

INCH-POUND

MIL-PRF-62140B

25 April 1997

SUPERSEDING

MIL-E-62140A(AT)

18 December 1989

PERFORMANCE SPECIFICATION

ENGINE, DIESEL: LIQUID-COOLED,
V-TYPE, 6-CYLINDER, 210 H.P.

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

1. SCOPE

1.1 Scope. This specification covers a 210 horsepower, 6-cylinder, V-type, liquid-cooled, 2-stroke-cycle, internal-combustion, compression-ignition (diesel) engine for use in military vehicles.

2. APPLICABLE DOCUMENTS

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

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

AMSC N/A

FSC 2815

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

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2.2 Government documents.

2.2.1 Specifications, standards, and handbooks. The following specifications, standards and handbooks form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents shall be those listed in the issue of the Department of Defense Index of Specifications and Standards (DoDISS) and supplement thereto, cited in the solicitation (see 6.2).

SPECIFICATIONS

FEDERAL

- | | |
|-----------|---|
| A-A-870 | - Antifreeze/Coolant, Engine: Ethylene Glycol, Inhibited Concentrated |
| A-A-50271 | - Plates, Identification. |
| A-A-52557 | - Fuel Oil, Diesel; For Posts, Camps and Stations. |
| P-C-437 | - Cleaning Compound, High Pressure (Steam) Cleaner. |

DEPARTMENT OF DEFENSE

- | | |
|-------------|---|
| MIL-L-2104 | - Lubricating Oil, Internal Combustion Engine, Combat/Tactical Service. |
| MIL-A-11755 | - Antifreeze, Arctic-Type. |
| MIL-L-21260 | - Lubricating Oil, Internal Combustion Engine, Preservative and Break-in. |
| MIL-A-46153 | - Antifreeze, Ethylene Glycol, Inhibited, Heavy Duty, Single Package. |
| MIL-F-46162 | - Fuel, Diesel, Referee Grade. |
| MIL-L-46167 | - Lubricating Oil, Internal Combustion Engine, Arctic. |
| MIL-A-53009 | - Additive, Antifreeze Extender, Liquid Cooling Systems. |

STANDARDS

DEPARTMENT OF DEFENSE

- | | |
|-------------|---|
| MIL-STD-461 | - Control of Electromagnetic Interference Emissions and Susceptibility, Requirements for the. |
| MIL-STD-462 | - Measurement of Electromagnetic Interference Characteristics, Test Method Standard for. |

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- | | |
|--------------|---|
| MIL-STD-1184 | - Electrical Components for Automotive Vehicles;
Waterproofness Tests. |
| MIL-STD-1400 | - Engines, Gasoline and Diesel, Methods of Test. |

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

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

DRAWINGS

DEPARTMENT OF DEFENSE

- | | |
|---------|----------------------|
| 8738127 | - Engine (Complete). |
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(Copies of these drawings are available from the U.S. Army Tank-automotive and Armaments Command, AMSTA-TR-E/BLUE, Warren, MI 48397-5000.)

NUCLEAR REGULATORY COMMISSION (NRC)

Code of Federal Regulations (CFR) - Title 10, Part 40.

(Copies of the Code of Federal Regulations (CFR) are available from the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402.)

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

3. REQUIREMENTS

3.1 First article. When specified (see 6.2), a sample shall be subjected to first article inspection in accordance with 4.3.

3.2 Materials. Unless otherwise specified herein, materials used shall be selected by the manufacturer. The diesel engines shall be fabricated from compatible materials, inherently corrosion resistant or treated to provide against corrosion and deterioration during storage and operational conditions experienced. Dissimilar metals shall not be used in intimate contact with

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each other unless protected against galvanic corrosion. Asbestos, cadmium, and radioactive material will not be used in this item. Radioactive material is defined by Title 10, Code of Federal Regulations, Part 40, and other radioactive material in which the radioactivity is greater than 0.002 microcuries per gram or 0.01 microcuries total activity for the item. (see 4.6.1)

3.2.1 Recycled, recovered, or environmentally preferable materials. Recycled, recovered, or environmentally preferable materials should be used to the maximum extent possible provided that the material meets or exceeds the operational and maintenance requirements, and promotes economically advantageous life cycle costs (see 4.6.1).

