

METRIC

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## MILITARY SPECIFICATION

### LUBRICATING OIL, INTERNAL COMBUSTION ENGINE, PRESERVATIVE AND BREAK-IN

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

#### 1. SCOPE

1.1 Scope. This 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 systems 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	PE-10	C-640
Grade 30	PE-30	C-642
Grade 40	PE-40	---
Grade 15W-40	PE-15/40	---

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:

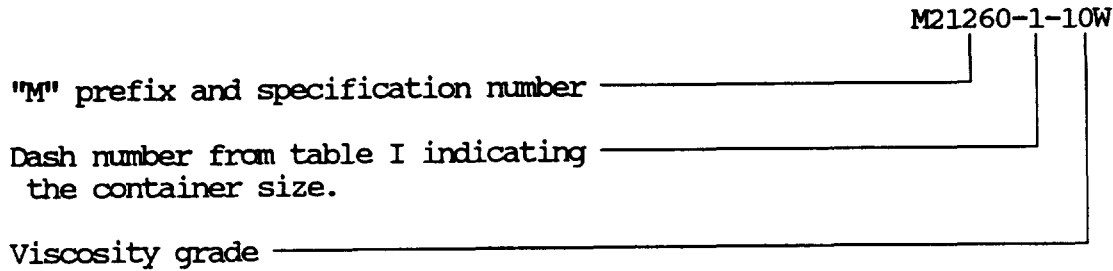
Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: USA Belvoir Research, Development, and Engineering Center, ATTN: STIRBE-TSE, Fort Belvoir, VA 22060-5606 by using the self-addressed Standardization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

AMSC N/A

FSC 9150

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

## MIL-L-21260D

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

## FEDERAL

O-A-51  
TT-N-95

- Acetone Technical.
- Naphtha, Aliphatic.

## MILITARY

MIL-L-2104  
MIL-L-46152  
MIL-L-46167

- Lubricating Oil, Internal Combustion Engine, Tactical Service.
- Lubricating Oil, Internal Combustion Engine, Administrative Service.
- Lubricating Oil, Internal Combustion Engine, Arctic.

## STANDARDS

## FEDERAL

FED-STD-313

- Material Safety Data Sheets Preparation and the Submission of.

## MIL-L-21260D

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 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 29CFR1900.1200

- 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.
- 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.

MIL-L-21260D

- D 4047 - Phosphorus in Lubricating Oils and Additives by Quinoline Phosphomolybdate Method.
- 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 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.

(Copies of Engine Test Sequence IIE and VE are available from ASTM Committee D.02.B0.01. 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.)

DETROIT DIESEL ALLISON (DDA)

C-3 Fluid Specification.

(Application for copies should be addressed to Detroit Diesel Allison, 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.)

## MIL-L-21260D

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.

### 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. The qualifying activity may require only partial qualification testing for approved MIL-L-2104 oils, to which additional corrosion inhibitors have been added, provided the oil formulation technology and corrosion inhibitor combination has previously been demonstrated to meet the performance requirements established herein.

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 oil whose qualification was based on an approved MIL-L-21260 or MIL-L-2104 lubricant shall not exceed that of the product 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 3.4.12).

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 viscosity requirements (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.

## MIL-L-21260D

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 under the Hazard Communication Standard (29CFR1910.1200). 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 3.4.12.

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 3.4.12.

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 (ASTM D 892).

## MIL-L-21260D

- a. Initial test at  $24 \pm 0.5$  °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  $93.5 \pm 0.5$  °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.
- c. Final test at  $24 \pm 0.5$  °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, $\mu\text{m}$	
Average (max.)	64
Maximum	178

## MIL-L-21260D

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 <sup>1/</sup>				
Kinematic, centistokes	X	X	X	X
Viscosity @ Temperature <sup>2/</sup>				
apparent, centipoise @°C				
min.	3500@-25	---	---	3500@-20
max.	3500@-20	---	---	3500@-15
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.) <sup>3/</sup>	-30	---	---	-23
Flash point, °C, (min.)	205	220	225	215
Other properties <sup>1/</sup>				
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
Phosphors	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
Average piston skirt varnish (min.)	6.0
Average rocker cover sludge (min.)	6.5
Oil ring clogging, % (max.)	15
Oil screen clogging, % (max.)	23



## MIL-L-21260D

Compression ring sticking (hot stuck)	None
Cam wear, $\mu\text{m}$	
Average (max.)	196
Maximum	441

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

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.

## MIL-L-21260D

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 (DDA 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, $\mu\text{m}$ (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 (DDA 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

3.4.10 Corrosion protection (humidity cabinet). After performance of the test procedure specified in 4.6.3 (a minimum of 720 hours of exposure in a humidity cabinet), not more than three corrosion spots, none of which exceeds one millimeter in length, width or diameter, shall be evident on any one of the test panels.

