

INCH-POUND
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SUPERSEDING
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DETAIL SPECIFICATION

ENGINE, DIESEL: 8 CYLINDER, V-TYPE 390 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 one type of 8 cylinder, V-type, liquid-cooled, 2-stroke-cycle, turbo-supercharged, internal-combustion, compression ignition engine for use in military vehicles (see 6.1).

2. APPLICABLE DOCUMENTS

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

2.2 Government documents.

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

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

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SPECIFICATIONS

FEDERAL

- A-A-870 - Engine Antifreeze/Coolant: Inhibited Concentrated, Ethylene Glycol.
- A-A-52624 - Antifreeze, Multi-Engine Type.

DEPARTMENT OF DEFENSE

- MIL-PRF-2104 - Lubricating Oil, Internal Combustion Engine, Combat/Tactical Service.
- MIL-F-46162 - Fuel, Diesel, Referee Grade.
- MIL-PRF-46167 - Lubricating Oil, Internal Combustion Engine, Arctic.
- MIL-A-53009 - Additive, Antifreeze Extender, Liquid Cooling Systems.
- MIL-PRF-62048 - Air Cleaners, Automotive: Heavy Duty, Dry-Type (For Internal-Combustion Engines) (Metric).

(Unless otherwise indicated, copies of the above specifications, standards, and handbooks are available from the Defense Printing Service Detachment Office, Bldg. 4D (Customer Service), 700 Robbins Avenue, 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 specification to the extent specified herein. Unless otherwise specified, the issues are those cited in the solicitation.

DRAWINGS

DEPARTMENT OF DEFENSE

- 11669155 - Engine Assembly (M110A3, M578).
- 12260210 - Engine Assembly (M109A2, M109A3).

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

2.3 Non-Government publications. The following document(s) form a part of this document to the extent specified herein. Unless otherwise specified, the issues of the documents which are DoD adopted are those listed in the issue of the DoDISS cited in the solicitation. Unless otherwise specified, the issues of documents not listed in the DoDISS are the issues of the documents cited in the solicitation (see 6.2).

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AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI/ASQC Z1.4 - Sampling Procedures and Tables for Inspections by Attributes (DoD Adopted).

(Application for copies should be addressed to The American National Standards Institute, 11 W 42nd Street, 13 th Floor, New York, NY 10036.)

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM D975 - Standard Specification for Diesel Fuel Oils.

(Application for copies should be addressed to the American Society for Testing and Materials, 100 Barr Harbor Drive, West Conshohocken, PA 19248-2959.)

NATO INTERNATIONAL STAFF - DEFENSE SUPPORT DIVISION

AC/225 (Panel II) - NATO Standard Engine Laboratory Test for
D/131 (Part II) Diesel and Gasoline Engines.
AEP-5

(Application for copies should be addressed to NATO, Military Agency for Standardization (MAS), 35 Chesham Place, London SW1, England.)

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

3. REQUIREMENTS

3.1 First article. When specified (see 6.2), a first article sample shall be subjected to first article inspection in accordance with 4.2.

3.2 Materials. Unless specified herein, materials used shall be in accordance with the manufacturer's materials specifications for 390 horsepower (hp) diesel engines. The materials shall be capable of meeting all of the operational and environmental requirements specified herein (see 4.6.1). Recovered materials shall be used to the maximum extent practicable.

3.2.1 Metals. All metals used in the construction of the engines shall be of a corrosion resistant type or shall be suitably protected to resist corrosion during the normal service life of the engines. The use of dissimilar metals in intimate metal to metal contact shall be avoided.

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3.3 Environmental requirements. The engine shall start within 2 minutes and shall demonstrate the performance characteristics specified herein under any of the following conditions or possible combination of conditions (see 4.6.3).

3.3.1 Temperature start conditions.

3.3.1.1 Low temperature start with aids. With integral cold starting aid and without external aids after being cold soaked, without benefit of solar radiation, to an ambient temperature of -25 degrees Fahrenheit (°F) (-31.6 degrees Celsius (°C)) (see 4.6.3.1.1).

