

INCH-POUND

MIL-PRF-62177D

7 May 1996

SUPERSEDING

MIL-E-62177C(AT)

23 February 1995

PERFORMANCE SPECIFICATION

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

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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1.2 Classification. This engine is classified in seven configurations as follows:

- | | |
|----------|--|
| 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. |
| 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 Specification, 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).

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SPECIFICATIONS

FEDERAL

- A-A-50271 - Plates, Identification, Instruction and Marking, Blank.
- A-A-52557 - Fuel Oil, Diesel.

DEPARTMENT OF DEFENSE

- MIL-L-2104 - Lubricating Oil, Internal Combustion Engine, Combat/Tactical Service.
- MIL-L-21260 - Lubricating Oil, Internal Combustion Engine, Preservative and Break-in.
- MIL-S-45005 - Seal, Plain, and Seal, Plain, Encased: Fluid, Radial, Single and Multiple Lip Sealing Member, Spring-Loaded.
- MIL-L-46167 - Lubricating Oil, Internal Combustion Engine, Arctic.
- MIL-F-46736 - Filter Element, Intake Air Cleaner: Dry Type.
- MIL-R-62576 - Regulator, Engine Generator.
- MIL-G-81322 - Grease, Aircraft, General Purpose, Wide Temperature Range.

STANDARDS

DEPARTMENT OF DEFENSE

- MIL-STD-193 - Painting Procedures and Marking for Vehicles, Construction Equipment, Material Handling Equipment, and Spare Parts.
- MIL-STD-1184 - Electrical Components for Automotive Vehicles; Waterproofness Tests.

(Unless otherwise indicated, copies of the federal and military specifications and standards 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 document to the extent specified herein. Unless otherwise specified, the issues are those cited in the solicitation.

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DRAWINGS

ARMY

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/BUE, Warren, MI 48397-5000.)

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. Materials shall be as specified herein, in applicable standards, drawings, or specifications (see 4.5.1).

3.2.1 Greases. Engine greases shall conform to MIL-G-81322, where applicable (see 4.5.1).

3.2.2 Recycled, virgin, and reclaimed materials. There are no requirements for the exclusive use of virgin materials; however, all materials shall be new and unused. The use of recycled or reclaimed (recovered) materials is acceptable provided that all other requirements of this specification are met (see 6.5.1).

3.3 Design and construction. 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, 4.5.2, and 6.2):

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DRAWINGS

ARMY

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

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 4.5.1 and 4.5.2).

3.3.2 Weight. The engine (including the generator/alternator) shall weigh no more than 5080 pounds (lbs.) (dry weight) (see 4.5.3).

3.3.3 Oil seals. Oil seals shall conform to MIL-S-45005 (see 4.5.1).

3.3.4 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 4.5.1).

3.3.5 Climatic. The engine shall be suitable for operation under all arctic, moderate, and tropical climatic conditions from -25 degrees Fahrenheit (°F) to +115°F (-32 degrees Celsius (°C)) to 46°C and suitable for storage and transit from -30°F to 160°F.

3.3.6 Break-in. The engine shall receive a break-in as specified in table I.

TABLE I. Break-in schedule.

Run number	Time (minutes)	Speed (rpm)	Torque (pound-feet) (lb-ft)
1	10	Idle (700-750)	Warm up
2	15	1000	85
3	15	1400	440
4	20	1800	837
5	20	2200	1024

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TABLE I. Break-in schedule - Continued.

Run number	Time (minutes)	Speed (rpm)	Torque (pound-feet) (lb-ft)
6	20	2400	1092
7	30	2400	1202
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
<p>Bare engine shall operate without generator (see 6.4.3). Basic engine shall operate with alternator and field excitation only (see 6.4.3). Engine shall operate on it's 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.</p>			

3.4 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-L-2104 or MIL-L-21260 (-10 to 115(°F) (-23 to 46°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 3.4.3 through 3.4.5 shall be met after correction of measured parameters to the following:
 1. Dry air barometric pressure: 29.92 inches mercury (Hg).
 2. Fuel temperature at the secondary fuel filter: 60°F (16°C).
 3. Turbocharger inlet air temperature: 60°F (16°C)

3.4.1 Leakage. The engine shall not leak fluid more than the degree defined as “droplet” (see 4.5.2 and 6.4.2).

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3.4.2 Governor. The engine governor shall limit the engine speed as follows (see 4.5.4.1):

- | | |
|---|-------------------|
| a. Auxiliary drive operation
(AVDS1790-2DR only) | 1750 to 1800 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.

3.4.3 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 4.5.4.2).

3.4.4 Torque. The engine shall develop the torques specified in table II at the full power setting (see 4.5.4.3).

TABLE II. Torque.

Speed (rpm)	Corrected torque (lb-feet)	GCBHP
1800	1770 - 1842	607 - 631
2400	1609 - 1707	735 - 780

3.4.5 Fuel consumption. The engine fuel consumption at the full power setting shall be as specified in table III (see 4.5.4.4).

TABLE III. Fuel consumption.