3.4.11 Corrosion protection (salt water immersion). After performance of the test procedure specified in 4.6.4 (20 hours of immersion in synthetic sea water), a total of not more than three corrosion spots, none of which exceeds one millimeter in length, width, or diameter, shall be evident on the three test panels.

## MIL-L-21260D

3.4.12 Acid neutralization. After performance of the test procedure specified in 4.6.5, a total of not more than three corrosion spots, none of which exceeds one millimeter in length, width, or diameter, shall be evident on the three test panels. In addition, there shall be no evidence of staining or other attack on any of the three test panels.

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 3.4.12, but test results shall be reported for all properties listed. The qualifying activity (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

## MIL-L-21260D

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.

#### 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 method 9601 of FED-STD-791.

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 or an approved MIL-L-2104 lubricant may be qualified in accordance with 3.1.

## MIL-L-21260D

4.5.1.4 Wear protection characteristics. The qualifying activity (see 6.4), may waive Sequence IIIIE testing of the candidate oil when acceptable supporting Sequence IIIIE 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. 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.  
 Corrosion protection (humidity cabinet).  
 Corrosion protection (salt water immersion).  
 Acid neutralization.

4.6 Test methods. Perform tests in accordance with table III and with 4.6.1 through 4.6.5, 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.

## MIL-L-21260D

TABLE III. Test methods.

Test	Test method		
	FED-STD-791	ASTIM	SAE
Viscosity, kinematic		D 445	J300
Viscosity, apparent <sup>1/</sup>			
Viscosity index		D 2270	
Pour point	203		
Stable pour point			
Borderline Pumping		D 4684	
Flash point		D 92	
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 <sup>2/</sup>		
Sulfur <sup>3/</sup>	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 <sup>4/</sup>		
Foaming	D 892		
Stability and compatibility	3470 <sup>5/</sup>		
Moisture-corrosion characteristics	Sequence IID <sup>6/</sup>		
Oxidation and wear characteristics	Sequence IIIE <sup>7/</sup>		
Low temperature deposits and wear	Sequence VE <sup>7/</sup>		
Bearing corrosion and shear stability	Labeco L-38 <sup>8/</sup>		
Ring-sticking, wear, and accumulation of deposits:			
Four-stroke cycle diesel engine	355	Caterpillar 1G2 <sup>8/</sup>	
Two-stroke cycle diesel engine			
Friction Retention characteristic and wear:			
Slip time and Wear		DDA C-3 <sup>9/</sup>	
Stopping time and wear		D 4736	
Seal Compatibility		DDA C-3 <sup>10/</sup>	

- 1/ Obtain the apparent viscosity using the method of test set forth by appendix A of SAE J300 JUN87.
- 2/ ASTM D 808 is the preferred method.
- 3/ ASTM D 1552 is the preferred method. ASTM D 4294 is only for use with base stocks.
- 4/ Other spectrochemical analysis methods as approved by the qualifying activity (see 6.4) may be used as alternates.
- 5/ See 4.6.1 for clarifying instructions.
- 6/ In accordance with ASTM STP 315H.
- 7/ In accordance with test procedure from ASTM Section D.02.B0.01.
- 8/ In accordance with ASTM STP 509A.

## MIL-L-21260D

- 9/ Use procedure described in item 9 Detroit Diesel Allison C-3 specification.  
 10/ Use procedure described in item 6 Detroit Diesel Allison C-3 specification.

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.

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  $120 \pm 5$  °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.

4.6.3 Corrosion-protection (humidity cabinet). Test the corrosion-protection properties of the oils in a humidity cabinet for 30 days (720 hours) in accordance with method 5329, FED-STD-791. Three test panels conforming to the requirements of method 5329, FED-STD-791 are to be used. This test shall be conducted only in a laboratory designated by the qualifying activity (see 6.4).

4.6.4 Corrosion-protection (salt-water immersion). Test the corrosion-protection properties of the oils in salt water in accordance with 4.6.4.1 through 4.6.4.4. This test shall be conducted only in a laboratory designated by the qualifying activity (see 6.4).

4.6.4.1 Test panels. Make three test panels of the composition specified in method 5329, FED-STD-791. 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. Round all corners and edges of the panels completely.

4.6.4.2 Preparation of test panels. Clean and sand-blast the test panels in accordance with method 5329, FED-STD-791. Immerse the panels in the oil sample at  $25 \pm 3$  °C. Agitate the oil gently for one minute. Suspend the panels on glass hooks and allow the oil to drain for 20 hours in a dust-free area maintained at  $25 \pm 3$  °C and a maximum relative humidity of 50 percent.

## MIL-L-21260D

4.6.4.3 Preparation of synthetic sea water. Prepare synthetic sea water with chemicals conforming to ACS specifications for analytical reagents and distilled water. The composition of the synthetic sea water shall be as specified in table IV. Adjust the pH of the salt solution to a value between 8.0 and 8.2 by the addition of a 5 percent 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.