3.3.1.2 High temperature start without aids. Without external aids, with cooling fan installed, and a fuel pressure of 5 pounds per square inch (psi) (34 kilopascals (kPa)) at the inlet to the fuel injector supply pumps, when operated at the following temperatures with exposure to maximum solar radiation (see 4.6.3.1.2):

Ambient air temperature	115°F (46.1°C)
Intake air temperature (at air cleaner inlet)	115°F (46.1°C)
Coolant outlet temperature	230°F (110°C)
Oil sump temperature	Maximum temperature attainable up to 275°F (135°C)

3.3.2 Elevation conditions. The engine shall have adequate torque and power requirements at any elevation from sea level to 8000 feet (ft) (2438 meters (m)), except that the power requirements of the engine shall be reduced proportional to the elevation. At 8000 ft (2438 m) elevation, the observed power output of the engine shall be not less than 90 percent (%) of rated power (see 4.6.4).

3.3.3 Humidity conditions. The engine shall perform under relative humidity conditions as low as 5 percent at a temperature of 115°F (46.1°C) and as high as 100 % at all temperatures from -25 to 85°F (-31.6 to 29.4°C) (see 4.6.5).

3.4 Design and construction. The engine construction and assembly shall be in accordance with Drawings 11669155 or 12260210 (see 4.6.2).

3.4.1 Electrical accessories and equipment. Unless otherwise specified (see 6.2), all electrical accessories and equipment, including wiring and electrical connections, shall be installed on the engine and properly adjusted (see 4.6.6).

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3.4.2 Interchangeability. Component assemblies and parts of the engine shall be so constructed that any part, except those furnished in matched sets or for which a selective fit is specified, may be installed, replaced, and adjusted without requiring modification (see 4.6.7).

3.4.3 Air cleaner. The air cleaner required for use with the engine, shall be either dry or oil-bath type of approved design and capacity. They shall conform to MIL-PRF-62048 or to the manufacturer's standard specification, respectively (see 4.6.8).

3.4.4 Oil. The lubricating oil required for the engine to perform as specified herein shall be in accordance with the seasonal requirements of MIL-PRF-2104 (or commercial equivalent) from -10 to 115 °F (-23.3 to 46.1°C) and MIL-PRF-46167 (or commercial equivalent) from -65 to 0°F (-53.8 to -17.7°C). The manufacturer may use oil of his own selection during engine build up and the break-in run. Reference grade oil used during the endurance test (see 4.6.10.12) shall be designated as specified (see 4.6.9).

3.5 Performance

3.5.1 Engine break-in run. An engine break-in run shall be performed by the contractor. The break-in run schedule shall be established by the contractor to ensure that the engine, as offered for delivery, is suitable for immediate operation. All the required checks or tests, complete and in sequence of performance and endurance, shall be performed with no loss in engine life expectancy (see 4.6.10.1, 4.6.10.1.1 and 4.6.10.1.2).

3.5.2 Speed range. The engine shall operate satisfactorily under all loads and conditions as specified herein through a speed range of 1150 to 2600 revolutions per minute (rpm) (see 4.6.10.2).

3.5.2.1 Idle speed. The engine shall maintain a satisfactory idle speed of 550 to 600 rpm when using diesel fuel conforming to grade 4-D of ASTM D975 (see 4.6.10.2.1).

3.5.3 Governor. The governor shall limit the engine speed as follows during vehicle operations:

Full Load	2275 to 2325 rpm
No Load	2450 to 2500 rpm minimum

When engine is equipped with a two speed governor, speed during winching operations shall be as follows:

Full Load	1150 rpm minimum
No Load	1350 rpm maximum

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In each case, the engine speed with no load on the engine shall stabilize within 3 seconds after full rack position is reached (see 4.6.10.3).

3.5.4 Brake horsepower (bhp). The bare engine at a full rack setting, upon the completion of the break-in run, shall develop not less than 374 observed bhp at 2300 rpm using diesel fuel conforming to grade 4-D of ASTM D975 (see 4.6.10.4).

3.5.4.1 Operating conditions. The engine horsepower rating shall be corrected to the following conditions (see 4.6.10.4).

Dry air barometer	28.33 inches (in.) of mercury (Hg) (96 kilopascals (kPa))
Inlet air temperature	90°F (32.2°C)
Fuel (specific gravity 0.853 at 60°F(15.5°C))	100°F (37.7°C)
Dry air density	0.0684 pounds per cubic feet (lb/ft ³) (1.0956 kilograms per cubic meter (kg/m ³))

3.5.5 Torque. The observed torque at the engine flywheel, upon completion of the break-in run with the full rack setting, shall be not less than 885 pounds feet (lb-ft) (1200 Newton-meters (N-m)) at 1700 rpm using diesel fuel conforming to grade 4-D of ASTM D975 (see 4.6.10.5).