3.3 Design and construction. The engine shall be constructed in accordance with Drawing 8738127 (see 4.6.1 and 4.6.2).

3.3.1 Accessories and equipment. Unless otherwise specified (see 6.2), all accessories and equipment shall be installed on the engine and properly adjusted. All electrical accessories and equipment, including wiring and electrical connections, shall conform to the applicable requirements of MIL-STD-1184 (see 4.6.1).

3.3.2 Interchangeability of parts. With the exception of parts furnished in material sets or for which a selective fit is specified, component assemblies, parts or service parts shall be so constructed as to facilitate ease of installation, replacement, and adjustment without requiring modification. Any design change that affects performance or changes the configuration of the above items requires Government approval (see 4.6.1).

3.3.3 Production break-in. The engine, using fuel oil conforming to grade 2 of A-A-52557, shall be given a break-in run by the contractor to ensure the engine, as submitted to the Government for acceptance, shall meet all requirements specified herein (see 4.6.3).

3.4 Performance. The engine performance requirements shall be met under the following conditions:

- a. Lubricating oil. Lubricating oil conforming to the seasonal requirements of MIL-L-2104 from -10 to 115 degrees Fahrenheit (°F) and MIL-L-46167 from -65 to 0°F shall be used. The contractor may use oil of his own selection, or oil conforming to grade 2 of MIL-L-21260, during engine build-up and the break-in run (see 6.3.3).
- b. Coolant. Water and antifreeze compound conforming to MIL-A-46153 heavy duty antifreeze or A-A-870, arctic-type antifreeze compound conforming to MIL-A-11755, or antifreeze extender additive conforming to MIL-A-53009 shall be used.

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- c. Rated operating conditions. The engine rating shall be corrected to the following conditions in accordance with MIL-STD-1400:

Dry air barometric pressure	29 inches (in.) of mercury (Hg)
Inlet air temperature	85°F
Vapor pressure	0.38 in. of Hg
Dry air density	0.0705 pound per cubic foot (lb/ft ³)

3.4.1 Endurance. Unless otherwise specified (see 6.2) , the engine shall retain 90 percent (%) of its rated horsepower (hp) after being subjected to a 400-hour endurance test without requiring any more maintenance than changing oil, replacing oil and fuel filters, and minor adjustments (see 4.6.4).

3.4.1.1 Endurance run fuel. During the endurance run, the engine shall be operated with referee-grade diesel fuel conforming to MIL-F-46162.

3.4.1.2 Endurance run lubricating oil. During the endurance run, the engine shall be operated with reference grade lubricating oil conforming to MIL-L-2104 (see 6.3.3).

3.4.2 Speed range. The engine shall operate satisfactorily under all loads and conditions as specified herein through a speed range of 1200 to 2785 revolutions per minute (rpm). The engine shall maintain an idle speed of 650 to 700 rpm when using diesel fuel conforming to grade 2 of A-A-52557 (see 4.6.4).

3.4.2.1 Governor. The governor shall limit the engine speed as follows:

Full-load operation	2785 to 2835 rpm
No-load operation	2940 to 2990 rpm

The engine speed with no load on the engine shall stabilize within 3 seconds (s) after full-rack position is reached (see 4.6.2 and 4.6.4).

3.4.3 Brake horsepower (bhp). At the completion of the production break-in run, the engine operating at 2785 rpm and corrected to MIL-STD-1400 operating conditions, shall develop not less than 202 gross bhp (see 4.6.4 and 6.3.2).

3.4.4 Torque. The engine operating at 1600 rpm shall develop not less than 420 pound-feet (lb-ft) observed torque using specified fuel at the completion of the production break-in run (see 4.6.4).

