.6, table III (Labeco L-38 Test) and exhibit test results meeting the following criteria:

Bearing weight loss, milligrams (max.)	50
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3.4.6.2 Shear stability. Grade 15W-40 oil shall demonstrate shear stability by remaining within the respective viscosity range at 100 °C when tested in accordance with 4.6.2.

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

3.4.7.1 Four-stroke cycle diesel engine. Satisfactory performance shall be demonstrated when the oils are tested and rated in accordance with 4.6, table III (Caterpillar 1G2 Test Method) and exhibit test results meeting the following criteria:

Top groove filling, % (max.)	80
Total weighted deposit, (max.)	300

3.4.7.2 Two-stroke cycle diesel engine. Satisfactory performance shall be demonstrated when the oils are tested and rated in accordance with 4.6, table III (method 355, FED-STD-791) and exhibit test results meeting the following criteria:

Piston area	
Average total deposits (max.)	400
Hot stuck rings	None
Average ring face distress, (max.)	
Fire ring	Report
Nos. 2 and 3 compression	13.0
Liner and head area	
Average liner distress, percentage area (max.)	12.0
Valve distress	None
Port plugging, percentage	Report

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3.4.8 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.

3.4.8.1 Slip time and torque. Satisfactory performance shall be demonstrated when the oils are tested and rated in accordance with 4.6, table III (ATD C-3 Fluid Specification) and exhibit test results meeting the following nominal criteria as adjusted to accommodate slight changes in individual friction plate batches:

Slip time at 5500 cycles, s (max.)	0.85
Torque, N.m	
at 0.2s slip time (min.)	101.7
difference between 1500 & 5500 cycles (max.)	40.7

3.4.8.2 Stopping time and wear. Satisfactory performance shall be demonstrated when the oils are tested and rated in accordance with 4.6, table III (ASTM D 4736) and two of three tests exhibit results meeting the following criteria (Report all results. When two passing tests are obtained, a third test is not required.):

	Grade 10W	Other Grades
Stopping time increase, % (max.)	20	15
Average total wear, μm (max.)	350	350

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

3.4.9.1 Effect on rubber seals. Satisfactory performance shall be demonstrated when the oils are tested and rated in accordance with 4.6, table III (ATD C-3 Fluid Specification) and exhibits test results meeting the following nominal criteria as adjusted to accommodate slight changes in individual elastomer batches:

a. Total immersion (Buna N)	
Volume changes, %	0 to +5
Hardness changes, points	0 \pm 5
b. Dip cycle (Polyacrylate)	
Volume changes, %	0 to 10
Hardness change, points	0 to +5
c. Tip cycle (Silicone)	
Volume changes, %	0 to +5
Hardness changes, points	0 to -10

3.5 Other requirements and tolerances for quality conformance testing. The following physical and chemical properties shall be tested in accordance with the appropriate methods listed in 4.6 to insure that purchased products are of the same compositions as the respective qualification samples and to identify the products. No specific values or limits are assigned in qualification testing, except as otherwise specified in table II and 3.4.1 through 3.4.9, but test results shall be reported for all properties listed. The qualifying activity

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(see 6.4) shall establish specific values and tolerances for subsequent quality conformance testing of the finished lubricant for these properties (see 6.3 and 6.4):

Viscosity
 Viscosity index
 Pour point
 Flash point
 Gravity, °API
 Carbon residue
 Foaming
 Phosphorus
 Sulfur
 Sulfated Ash
 Metallic components
 Nitrogen

4. QUALITY ASSURANCE PROVISIONS

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

4.1.1 Responsibility for compliance. All items must 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 in quality conformance does not authorize submission of known defective material, either indicated or actual, nor does it commit the Government to acceptance of defective material.

4.2 Lot.

4.2.1 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.

4.2.2 Packaged lot. An indefinite number of 55 gallon drums 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.

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4.3 Sampling.

4.3.1 Sampling for the examination of filled containers. Take a random sample of filled containers from each lot in accordance with MIL-STD-105, at inspection level II. AQL shall be 1.0 percent defective for major defects.