3.5.6 Exhaust smoke density. The exhaust smoke density, at full rack position, shall be not more than the conditions as listed in table I or table II using diesel fuel conforming to grade 4-D of ASTM D975 (see 4.6.10.6).

TABLE I. Exhaust smoke density.

Engine speed (rpm)	Meter number	Visual number
1000	6	3
1400	5	3
2600	4	1

NOTE: The meter reading number shall take precedence over the visual reading.

TABLE II. Visual exhaust smoke density classification.

Exhaust smoke description	Visual number
Clear	1
Haze	2
Light gray	3
Medium gray	4
Dark gray to black	5

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3.5.7 Fuel consumption. The fuel consumption of the base engine shall not exceed the limits specified in table III when operating at the full rack setting as specified in 3.5.4 using diesel fuel conforming to grade 4-D of ASTM D975 (see 4.6.10.7).

TABLE III. Maximum observed brake specific fuel consumption.

Engine speed (rpm)	Fuel consumption (lb per bhp hour)
1400	0.44
2300	0.43

3.5.8 Oil consumption. The engine oil consumption shall be not more than 0.007 lb (3.2 grams (g)) of lubricating oil per observed bhp hour after 25 hours of operation at full rack throughout the engine power check phase (see 4.5.2.1) with oil sump temperatures of 180 to 260°F (82.2 to 126.6°C), using oil as specified (see 4.6.10.8).

3.5.8.1 Oil pressure. With the engine operating at 2300 rpm, the gallery oil pressure shall be not more than 80 psi (551 kPa) nor less than 35 psi (241 kPa), measured at the pressure sending unit, under all operating conditions specified herein, including a one quart low oil sump condition, with an oil sump temperature of not less than 180°F (82.2°C). The oil shall be as specified in 3.4.4 and shall be not less than 5 psi (34 kPa) when engine is idling as specified in 3.5.2.1 (see 4.6.10.8.1).

3.5.9 Coolant. The engine shall perform as specified herein using water and antifreeze compound conforming to A-A-870, multi-engine type antifreeze compound conforming to A-A-52624, or water and corrosion inhibitor compound conforming to MIL-A-53009 (see 4.6.10.9).

3.5.10 Limiting operating temperature. The engine shall not exceed the following limiting temperatures when operating at full load throughout the speed range of the engine under any of the conditions specified herein (see 4.6.10.10):

- a. Oil sump 275°F (135°C) (measured at the drain plug).
- b. Coolant 230°F (110°C) (measured at coolant outlet).

3.5.11 Supercharger. The turbo supercharger shall develop an intake manifold pressure of not less than 55 in. of Hg (186.2 kPa) absolute when operating at full load and 2300 rpm, using fuel conforming to grade 4-D of ASTM D975 (see 4.6.10.11).

3.5.12 Endurance. The engine shall be capable of passing AEP-5 (June 1980) NATO standard engine 400 hour endurance laboratory test for diesel engines (part II) using reference

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fuels, lubricants and coolants. Unless otherwise specified the reference test fuel shall conform to MIL-F-46162, type I. The 400 hour test is divided into 10 hour schedules as defined in the AEP-5 document (see 4.6.10.12).

3.6 Grades and slopes. The engine shall start and demonstrate the performance characteristics specified herein when operated throughout the speed range of the engine. For not less than 30 minutes in each direction, with full and one quart low oil level conditions in the sump, on longitudinal grades or lateral slopes up to 60 % in all directions, and, as a result of said operation, no evidence of faulty lubrication, cooling, fuel supply, leakage, or other malfunction shall be found (see 4.6.11).

3.7 Submersion. The engine, with intake and exhaust ducted to the atmosphere, and with the applicable crankcase fording kit installed, shall operate for a period of 30 minutes while completely submerged in either fresh or salt water, and while still submerged shall restart after being stopped for 3 minutes and then operated for an additional 15 minutes. At the conclusion of operation a maximum of one percent water contamination in the lubricating oil is permissible (see 4.6.12).

