INCH POUND
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DETAIL SPECIFICATION

ENGINE, DIESEL: 12 CYLINDER, 90° V-TYPE, 750 H.P., AVDS1790-2, AVDS1790-2A, AVDS1790-2C, AVDS1790-2D, AVDS1790-2DR, AVDS1790-2CA AND AVDS1790-2DA

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

1. SCOPE

1.1 Scope. This specification covers 7 types of 12-cylinder, 90° V-type, air-cooled, 4 stroke-cycle, turbo-supercharged, internal-combustion, compression-ignition (diesel) engines for use in military vehicles (see 6.1).

1.2 Classification. This engine is classified in seven configurations as follows (see 6.2):

Type I	- AVDS1790-2 (Army Drawing 8725265) furnished with air-cooled generator and associated accessory drive.
Type II	- AVDS1790-2A (Army Drawing 10912450) furnished with air-cooled generator and associated accessory drive.
Type III	- AVDS1790-2C (Army Drawing 11682700). Furnished with oil-cooled alternator and associated accessory drive.
Type IV	- AVDS1790-2D (Army Drawing 11684000) furnished with air-cooled generator and associated accessory drive.

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

Type V	- AVDS1790-2DR (Army Drawing 11684150) furnished with air-cooled generator and associated accessory drive and an auxiliary power take-off drive.
Type VI	- AVDS1790-2CA (Army Drawing 12314611) furnished with oil-cooled alternator and associated accessory drive and the Clean Air System, composed of the Dust Detector and Dust Ejector.
Type VII	- AVDS1790-2DA (Army Drawing 12314641) furnished with air-cooled generator and associated accessory drive and the Clean Air System, composed of the Dust Detector and Dust Ejector.

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 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 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 supplement thereto, cited in the solicitation (see 6.2).

SPECIFICATIONS

FEDERAL

A-A-50271	- Plates, Identification.
A-A-52524	- Seal, Plain, and Seal, Plain, Encased: Fluid, Radial, Single and Multiple Lip Sealing Member.
A-A-52557	- Fuel Oil, Diesel; For Posts, Camps And Stations.

DEPARTMENT OF DEFENSE

MIL-PRF-2104	- Lubricating Oil, Internal Combustion Engine, Combat/ Tactical Service.
MIL-PRF-10924	- Grease, Automotive and Artillery.

MIL-L-21260	- Lubricating Oil, Internal Combustion Engine, Preservative and Break-in.
MIL-L-46167	- Lubricating Oil, Internal Combustion Engine, Arctic.
MIL-PRF-46736	- Filter Element, Intake Air Cleaner: Dry Type.
MIL-PRF-62576	- Regulator, Engine Generator.

(Unless otherwise indicated, copies of the above specifications, standards, and handbooks 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 specification to the extent specified herein. Unless otherwise specified, the issues are those cited in the solicitation.

DRAWINGS

8725265	- Engine Assembly (AVDS1790-2).
10912450	- Engine Assembly (AVDS1790-2A).
11682700	- Engine Assembly (AVDS1790-2C).
11684000	- Engine Assembly (AVDS1790-2D).
11684150	- Engine Assembly (AVDS1790-2DR).
12314611	- Engine Assembly (AVDS1790-2CA).
12314641	- Engine Assembly (AVDS1790-2DA).
12354334	- Regulator - Solid State.

(Application for copies should be addressed to the U.S. Army Tank-automotive and Armaments Command, ATTN: 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 issue of the documents cited in the solicitation (see 6.2).

NATO INTERNATIONAL STAFF - DEFENSE SUPPORT DIVISION

AC/225 (Panel II) D131 (part II)	- NATO Standard Engine Laboratory Test for Diesel and Gasoline Engines.

(Application for copies should be addressed to NATO, Military Agency for Standardization (MAS), 35 Chesham Place, London SWI, 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 sample shall be subjected to first article inspection in accordance with 4.3.

3.2 Design, materials, and manufacturing processes. Unless otherwise specified, the design, materials and manufacturing process selection is the prerogative of the contractor as long as all articles submitted to the Government fully meet the operating, interface, support and ownership, and operating environment requirements specified (see 4.5.1).

3.2.1 Design and manufacturing processes. The design and construction of the diesel engine shall be in accordance with the applicable Army drawing for the engine type as follows (see 1.2, 4.5.1, 4.5.2 and 6.2):

Type I - 8725265
Type II - 10912450
Type III - 11682700
Type IV - 11684000
Type V - 11684150
Type VI - 12314611
Type VII - 12314641

3.2.2 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.

3.2.3 Greases. Engine greases shall conform to MIL-PRF-10924, where applicable (see 4.5.1).

3.2.4 Protective coatings. Exposed exterior surfaces of the engine and its components, except the turbocharger compressor housing and the fuel injection pump aluminum parts, shall be leaned, and painted or treated for corrosion resistance as specified on the applicable drawings (see 4.5.1 and 4.5.2).

3.2.5 Metals. The use of dissimilar metals in intimate metal to metal contact shall be avoided.

3.3 Operating requirements. Each engine shall provide the following functional, operational, and performance capabilities.

3.3.1 Break-in. The engine shall receive a break-in period that meets the time/speed/torque schedule specified in 4.6.2.1.12.

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

a. Fuel. Diesel fuel conforming to A-A-52557, grade DF-2 shall be used.
b. Lubricating oil. Unless otherwise specified herein, lubricating oil conforming to the seasonal requirements of MIL-PRF-2104 or MIL-L-21260 (-10 to 115 degrees Fahrenheit (°F) [(23 to 46 degrees Celsius (°C)] and MIL-L-46167 (-65 to 0°F) (-54 to -18°C) shall be used.
c. Rated operating conditions. The engine performance requirements specified in 3.3.3 through 3.3.14.1 shall be met after correction of measured parameters to the following:

1. Dry air barometric pressure:	29.92 inches (in.) mercury (Hg), (101.3 kilopascal (kPa)) Hg.
2. Fuel temperature at the secondary fuel filter:	60°F (16°C).
3. Turbocharger inlet air temperature:	60°F.

