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PERFORMANCE SPECIFICATION

LUBRICATING OIL, INTERNAL COMBUSTION ENGINE, COMBAT/TACTICAL SERVICE

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 lubricating oils suitable for lubrication of all reciprocating compression-ignition internal combustion engines (with the exception that the 10W grade should not be used in high output 2-cycle engines) and for power transmission fluid applications in combat/tactical service equipment (see 6.1).

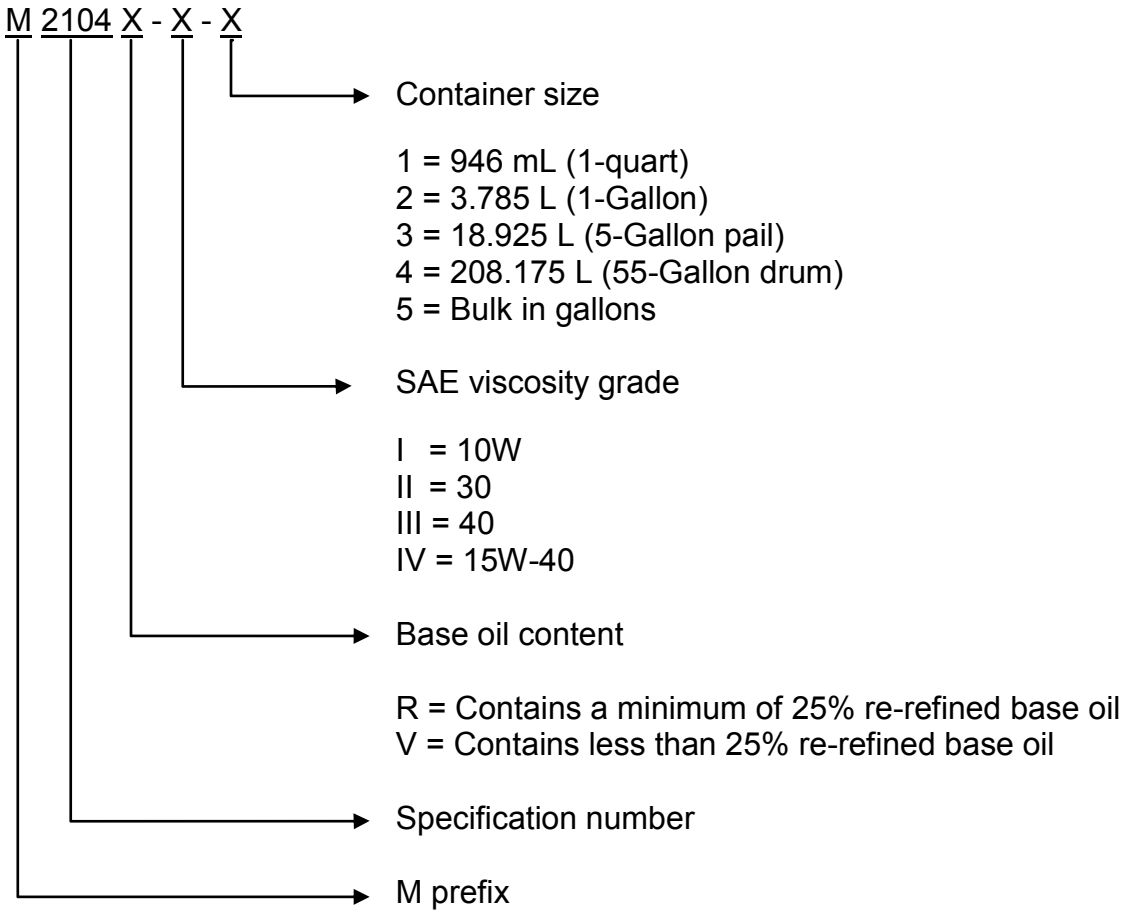
1.2 Classification. The lubricating oils are of the following viscosity grades:

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

Comments, suggestions, or questions on this document should be addressed to Tank-automotive and Armaments Command, 6501 E. 11 Mile Road, Warren, MI 48397-5000, or emailed to usarmy.detroit.rdecom.mail.tardec-standardization@mail.mil. Since contact information can change, you may want to verify the currency of this address information using the ASSIST Online database at https://assist.dla.mil.

AMSC N/A FSC 9150

1.3 Part or identifying number (PIN). PINs to be used in procurement of the lubricating oils acquired to this specification are created as follows: Example of reference part number: M2104 R-II-2



2. APPLICABLE DOCUMENTS

2.1 General. The documents listed in this section are specified in sections 3, 4 or 5 of this specification. This section does not include documents cited in other sections of this specification or recommended for additional information or as examples. While every effort has been made to ensure the completeness of this list, document users are cautioned that they must meet all specified requirements documents cited in sections 3, 4 and 5 of this specification, whether or not they are listed.

2.2 Government documents. This section is not applicable.

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 these documents are those cited in the solicitation or contract.