3.8 Stream and water jet cleaning. The engine and all its components shall withstand cleaning with high pressure steam using an alkaline cleaning compound 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 deficiency (see 4.6.13).

3.9 Exterior surface treatment. All exposed exterior surfaces of the engine and its components shall be cleaned, treated, and painted to provide corrosion resistance (see 4.6.14).

3.10 Engine nameplate. The engine nameplate, data, and instruction plates shall be in accordance with manufacturer's specifications, unless otherwise shown on the applicable drawings (see 4.6.15).

3.11 Workmanship. The workmanship shall be such quality as to assure that engines procured under contract meet all requirements specified herein. The engines produced shall be free of any defects or safety hazards which affect its performance or serviceability (see 4.6.16).

4. VERIFICATION

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

- a. First article inspection (see 4.2).
- b. Conformance inspection (see 4.3).

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4.2 First article inspection. Unless otherwise specified (see 6.2), first article inspection shall be performed on preproduction or initial production samples as specified when a first article sample is required (see 3.1). This inspection shall include the examinations of 4.4 (see table IV) and the applicable tests of 4.6.1 through 4.6.16 (see table V).

TABLE IV. Classification of defects.

Category	Defect	Method of examination
<u>Major:</u>		
101	Improper adjustment of valve tappet clearance, each valve: Intake and exhaust (see 3.4).	Gage
102	Improper torque on cylinder head bolts, intake and exhaust manifold flange bolts and vibration damper (see 3.4).	Torque wrench
103	Dirt and foreign particles, in the oil sump, fuel, air, and oil filters (see 3.5.1).	Visual and functional
104	Malfunction, of governor (see 3.5.3).	Visual and functional
105	Leakage of fuel, oil and coolant (see 3.11).	Visual
106	Damage to fuel line (see 3.11).	Visual and functional
107	Excessive or restrictive end play of the crankshaft (see 3.11).	Gage and functional
108	Malfunction, of engine (see 3.11).	Functional
109	Malfunction, damage or leakage of fuel system components (see 3.11).	Visual and functional
110	Malfunction and improper adjustment of fuel injection system timing and components (see 3.11).	Visual and functional
<u>Minor:</u>		
201	Improper linkage adjustment (see 3.4).	Visual
202	Omitted minor assemblies (see 3.4).	Visual
203	Improper adjustment or installation of components (see 3.4).	Visual and functional
204	Improper assembly or installation of fuel lines, hoses, vents and shut-off valve (see 3.4).	Visual
205	Improper application of paint (see 3.9).	Visual
206	Missing engine nameplate (see 3.10).	Visual
207	Faulty workmanship, improper installation or adjustment of components (see 3.11).	Visual

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TABLE V. Classification of inspections.

Title	Requirement	Inspection	First article	Conformance	
				Acceptance (100%)	Control
Materials, design and construction	3.2, 3.2.1, and 3.4	4.6.1 and 4.6.2	X		X
Environment	3.3	4.6.3	X		
Low temperature start with aids	3.3.1.1	4.6.3.1.1	X		
High temperature start without aids	3.3.1.2	4.6.3.1.2	X		
Elevation	3.3.2	4.6.4	X		
Humidity	3.3.3	4.6.5	X		
Engine break-in run	3.5.1	4.6.10.1 thru 4.6.10.1.2	X	X	X
Speed range	3.5.2	4.6.10.2	X	X	X
Idle speed	3.5.2.1	4.6.10.2.1	X		
Governor	3.5.3	4.6.10.3	X	X	X
Brake horsepower	3.5.4	4.6.10.4	X	X	X
Operating conditions	3.5.4.1	4.6.10.4	X		
Torque	3.5.5	4.6.10.5	X	X	X
Exhaust smoke density	3.5.6	4.6.10.6	X	X	X
Fuel consumption	3.5.7	4.6.10.7	X		X
Oil consumption	3.5.8	4.6.10.8	X		X
Oil pressure	3.5.8.1	4.6.10.8.1	X	X	X
Coolant	3.5.9	4.6.10.9	X		
Limiting operating temperatures	3.5.10	4.6.10.10	X		X
Supercharger	3.5.11	4.6.10.11	X		X
Endurance	3.5.12	4.6.10.12	X		
Grades and slopes	3.6	4.6.11	X		
Submersion	3.7	4.6.12	X		
Steam and water jet cleaning	3.8	4.6.13	X		
Exterior surface treatment	3.9	4.6.14	X		
Engine nameplate	3.10	4.6.15	X	X	
Workmanship	3.11	4.6.16	X		

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4.2.1 Preproduction inspection. When specified (see 6.2), the preproduction sample shall consist of two diesel engines. Preproduction inspection shall include the examinations of 4.4 (see table IV) and the applicable tests of 4.6.1 through 4.6.16 (see table V).