3.3.3 Leakage. The engine shall not leak fluid more than the degree defined as “droplet” (see 4.5.2 and 6.4).

3.3.4 Governor. The engine governor shall limit the engine speed as follows, (see 4.6.2.1.1):

a. Auxiliary drive operation (For AVDS1790-2DR engine only)	1750 to 1800 revolutions per minute (rpm).
b. Idle	700 to 750 rpm.
c. Speed (no load)	2600 to 2660 rpm.
d. Speed (full load)	2400 to 2450 rpm.

The engine speed shall stabilize within 30 seconds after the full power setting is reached.

3.3.5 Gross corrected brake horsepower (GCBHP). The engine shall develop not less than 735 nor more than 780 GCBHP at 2400 to 2450 rpm at the full power setting (see 4.6.2.1.2).

3.3.6 Torque. The engine shall develop the torques specified in table I at the full power setting (see 4.6.2.1.3).

TABLE I. Torque.

Speed rpm	Corrected torque lb-ft (N·m) 1/	GCBHP
1800	1770 - 1842 (2400 - 2498)	607 - 631
2400	1609 - 1707 (2182 - 2315)	735 - 780

1/ lb-ft (N·m) = pound foot (Newton meter)

3.3.7 Fuel consumption. The engine fuel consumption at the full power setting shall be as specified in table II (see 4.6.2.1.4).

TABLE II. Fuel consumption.

Speed rpm	Maximum fuel consumption lb per hp-hour (kg per hp-hour) 1/
1800	0.400 (181)
2400	0.420 (191)

1/ lb per horsepower hour = (kilogram (kg) per hp-hour)

3.3.8 Oil pressure. At an engine speed of 2400 to 2450 rpm with the engine oil temperature at 140 to 250°F (60 to 121°C) measured at the main oil gallery (oil cooler outlet), using grade 30 oil, the gallery oil pressure shall be not less than 40 pounds per square inch (psi), (275.8 kPa) nor more than 70 psi (482.7 kPa), measured at the pressure sending unit, and shall be not less than 15 psi (103.4 kPa) when the engine is idling (700 to 750 rpm) at all oil levels ranging from the “add” mark to the “full” mark on the dipstick (see 4.6.2.1.5).

3.3.9 Intake manifold pressure. The intake manifold pressure at the full power setting and at an engine speed of 2400 rpm shall be 2.05 to 2.35 times the turbocharger compressor housing inlet pressure (wet barometer reading). Variations between left and right banks shall not exceed 4 in. (13.5 kPa) Hg (see 4.6.2.1.6).

3.3.10 Exhaust smoke density. The exhaust smoke density (see 6.3) at the full power setting measured within the exhaust pipe not more than 3 feet (ft) [(0.91 meter (m)] from the turbocharger exhaust outlet flange shall be as specified in table III (see 4.6.2.1.7).

TABLE III. Exhaust smoke density.

Speed rpm	Bosch smoke meter reading or equivalent (maximum)
1800	3.5
2000	3.2
2200	2.6
2400	2.4

3.3.11 Blow-by flow. The blow-by flow at the full power setting shall not exceed 18 cubic feet per minute (ft^3/min) [(0.51 cubic meters per minute(m^3/min)] (see 4.6.2.1.8).

3.3.12 Manifold flame heater. The manifold flame heater shall ignite and sustain burning within the manifold without interruption for at least 15 seconds (see 4.6.2.1.9).

3.3.13 Air pressure. The engine shall withstand an internal air pressure of 3 psi (20.7 kPa) for 3 minutes with a pressure drop of not more than 1.75 psi (12.1 kPa). The engine shall also withstand an internal air pressure of 5 psi (34.5 kPa) with no indication of faulty seals or joints (see 4.6.2.1.10).

3.3.14 Water submergence. The engine shall operate while submerged in water to a depth of 60 in. (1.52 m) above the cooling fans. While submerged and after being stopped, the engine shall restart (see 4.6.2.1.11).

3.3.14.1 Water contamination. After the engine is submerged in water as specified in 3.3.14, there shall be not more than 2% water contamination by volume in the lubricating oil (see 4.6.2.1.11.1).

3.4 Interface requirements. Each engine shall accommodate the following inputs and interfaces.

3.4.1 Accessories and equipment. Unless otherwise specified (see 6.2), all accessories and equipment including wiring and electrical connections, shall be installed on the engine and properly adjusted (see 4.5.1, 4.5.2 and 6.7).

3.4.2 Weight. The engine (including the generator/alternator) shall weigh no more than 5080 lb (2304 kg) (dry weight) (see 4.6.3.1).

3.4.3 Oil seals. Oil seals shall conform to class 3 of A-A-52524 (see 4.5.1).

3.4.4 Interchangeability of parts. Component assemblies and parts of the engines shall be so constructed that any part, except those furnished in matched sets or for which a selection fit is specified, may be installed, replaced, and adjusted without requiring modification (see 4.5.2).

3.4.5 Electrical and mechanical interfaces. The engine envelope, dimensions, mountings, electrical and mechanical interfaces all shall conform to the applicable Drawings below:

8725265	11684150
10912450	12314611
11682700	12314641
11684000	

3.5 Support and ownership requirements. Each engine shall possess the following life cycle ownership characteristics.

3.5.1 Endurance. The engine shall retain 90% of the rated power after being subjected to a 400-hour endurance test cycle, operating in an operating profile scenario (see 4.6.4.1).

3.5.2 Identification marking. Parts requiring identification shall be identified in accordance with the requirements of the specific product drawings (see 4.5.2).

3.5.3 Nameplates. Unless otherwise specified in applicable drawings (see 6.2), the nameplate, data and instruction plates shall conform to A-A-50271 (see 4.5.2).

3.5.4 Workmanship/safety. Manufacturing techniques shall not cause the degradation of inherent engine reliability or durability, and shall pose no hazards, physically or electrically to personnel operating the engine (see 4.5.2 and 4.6.4.2)

3.6 Operating environment requirements. Each engine shall operate under the following environmental conditions, without degradation in performance.