ASTM INTERNATIONAL

ASTM D92 - Standard Test Method for Flash and Fire Points by Cleveland Open Cup Tester
ASTM D97 - Standard Test Method for Pour Point of Petroleum Products
ASTM D130 - Standard Test Method for Corrosiveness to Copper from Petroleum Products
ASTM D445 - Standard Test Method for Kinematic Viscosity of Transparent and Opaque Liquids (and the Calculation of Dynamic Viscosity)
ASTM D874 - Standard Test Method for Sulfated Ash from Lubricating Oils and Additives
ASTM D892 - Standard Test Method for Foaming Characteristics of Lubricating Oils
ASMT D4485 - Standard Specification for Performance of Active API Service Category Engine Oils
ASTM D4683 - Standard Test Method for Measuring Viscosity of New and Used Engine Oils at High Shear Rate and High Temperature by Tapered Bearing Simulator Viscometer at 150°C
ASTM D4684 - Standard Test Method for Determination of Yield Stress and Apparent Viscosity of Engine Oils at Low Temperature
ASTM D4741 - Standard Test Method for Measuring Viscosity at High Temperature and High Shear Rate by Tapered-Plug Viscometer
ASTM D5293 - Standard Test Method for Apparent Viscosity of Engine Oils and Base Stocks Between -5 and -35°C Using Cold-Cranking Simulator
ASTM D5481 - Standard Test Method for Measuring Apparent Viscosity at High-Temperature and High-Shear Rate by Multicell Capillary Viscometer
ASTM D5800 - Standard Test Method for Evaporation Loss of Lubricating Oils by the Noack Method
ASTM D5949 - Standard Test Method for Pour Point of Petroleum Products (Automatic Pressure Pulsing Method)
ASTM D5950 - Standard Test Method for Pour Point of Petroleum Products (Automated Tilt Method)
ASTM D5966 - Standard Test Method for Evaluation of Engine Oils for Roller Follower Wear in Light-Duty Diesel Engine
ASTM D5967 - Standard Test Method for Evaluation of Diesel Engine Oils

in T-8 Diesel Engine
ASTM D6278 - Standard Test Method for Shear Stability of Polymer Containing Fluids Using a European Diesel Injector Apparatus
ASTM D6417 - Standard Test Method for Estimation of Engine Oil Volatility by Capillary Gas Chromatography.
ASTM D6594 - Standard Test Method for Evaluation of Corrosiveness of Diesel Engine Oil at 135°C
ASTM D6681 - Standard Test Method for Evaluation of Engine Oils in a High Speed, Single-Cylinder Diesel Engine—Caterpillar 1P Test Procedure
ASTM D6750 - Standard Test Method for Evaluation of Engine Oils in a High-Speed, Single-Cylinder Diesel Engine—1K Procedure (0.4% Fuel Sulfur) and 1N Procedure (0.04% Fuel Sulfur)
ASTM D6838 - Standard Test Method for Cummins M-11 High Soot Test
ASTM D6894 - Standard Test Method for Evaluation of Aeration Resistance of Engine Oils in Direct-Injected Turbocharged Automotive Diesel Engine
ASTM D6922 - Standard Test Method for Determination of Homogeneity and Miscibility in Automotive Engine Oils
ASTM D6923 - Standard Test Method for Evaluation of Engine Oils in a High Speed, Single-Cylinder Diesel Engine—Caterpillar 1R Test Procedure
ASTM D6975 - Standard Test Method for Cummins M11 EGR Test
ASTM D6984 - Standard Test Method for Evaluation of Automotive Engine Oils in the Sequence IIIF, Spark-Ignition Engine
ASTM D6987 - Standard Test Method for Evaluation of Engine Oils in the T-10 Exhaust Gas Recirculation Diesel Engine
ASTM D7216 - Standard Test Method for Determining Automotive Engine Oil Compatibility with Typical Seal Elastomers
ASTM D7320 - Standard Test Method for Evaluation of Automotive Engine Oils in the Sequence IIIG, Spark-Ignition Engine
ASTM D7422 - Standard Test Method for Evaluation of Diesel Engine Oils in T-12 Exhaust Gas Recirculation Diesel Engine
ASTM D7468 - Standard Test Method for Cummins ISM Test
ASTM E29 - Standard Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications

(Copies of these documents are available from ASTM International, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959 or website: http://www.astm.org).

ALLISON TRANSMISSION INC.

C-4 - Heavy-Duty Automatic Transmission Fluid Specification (TES-228)

(Copies of these documents are available from Southwest Research Institute, C4 Coordinator, Specialty and Driveline Fluids Lab, P.O. Box 28510, San Antonio, TX 78223-0510, or website: http://www.swri.org)

CATERPILLAR INC.