4.2.2 Initial production inspection. Unless otherwise specified (see 6.2), the Government shall select two units, from the first ten engines produced under the production contract for initial production inspection. Initial production inspection shall include the examinations of 4.4 (see table IV) and the applicable tests of 4.6.1 through 4.6.16 (see table V).

4.3 Conformance inspection. Conformance inspection shall include the examinations of 4.4 and the applicable tests of 4.6.1, 4.6.10.1 through 4.6.10.11, and 4.6.15 (see table V).

4.4 Examination.

4.4.1 Sampling. Samples from an inspection lot for conformance inspection shall be selected in accordance with ANSI/ASQC Z1.4. Any redesign or modification of the contractor's standard to comply with specified requirements shall receive particular attention for adequacy and suitability. This element of inspection shall encompass all visual examinations, dimensional measurements, and functional requirements listed in table IV. Noncompliance with any specified requirement or presence of one or more defects preventing or lessening maximum efficiency shall constitute cause for rejection.

4.5 Conformance tests.

4.5.1 Acceptance tests (100 %). Each engine submitted shall be subjected to the tests specified in table V.

4.5.2 Control tests (50 hour). A 50 hour control test shall be conducted on one engine selected at random from each lot of 100 engines produced. However, not more than two engines shall be tested in any 30 day period. If production is less than 100 engines per month or on curtailed production, one engine in every 60 day period shall be tested. The engines shall be subjected to the tests as specified in table VI after being examined for deficiencies specified in table IV and shall conform to performance requirements listed in table V. The engine shall be operated for 50 hours as near continuously as possible.

4.5.2.1 Power check test. The engine shall be operated according to the schedule as listed for period 7 in table VI. The performance characteristics for the power check test shall be as listed under control test in table V.

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TABLE VI. Control test schedule (50 hour).

Period	Time (hours)	Speed (rpm)	Rack position (% of full rack)	Fuel (grade)
1 Run-in	(see 4.6.10.1)			4-D
2	5	1400	50	4-D
3	5	1800	75	4-D
4	5	2300	75	4-D
5	5	2100	100	4-D
6	30	2300	100	4-D
7 Power	check (see 4.5.2.1)			
1		1200	100	4-D
2		1400	100	4-D
3		1800	100	4-D
4		2100	100	4-D
5		2300	100	4-D

NOTE: The coolant temperature shall be maintained at $180 \pm 5^{\circ}\text{F}$ ($82.2 \pm 2.77^{\circ}\text{C}$)

4.5.3 Failure. Failure of any engine to pass any of the specified tests shall be cause for the Government to refuse acceptance of the production quantity represented, until action taken by the contractor to correct the defects and prevent recurrence has been approved by the Government.

NOTE: Any engine assembly subjected to control tests shall not be delivered to the Government as an end item of the contract until the engine has been disassembled and examined for wear and damage. Wear limits shall not exceed those specified for overhaul by the manufacturer. Scuffing, galling, or burning of parts or surfaces shall not be permitted. Subsequent to the inspection, performed above, the engine may be reassembled using all parts that meet new part drawing requirements, or replacing worn or damaged parts with new parts. Following reassembly the engine shall pass the break-in run and acceptance tests as specified herein.

4.6. Methods of inspection.

4.6.1 Materials. Conformance to 3.2 shall be determined by inspection of contractor records providing proof or certification that materials conform to requirements. Applicable records shall include drawings, specifications, design data, receiving inspection 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 shall be determined by examination for the defects listed in table IV. Examination shall be visual, tactile, or by measurement.

4.6.3 Environmental requirements verification. To determine conformance to 3.3, with the engine mounted on a dynamometer, the engine shall start within 2 minutes and meet the performance requirements of this specification under all of the following conditions or combination of conditions.