3.6.1 Extreme-temperature starting ability. The engine shall start under the following conditions (see 4.6.5.1):

a. After being cold-soaked to an ambient temperature of -25°F (-32°C) without external aids or benefit of solar radiation. (Cold-soak is to reduce the temperature of the engine, fuel, and lubricating oil to within 5°F (-2.8°C) of the ambient air temperature).
b. After being cold-soaked to an ambient temperature of -65°F, with the winterization kit preheating the cold-soaked batteries and lubricating oil to -25°F.
c. After being operated at an ambient temperature of 115°F with exposure to maximum solar radiation with the lubricating oil at the maximum attainable temperature up to 250°F measured at the main oil gallery (oil cooler outlet).

3.6.2 High-temperature operation. Engine temperatures shall not exceed the following limits when operating at the maximum GCBHP full power setting (see table II) with an air inlet temperature of 115°F (see 4.6.5.2):

a. Lubricating oil temperature (measured at the main oil gallery; oil cooler outlet) 250°F

b. Exhaust gas temperature (measured at individual cylinder ports; temperature variation between cylinders shall not exceed 150°F (66°C) under full power setting).	1250°F (677°C)

3.6.3 Low pressure. The engine shall output not less than 75% of the rated power during exposure to ambient conditions equivalent to altitudes up to 8000 ft (2438 m) (see 4.6.5.3).

3.6.4 Grades and slopes. The engine shall operate satisfactorily on longitudinal grades up to 60% and on lateral slopes up to 36% with no evidence of faulty lubrication, cooling, fuel supply, or leakage (see 4.6.5.4).

4. VERIFICATION

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

a. First article inspection (see 4.3).
   1. Preproduction inspection (see 4.3.1).
   2. Initial production (see 4.3.2).

b. Conformance inspection (see 4.4).
   1. Examination (see 4.4.2).
   2. Tests (see 4.4.3).

4.2 Inspection conditions. Unless otherwise specified (see 6.2), all inspections shall be conducted under the following condition:

Air temperature: 55°F (13°C) to 100°F (38°C).

4.3 First article inspection. First article inspection shall be performed on preproduction and initial production samples as specified herein, except where production of engines is continuously maintained, then the most recent first article inspection and first article endurance or NATO endurance cycle test shall be sufficient. Approval of the first article sample by the Government shall not relieve the contractor of the obligation to supply engines that are fully representative of those inspected as a first article sample. Any changes or deviation of the production units from the first article sample shall be subject to the approval of the contracting officer.

4.3.1 Preproduction inspection. When specified (see 6.2), the preproduction sample shall consist of one engine of each type (see 1.2). Preproduction inspection shall consist of inspection as specified in table IV.

4.3.2 Initial production inspection. Unless otherwise specified (see 6.2), the Government shall randomly select one engine from the first ten engines of each type (see 1.2) produced under

the production contract for initial production inspection. The initial production sample shall be inspected as specified in table IV.

4.3.3 First article inspection failure. Deficiencies found during, or as a result of, the first article inspection shall be cause for rejection of the first article sample until evidence has been provided by the contractor that corrective action has been taken to eliminate the deficiency. Any deficiency found during, or as a result of, the first article inspection shall be evidence that all items already produced prior to completion of the first article test are similarly deficient unless contrary evidence satisfactory to the contracting officer is furnished by the contractor. Such deficiencies on all items shall be corrected by the contractor. The Government shall not accept products until first article inspection is completed to the satisfaction of the Government.

4.4 Conformance inspection (CI). CI shall include the examination of 4.4.2 and the tests of 4.4.3. Noncompliance with any of the specified requirements in sections 3 and 5 shall be cause for rejection of the sample and the inspection lot.

4.4.1 Sampling plan. The sampling plan to be used shall be per the contract or purchase order (see 6.2).

4.4.2 Examination. The sample selected in accordance with 4.4.1 shall be examined and defects classified as specified in table V (see 4.5.2). The acceptance number in all cases is zero.

4.4.3 Tests. Each item shall be subjected to the tests specified in table IV.

4.4.4 Conformance inspection examination failure. Any item that fails to conform to any specified requirement shall be rejected; and failure (one or more) of the selected sample in either the Major/Minor categories or test for the appropriate inspection lot size shall constitute a failure of the entire lot.

4.5 Methods of inspection.

a. Unless otherwise specified herein, AVDS1790-2, -2A, -2D, -2DR, and -2DA engine testing shall be performed on a bare engine (see 6.5). Testing of the bare engine, when specified with external electrical loading, shall be performed with a voltage regulator conforming to MIL-PRF-62576 in the generator electrical circuit.
b. Unless otherwise specified herein, AVDS1790-2C and -2CA engine testing shall be performed on a basic engine (see 6.5). Testing of the basic engine, with field excitation and minimum external electrical loading, shall be performed with a voltage regulator conforming to Army Drawing 12354334 in the alternator electrical circuit.

TABLE IV. Classification of inspections.

Title	Requirement	Inspection	First article	Conformance	
				Examination	Acceptance 100%
Group A:	3.2, thru 3.2.5, 3.4 thru	4.5.1	X		X
Materials and construction	3.4.5, and 3.5 thru 3.5.4				
Defects (see table V)	3.2.1, 3.2.4, 3.3.3, 3.4.1, and 3.5.2 thru 3.5.4	4.5.2	X	X	
Weight	3.4.2	4.6.3.1	X		
Group B (Performance):					
Leakage	3.3.3	4.5.2	X		X
Governor	3.3.4	4.6.2.1.1	X		X
Gross horsepower	3.3.5	4.6.2.1.2	X		X
Torque	3.3.6	4.6.2.1.3	X		X
Fuel consumption	3.3.7	4.6.2.1.4	X		X
Oil pressure	3.3.8	4.6.2.1.5	X		X
Intake manifold pressure	3.3.9	4.6.2.1.6	X		X
Exhaust smoke density	3.3.10	4.6.2.1.7	X		X
Blow-by flow	3.3.11	4.6.2.1.8	X		X
Manifold flame heater	3.3.12	4.6.2.1.9	X		X
Air pressure	3.3.13	4.6.2.1.10	X		X
Water submergence	3.3.14	4.6.2.1.11	X		
Water contamination	3.3.14.1	4.6.2.1.11.1	X		
Endurance	3.5.1	4.6.4.1	X		
First article	3.5.1	4.6.4.1.1	X		
NATO cycle	3.5.1	4.6.4.1.2	X		
Group C (Environmental):					
Extreme temperature starting ability	3.6.1	4.6.5.1	X		
High temperature	3.6.2	4.6.5.2	X		
Low pressure	3.6.3	4.6.5.3	X		
Grades and slopes	3.6.4	4.6.5.4	X		
Group D (Life):					
Borescope inspection	3.5.4	4.6.4.2	X		X 1/

1/ This test shall be performed only on one (1) engine randomly selected of each 24 engines built.