TO-4 - Transmission and Drive Train Fluid Requirements
TO-4M - Multigrade Transmission and Drive Train Fluid Requirements

(Copies of these documents are available from Caterpillar Inc., Fluids Engineering, Building H2000, Old Galena Road, Mossville, IL 61552, or website: http://www.parts.cat.com/parts/machine-fluids)

GENERAL MOTORS CORPORATION

GMW16444 - DEXRON-VI Automatic Transmission Fluid

(Copies of these documents are available from General Motors Corporation, General Motors Automatic Transmission Fluid Committee, Technology Licensing, Mail Code 483-720-220, 777 Joslyn Road, Pontiac, MI 48340)

SAE INTERNATIONAL

J300 - Engine Oil Viscosity Classification

(Copies of these documents are available from SAE World Headquarters, 400 Commonwealth Drive Warrendale, PA 15096-0001 USA, website: http://www.sae.org)

2.4 Order of precedence. Unless otherwise noted herein or in the contract, 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. Lubricating oils furnished under this specification shall be products that are authorized by the qualifying activity for listing on the applicable qualified products list before contract award (see 4.2 and 6.3).

3.2 Materials. Lubricating oils shall be derived from petroleum fractions, synthetically prepared compounds or a combination of the two types of products. They may be virgin, re-refined stocks or a combination thereof. The stocks shall be

compounded with such functional additives (e.g., detergents, dispersants, oxidation inhibitors, corrosion inhibitors, etc.) as are necessary to meet the specification requirements.

3.3 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.

3.4 Engine performance. Oils meeting the requirements of this specification shall lubricate, cool, and prevent corrosion of oil wetted components of diesel engines used in combat and tactical equipment. The oils shall limit wear, friction, and deposits of oil wetted engine parts. The qualifying activity shall waive engine performance testing of SAE 10W, 30, and 40 grade oils if they have been formulated using the same performance additive package, at the same treat rate, as those used in the formulation of an SAE 15W-40 grade oil qualified under this specification.

3.4.1 Engine performance requirements. SAE 10W, 30, and 40 grade oils qualified under this specification shall comply with the conformance criteria as specified in section 3.4.1.1 through section 3.4.1.8. SAE 15W-40 grade oils qualified under this specification shall comply with the acceptance criteria as specified in section 3.4.1.1 through section 3.4.1.9

3.4.1.1 Cylinder liner, piston, and bearing wear. All grades shall prevent cylinder liner, piston, and bearing wear under conditions of high soot in accordance with Table I *or* Table II. Oil grades 10W, 30, and 40 shall comply with the liner wear, ring weight loss, and lead content requirements only. Oil grade 15W-40 shall comply with the merit rating requirement only. See section 4.3.1 for the verification test methods.

TABLE I. Cylinder liner, piston and bearing wear (T-12).

Rated or measured parameter	Primary performance criteria		
	One-Test	Two-Test	Three-Test
Liner wear, µm[A], max[B]	30.0	30.8	31.1
Top ring weight loss, mg[C], max	120	132	137
Lead content at EOT, mg/kg[D], max	65	75	79
Merit rating, min[E]			
15W-40 only	1000	1000	1000

[A] micrometer
[B] maximum
[C] milligram
[D] milligram per kilogram
[E] minimum

TABLE II. Cylinder liner, piston and bearing wear (T-10).

Rated or measured parameter	Primary performance criteria		
	One-Test	Two-Test	Three-Test
Liner wear, µm, max	32	34	35
Ring wear, mg, max	150	159	163
Lead content at EOT, mg/kg, max	50	56	59
Merit rating, min (15W-40 only)	1000	1000	1000

3.4.1.2 Foaming/Aeration. All grades shall reduce the potential for loss of oil pressure or film and the associated malfunction or damage of oil operated and lubricated components when tested in accordance with of Table III *and* IV. See section 4.3.2 for the verification test methods.

TABLE III. Properties of foaming.

Rated or measured parameter	Primary performance criteria
Sequence I, foaming/settling, mL[A], max	10/0
Sequence II, foaming/settling, mL, max	20/0
Sequence III, foaming/settling, mL, max	10/0

[A] milliliter

TABLE IV. Properties of aeration.

Rated or measured parameter	Primary performance criteria
Aeration (EOAT)[A], volume, %, max	8.0 (MTAC)[B]

[A] Engine Oil Aeration Test

[B] Multiple Test Acceptance Criteria (MTAC) is a data based approach for evaluation of the quality and performance of a formulation where more than one test may be run. See ASTM D 4485, Annex A1 for additional information.

3.4.1.3 Piston deposit and scuffing control. All grades shall prevent the buildup of ring belt deposits on pistons, including those of the piston crown and lands, piston ring grooves, piston undercrown and piston skirts. Oil grades 10W, 30, and 40 shall comply with the requirements of Table V *and* Table VI. Oil grade 15W-40 shall comply with the requirements of Table V and, Table VI *or* Table VII. See section 4.3.3 for the verification test methods.

TABLE V. Piston deposit and scuffing control – aluminum piston (1K).

Rated or measured parameter	Primary performance criteria		
	One-Test	Two-Test	Three-Test
Weighted demerits (WDP), max	332	347	353
Top groove fill (TGF), %, max	24	27	29
Top land heavy carbon (TLHC), %, max	4	5	5
Average oil consumption, g/MJ[A] (0-250 h[B]), max	0.139	0.139	0.139
Piston, ring, and liner scuffing	None	None	None

[A] grams per megajoule

[B] hour

TABLE VI. Piston deposit and scuffing control – steel piston (1P).