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3.4.5 Exhaust smoke density. The exhaust smoke density at the full power position, when measured within 3 feet (ft) of the exhaust manifold outlet, shall not exceed the conditions specified in table I when using fuel specified herein (see 4.6.4 and 6.3.4).

TABLE I. Exhaust smoke density.

Engine speed (rpm)	Visual no.	Meter no. <u>1/</u>
1000	3	8
1400	3	7
2600	1	4

1/ The meter reading shall have precedence over the visual reading.

3.4.5.1 Engine emissions. The engine shall comply with all current air emissions quality regulations (see 4.6.1).

3.4.6 Fuel consumption. With the engine operating at 2785 rpm, using fuel specified herein, the fuel consumption shall not exceed that specified in table II (see 4.6.4).

TABLE II. Maximum observed brake specific fuel consumption.

Engine speed (rpm)	Pound per bhp-hour
1800	0.460
2785	0.450

3.4.7 Oil consumption. After 25 hours (h) of operation, the engine shall consume not more than 0.007 pounds (lb) of lubricating oil per observed bhp-hour, when operating at full rack throughout the power check phase of the engine with an oil sump temperature of 180 to 260°F. The power check phase shall be determined at full rack position with the engine operating at full load at speeds of 1600, 2000, 2400, and 2785 rpm to assure meeting the performance requirements (see 4.6.4).

3.4.8 Oil pressure. Under all operating conditions specified herein, including a 1-quart-low oil sump condition, and with an oil sump temperature of not less than 180°F, the gallery oil pressure shall not be more than 80 pounds per square inch (psi) nor less than 40 psi when the engine is operating at 2785 rpm using specified oil, and shall not be less than 5 psi when the engine is idling at 650 to 700 rpm (see 4.6.4).

3.4.9 Grades and slopes. The engine shall start and demonstrate the performance characteristics specified herein on longitudinal grades and lateral slopes up to 60% in all directions, when operated throughout the speed range of the engine, with full and 1-quart-low oil level conditions in the sump. As a result of said operation, no evidence of faulty lubrication, cooling, fuel supply, leakage, or other malfunction shall be found (see 4.6.5).

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3.4.10 Steam and water jet cleaning. The engine and all its components shall withstand cleaning with a high-pressure steam cleaner conforming to P-C-437 and water jet without deterioration of seals or hoses, water leakage past seals or gaskets, or other defects (paint removal shall not be considered a defect). The jet shall be applied perpendicular to the surface being cleaned at a distance of not less than 1 ft from the surface and cleaned at a rate of 1 square foot per minute (ft²/min.). The jet pressure shall not be less than 100 psi, nor more than 110 psi (see 4.6.6).

3.4.11 Electromagnetic compatibility. Unless otherwise specified (see 6.2), the engine shall meet the functional suppression requirements in accordance with applicable sections of MIL-STD-461 (see 4.6.7).

3.5 Environmental. The engine shall start within 2 minutes (min) and shall demonstrate the performance characteristics specified herein under any of the following conditions or possible combination of conditions (see 3.5.1 through 3.5.3)

3.5.1 Temperature (see 4.6.8.1).

- a. Low. With integral cold starting aid, and without external aids after being cold-soaked, without benefit of solar radiation, to an ambient temperature of 25°F. Not less than 100 rpm cranking speed shall be demonstrated with 16 volts of direct current (V dc) available at the starter terminals. (Cold-soak shall be defined as reducing the temperature of the engine and its fuel, coolant, and lubricating oil to within 5°F of the ambient air temperature.)
- b. High. Without external aids, and a fuel pressure of 5 psi at the inlet to the fuel injector supply pumps, when operated at the following temperature with exposure to maximum solar radiation:

Ambient air	115°F
Intake air (at air cleaner inlet)	115°F
Coolant outlet	230°F
Oil sump	At maximum temperature attainable up to 275°F

3.5.2 Elevation. At any elevation from sea level to 8000 ft, except that the power requirements shall be reduced proportional to the elevation, so that at the 8000-ft elevation, the observed power output of the engine shall not be less than 75% of rated power (see 4.6.8.2).