4.3.2 Sampling for tests. Take samples from bulk or packaged lots for tests in accordance with ASTM D 4057.

4.4 Inspection. Perform inspection in accordance with FED-STD-791 method 9601.

4.4.1 Examination of filled containers. Examine samples taken in accordance with 4.3.1 for compliance with MIL-STD-290 with regard to fill, closure, sealing, and leakage. Reject any container having one or more defects or under the required fill. If the number of defective or under filled containers exceeds the acceptance number for the appropriate sampling plan of MIL-STD-105, reject the lot represented by the sample. In addition, the manufacturer shall provide certification of noncarcinogenicity (i.e. materials are not considered carcinogenic or potentially carcinogenic) and shall provide material safety data sheets.

4.5 Classification of tests.

- a. Qualification tests (see 4.5.1).
- b. Quality conformance test (see 4.5.2).

4.5.1 Qualification tests. Qualification tests consist of tests for all of the requirements specified in section 3 and may be conducted in any plant or laboratory approved by the qualifying activity (see 6.4). Qualification tests shall be performed on each viscosity grade except as specified in 4.5.1.1 through 4.5.1.6.

4.5.1.1 Stable pour-point. The stable pour-point test (method 203 of FED-STD-791) shall be required only on grade 10W and 15W-40 oils.

4.5.1.2 Shear stability. Shear stability shall be required for only grade 15W-40 oil.

4.5.1.3 Modified formulations. Oils based on modification of the formulation of grade 30 oil qualified under this specification lubricant may be qualified in accordance with 3.1.

4.5.1.4 Wear protection characteristics. The qualifying activity (see 6.4), may waive Sequence IIIE testing of the candidate oil when acceptable supporting Sequence IIIE wear evaluations for formulations similar in additive technology to the candidate lubricant are presented to substantiate the wear protection characteristics.

4.5.1.5 Ring-sticking, wear and accumulation of deposits. The two-stroke cycle diesel engine test (method 355, FED-STD-791) shall be required only for grade 30, 40, and 15W-40 oils. Requirements for this test may be waived for oils formulated with a specific additive technology (detergent, dispersant, inhibitor system) provided satisfactory performance is demonstrated for the technology used in conjunction with various base stock-viscosity improver additive combinations.

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Satisfactory performance shall be demonstrated by conducting the following acceptable two-stroke cycle diesel engine tests:

- a. One test each of three grade 15W-40 oils formulated using the additive system, a viscosity index improver additive but with base stocks of different manufacture.
- b. One test each of a grade 15W-40 oil formulated using the additive system, a base stock employed in 4.5.1.5.a for each viscosity index improver additive to be used in conjunction with the additive system.

4.5.1.6 Friction retention characteristics and wear. Test for friction retention characteristics and wear shall be required only for grade 10W, 30, and 15W-40 oils. The qualifying activity (see 6.4) may waive testing for those requirements when acceptable supporting friction retention characteristics and wear evaluations for formulations similar in additive technology to the candidate lubricant are presented to substantiate these performance requirements.

4.5.2 Quality conformance tests. Tests for quality conformance of individual lots shall consist of tests for all of the requirements in Section 3, except for the following (see table III):

- Requirements for base stock.
- Stable pour point.
- Stability and compatibility.
- Moisture-corrosion characteristics.
- Wear protection characteristics.
- Low-temperature deposits and wear.
- Bearing corrosion and shear stability.
- Ring-sticking, wear and accumulation of deposits.
- Friction retention characteristics and wear.
- Seal compatibility.

4.6 Test methods. Perform tests in accordance with table III and with 4.6.1 through 4.6.2, as applicable.

4.6.1 Stability and compatibility. Determine the stability and compatibility of the oils by the procedures for "Homogeneity" and "Miscibility" given in method 3470 of FED-STD-791, as explained in 4.6.1.1 and 4.6.1.2. The procedures in 4.6.1.1 and 4.6.1.2 should be performed at the same time.

4.6.1.1 Stability. Determine the stability by subjecting an unmixed sample of oil to the prescribed cycle of temperature changes, then examine the sample for conformance to the requirements of 3.4.2.1. Record the test results on a copy of the "Homogeneity and Miscibility Test" form in the column marked "None."