Rated or measured parameter	Primary performance criteria		
	One-Test	Two-Test	Three-Test
Weighted demerits (WDP), max	350	378	390
Top groove carbon (TGC), demerits, max	36	39	41
Top land carbon (TLC), demerits, max	40	46	49
Average oil consumption, g/h[A] (0 - 360 h), max	12.4	12.4	12.4
Final oil consumption, g/h (312 - 360 h), max	14.6	14.6	14.6
Piston, ring, and liner scuffing	None	None	None

[A] grams per hour

TABLE VII. Piston deposits, oil consumption and scuffing performance (1R).

Rated or measured parameter	Primary performance criteria		
	One-Test	Two-Test	Three-Test
Weighted Piston Demerits (WDP), max	382	396	402
Top groove carbon (TGC), demerits, max	52	57	59
Top land carbon (TLC), demerits, max	31	35	36
Initial oil consumption (IOC), average (0 - 252 h), g/h, max	13.1	13.1	13.1
Final oil consumption, average (432 - 504 h), g/h, max	IOC + 1.8	IOC + 1.8	IOC + 1.8
Piston, ring, and liner scuffing	None	None	None
Ring sticking	None	None	None

3.4.1.4 Roller follower wear. All grades shall prevent camshaft roller follower wear in accordance with Table VIII. See section 4.3.4 for the verification test method.

TABLE VIII. Roller follower wear test (RFWT).

Rated or measured parameter	Primary performance criteria		
	One-Test	Two-Test	Three-Test
Average pin wear, µm, max	7.6	8.4	9.1

3.4.1.5 Sludge control, filterability and sliding valve train wear. All grades shall prevent sliding valve train wear, filter plugging, and sludge deposits. Oil grades 10W, 30, and 40 shall comply with the requirements of Table IX *or* Table X. Oil grade 15W-40 shall comply with the requirements of Table IX *or* Table XI. See section 4.3.5 for the verification test methods.

TABLE IX. Sludge control, filterability and sliding valve train wear (ISM).

Rated or measured parameter	Primary performance criteria		
	One-Test	Two-Test	Three-Test
Crosshead wear, mg, max	7.5	7.8	7.9
Sludge rating, CRC merits, min[A]	8.1	8.0	8.0
Oil filter delta pressure at 150 h, kPa[B], max			
10W, 30, and 40 grades	79	95	103
15W-40 grade	55	67	74

[A] minimum
[B] kilopascal

TABLE X. Sludge control, filterability and sliding valve train wear (M-11).

Rated or measured parameter	Primary performance criteria		
	One-Test	Two-Test	Three-Test
Rocker pad average weight loss, normalized to 4.5 % soot, mg, max	6.5	7.5	8.0
Oil filter delta pressure at EOT, kPa, max	79	93	100
Average sludge rating, CRC merits at EOT, min	8.7	8.6	8.5

TABLE XI. Sludge control, filterability and sliding valve train wear (M11 EGR).

Rated or measured parameter	Primary performance criteria		
	One-test	Two-test	Three-test
Average crosshead weight loss, mg, max	20.0	21.8	22.6
Oil filter differential pressure, at 250 h, kPa, max	275	320	341
Average engine sludge, CRC merits, min	7.8	7.6	7.5

3.4.1.6 Soot induced viscosity control. All grades shall prevent excessive viscosity increase caused by soot build up in the oil in accordance with Table XII. See section 4.3.6 for the verification test method.

TABLE XII. Soot induced viscosity increase (T-8E).

Rated or measured parameter	Primary performance criteria		
	One-test	Two-test	Three-test
Relative viscosity at 4.8% soot by TGA[A], max			
10W, 30, 40 grades	2.1	2.2	2.3
15W-40	1.8	1.9	2.0
Viscosity increase at 3.8% soot by TGA, mm^2/s[B], max			
10W, 30, 40 grades	11.5	12.5	13.0

[A] Thermogravimetric Analysis
[B] square millimeter per second

3.4.1.7 Oil thickening under high temperature conditions. All grades shall prevent excessive oil thickening under high temperature conditions in accordance with Table XIII *or* Table XIV. See section 4.3.7 for the verification test methods.

TABLE XIII. Oil thickening under high temperature conditions (IIIG).

Rated or measured parameter	Primary performance criteria
Kinematic viscosity, % increase at 40°C, max	150 (MTAC)

TABLE XIV. Oil thickening under high temperature conditions (IIIF).

Rated or measured parameter	Primary performance criteria
60 hour viscosity at 40°C, increase from 10 minute sample, %, max	
10W, 30, and 40	295 (MTAC)
Kinematic viscosity at 40°C, % increase, max	
15W-40	275 (MTAC)

3.4.1.8 Oil corrosiveness at high temperatures. All grades shall inhibit the corrosion of oil wetted non-ferrous components in accordance with Table XV. See section 4.3.8 for the verification test method.