4.6.3.1 Temperature start conditions.

4.6.3.1.1 Low temperature start with aids. To determine conformance to 3.3.1.1, the base engine with integral winterization aids shall be cold started at -25°F (-31.6°C) using diesel fuel in accordance with grade 4-D of ASTM D975. Prior to start, the engines shall be cold-soaked in an ambient temperature of -25°F (-31.6°C) for a period of 24 hours. After each start the engine must operate for a sufficient amount of time to stabilize engine operation.

4.6.3.1.2 High temperature start without aids. To determine conformance to 3.3.1.2, the bare engine, without aids, shall be placed in a high temperature chamber maintained at a temperature of 115°F (46.1°C), and operated at full load until all temperatures are stabilized within the limits specified in 3.5.10. The engine shall then be shut down, hot soaked, and restarted when the fuel temperature at the inlet to the inspection pump reaches its maximum value. Fuel shall be supplied to the engine mounted fuel pump at a pressure of 5 psi (34 kPa). The fuel pressure shall be shut off during the hot soak period. The starting time shall not exceed 2 minutes.

4.6.4 Elevation conditions. To determine conformance to 3.3.2, the engine shall be placed in a simulated environmental condition of 8000 ft (2438 m) elevation with a pressure of 22.2 in. of Hg (75.2 kPa) measured at the air cleaner outlet and exhaust outlet at a temperature of 90°F (32.2°C), and its general performance characteristics observed.

4.6.5 Humidity conditions. To determine conformance to 3.3.3, verify that the engine meets all performance requirements when subjected to relative humidity conditions as low as 5 % at a temperature of 115°F (46.1°C) and as high as 100 % at all temperatures from -25 to 85°F (-31.6 to 29.4°C).

4.6.6 Electrical accessories and equipment. To determine conformance to 3.4.1, verify that electrical accessories and equipment conform to the applicable engine drawings and that the manufacturer has a certificate attesting conformance of electrical components (see 6.4).

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4.6.7 Interchangeability. To determine conformance to 3.4.2, the manufacturer shall provide a certificate attesting that all parts except assemblies requiring individual select fitting components, may be installed in a like engine without modification.

4.6.8 Air cleaner. To determine conformance to 3.4.3, verify that the air cleaner capacity and design for this engine conforms to MIL-PRF-62048 for dry types, or to the manufacturer's standard specification for oil-bath types.

4.6.9 Oil. To determine conformance to 3.4.4, verify that the engine shall operate without damage during all testing specified herein using oil as specified. Reference grade oil required for the endurance test (see 3.5.12) shall be designated as follows:

<u>Grade</u>	<u>Government designation</u>
10	MC-1065
30	MC-1066
40	MC-1115

4.6.10 Performance. Unless otherwise specified all tests specified herein shall be conducted on an engine dynamometer.

4.6.10.1 Engine break-in run. In conformance with 3.5.1, each engine shall be operated through the break-in run schedule developed by the contractor. The break-in run shall be conducted on all engines prior to further testing. Any unsatisfactory operations or conditions which require correction shall be corrected by the contractor before the engine is presented for further testing.

4.6.10.1.1 Engine break-in run inspection. To determine conformance to 3.5.1, when specified (see 6.2) at the conclusion of the break-in run the first ten engines, and every second engine of the next ten of any contract, except overlapping contracts shall be disassembled and inspected by the contractor in the presence of the Government inspector. 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 and accessory drive case.
- c. Main bearing bolt torque.
- d. Connecting rod bolt torque.
- e. Cylinder bore scuffing, scoring and galling.
- f. Piston scuffing and burning.

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4.6.10.1.2 Corrections and reassembly. To determine conformance to 3.5.1, evidence of any condition of engine or parts requiring correction, such correction shall be made by the contractor prior to reassembly of the engine and resubmission to the break-in run. In addition, the contractor shall submit objective evidence to the Government that corrective action has been taken in production to eliminate any deficiency disclosed. Failure of the contractor to submit such evidence shall be cause for refusal by the Government to continue acceptance of subsequent engines. Any engine requiring replacement parts shall be reassembled and subjected to the break-in run (see 4.6.10.1) and acceptance power check test (see 4.5.2.1). Any engine not requiring replacement parts shall be reassembled and subjected to the acceptance power check test only.

4.6.10.2 Speed range. To determine conformance to 3.5.2, verify that the engine operates satisfactorily within the speed range of 1150 to 2600 rpm, under all loads and conditions specified in 4.5.1.