4.6.1.2 Compatibility. Determine the compatibility of the oil with other oils previously qualified under MIL-L-2104, MIL-L-21260, MIL-L-46152 and MIL-L-46167 by subjecting separate mixtures of the oil with selected reference oils designated by the qualifying activity (see 6.4) to the prescribed cycle of temperature changes, then examine the mixtures for conformance to the requirements of 3.4.2.2. Record the test results on the same copy of the "Homogeneity and Miscibility Test" form (see 4.6.1.1) in the appropriate columns marked "1-30", "2-30", etc. Reference oils for conducting compatibility tests are to be obtained from the SAE, 400 Commonwealth Drive, Warrendale, PA 15096.

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TABLE III. Test methods.

Test	Test method			
	FED-STD-791	ASTM	SAE	
Viscosity, kinematic	203	D 445	J300	
Viscosity, apparent ^{1/}				
High temperature/high shear viscosity		D 4683		
Viscosity index		D 2270		
Pour point		D 97		
Stable pour point				
Borderline pumping		D 4684		
Flash point		D 92		
Evaporative loss ^{2/}		DIN 51581		D 2887
Gravity, API				D 287
Carbon residue				D 524
Color				D 1500
Total acid number				D 664
Total base number				D 2896
Phosphorus		D 1091, D 4047		
Chlorine		D 808 or D 1317 ^{3/}		
Sulfur ^{4/}		D 129, D 1552, D 2622, D 4294		
Nitrogen		D 3228		
Saponification number		D 94		
Sulfated residue		D 874		
Boiling range distribution		D 2887		
Metallic components	5601	D 4628 ^{5/}		
Foaming		D 892		
Stability and compatibility	3470 ^{6/}			
Moisture-corrosion characteristics		Sequence IID ^{7/}		
Oxidation and wear characteristics		Sequence IIIF ^{8/}		
Low temperature deposits and wear		Sequence VE ^{8/}		
Bearing corrosion and shear stability		Labeco L-38 ^{9/}		
Ring-sticking, wear, and accumulation of deposits:				
Four-stroke cycle diesel engine		Caterpillar 1G2 ^{9/}		
Two-stroke cycle diesel engine	355			
Friction Retention characteristic and wear:				
Slip time and Wear		Allison C-3 ^{10/}		
Stopping time and wear		D 4736		
Seal Compatibility		Allison C-3 ^{11/}		

1/ Obtain the apparent viscosity using the method of test set forth by appendix A of SAE J300.

2/ The DIN 51581 is the preferred method.

3/ ASTM D 808 is the preferred method.

4/ ASTM D 1552 is the preferred method. ASTM D 4294 is only for use with base stocks.

5/ Other spectrochemical analysis methods as approved by the qualifying activity (see 6.4) may be used as alternates.

6/ See 4.6.1 for clarifying instructions.

7/ In accordance with ASTM STP 315H.

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- 8/ In accordance with test procedure from ASTM Section D.02.B0.01.
- 9/ In accordance with ASTM STP 509A.
- 10/ Use procedure described in item 9 ATD C-3 specification.
- 11/ Use procedure described in item 6 ATD C-3 specification.

4.6.2 Shear stability. Determine the shear stability of grade 15W-40 oil by the following method:

- a. Weigh 25 grams of used oil, obtained at 10 hours of testing in accordance with Labeco L-38 test, into a 50 mL three-necked round bottom flask equipped with a thermometer, gas inlet tube, stirrer, and distillation side arm.
- b. Heat the sample at 120 ± 5 °C in a vacuum of 100 mm of mercury with a nitrogen sparge for one hour.
- c. Filter the stripped sample through a 0.5 micron filter pad.
- d. Determine the kinematic viscosity at 100 °C of the filtered sample using ASTM D 445. Check the resulting viscosity for conformance to the requirements of 3.4.6.2.

4.7 Inspection of packaging.

4.7.1 Quality conformance inspection of pack.

4.7.1.1 Unit of product. For the purpose of inspection, a complete pack prepared for shipment shall be considered a unit of product.

4.7.1.2 Inspection lot. The inspection lot shall be as defined in 4.2 packed for shipment.

4.7.1.3 Sampling. Samples for examination of packaging shall be selected at random from each inspection lot in accordance with procedures prescribed in MIL-STD-105.