TABLE XV. Oil corrosiveness at high temperatures (HTCBT).

Rated or measured parameter	Primary performance criteria Used oil elemental concentration
Copper, mg/kg increase, max	20
Lead, mg/kg increase, max	120
Tin, mg/kg increase, max	report
Copper strip rating, max	3

3.4.1.9 Used oil pumpability. Oil grade 15W-40 shall minimize the effects of combustion blow-by products, soot accumulation, and other in-service contaminants on used oil pumpability in accordance with Table XVI. See section 4.3.9 for the verification test method.

TABLE XVI. Properties of used oil pumpability.

Requirement	Rated or measured parameter	Primary performance criteria
A	Viscosity after 75 h of Mack T-10A test, or viscosity after 100 h of Mack T-12A test, tested at -20°C, mPa-s[A], max	25 000
B[1/]	Viscosity after 75 h of Mack T-10A test, or viscosity after 100 h of Mack T-12A test, tested at -20°C, mPa-s, max	25 000
	Yield stress, Pa[B]	< 35

[A] millipascal second

[B] pascal

[1/] If yield stress is detected use requirement B

3.5 Physical and Chemical properties. All grades listed in this specification shall comply with the chemical and physical requirements listed in sections 3.5.1 to 3.5.10, and Table XVII.

3.5.1. Evaporation loss. All grades shall limit oil volatility at high temperatures in accordance with Table XVII. See section 4.3.10 for the verification test method.

3.5.2 Homogeneity and miscibility. All grades shall remain homogeneous and miscible with each other over ambient and operating temperatures typical for the application (see 1.1). No evidence of separation shall be detected when the candidate oil is diluted with standard reference oils and submitted to the prescribed cycle of temperature changes outlined in the test procedure designated in section 4.3.11.

3.5.3 Flash point. All grades shall limit the overall flammability hazard of its components in accordance with Table XVII. See section 4.3.12 for the verification test method.

TABLE XVII. Chemical and physical properties.

Property	SAE Grade 10W [1/]	SAE Grade 30	SAE Grade 40	SAE Grade 15W-40
Kinematic viscosity, mm^2/s at 100°C	5.6 to <7.4	9.3 to <12.5	12.5 to <16.3	12.5 to <16.3
Low temperature cranking viscosity, mPa·s, at -30°C, min	6600	----	----	----
Low temperature cranking viscosity, mPa·s, at -25°C, max	7000	----	----	----
Low temperature cranking viscosity, mPa·s, at -25°C, min	----	----	----	7000
Low temperature cranking viscosity, mPa·s, at -20°C, max	----	----	----	7000
High-temperature/high-shear viscosity, mPa·s, at 150°C, min	----	3.5	3.7	3.7
Low temperature pumping viscosity, mPa·s, at -30°C, max	60 000	----	----	----
Low temperature pumping viscosity, mPa·s, at -25°C, max	----	----	----	60 000
Pour point, °C, max	-30	-18	-15	-25
Flash point, °C, min	205	220	225	215
Evaporative loss, %, at 250°C, max	18	----	----	15
Sulfated ash, mass %, max	----	1.5	1.5	1.5
Base Oil Viscosity, mm^2/s at 100°C, min	----	----	----	6.5

[1/] Kinematic viscosity requirements at 100°C have been modified from SAE J300 requirements

3.5.4 Kinematic viscosity. All oil grades shall meet the kinematic viscosity requirements in accordance with Table XVII. See section 4.3.13 for the verification test method.

3.5.5 Low temperature viscosity. All oil grades shall meet the low temperature cranking and pumping viscosity requirements in accordance with Table XVII. See section 4.3.14 for the verification test method.

3.5.6 High temperature and high shear viscosity. All oil grades shall meet the high temperature and high shear viscosity requirements in accordance with Table XVII. See section 4.3.15 for the verification test method.

3.5.7 Pour point. All oil grades shall meet the pour point requirements in accordance with Table XVII. See section 4.3.16 for the verification test method.

3.5.8 Sulfated ash. All oil grades shall meet the sulfated ash requirements in accordance with Table XVII. See section 4.3.17 for the verification test method.

3.5.9 Shear stability. Oil grade 15W-40 shall resist permanent viscosity loss from high shear conditions in accordance with Table XVIII, particularly those containing polymeric viscosity modifiers. See section 4.3.18 for the verification test method.

TABLE XVIII. Shear stability performance.

Rated or measured parameter	Primary performance criteria
Kinematic viscosity after shearing, mm^2/s, min	12.5

3.5.10 Base oil viscosity. Oil grade 15W-40 shall meet the base oil viscosity (BOV) requirements in accordance with Table XVII. See section 4.3.19 for the verification test method.