TABLE V. Classification of defects.

Category	Defect	Method of examination
Critical	None	
Major:		
101	Assembly, incomplete (see 3.2.1).	Visual
102	Dimensions affecting interchangeability (see 3.2.1).	SIE 1/
103	Leakage, excessive (see 3.3.3 and 6.4).	Visual
104	Linkage, improperly adjusted (see 3.4.1).	Visual
105	Identification marking, improper (see 3.5.2 and 3.5.3).	Visual
106	Faulty workmanship affecting performance (see 3.5.4).	Visual
Minor:		
201	Dimensions not affecting interchangeability (see 3.2.1).	SIE
202	Paint, improper application (see 3.2.4).	Visual
203	Faulty workmanship affecting appearance (see 3.5.4).	Visual

1/ SIE = Standard Inspection Equipment

4.5.1 Materials and construction. Conformance to 3.2, 3.2.1, 3.2.3, 3.2.4, 3.4.1, and 3.4.3 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 inspection records, processing and quality control standards, vendor catalogs and certifications, industry standards, test reports, and rating data.

4.5.2 Defects. Conformance to 3.2.1, 3.2.4, 3.3.3, 3.4.1, 3.4.4, 3.5.2 through 3.5.4 and 4.4.2 shall be determined by examination for the defects listed in table V. Examination shall be visual, tactile, or by measurement with standard inspection equipment (SIE).

4.6 Verification methods. The types of verification methods included in this section are visual, inspection, measurement, sample tests, full-scale demonstration tests, simulation, modeling, engineering evaluation, component properties analysis, and similarity to previously-approved or previously-qualified designs.

4.6.1 Verification alternatives. The manufacturer may propose alternative test methods, techniques, or equipment, including the application of statistical process control, tool control, or cost-effective sampling procedures, to verify performance. See the contract for alternatives that replace verifications required by this specification.

4.6.2 Operating requirements verification.

4.6.2.1 Performance tests. The performance tests may be run concurrently with the break-in specified in 3.3.1. The engine performance shall be required under the following conditions:

a. The engine speeds shall be governed as specified in 3.3.4.
b. The engine shall function with external interface inputs as follows:

Fuel supply flow rate (minimum)	1400 lb (635 kg) per hour at 2400 rpm.
Fuel supply pressure (minimum)	3 psi.
Combustion air restriction (maximum)	20 in. (0.51 m) of water (1.5 in. Hg) at 2400 rpm.
Intake air filter	Equal to the requirements of MIL-PRF-46736.
Cooling airflow	24 000 ft^3/min (672 m^3/min) approximate.

c. Diesel fuel conforming to A-A-52557, grade DF-2 shall be used. MIL-L-21260, type I (-10 to 115°F) and MIL-L-46167 (-65 to 0°F) shall be used.

4.6.2.1.1 Governor. To determine conformance to 3.3.4, a bare/basic engine (see 6.5) shall be operated at full power rpm, high idle rpm, and low idle rpm. On the AVDS1790-2DR engine only, the rpm of the auxiliary drive operation shall be checked.

4.6.2.1.2 Gross hp. To determine conformance to 3.3.5, the engine shall be operated at 400 to 2450 rpm at the full power setting. The corrected gross hp shall be calculated and recorded.

4.6.2.1.3 Torque. To determine conformance to 3.3.6, the engine shall be operated at 1800 and 2400 rpm at the full power setting. The corrected torque is a value that can be calculated from the GCBHP.

4.6.2.1.4 Fuel consumption. To determine conformance to 3.3.7, the engine shall be operated at 1800 and 2400 rpm at the full power setting under full load. The corrected fuel consumption shall be calculated and recorded.

4.6.2.1.5 Oil pressure. To determine conformance to 3.3.8, the engine shall be operated at 2400 rpm with the oil temperature at 140 to 250°F measured at the main oil gallery (oil cooler outlet). The oil pressure shall be measured and recorded. Also, when the engine is idling, the oil pressure shall be measured and recorded.

4.6.2.1.6 Intake manifold pressure. To determine conformance to 3.3.9, the engine shall be operated at 2400 rpm at the full power setting. The intake manifold pressure shall be measured and recorded.

4.6.2.1.7 Exhaust smoke density. To determine conformance to 3.3.10, the engine shall be operated at 1800, 2000, 2200, and 2400 rpm at the full power setting. The exhaust smoke density shall be measured not more than 3 ft from the turbocharger exhaust outlet flange and recorded.

4.6.2.1.8 Blow-by flow. To determine conformance to 3.3.11, the engine shall run at 2400 rpm at the full power setting with a blow-by flow meter or equivalent.

4.6.2.1.9 Manifold flame heater (if applicable). To determine conformance to 3.3.12, the engine shall be cranked and the manifold flame heater shall be checked if it has been energized. The results shall be recorded.

4.6.2.1.10 Air pressure. To determine conformance to 3.3.13, all engine openings shall be closed to ambient with appropriate plugs and covers. A port shall be provided for applying air pressure into the engine crankcase with a gage and a shut-off valve. An air pressure of 3 psi shall be applied for 3 minutes. Any pressure drop shall be measured. Also, an air pressure of 5 psi shall be applied, and checked for any indication of faulty seals or joints.