4.7.1.4 Examination. Samples selected in accordance with 4.7.1.3 shall be examined for the defects listed below. AQL shall be 1.0 percent defective.

101. Unit container not as specified and not in accordance with the requirements of MIL-STD-290.
102. Intermediate container when required, not as specified in MIL-STD-290.
103. Quantity and arrangement of unit containers packed in intermediate containers not as specified in MIL-STD-290.
104. Exterior container not as specified in MIL-STD-290.
105. Quantity and arrangement of intermediate containers packed in exterior containers not as specified in MIL-STD-290.
106. Marking not as specified in MIL-STD-290.

5. PACKAGING

5.1 Unit, intermediate and exterior packing and marking. Unit, intermediate and exterior packing and marking of lubricating oil shall be in accordance with

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MIL-STD-290, level B or C as specified (see 6.2). Type and size of unit container shall be as specified (see 1.3 and 6.2).

6. NOTES

6.1 Intended use. The grade 10W 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 crankcase lubrication of reciprocating spark-ignition and compression-ignition engines used in all types of military tactical/combat ground equipment and for the crankcase lubrication of 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 tactical/combat ground equipment. The lubricating oils covered by this specification meet service classifications CD and SE of SAE J183 and are intended for all conditions of operational service, as defined by appropriate lubrication orders, when temperatures are above -25°C . Recommended ambient temperature ranges for specific grade oils are shown by table V.

TABLE V. Recommended ambient temperature range.

E X P E C T E D A M B I E N T T E M P E R A T U R E							
Below -25°C (-15°F)	-25°C (-15°F)	-18°C (0°F)	-10°C (15°F)	-5°C (25°F)	5°C (40°F)	30°C (90°F)	Above 30°C (90°F)
	OE/HDO-10 (GRADE 10W)						
		OE/HDO-30 (Grade 30)					
			OE/HDO-40 (Grade 40)				
		OE/HDO-15/40 (Grade 15W/40)					

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

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6.2 Ordering data.

6.2.1 Acquisition requirements. Acquisition documents shall specify the following:

- a. Title, number, and date of this specification.
- b. Date of issue of DoDISS applicable and exceptions thereto (see 2.1.1).
- c. Grade of oil required (see 1.2).
- d. Certification of non-carcinogenicity (see 3.2).
- e. Quantity of oil required.
- f. Type and size of containers required (see 5.1).
- g. Degree of packaging required (see 5.1).

6.3 Other requirements and tolerances for quality conformance testing.

Definite numerical values are not specified for certain of the physical and chemical properties listed in 3.5, and for which corresponding test methods are given in Section 4. Values of some properties vary from one commercial 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 (see 6.4) can set values, including permissible tolerances, for future quality conformance testing.

6.4 Qualification. Lubricating oils are submitted for qualification with the intent to manufacture and supply the products to the Federal Government. With respect to products requiring qualification, awards will be made only for products which are at the time set for opening of bids, qualified for inclusion in the applicable qualified products list whether or not such products have actually been so listed by that date. The attention of the contractors is called to this requirement, and manufacturers are urged to arrange to have the products that they propose to offer to the Federal Government tested for qualification in order that they may be eligible to be awarded contracts or orders for the products covered by this specification. The activity responsible for the qualified products list is the U. S. Army Belvoir Research, Development and Engineering Center, ATTN: STRBE-VF, Fort Belvoir, VA 22060-5606, and information pertaining to qualification of products may be obtained from that activity.

6.5 Subject term (key word) listing.

Combat service
 Heavy duty diesel
 Internal combustion engine
 Lubricating oil
 Tactical service

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

6.7 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 would affect or violate the international agreement concerned, the preparing activity will take appropriate reconciliation action through international standardization channels, including departmental standardization office, if required.

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

Custodians:
activity:

Army - ME
Navy - SH
Air Force - 68

Preparing

Army - ME
Project 9150-1024

Review activities:

Army - MI, SM
Navy - AS, MC, SA, YD
Air Force - 11
DLA - GS, PS

User activities:

Army - AR, AT, AV
Navy - OS

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