3.6 Transmission frictional characteristics and wear. All oil grades shall maintain a stable coefficient of friction and shall minimize distress and wear in accordance with Table XIX during use in heavy-duty automatic and powershift transmissions and other cooled friction components such as steering, braking and disconnect clutches. See section 4.4 for the verification test methods.

3.7 Elastomer seal compatibility. All oil grades shall minimize the deterioration, softening, and/or excessive hardening of elastomer seals in accordance with Table XX. See section 4.5 for the verification test method.

TABLE XIX. Properties of frictional characteristics and wear.

Rated or measured parameter	Primary performance criteria
Allison Graphite and Paper Friction Test Mid-point dynamic friction Coefficient (see notes 1/ and section 4.4)	Measured mid-point dynamic friction coefficient shall be greater than or equal to the qualified batch sample mean mid-point friction coefficient minus 0.012
Allison Graphite and Paper Friction Test Slip time, seconds (see notes 1/, 2/, and section 4.4)	Slip time shall be less than or equal to the maximum acceptable slip time criteria
Caterpillar TO-4 or TO-4M, SEQ1220 Average dynamic coefficient, % Average static coefficient, % Disc wear, mm, max Energy limit, m/s, min (see note 3/ and 4.4)	 90.0 – 140.0 91.0 – 127.0 0.04 25
Caterpillar TO-4 or TO-4M, SEQFRRET Average dynamic coefficient, % @ 3000 cycles @ 8000 cycles @ 15 000 cycles @ 25 000 cycles (see note 3/ and 4.4)	 85.0 – 130.0 90.0 – 125.0 90.0 – 125.0 95.0 – 125.0

1/ Variation in frictional performance from one batch of friction plates to the next demands that minimum acceptance criteria be developed with respect to individual batches

2/ Maximum acceptable slip time (tmax)
   a. Allison Paper Friction Test: tmax = 1.108 – 6.012μ
   b. Allison Graphite Friction Test: tmax = 1/[-221*(μ-0.1421)^2 + 1.756]
   c. Where μ is the minimum acceptable coefficient at mid-point.

3/ TO-4M requirements are only for the 15W-40 viscosity grade; grades 10W, 30, and 40 shall use TO-4 requirements

TABLE XX. Properties of elastomer seal compatibility.

Material designation	Volume change limits	Hardness change limits
V1 (Ethylene/Acrylic)	7 to 20	-15 to -2
V2 (Ethylene/Acrylic)	2 to 12	-7 to +3
V3 (Ethylene/Acrylic)	7 to 22	-14 to -2
P1 (Polyacrylate)	0.00 to 8	-10 to 0.00
P2 (Polyacrylate)	0.00 to 8	-11 to +3
P3 (Polyacrylate)	0.00 to 4	-8 to +4
F1 (Fluoroelastomer)	0.00 to 4	-5 to +4
F2 (Fluoroelastomer)	0.00 to 4	-2 to +5
N1 (Nitrile)	Report	Report

4. VERIFICATION

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

a. Qualification inspections (see 4.2).

4.2 Qualification inspections. Qualification inspections shall consist of all verifications listed in table XVII and sections 4.3, 4.4, and 4.5. Table XXI cross-references requirements with appropriate qualification verification test methods.

TABLE XXI. Qualification requirements and verification.

	Requirements	Verification
Cylinder liner, piston, and bearing wear	3.4.1.1	4.3.1
Foaming/aeration	3.4.1.2	4.3.2
Piston deposits and scuffing control pistons	3.4.1.3	4.3.3
Roller follower wear	3.4.1.4	4.3.4
Sludge control, filterability and sliding valve train wear	3.4.1.5	4.3.5
Soot induced viscosity control	3.4.1.6	4.3.6
Oil thickening under high temperature conditions	3.4.1.7	4.3.7
Oil corrosiveness at high temperatures	3.4.1.8	4.3.8
Used oil pumpability	3.4.1.9	4.3.9
Evaporation loss	3.5.1	4.3.10
Homogeneity and miscibility	3.5.2	4.3.11
Flash point	3.5.3	4.3.12
Kinematic viscosity	3.5.4	4.3.13
Low temperature viscosity	3.5.5	4.3.14
High temperature and high shear viscosity	3.5.6	4.3.15
Pour point	3.5.7	4.3.16
Sulfated ash	3.5.8	4.3.17
Shear stability	3.5.9	4.3.18
Base oil viscosity	3.5.10	4.3.19
Transmission frictional characteristics and wear	3.6	4.4
Elastomer seal compatibility	3.7	4.5

4.3 Verification test procedures.. Tests shall be conducted as specified in table XVII and sections 4.3.1 thru 4.3.19, 4.4, and 4.5. For purposes of determining conformance with each requirement, an observed value or calculated value shall be rounded off to the nearest unit in the last right-hand place of figures used in expressing the limiting value, in accordance with the rounding-off procedure given in ASTM E 29.