4.6.4.4 Procedure. Immerse each of the oil-coated test panels separately in a tall-form beaker containing synthetic sea water at  $25 \pm 3$  °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 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  $25 \pm 3$  °C. Cover each beaker with a watch glass before the start of the 20-hour immersion period. After immersion, rinse the panels thoroughly in distilled water in rapid sequence, then rinse with acetone conforming to O-A-51, and finally rinse with aliphatic naphtha conforming to TT-N-95. Allow the panels to dry at  $25 \pm 3$  °C and inspect them immediately for conformance to 3.4.4. 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 degrees to 40 degrees with the plane of the panel. Corrosion occurring within 3mm 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 not be considered in the evaluation of the test results.

4.6.5 Acid neutralization. Clean and sand-blast three test panels which shall be of the material, design, and dimensions specified in 4.6.4.1. Handling each panel separately with forceps, immerse the panel completely for not more than one second in a  $0.1 \pm 0.01$  percent 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  $25 \pm 3$  °C and 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 seconds. Change the position of the tips for each immersion to assure access of the oil to all surfaces of the panel. Place the panel in a slotted wooden block (see 4.6.4.4) and allow it to stand in the air at  $25 \pm 3$  °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 in evaluation of the test results. This test shall be conducted only in a laboratory designated by the qualifying activity (see 6.4).



## MIL-L-21260D

TABLE IV. Composition of synthetic sea water.

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

4.7 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 MIL-STD-290, level B, level C or commercial 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. With the exception of grade 10W oil which is not to be used in high-output, two-cycle compression-ignition engines, the lubricating oils covered by this specification are intended for preservative, break-in and operational use until the first scheduled oil change in all spark-ignition and compression-ignition engines used in all types of military tactical/combat ground equipment. The oils are also intended for the same application in power transmissions, hydraulic systems and non hypoid gear units of engineer/

## MIL-L-21260D

construction equipment, materials handling equipment and tactical/combat 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  $-25^{\circ}\text{C}$ . Recommended ambient temperature ranges for specific grade oils are shown by table V.

TABLE V. Recommended ambient temperature range.

Below $-25^{\circ}\text{C}$ ( $-15^{\circ}\text{F}$ )	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						Above $30^{\circ}\text{C}$ ( $90^{\circ}\text{F}$ )
	$-25^{\circ}\text{C}$ ( $-15^{\circ}\text{F}$ )	$-18^{\circ}\text{C}$ ( $0^{\circ}\text{F}$ )	$-10^{\circ}\text{C}$ ( $15^{\circ}\text{F}$ )	$-5^{\circ}\text{C}$ ( $25^{\circ}\text{F}$ )	$5^{\circ}\text{C}$ ( $40^{\circ}\text{F}$ )	$30^{\circ}\text{C}$ ( $90^{\circ}\text{F}$ )	
	PE-10 (GRADE 10W)						
			PE-30 (Grade 30)				
				PE-40 (Grade 40)			
		PE-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.

6.2 Ordering data. Procurement documents should specify the following information:

- Title, number, and date of this specification.
- Date of issue of DoDISS applicable and exceptions thereto (see 2.1.1).
- Grade of oil required (see 1.2).
- Certification of non-carcinogenicity (see 3.2).
- Quantity of oil required.
- Type and size of containers required (see 5.1).
- 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

## MIL-L-21260D

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  
Preservative

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.

MIL-L-21260D

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:

Army - ME  
Navy - SH  
Air Force - 68

Preparing activity:

Army - ME

Project 9150-0745

Review activities:

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

User activities:

Army - AT, MI  
Navy - OS

## STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

(See Instructions - Reverse Side)

1. DOCUMENT NUMBER NIL-L-21260D		2. DOCUMENT TITLE Lubricating Oil, Internal Combustion Engine, Preservative and Break-In	
3a. NAME OF SUBMITTING ORGANIZATION		4. TYPE OF ORGANIZATION (Mark one)	
b. ADDRESS (Street, City, State, ZIP Code)		<input type="checkbox"/> VENDOR	
		<input type="checkbox"/> USER	
		<input type="checkbox"/> MANUFACTURER	
		<input type="checkbox"/> OTHER (Specify) _____	
5. PROBLEM AREAS			
a. Paragraph Number and Wording			
b. Recommended Wording			
c. Reason/Rationale for Recommendation			
6. REMARKS			
7a. NAME OF SUBMITTER (Last, First, MI) - Optional		b. WORK TELEPHONE NUMBER (Include Area Code) - Optional	
c. MAILING ADDRESS (Street, City, State, ZIP Code) - Optional		8. DATE OF SUBMISSION (YYMMDD)	

(TO DETACH THIS FORM, CUT ALONG THIS LINE.)

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**NOTE** This form may not be used to request copies of documents, nor to request waivers, deviations, or clarification of specification 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.

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