3.5.3 Humidity. Under relative humidity conditions as low as 5% at a temperature of 115°F and as high as 100% at temperatures from -25 to 85°F (see 4.6.8.3).

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3.6 Exterior surface treatment. All exposed exterior surfaces of the engine and its accessories and components shall be cleaned and painted or treated for corrosion resistance in accordance with the manufacturer's standard practice (see 4.6.2).

3.7 Plates. Unless otherwise shown on the applicable drawings, the nameplate, data, and instruction plates shall conform to A-A-50271 (see 4.6.2).

3.8 Workmanship. Workmanship shall be of the quality necessary to produce engines free from defects that would affect their serviceability (see 4.6.2).

4. VERIFICATION

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

- a. First article inspection (see 4.3).
- b. Conformance inspection (CI) (see 4.4).
 - 1. Examination (see 4.4.1)
 - 2. Tests (see 4.4.2)
- c. Control Tests (see 4.5)

4.2 Inspection conditions. Unless otherwise specified herein, all inspections shall be performed under the following standard (room) ambient conditions:

- a. Temperature: $77 \pm 18^{\circ}\text{F}$.
- b. Relative humidity: Uncontrolled room ambient.
- c. Atmospheric pressure: Site pressure.

4.3 First article inspection. First article inspection shall be performed on one or more engines when a first article sample is specified (see 6.2). Unless otherwise specified (see 6.2), first article inspection shall include the inspections specified in table III.

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TABLE III. Classification of inspection.

Title	Requirement	Inspection	First article	Conformance		Control tests
				Examination	Tests	
Materials, design, and construction	3.2 through 3.3.2	4.6.1	X	X		
Examination (see table IV)	3.3, 3.4.2.1, 3.6, 3.7 and 3.8	4.6.2	X			
Production break-in	3.3.3	4.6.3	X			
Endurance						
First article	3.4.1	4.6.4.1	X			
Control	3.4.1	4.6.4.2				X
Speed range	3.4.2	4.6.4	X		X	X
Governor	3.4.2.1	4.6.4	X		X	X
Bhp	3.4.3	4.6.4	X		X	X
Torque	3.4.4	4.6.4	X		X	X
Exhaust smoke density	3.4.5	4.6.4	X			X
Engine emissions	3.4.5.1	4.6.1	X		X	
Fuel consumption	3.4.6	4.6.4	X			
Oil consumption	3.4.7	4.6.4	X			X
Oil pressure	3.4.8	4.6.4	X			X
Grades and slopes	3.4.9	4.6.5	X			
Steam and water jet cleaning	3.4.10	4.6.6	X			
Electromagnetic compatibility	3.4.11	4.6.7	X			
Temperature	3.5.1	4.6.8.1	X			
Elevation	3.5.2	4.6.8.2	X			
Humidity	3.5.3	4.6.8.3	X			

4.4 Conformance inspection. Conformance inspection shall be conducted on the sample engines and shall include the examination of 4.4.1 and the tests of 4.4.2. Sample size shall be as specified in the contract (see 6.2).

4.4.1 Examination. The sample engine shall be examined for the defects specified in table IV.

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TABLE IV. Classification of defects.