4.3.1. Cylinder liner, piston, and bearing wear. All grades shall demonstrate compliance with 3.4.1.1, Table I or II, when tested in accordance with one of the following standards:

a. Table I - Test procedure ASTM D7422 (T-12)
b. Table II - Test procedure ASTM D6987/D6987M (T-10)

4.3.2 Foaming/Aeration. All grades shall demonstrate compliance with 3.4.1.2, Table III and Table IV, when tested in accordance with *each* of the follow standards:

a. Foaming (see Table III) - Test procedure ASTM D892 (Option A is not allowed)
b. Aeration (see Table IV) - Test procedure ASTM D6894, Engine Oil Aeration Test (EOAT)

4.3.3 Piston deposit and scuffing control. All grades shall demonstrate compliance with 3.4.1.3 when tested in accordance the following standards as appropriate:

a. Table V (Aluminum pistons) - Test procedure ASTM D6750 (1K)
b. Table VI (Steel pistons) - Test procedure ASTM D6681 (1P)
c. Table VII - Test procedure ASTM D6923 (1R)

4.3.4 Roller follower wear. All grades shall demonstrate compliance with 3.4.1.4, Table VIII, when tested in accordance with the ASTM D 5966 (RFWT).

4.3.5 Sludge control, filterability and sliding valve train wear. All grades shall demonstrate compliance with 3.4.1.5, Table IX, Table X, or Table XI when tested in accordance with one of the following standards:

a. Table IX - Test procedure ASTM D7468 (ISM)
b. Table X - Test procedure ASTM D6838 (M11)
c. Table XI - Test procedure ASTM D6975 (M11 EGR)

4.3.6 Soot induced viscosity increase. All grades shall demonstrate compliance with 3.4.1.6, Table XII, when tested in accordance with ASTM D5967 (T-8E).

4.3.7 Oil thickening and piston deposits under high-temperature conditions. All grades shall demonstrate compliance with 3.4.1.7, Table XIII or Table XIV, when tested in accordance with one of the following standards:

a. Table XIII - Test procedure ASTM D7320 (Seq. IIIG)
b. Table XIV - Test procedure ASTM D6984 (Seq. IIIF)

4.3.8 Oil corrosiveness at high temperatures. All grades shall demonstrate compliance with 3.4.1.8, Table XV, when tested in accordance with ASTM D6594. Use the rating system in ASTM D130 to rate the copper strip.

4.3.9 Used oil pumpability. Oil grade 15W-40 shall demonstrate compliance with 3.4.1.9, Table XVI, when tested in accordance with ASTM D4684 (MRV-TP-1). If yield stress is detected use modified D4684 (external preheat).

4.3.10 Evaporation loss. All grades shall demonstrate compliance with 3.5.1, Table XVII, when tested in accordance with ASTM D5800. Alternatively, ASTM D6417 may be used but the requirements shall be adjusted downward by 3% (e.g., 18% by method D5800 shall be adjusted to 15% for method D6417).

4.3.11 Homogeneity and miscibility. All grades shall demonstrate compliance with 3.5.2, when tested in accordance with ASTM D6922.

4.3.12 Flash point. All grades shall demonstrate compliance with 3.5.3, Table XVII, when tested in accordance with ASTM D92.

4.3.13 Kinematic viscosity. All grades shall demonstrate compliance with 3.5.4, Table XVII, when tested in accordance with ASTM D445.

4.3.14 Low temperature viscosity. All grades shall demonstrate compliance with 3.5.5, Table XVII, when tested in accordance with the following standards:

a. Low temperature cranking viscosity - ASTM D5293
b. Low temperature pumping viscosity - ASTM D4684

4.3.15 High temperature and high shear viscosity. All grades shall demonstrate compliance with 3.5.6, Table XVII, when tested in accordance with ASTM D4683, ASTM D4741, or ASTM D5481.

4.3.16 Pour point. All grades shall demonstrate compliance with 3.5.7, Table XVII, when tested in accordance with ASTM D97, ASTM D5949, or ASTM D5950.

4.3.17 Sulfated ash. All grades shall demonstrate compliance with 3.5.8, Table XVII, when tested in accordance with ASTM D874.

4.3.18 Shear stability. Oil grade 15W-40 shall demonstrate compliance with 3.5.9, Table XVIII, when tested in accordance with ASTM D6278.

4.3.19 Base oil viscosity. Oil grade 15W-40 shall demonstrate compliance with 3.5.10, Table XVII, when tested in accordance with ASTM D445. Base oil viscosity (BOV) is to include base stocks and diluents used with viscosity modifiers.

4.4 Transmission Frictional characteristics and wear. All oil grades shall demonstrate compliance with 3.6, Table XIX, when tested in accordance with the selected test procedures from Allison Transmission specification C-4 Heavy-Duty Automatic Transmission Fluid Specification (TES – 228) and Caterpillar TO-4/TO-4M Transmission and Drive Train Fluid Requirements. Verification shall be demonstrated when tested in accordance with test procedure a, b, and c below.

a. Allison C-4 Graphite and Paper-Composite Friction Test
b. Caterpillar TO-4 or TO-4M, SEQ1220
c. Caterpillar TO-4 or TO-4M, SEQFRRET

4.5 Elastomer seal compatibility. All oil grades shall demonstrate compliance with 3.7, Table XX, when tested and rated in accordance with the most recent version of GMW 16444, Appendix B - Elastomer Test.