4.6.2.1.11 Water submergence. To determine conformance to 3.3.14, the engine shall be operated for 30 minutes while submerged in water (fresh water or 4% by volume salt water) to a depth of 60 in. above the cooling fans with the intake and exhaust ducted to the atmosphere. The engine shall then be stopped for 3 minutes and shall then be restarted for an additional 15 minutes. The basic engine (see 6.5) shall operate with field excitation only to the alternator, which shall operate at no load. The results shall be recorded.

4.6.2.1.11.1 Water contamination. To determine conformance to 3.3.14.1, the water contamination in the lubricating oil shall be measured and recorded after the engine is subjected to the test specified in 4.6.2.1.11.

4.6.2.1.12 Break-in. To determine conformance to 3.3.1, the engine shall follow the break-in schedule in table VI.

4.6.3 Interface requirements verification.

4.6.3.1 Weight. To determine conformance to 3.4.2, the engine, including the generator or alternator, shall be weighed (dry weight).

TABLE VI. Break-in schedule.

Run number	Time minutes	Speed rpm	Torque lb ft (N·m)
1	10	Idle 700-750	Warm up
2	15	1000	85 (115)
3	15	1400	440 (597)
4	20	1800	837 (1135)
5	20	2200	1024 (1389)
6	20	2400	1092 (1481)
7	30	2400	1202 (1630)
8	30	2400	Full power setting
9	5	2400	Full power setting
10	5	2200	Full power setting
11	5	2000	Full power setting
12	5	1800	Full power setting

NOTES:

-Bare engine shall operate without generator (see 6.5).
-Basic engine shall operate with alternator and field excitation only (see 6.5).
-Engine shall operate on its designed oil system, not on a test cell oil system.
-Check for low idle at 700 to 750 rpm - adjust if necessary.
-Inspect visually for air, exhaust, oil, and fuel leaks.
-Check governor high idle speed at 2600 to 2660 rpm (no load, dynamometer water off). If adjustment is required, recheck the horsepower at 1800 and 2400 rpm at the full power setting.
-The governor shall be resealed after adjustment.

4.6.4 Support and ownership requirements verification.

4.6.4.1 Endurance. To determine conformance to 3.5.1, the engine shall be subjected to an applicable test as follows.

4.6.4.1.1 First article. The engine shall be tested as specified in table VII for 20 cycles. The engine shall require only minor services (such as replacing oil or fuel filter elements) during these runs. Adjustments or replacement of parts must have approval by the Government. The test shall be conducted under the following conditions:

a. Running time less than 30 minutes shall not be counted toward the fulfillment of endurance hours.
b. The inlet air temperature shall be not less than 60°F nor more than 100°F.

c. Electrical loading:
   1. Bare engine (see 6.5). A bare engine shall have a 300 ampere (A) direct current (dc) generator installed with an applicable voltage regulator. The generator shall operate at 100 ± 10 A throughout the test.
   2. Basic engine (see 6.5). A basic engine, with the applicable voltage regulator, shall have its generator (alternator) operated at 200 ± 10 A throughout the test.
d. After the break-in and before initiation of the test, the engine shall be borescope inspected and the condition of the cylinders recorded.
e. The engine shall operate on its designed oil system, not on a test cell system. At specified idle periods, engine lubricating oil level shall be checked with engine dipstick and oil shall be added to reach full mark on dipstick. Quantity of oil added shall be recorded. At the end of every 5th test cycle, brake specific oil consumption (BSOC) shall be calculated based on total oil used and average horsepower hours. Oil consumption shall not exceed 0.0075 pound per brakehorsepower-hour (lb/bhp-hr), (0.0034 kg/bhp-hr).

4.6.4.1.1.1 Engine endurance test results. The following engine parameters shall be observed/measured based on engine endurance testing and monitored at the end of watch 10 minute or longer period of the 20-hour cycle, and just prior to each stopping of the engine (emergency stops excluded) except as noted:

a. Engine speed, rpm.
b. Engine load, torque, lb- ft.
c. Intake manifold pressure, in. of Hg.
d. Lubricating oil pressure, (main oil gallery), psi.
e. Crankcase pressure, in. of water.
f. Lubricating oil temperature, °F (sump).
g. Blow-by, ft^3/min.
h. Fuel flow, lb per hour.
i. Fuel pressure after secondary fuel filter, psi.
j. Fuel temperature at secondary fuel filter, °F.
k. Air temperature at air cleaner inlet, °F.
l. Test cell ambient air temperature, °F.
m. Specific oil consumption, lb per gross hp-hour, at end of every 5th test cycle (see table VII).
n. Generator/Alternator, volts and amperes.

In addition to the above, the following shall also be monitored:

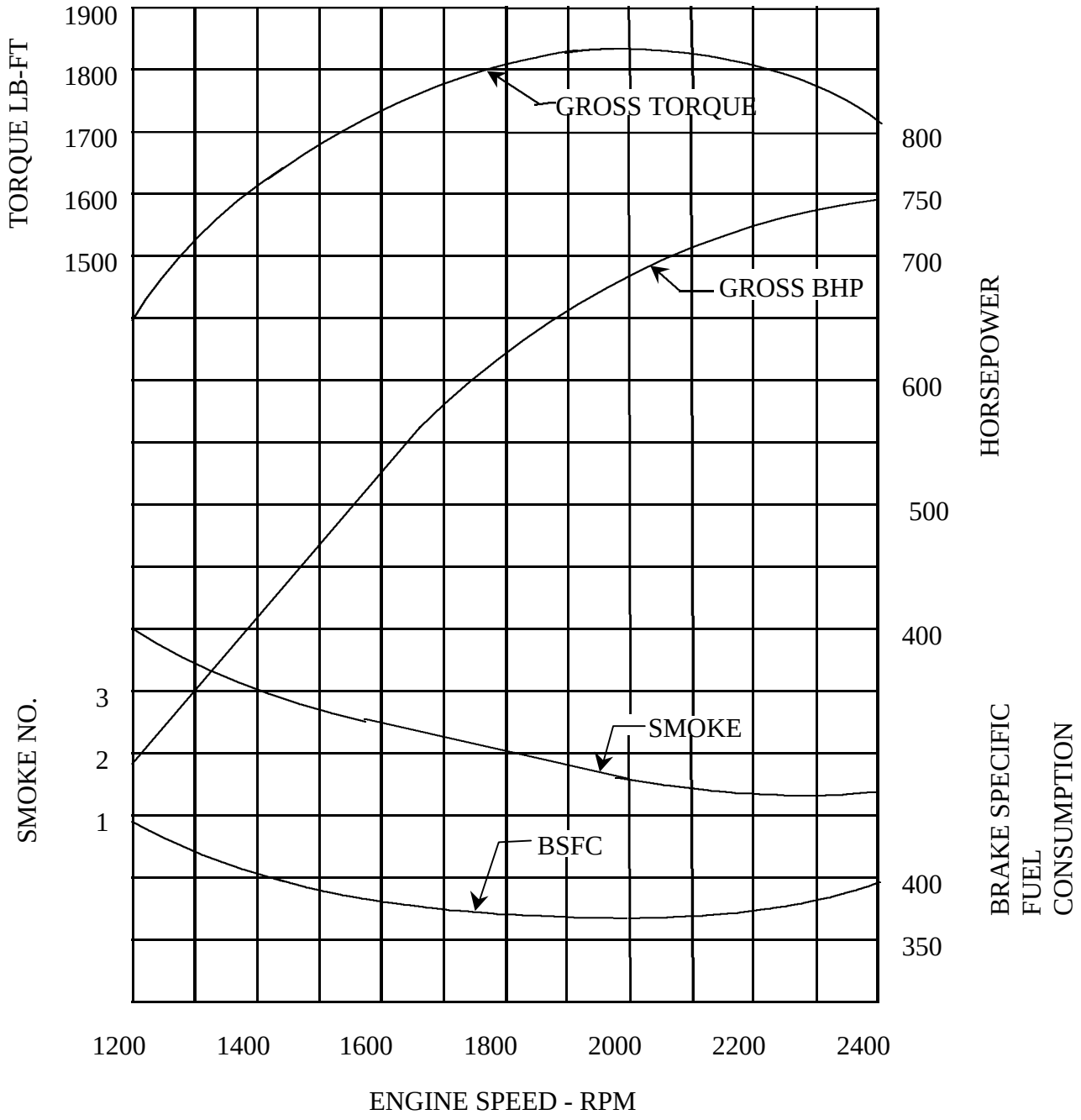
o. Barometric pressure of test cell-once each 4-hour period.
p. Exhaust smoke density-once each 50-hour period, ±5 hours.
q. Lubricating oil quantity (quarts) added at idle periods 17, 46, 72, and 90.

r. At the start and end of test and at the end of every 5th cycle, a full power setting corrected performance test curve (see figure 1 for a sample) shall be plotted from measurements taken at a minimum of seven speed settings in descending order, the first setting being at rated speed. The speeds to be run shall include 1200, 1400, 1600, 1800, 2000, 2200, and 2400 rpm.

4.6.4.1.1.2 Test cycle. The test cycle shall be as specified in table VII.

4.6.4.1.2 NATO cycle. When specified (see 6.2), the test according to 4.6.4.1.1.2. shall not be required, and the first article test shall be the NATO cycle specified in 4.6.4.1.2.2. The engine shall require only minor services (such as replacing oil or fuel filter elements) during this test. Adjustments or replacement of parts must have approval by the Government. The test shall be conducted under the following conditions:

a. Running time less than 30 minutes shall not be counted toward the fulfillment of endurance hours.
b. The inlet air temperature shall be not less than 60°F nor more than 100°F.
c. The engine shall be operated with the same cooling airflow as prevailed during the full power setting (run number 8 of table VI).
d. Electrical loading:
    1. Bare engine (see 6.5). The bare engine shall have a 300 A dc generator installed with an applicable voltage regulator. The generator shall operate at 100 ± 10 A throughout the test.
    2. Basic engine (see 6.5). The basic engine, with the applicable voltage regulator, shall have its generator (alternator) operated at 200 ± 10 A throughout the test.
e. The lubricating oil and oil filter elements shall be replaced at the end of 20 completed cycles (100 hours).
f. After the break-in and before initiation of the test, the engine shall be borescope inspected and the condition of the cylinders recorded.



(Corrected to 29.92 in. Hg (abs.) Pressure and
60° F Temperature Ambient)

FIGURE 1. Sample of a full power setting corrected performance test curve.

TABLE VII. First article endurance test cycle.

Period number	Period length (minutes)	Gross hp	rpm	Period number	Period length (minutes)	Gross hp	rpm
1	Start	0	0	47	30	300	1600
2	5		Idle	48	5		Idle
3	5	300	1600	49	30	750	2400
4	120	600	2000	50	5		Idle
5	5	300	1600	51	5		Stop
6	5		Idle	52	5		Idle
7	5		Stop	53	15	460	1800
8	5		Idle	54	5		Idle
9	5	300	1600	55	5		Stop
10	25	720	2200	56	30	550	1900
11	5		Idle	57	5		Idle
12	50	650	2100	58	35	460	1800
13	5		Idle	59	5		Idle
14	5		Stop	60	20	550	1900
15	5		Idle	61	5		Idle
16	15	200	2400	62	15	200	1400
17	5		Idle	63	5		Idle
18	5		Stop	64	5	300	1600
19	5	200	1400	65	5		Idle
20	5		Idle	66	5		Stop
21	30	200	1400	67	40	300	1600
22	5		Idle	68	5		Idle
23	25	600	2000	69	20	460	1800
24	5		Idle	70	5		Idle
25	5		Stop	71	10	200	1400
26	100	600	2000	72	5		Idle
27	5		Idle	73	5		Stop
28	5		Stop	74	5	300	1600
29	5		Idle	75	5		Idle
30	15	750	2400	76	30	300	1600
31	5		Idle	77	5		Idle
32	15	650	2100	78	15	750	2400
33	5		Idle	79	5		Idle
34	5	300	1600	80	5		Stop
35	5		Idle	81	10	750	2400
36	5		Stop	82	5		Idle
37	5		Idle	83	25	550	1900

TABLE VII. First article endurance test cycle - Continued.