Category	Defect	Method of examination
<u>Major:</u>		
101	Exhaust valve tappet clearance - improper adjustment (see 3.3).	Gage
102	Oil sump; fuel and oil filters - dirt, chips, or foreign objects (see 3.3).	Visual and functional
103	Fuel, oil, and coolant - leakage (see 3.3).	Visual
104	Fuel lines - damaged (see 3.3).	Visual and functional
105	Fuel system components - malfunction, damaged, or leaks (see 3.3).	Visual and functional
106	Fuel injection system, timing, and components - malfunction, improper adjustment (see 3.3).	Gage and functional
107	Cylinder head bolts, intake and exhaust manifold flange bolts, and vibration damper bolts - improper torque (see 3.3).	Torque wrench
108	Crankshaft - excessive or restrictive end play (see 3.3).	Gage and functional
109	Crankshaft pressure - exceeds limits (see 3.3).	Gage
110	Air cleaner - malfunction (see 3.3).	Functional
111	Air box pressure - exceeds limits (see 3.3).	Gage
112	Governor - malfunction (see 3.4.2.1).	Visual and functional
113	Workmanship - faulty affecting performance(see 3.8).	Visual and functional
<u>Minor:</u>		
201	Linkage - improper adjustment (see 3.3).	Visual
202	Minor assemblies - omitted (see 3.3).	Visual
203	Engine - improper adjustment or installation of components (see 3.3).	Visual and functional
204	Fuel lines, hose, vents, and shut-off valve - improper assembly or installation (see 3.3).	Visual
205	Exterior surface treatment - improper application (see 3.6).	Visual
206	Corrosion - appearance of damage (see 3.6).	Visual
206	Plates - improper (see 3.7).	Visual
207	Workmanship - faulty affecting appearance (see 3.8).	Visual

4.4.2 Conformance inspection tests. Subsequent to the examination of 4.4.1, the sample engines shall be subjected to the conformance inspection tests specified in table III.

4.5 Control Tests. Control test sample(s) shall be new and examined in accordance with 4.4.1 prior to being subject to the control tests (see table III and 4.6.4.2). Sample size and frequency of tests shall be specified in the contract (see 6.2).

4.6 Methods of inspection.

4.6.1 Materials, design and construction. Conformance to 3.2 through 3.3.2 shall be determined by inspection of contractor records providing proof or certification that design, construction, processing, and materials conform to requirements. Applicable records shall include drawings, specifications, design data, receiving records, processing and quality control standards, vendor catalogs and certifications, industry standards, test reports, and rating data.

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4.6.2 Defects. Conformance to 3.3, 3.4.2.1, 3.6, 3.7, and 3.8 shall be determined by examination for the defects listed in table IV.

4.6.3 Production break-in. To determine conformance to 3.3.3, the engine shall be operated as specified herein. Any unsatisfactory operation or conditions which require correction shall be corrected by the contractor before the engine is presented for acceptance.

4.6.3.1 Teardown inspection. At the conclusion of the break-in run, the contractor, in the presence of the Government, shall disassemble and inspect the first 10 engines, and every second engine of the next 10 of any contract except overlapping contracts. Disassembly shall be accomplished to the extent required to perform the following inspection:

- a. Oil contamination.
- b. Dirt, chips, or foreign matter in the engine block, oil pan filters, or accessory drive case.
- c. Main bearing bolt torque. 1/
- d. Connecting rod bolt torque. 1/
- e. Cylinder head bolt torque. 1/
- f. Cylinder bore scuffing, scoring, galling, etc.
- g. Piston scuffing and burning.
- h. Correct valve adjustment.
- i. Correct rack and governor linkage adjustment.
- j. Missing parts.
- k. Valves, valve train, and camshaft inspection.
- l. Corrosion damage.

1/ Nuts and bolts listed by the manufacturer as requiring exceptions to standard bolt and nut torque specifications.

Any engine not requiring replacement parts shall be reassembled and subjected to the acceptance power check test only.

4.6.3.1.1 Corrections and re-assembly. Any engine requiring replacement parts shall be reassembled and subjected to the break-in run and acceptance power check test.

4.6.4 Endurance. To determine conformance to 3.4.1 and 3.4.2 through 3.4.8, the engine shall be subjected to the applicable test as follows.

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4.6.4.1 First article.

4.6.4.1.1 NATO 400-hour test. Unless otherwise specified (see 6.2), the first article engine shall be subjected to a NATO 400-hour test. The test shall consist of four periods of 100 h. Each 100 h period shall consist of ten 10 h cycles. Each 10 h cycle shall be as specified in table V. The test shall be conducted under the following conditions:

- a. Running time less than 30 min shall not be counted toward fulfillment of the 400 endurance hours.
- b. The inlet air temperature shall be not less than 70°F nor more than 100°F.
- c. The fuel used shall be as specified in 3.4.1.1.