4.6.10.2.1 Idle speed. To determine conformance to 3.5.2.1, verify that the range idle speed of 550 to 600 rpm is maintained using diesel fuel conforming to grade 4-D of ASTM D975.

4.6.10.3 Governor. To determine conformance to 3.5.3, verify that the full load engine speed is 2275 to 2325 rpm and the no load engine speed is not less than 2450 to 2500 rpm. When a two speed governor is installed on an engine, the governor speeds during winching operations shall be not less than 1150 rpm for full load and not more than 1350 rpm for no load. Verify in each no load case that the engine speed stabilizes within 3 seconds after a full rack position is reached.

4.6.10.4 Brake horsepower. To determine conformance to 3.5.4 and 3.5.4.1, verify that the observed brake horsepower is not less than 374 bhp at 2300 rpm when corrected to specified operating conditions, upon completion of the engine break-in run (see 3.5.1).

4.6.10.5 Torque. To determine conformance to 3.5.5, verify that the observed torque measured at the engine flywheel, upon completion of the break-in run, is not less than 885 lb-ft (1200 N-m) at 1700 rpm with a full rack setting.

4.6.10.6 Exhaust smoke density. To determine conformance to 3.5.6, verify that the exhaust smoke density measured with a smoke meter and sampling pump or visually against a white background, within 3 feet (ft) (0.9 m) of the turbocharger outlet, shall meet the conditions listed in table I or table II respectively.

4.6.10.7 Fuel consumption. To determine conformance to 3.5.7, verify that the fuel consumption does not exceed the limits specified in table III when operating at the specified full rack setting.

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4.6.10.8 Oil consumption. To determine conformance to 3.5.8, verify that the oil consumption does not exceed 0.007 lb (3.2 g) per observed bhp hour after 25 hours of full rack operation at conditions as specified in 3.5.4 and 3.5.4.1.

4.6.10.8.1 Oil pressure. To determine conformance to 3.5.8.1, verify that the engine gallery oil pressure, measured at the oil pressure sending unit, does not exceed 80 psi (551 kPa) nor is less than 35 psi (241 kPa) when the engine is operating at 2300 rpm with an oil sump temperature of not less than 180°F (82.2°C). The oil pressure when the engine is idling at 550 to 600 rpm shall be not less than 5 psi (34 kPa).

4.6.10.9 Coolant. To determine conformance to 3.5.9, verify that the engine meets all performance and operating temperature (see 3.5.10) requirements when using coolants and additives that conform to A-A-870, A-A-52624 and MIL-A-53009.

4.6.10.10 Limiting operating temperatures. To determine conformance to 3.5.10, measure engine oil sump temperature at the drain plug and the coolant temperature at the drain plug and the coolant temperature at the coolant outlet to verify limiting operating temperatures are not exceeded when operating at full load throughout the speed range of the engine.

4.6.10.11 Supercharger. To determine conformance to 3.5.11, verify that the turbo supercharger intake manifold pressure is not less than 55 in. Hg (186.25 kPa) absolute when operating at full load and 2300 rpm.

4.6.10.12 Endurance. Verify that the engine has passed the AEP-5, NATO standard 400 hour endurance laboratory test as specified in 3.5.12.

4.6.11 Grades and slopes. To determine conformance to 3.6, the engine shall start and operate on the longitudinal grades or lateral slopes up to 60 % in all directions for not less than 30 minutes. Verify that there is no evidence of inadequate lubrication, cooling, fuel supply, leakage or other malfunction.

4.6.12 Submersion. To determine conformance to 3.7, the engine shall be submerged in a tank or container of either fresh or salt water and operated for a period of 30 minutes. The air intake and exhaust systems shall be ducted to the atmosphere with an applicable crankcase fording kit. After 30 minutes of operation, and while still submerged, the engine shall be stopped for a 3 minute period and then restarted and operated for an additional 15 minutes. There shall be not more than one percent water contamination by volume evident in the lubricating oil at the conclusion of the test.