Period number	Period length (minutes)	Gross hp	rpm	Period number	Period length (minutes)	Gross hp	rpm
38	5	300	1600	84	5		Idle
39	5		Idle	85	15	300	1600
40	30	750	2400	86	5		Idle
41	5	460	1800	87	70	750	2400
42	60	750	2400	88	5		Idle
43	5		Idle	89	5	200	1400
44	5		Stop	90	30		Idle
45	5	300	1600	91	Stop	0	0
46	5		Idle	20.5 hours			

4.6.4.1.2.1 NATO endurance test results. During the NATO standard engine test AC/225 (panel II) D 131 (part II), the engine performance and other characteristics (parameters) shall be measured/calculated and monitored as follows:

a. Pre- and post-test performance. Before and after the test, and at the end of each 100 hour period, a full power setting corrected performance test curve (see figure 1 for a sample) shall be plotted from measurements taken at a minimum of seven speed settings in descending order, the first setting being at the rated speed. The speeds to be run include 1200, 1400, 1600, 1800, 2000, 2200 and 2400 rpm.
b. Oil consumption. The quantity of oil in the engine shall be checked with the engine dipstick at the idle period of each 5-hour cycle and oil shall be added to reach full mark on dipstick. Quantity of oil added shall be recorded. Brake specific oil consumption shall be calculated every 50 hours based on oil used and average horsepower hours run.
c. Fuel leakage. At the conclusion of each 100-hour test period, the engine cooling fans shall be removed and fuel injection lines, nozzles, pumps, etc. shall be visually inspected for defects and fuel and oil leaks, and the results recorded.
d. Engine output checks. At the conclusion of each 100 hour test period, the engine shall be operated at 2400 rpm full power setting. The fuel flow shall be checked and adjusted within 2 pounds per hour (lb/hr) (0.907 kg/hr) of that observed for the pre-test performance test specified in 4.6.4.1.2.1.a. The details of any adjustments made shall be recorded. Then the engine output shall be calculated and recorded.
e. Engine parameters. The following engine parameters shall be monitored at the end of period numbers 2, 4, 5, and 6 of the test except as noted:
    1. Engine speed, rpm.
    2. Engine load, torque, lb-ft.
    3. Intake manifold pressure, in. of Hg.

4. Lubricating oil pressure, (main oil gallery), psi.
5. Crankcase pressure, in. of water.
6. Lubricating oil temperature, °F.
7. Blow-by, ft^3/min.
8. Fuel flow, lb per hour.
9. Fuel pressure after secondary fuel filter, psi.
10. Fuel temperature at secondary fuel filter, °F.
11. Air temperature at air cleaner inlet, °F.
12. Test cell ambient air temperature, °F.
13. Specific oil consumption, lb per gross hp-hour, at 50-hour intervals.
14. Generator/Alternator, volts and amperes.
15. Lubricating oil quantity (quarts) added at idle periods.

In addition to the above, the following shall also be monitored:

16. Barometric pressure of test cell-once one 4-hour period.
17. Exhaust smoke density-once each 50-hour period, ± 5 hours.

f. Smoke. The smoke at the rated power and speed shall be monitored and shall not exceed a 3.5 Bosch rating throughout the test (see 6.3).
g. Disassembly. At the completion of the post-test performance test specified in 4.5.4.12.2.1.a, the engine shall be disassembled completely (as required) for visual inspection for evidence of wear or stress, and the recorded results published for corrective action as required. Depot Maintenance Work Requirement (DMWR) accept and reject procedures are the basis of inspection criteria.

4.6.4.1.2.2 Test cycle. The test cycle shall be 400 hours divided into 4 periods of 100 hours each. Each 100-hour period shall consist of twenty 5-hour cycles. Each 5-hour cycle shall be as follows:

Period	Engine speed	Power	Endurance hours
1	Idle	0	0.5
2	2000	100	1.0
3	2400	0	0.5
4	1800	85	1.0
5	2400	50	0.5
6	2400	100	1.0
7	1200	25	0.5
		Total endurance	5.0

NOTE: In percentage of full power setting gross hp at respective speed

Endurance hours	Electrical loading -2, -2A, -2D, -2DR or -2DA engine	-2C or -2CA engine
0-100	100 ± 10 A	300 ± 10 A
101-200	200 ± 10 A	400 ± 10 A
201-300	200 ± 10 A	500 ± 10 A
301-400	300 ± 10 A	650 ± 10 A

4.6.4.2 Borescope inspection. To determine conformance to 3.5.4, the engine shall be borescope inspected and the condition of the cylinders recorded.

4.6.5 Operating environment requirements verification.

4.6.5.1 Extreme temperature starting ability. To determine conformance to 3.6.1, the engine shall be subjected to the following tests:

a. The engine shall be cold-soaked to an ambient temperature of -25°F. Then, without external aids or benefit of solar radiation, the engine shall be started.
b. The engine shall be cold-soaked to an ambient temperature of -65°F with the winterization kit preheating the cold-soaked batteries and lubricating oil to -25°F). Then the engine shall be started.
c. The engine shall be operated at the full power setting and at an ambient temperature of 115°F with exposure to maximum solar radiation until the lubricating oil reaches the maximum attainable temperature up to 250°F measured at the main oil gallery (oil cooler outlet). Then the engine shall be stopped, and restarted.

4.6.5.2 High temperature operation. To determine conformance to 3.6.2, the engine shall be operated at the maximum GCBHP (see table I) with a maximum air inlet temperature of 115°F. The lubricating oil temperature shall be measured at the main oil gallery (oil cooler outlet), and the exhaust gas temperature at each cylinder port.

4.6.5.3 Low pressure. To determine conformance to 3.6.3, the engine shall be operated at the following ambient conditions:

Elevation ft (m)	Pressure in. of Hg (cm of Hg)	Temperature
3000 (914)	26.8 (68.1)	115°F
4000 (1219)	25.8 (65.5)	108°F (42°C)
5000 (1524)	24.9 (63.2)	100°F
6000 (1829)	24.0 (61)	97°F (36°C)
7000 (2134)	23.1 (58.7)	93°F (34°C)
8000 (2438)	22.2 (56.4)	90°F (32°C)

4.6.5.4 Grades and slopes. To determine conformance to 3.6.4, the engine shall be operated for not less than 30 minutes in each position of forward and backward inclinations of 60% (31.0 degrees) and of left and right inclinations of 36% (19.8 degrees).