TABLE V. Ten hour cycle.

Period	% rated speed	% load	Duration (hours)
1	Idle	0	0.5
2	100	100	2.0
3	Governed speed	0	0.5
4	75	100	1.0
5	Idle _____ 100	0 _____ 100 4 min 6 min	2.0
6	60	100	0.5
7	Idle	0	0.5
8	Governed speed	70	0.5
9	Max. torque speed	100	2.0
10	60	50	0.5
Total duration:			10.0

4.6.4.1.1.1 Power checks. Full rack performance characteristics of the engine shall be determined by operating the engine according to the following schedule before the NATO 400-hour test and after each 100 h of operation.

<u>Period</u>	<u>Engine speed (rpm)</u>	<u>Rack position</u>
1	1600	Full rack
2	2000	Full rack
3	2400	Full rack
4	2785	Full rack

4.6.4.1.1.1.1 Servicing. Prior to the power checks, the lubricating oil shall be changed, all filters serviced, and valve clearances checked and adjusted to applicable requirements.

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4.6.4.1.1.1.2 Atmospheric conditions. The observed barometric pressure and wet and dry bulb temperatures existing within 4 ft of engine air inlet shall be monitored during the power checks.

4.6.4.1.1.2 Readings. The following readings shall be observed at the end of each hour of operation, at the completion of each period, and just prior to stopping the engine (emergency stop excluded):

- a. Engine speed, rpm.
- b. Observed bhp.
- c. Observed torque, lb-ft.
- d. Air box pressure, in. of Hg (gage).
- e. Exhaust manifold pressure, in. of Hg (gage).
- f. Fuel pressure after secondary filter, psi.
- g. Fuel supply pressure at transfer pump, psi.
- h. Lubrication oil pressure, gallery, psi.
- i. Crankcase pressure, in. of water.
- j. Lubricating oil temperature, sump, °F.
- k. Lubricating oil temperature, inlet gallery, °F.
- l. Fuel temperature after secondary filter, °F.
- m. Air temperature at air cleaner inlet, °F.
- n. Air temperature at air box, °F.
- o. Coolant temperature, inlet and outlet, °F.
- p. Exhaust temperature, °F.
- q. Test cell ambient air temperature, °F.
- r. Blowby, cubic foot per minute (cfm).
- s. Fuel flow, pounds per hour.
- t. Specific oil consumption, pounds per bhp-hour (at power check).
- u. Specific oil consumption, pounds per bhp-hour each 4 h period, in. of Hg.
- v. Barometric pressure 1/
- w. Exhaust smoke density (see 6.3.4).

1/ NOTE: Local observed barometric pressure.

4.6.4.1.1.3 Acceptable performance. During the NATO 400-hour test, the engine shall be observed for conformance to the following performance requirements during the power checks (see 4.6.4.1.1.1):

- a. Speed range (see 3.4.2).
- b. Governor (see 3.4.2.1).
- c. Bhp (see 3.4.3).
- d. Torque (see 3.4.4).

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- e. Exhaust smoke density (see 3.4.5).
- f. Fuel consumption (see 3.4.6).
- g. Oil consumption (see 3.4.7).
- h. Oil pressure (see 3.4.8).
- i. Engine life (see 3.4.1).

4.6.4.1.1.4 Teardown inspection. At the conclusion of the NATO 400-hour test, a teardown inspection as specified in 4.6.3.1 shall be performed.