4.6.13 Steam and water jet cleaning. To determine conformance to 3.8, the engine assembly shall be steam and water jet cleaned as follows: The jet is applied perpendicular to the

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surface being cleaned at a distance not more than 1 ft (0.3 m) from the surface for steam cleaning, and not more than 5 ft (0.15 m) from the surface for water jet cleaning, and cleaned at a rate of 1 square foot per minute (ft²/min) (0.00155 m²/s). The jet pressure shall be not less than 100 psi (690 kPa) and not more than 110 psi (758 kPa). Subsequent to the cleaning operation, the engine and components shall be disassembled to the extent necessary to determine if any deterioration to seals, hose, gaskets, or driving belts exists, and to determine if any entry of water has occurred into the engine or any component. Any evidence of seals, hose gasket, or driving belt deterioration, or any sign of water entry resulting from above testing, shall be cause for rejection.

4.6.14 Exterior surface treatment. To determine conformance to 3.9, the engine assembly shall be examined to assure that there are no exposed bare metal surfaces, except for mating mounting surfaces.

4.6.15 Engine nameplate. As required by 3.10, verify that nameplates, data and instruction plates shall conform to manufacturer's specifications or to applicable drawings.

4.6.16 Workmanship. The engine assembly shall be visually examined to verify that the workmanship at all phases of fabrication, assembly and test meet all specified requirements (see 3.11).

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 of Defense Agency, or within the Military Department's System Command. Packaging data retrieval is available from the managing Military Department's or Defense Agency's automated packaging files, CD-ROM products, or by contacting the responsible packaging activity.

6. NOTES

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

6.1 Intended use. The engines covered by this specification are intended for production use as spares or replacements for military combat and tactical vehicles. Due to the extreme environmental conditions under which these engines must perform (-25 to 115°F (-31.6 to 46.1°C)), up to 100 % humidity, and up to 8000 ft (2438 m) above sea level, conditions that would cause catastrophic failure in commercial counterparts, this item is military unique.

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6.2 Acquisition data. Acquisition documents should specify the following:

- a. Title, number, 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 and 2.3).
- c. If first article samples are not required (see 3.1).
- d. If preproduction inspection is required (see 4.2.1).
- e. If initial production inspection is not required (see 4.2.2).
- f. If engine break-in inspection is required (see 4.6.10.1.1).
- g. Packaging requirements (see 5.1).

6.3 Subject term (key word) listing.

Compression ignition	Internal-combustion
Coolant	Liquid-cooled
Fuel	Oil
Horsepower	Turbo supercharged

6.4 Electrical accessories and equipment. MIL-HDBK-1184 should be used as a guideline for waterproofness of the electrical accessories and equipment of the engine.

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

Custodian:
Army - AT

Preparing Activity:
Army- AT

Review Activity:
DLA - CC

(Project 2815-0181)

STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

INSTRUCTIONS

1. The preparing activity must complete blocks 1, 2, 3, and 8. In block 1, both the document number and revision letter should be given.
2. The submitter of this form must complete blocks 4, 5, and 7.
3. The preparing activity must provide a reply within 30 days from receipt of the form.

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

I RECOMMEND A CHANGE:	1. DOCUMENT NUMBER MIL-DTL-46796C	2. DOCUMENT DATE (YYMMDD) 980930
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3. DOCUMENT TITLE Engine, Diesel: 8 Cylinder, V-Type 390 H.P.

4. NATURE OF CHANGE (*Identify paragraph number and include proposed rewrite, if possible. Attach extra sheets as needed.*)

5. REASON FOR RECOMMENDATION

6. SUBMITTER

a. NAME (<i>Last, First, Middle Initial</i>)	b. ORGANIZATION	
c. ADDRESS (<i>Include Zip Code</i>)	d. TELEPHONE (<i>Include Area Code</i>) (1) Commercial (2) AUTOVON (<i>If applicable</i>)	7. DATE SUBMITTED (YYMMDD)

8. PREPARING ACTIVITY

a. NAME	b. TELEPHONE (<i>Include Area Code</i>) (1) Commercial (810) 574-8745	(2) AUTOVON 786-8745
c. ADDRESS (<i>Include Zip Code</i>) Commander U.S. Army Tank-automotive and Armaments Command ATTN: AMSTA-TR-E/BLUE Warren, MI 48397-5000	IF YOU DO NOT RECEIVE A REPLY WITHIN 45 DAYS, CONTACT: Defense Quality and Standardization Office 5203 Leesburg Pike, Suite 1403 Falls Church, VA 22041-3466 Telephone (703) 756-2340 AUTOVON 289-2340	