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.

6. NOTES

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

6.1 Intended use. The AVDS1790 series of engines as classified in 1.2 are intended to be used for production, as spares, or as replacements in military combat and tactical transport vehicles. These series of engines are military unique because they are used on military combat vehicles that must operate satisfactorily and reliably at extreme ambient temperatures of -65°F to 115°F.

6.2 Acquisition requirements. Acquisition documents must specify the following:

a. Title, number, and date of this specification.
b Type of engine, applicable Army drawing no. (see 1.2 and 3.2.1).
c. 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).
d. If a first article sample is required (see 3.1).
e. If all accessories and equipment will not be installed on engines and adjusted (see 3.4.1).
f. If nameplates will be other than as specified (see 3.5.3).
g. If inspection conditions will be other than as specified (see 4.2).
h. Arrangements for first article inspection and rights of the Government (see 4.3.1 and 4.3.2).
i. When first article preproduction inspection is other than as specified (see 4.3.1).
j. If initial production inspection is other than as specified (see 4.3.2).
k. Sampling plan (see 4.4.1).

l. If the first article test will be the NATO cycle (see 4.6.4.1.2).
m. Packaging requirements (see 5.1).
n. Engine diesel type; applicable drawing no., title, date, part number (see 6.6).

6.3 Exhaust smoke measurement. A Bosch model EFAW 68 smoke meter or equal (as approved by the Government), and model EFAW 65 sampling pump or equal (as approved by the Government) have been found satisfactory in determining the degree of smoke density. The following may be used to visually define the degree of exhaust smoke density in lieu of the smoke meter:

Description of exhaust smoke	Classification
Clear	1
Haze	2
Light Gray	3
Medium Gray	4
Dark Gray to Black	5

NOTE: Observation of exhaust smoke should be made against a white background within 3 ft of the exhaust outlet (see 3.3.10 and 4.6.2.1.7).

6.4 Leakage. The following definitions will be used for leakage (see 3.3.1 and 4.5.2).

a. Weep. Slight loss of fluid which causes staining or discoloration of surfaces (usually dry to the touch).
b. Seep. Any recurring evidences of fluid that does not result in the formation of a droplet (usually moist to the touch).
c. Droplet. Loss of fluid which forms no more than one drop per hour.
d. Leak. Loss of fluid which forms more than one drop per hour.

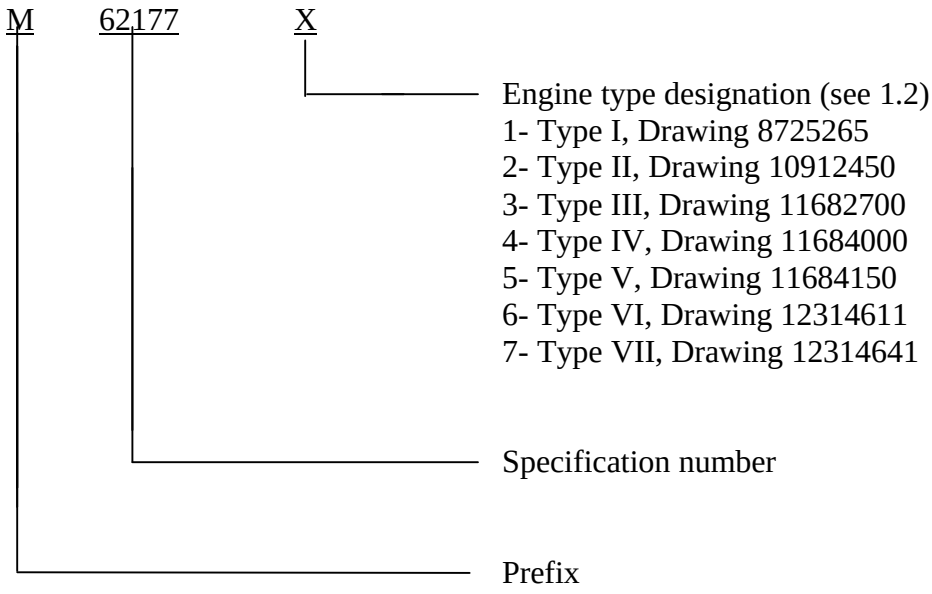
The term “drop” is defined as a volume of fluid equal to 0.05 cm^3.

6.5 Engine configuration.

a. Bare engine. The term “bare engine” is defined as a -2, -2A, -2D, -2DR, or -2DA engine without air cleaners, mufflers or generator and less all other power consuming accessories not considered essential for the operation of the engine. In addition, the -2DA “bare engine” excludes the Dust Ejector of the Clean Air System.
b. Basic engine. The term “basic engine” is defined as a -2C or -2CA engine without air cleaners or mufflers but with a generator (alternator) operated with field excitation and minimum external electrical load. In addition, all other power consuming accessories not considered essential for the operation of the engine are

excluded. The -2CA "basic engine" also excludes the Dust Ejector of the Clean Air System.

6.6 Part or identifying number (PIN). The PINs to be used for engines acquired to this specification are created as follows:



6.7 Accessories and equipment. MIL-HDBK-1184 may be used as a guide for electrical component waterproofness testing (see 3.4.1).

6.8 Subject term (key word) listing.

Blow-by
Compression-ignition
Fuel
Horsepower
Internal-combustion

6.9 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.

Custodian:
Army - AT

Preparing Activity:
Army - AT

Review Activity:
DLA - CC

(Project 2815-0180)

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-62177E	**2. DOCUMENT DATE *(YYMMDD)*** 980917

3. DOCUMENT TITLE

Engine Diesel: 12 cylinder, 90° V-Type, 750 HP

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

8. PREPARING ACTIVITY

a. NAME	**b. TELEPHONE *(Include Area Code)*** **(1) Commercial** **(2) AUTOVON** **(810) 574-8745** **786-8745**
c. ADDRESS *(Include Zip Code)* **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**