5. PACKAGING

5.1 Packaging. For acquisition purposes, the packaging requirements shall be as specified in the contract or order (see 6.2). When packaging of materiel is to be performed by DoD or in house contractor personnel, these personnel need to contact the responsible packaging activity to ascertain packaging requirements. Packaging requirements are maintained by the Inventory Control Point's packaging activity within the Military Service or Defense Agency, or within the military service's system commands. Packaging data retrieval is available from the managing Military Department's or Defense Agency's automated packaging files, CD-ROM products, or by contacting the responsible packaging activity.

6. NOTES

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

6.1 Intended use. The lubricating oils covered by this specification are military standard lubricants. The combination of engine and heavy-duty transmission requirements in this specification are not required of typical commercial diesel engine oils. They are intended for use in combat and tactical equipment including the crankcase lubrication of reciprocating compression-ignition engines, heavy-duty automatic and powershift transmissions, hydraulic systems, and non-hypoid gear units of engineer/construction and material handling equipment. Although lubricants meeting the requirement of this specification have been formulated to meet a wide range of lubricating functions, it is brought to the attention of the equipment developer the requirement to ensure that equipment, whether military unique or commercially-off-the-shelf (COTS), are compatible with military standard lubricants (see AR 70-12 and MIL-HDBK-838 for additional guidance). Monograde lubricating oils (i.e., 10W, 30, and 40) covered by this specification meet, at a minimum, service category API CH-4. The 10W oil should not be used in high output 2-cycle heavy-duty diesel engines. Multigrade lubricating oil (i.e., 15W-40) covered by this specification meet, at a minimum, service category API CI-4. Although lubricants qualified to this specification have been tested in accordance with selected Allison Transmission Inc. and Caterpillar Inc. transmission lubricant requirements, without further testing and certification, they cannot be recognized as compliant with either company's lubricant specifications.

6.2 Acquisition requirements. Acquisition documents should specify the following:

a. Title, number, and date of this specification.
b. PIN (oil type, quantity of oil and type container) (see 1.3).
c. Packaging requirements (see 5.1).

6.3 Qualification. With respect to products requiring qualification, awards will be made only for products which are, at the time of award of contract, qualified for inclusion in Qualified Products List No. 2104 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 orders for the products covered by this specification. Information pertaining to qualification of products may be obtained from:

U.S. Army RDECOM-TARDEC
6501 E. 11 Mile Road
ATTN: Fuels and Lubricants Technology Team
RDTA-SIE-ES-FPT-FLT (MS-110)
Warren, MI 48397-5000
Tardec.pol.help@us.army.mil

An online listing of products qualified to this specification may be found in the Qualified Products Database (QPD) at https://assist.dla.mil.

6.4 Subject term (key word) listing.

Diesel oil
Tracked vehicles
Transmission fluid
Wheeled vehicles

6.5 International standardization agreement implementation. This specification implements STANAG 1135, “Interchangeability of fuels, lubricants and associated products used by the armed forces of the North Atlantic Treaty Nations”. When amendment, revision, or cancellation of this specification is proposed, the preparing activity must coordinate the action with the U.S. National Point of Contact for the international standardization agreement, as identified in the ASSIST database at https://assist.dla.mil.

6.6 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.

6.7 Shelf-life. This specification covers an item where the assignment of a Federal shelf-life code is a consideration. Specific shelf-life requirements should be specified in the contract or purchase order, and should include, as a minimum, shelf-life code, shelf-life package markings in accordance with MIL-STD-129 or FED-STD-123, preparation of a materiel quality storage standard for type II (extendible) shelf-life items, and a minimum of 85 percent shelf-life remaining at time of receipt by the Government. These and other requirements, if necessary, are in DoD 4140.27-M, *Shelf-life Management Manual*. The shelf-life codes are in the Federal Logistics Information system Total Item Record. Additive information for shelf-life management may be obtained from DoD 4140.27-M, or the designated shelf-life Points of Contact (POC). The POC should be contacted in the following order: (1) the Inventory Control Points that manage the item and (2) the DoD Service and Agency administrators for the DoD Shelf-Life Program. Appropriate POCs for the DoD Shelf-Life Program can be contacted through the DoD Shelf-Life Management website: https://www.shelflife.hq.dla.mil/.

Custodians:
Army - AT
Navy - SH
Air Force - 68

Preparing activity:
Army - AT

(Project 9150-2010-009)

Review activities:
Army - AR, MI, SM
Navy - AS, MC, SA, YD
Air Force - 03, 11, 99
DLA - GS, PS
CIV - 6FEE

Industry associations:
ASTM, API, SAE

NOTE: The activities listed above were interested in this document as of the date of this document. Since organizations and responsibilities can change, you should verify the currency of the information above using the ASSIST Online database at https://assist.dla.mil.