4.6.4.2 Control test. Each engine selected in accordance with 4.5 shall be subjected to the 50-hour test specified in table IV. At each start, the engine shall be warmed up until the torque, speed, and temperatures have been stabilized for a period of not less than 1 min. All applicable temperatures shall be recorded at the conclusion of each warm-up period. Warm-up starting and stopping times shall be recorded; however, warm-up time and running time of less than 30 min, unless specified in table VI, shall not be counted toward fulfillment of test run hours. Prior to the test, all applicable settings and adjustments (such as valve lash) shall be reset to specifications before the test has started. The test shall be conducted under the following conditions:

- a. The inlet air temperature shall be not less than 70°F nor more than 100°F.
- b. The lubricating oil temperature shall not exceed 240°F.
- c. The coolant temperature shall be maintained at $180 \pm 5^\circ\text{F}$.
- d. The fuel used shall conform to grade 2 of A-A-52577.

TABLE VI. 50-hour test.

Period	Time (h)	Speed (rpm)	Rack Position (% of full rack)
1	(run in schedule)	(see table I)	
2	5	1600	50
3	5	2000	75
4	5	2785	75
5	5	2400	100
6	30	2785	100
7	Power checks (see 4.6.4)		

4.6.4.2.1 Readings. The following readings shall be recorded after each hour of operation, at the completion of each period, and just prior to stopping the engine. All data shall be obtained under stabilized conditions, with the engine coupled to a dynamometer:

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- a. Engine speed, rpm.
- b. Observed bhp.
- c. Observed torque, lb-ft.
- d. Air box pressure, in. of Hg (gage).
- e. Fuel pressure after secondary filter, psi.
- f. Fuel supply pressure at inlet to engine driven supply pump, psi.
- g. Lubrication oil pressure, gallery, psi.
- h. Lubricating oil temperature, sump, °F.
- i. Fuel temperature after secondary filter, °F.
- j. Coolant temperature, inlet and outlet, °F.
- k. Air temperature at air cleaner inlet, °F.
- l. Cell ambient air temperature, °F.
- m. Exhaust temperature, °F.
- n. Fuel flow, pounds per hour (lb/hr).
- o. Brake specific fuel consumption, pounds per observed bhp-hour.
- p. Specific oil consumption, pounds per bhp-hour.
- q. Exhaust smoke density (see 6.3.4).

4.6.4.2.2 Acceptable performance. The engine shall be observed for conformance to the following performance requirements at the completion of the 50-hour test, and shall be reinspected for the characteristics specified in table IV:

- a. Speed range (see 3.4.2).
- b. Governor (see 3.4.2.1).
- c. Bhp (see 3.4.3).
- d. Torque (see 3.4.4).
- e. Exhaust smoke density (see 3.4.5).
- f. Fuel consumption (see 3.4.6).
- g. Oil consumption (see 3.4.7).
- h. Oil pressure (see 3.4.8).

4.6.5 Grades and slopes. To determine conformance to 3.4.9, the engine shall be operated for 30 min in each direction as specified in 3.4.9.

4.6.6 Steam and water jet cleaning. To determine conformance to 3.4.10, the engine shall be subjected to normal steam cleaning with cleaner conforming to P-C-437 at the completion of the first article endurance test and just prior to the teardown inspection. Immediately upon completion of the steam cleaning operation, the engine shall be subjected to normal water jet cleaning as specified herein. Prior to cleaning, the air intake opening, flywheel, exhaust, and all other openings that might be affected shall be covered. The engine shall start and operate at idle speed without misfiring within 2 min immediately after the completion of both the steam and water jet operations. During the disassembly of the engine, special notice shall be made of water

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entering the engine through joints, seals, gaskets, etc. Evidence of malfunction or of water seepage past joints, seals, gaskets, etc., shall constitute failure of the test.

4.6.7 Electromagnetic compatibility. Unless otherwise specified (see 6.2), conformance to 3.4.11, radiated emission suppression, shall be determined by testing in accordance with applicable plans in MIL-STD-461 and correlative procedures in MIL-STD-462.

4.6.8 Environmental.

4.6.8.1 Temperature.

- a. Low. To determine conformance to 3.5.1a, the engine with integral winterization aids, shall be cold-soaked at an ambient temperature of -25°F for a period of 24 h using the fuel specified in 3.4.1.1. The engine shall be started and shall operate for a sufficient time to stabilize engine operation.
- b. High. To determine conformance to 3.5.1b, the engine, without aids, shall be placed in a high-temperature chamber maintained at a temperature of 115°F and operated at full load until all temperatures are stabilized. The engine shall then be shut down, hot-soaked, and restarted when the fuel temperature at the inlet to the injection pump reaches its maximum value. Fuel shall be supplied to the engine mounted fuel supply pump at a pressure of 5 psi. The fuel pressure shall be shut off during the hot-soak period.

4.6.8.2 Elevation. To determine conformance to 3.5.2, the engine shall be placed in a simulated environmental condition of 8000 ft elevation, a pressure of 22.2 in. of Hg measured at the air cleaner inlet and exhaust outlet, and a temperature of 90°F. The engine shall be started and shall operate for a sufficient time to stabilize engine operation.

4.6.8.3 Humidity. To determine conformance to 3.5.3, the engine shall be placed in conditions as specified therein. The engine shall be started and shall operate for a sufficient time to stabilize engine operation.

5. PACKAGING

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

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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 engine covered by this specification is intended for production use, as a spare, or as a replacement for military tactical and combat vehicles.

6.2 Acquisition requirements. Acquisition documents must specify the following:

- a. Title, number, revision, and date of this specification.
- b. Issue of DoDISS to be cited in the solicitation, and if required, the specific issue of individual documents referenced (see 2.2.1).
- c. If first article is required (see 3.1).
- d. If all accessories and equipment shall not be installed on engines and adjusted (see 3.3.1).
- e. If endurance requirements should be other than as specified (see 3.4.1).
- f. If electromagnetic compatibility requirements should be other than as specified in MIL-STD-461(see 3.4.11).
- g. Type of first article sample, and the number of samples to be inspected (see 4.3).
- h. First article inspection, if other than as specified (see 4.3).
- i. Sample size for conformance inspection examination and tests (4.4).
- j. Control test sample size and frequency of tests (see 4.5).
- k. If first article test should be other than the NATO 400-hour test (see 4.6.4.1.1).
- l. If electromagnetic compatibility testing should be other than as specified (see 4.6.7)
- m. Packaging requirements (see 5.1).

6.3 Definitions.

6.3.1 Recovered materials. "Recovered materials" are materials that have been collected or recovered from solid waste (see 3.2.1).

6.3.2 Bhp. Observed bhp should be corrected to standard atmospheric conditions using the following formula:

$$\text{Corrected bhp} = \text{observed bhp} \times \frac{29.00}{B - e} \times \sqrt{\frac{460 + t}{545}}$$

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Where:

B = test barometric pressure, in. Hg wet.

e = water vapor pressure, in. Hg.

t = intake air temperature, °F (see applicable sections of MIL-STD-1400).

6.3.3 Referee grade oil. The following designation applies for the grade required:

<u>Grade</u>	<u>Government designation</u>
15/40	MC 2777

6.3.4 Exhaust smoke density. Exhaust smoke density should be determined with a Robert Bosch Model EFAW 68 Smoke Meter or equivalent (as approved by the Government) and Model EFAW 65 Sampling Pump or equivalent (as approved by the Government). The following may be used to visually define the degree of exhaust smoke density:

<u>Description of exhaust smoke</u>	<u>Classification</u>
Clear	1
Haze	2
Light gray	3
Medium gray	4
Dark gray to black	5

NOTE: Observation of exhaust should be made against a white background.

6.4 Log sheet. The contracting officer should specify in acquisition documents the Government's requirements for the log sheet, e.g., format, Government approval, and number of copies required.

6.5 Subject term (key word) listing.

Brake horsepower (bhp)
 Compression-ignition
 Endurance run
 Governor
 Internal-combustion
 NATO 400-hour test
 Torque
 Two-stroke

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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.

Custodian:
Army - AT

Preparing Activity:
Army - AT

Review Activity:
DLA - CS

(Project 2815-0170)