Speed (rpm)	Maximum fuel consumption (lb per hp-hour)
1800	0.400
2400	0.420

3.4.6 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) nor more than 70 psi, measured at the pressure sending unit, and shall be not less than 15 psi 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 4.5.4.5).

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3.4.7 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 inches Hg (see 4.5.4.6).

3.4.8 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 (0.91 meter (m)) from the turbocharger exhaust outlet flange shall be as specified in table IV (see 4.5.4.7).

TABLE IV. Exhaust smoke density.

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

3.4.9 Blow-by flow. The blow-by flow at the full power setting shall not exceed 18 cubic feet per minute (0.51 cubic m per minute) (see 4.5.4.8).

3.4.10 Manifold flame heater. The manifold flame heater shall ignite and sustain burning within the manifold without interruption for at least 15 seconds (see 4.5.4.9).

3.4.11 Air pressure. The engine shall withstand an internal air pressure of 3 psi for 3 minutes with a pressure drop of not more than 1.75 psi. The engine shall also withstand an internal air pressure of 5 psi with no indication of faulty seals or joints (see 4.5.4.10).

3.4.12 Water submergence. The engine shall operate while submerged in water to a depth of 60 inches (1.52 m) above the cooling fans. While submerged and after being stopped, the engine shall restart (see 4.5.4.11).

3.4.12.1 Water contamination. After the engine is submerged in water as specified in 3.4.12, there shall be not more than 2% water contamination by volume in the lubricating oil (see 4.5.4.11.1).

3.4.13 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 4.5.4.12).

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3.4.14 Environmental.

3.4.14.1 Extreme-temperature starting ability. The engine shall start under the following conditions (see 4.5.4.13.1):

- 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 (-54°C), with the winterization kit preheating the cold-soaked batteries and lubricating oil to -25°F (-32°C).
- c. After being operated at an ambient temperature of 115°F (46°C) with exposure to maximum solar radiation with the lubricating oil at the maximum attainable temperature up to 250°F (121°C) measured at the main oil gallery (oil cooler outlet).

3.4.14.2 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 (46°C) (see 4.5.4.13.2):

- a. Lubricating oil temperature 250°F (121°C)
(measured at the main oil gallery
(oil cooler outlet).
- b. Exhaust gas temperature 1250°F (677°C)
(measured at individual cylinder ports;
temperature variation between cylinders
shall not exceed 150°F (66°C) under full
power setting).

3.4.14.3 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 4.5.4.13.3).

3.4.14.4 Grades and slopes. The engine shall operate satisfactorily on longitudinal grades up to 60% (31°) and on lateral slopes up to 36% (19.8°) with no evidence of faulty lubrication, cooling, fuel supply, or leakage (see 4.5.4.13.4).

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3.5 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 cleaned, and painted or treated for corrosion resistance as specified on the applicable drawings in accordance with the applicable provisions of MIL-STD-193 (see 4.5.1 and 4.5.2).

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

3.6.1 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).

3.7 Workmanship. Manufacturing techniques shall not cause the degradation of inherent engine reliability and durability (see 4.5.2 and 4.5.5).

4. VERIFICATION

4.1 Classification of inspection. The inspection requirements 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.

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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 V.

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 V.

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 will not accept products until first article inspection is completed to the satisfaction of the Government.

TABLE V. Classification of inspections.

Title	Requirement	Inspection	First article	Conformance	
				Examination	Tests
<u>Group A:</u> Materials and construction	3.2, 3.2.1, 3.3.1, 3.3.3 thru 3.3.6, and 3.5	4.5.1	X	X	X
Defects (see table VII)	3.3, 3.3.1, 3.4.1, and 3.5 thru 3.7	4.5.2	X		
Weight	3.3.2	4.5.3	X		
<u>Group B (Performance):</u> Leakage	3.4.1	4.5.2	X		X
Governor	3.4.2	4.5.4.1	X		X
Gross horsepower	3.4.3	4.5.4.2	X		X
Torque	3.4.4	4.5.4.3	X		X
Fuel consumption	3.4.5	4.5.4.4	X		X
Oil pressure	3.4.6	4.5.4.5	X		X
Intake manifold pressure	3.4.7	4.5.4.6	X		X
Exhaust smoke density	3.4.8	4.5.4.7	X		X

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TABLE V. Classification of inspection - Continued.

Title	Requirement	Inspection	First article	Conformance	
				Examination	Tests
Blow-by flow	3.4.9	4.5.4.8	X		X
Manifold flame heater	3.4.10	4.5.4.9	X		X
Air pressure	3.4.11	4.5.4.10	X		X
Water submergence	3.4.12	4.5.4.11	X		
Water contamination	3.4.12.1	4.5.4.11.1	X		
Endurance	3.4.13	4.5.4.12	X		
First article	3.4.13	4.5.4.12.1	X		
NATO cycle	3.4.13	4.5.4.12.2	X		
Group C (<u>Environmental</u>):					
Extreme temperature starting ability	3.4.14.1	4.5.4.13.1	X		
High temperature	3.4.14.2	4.5.4.13.2	X		
Low pressure	3.4.14.3	4.5.4.13.3	X		
Grades and slopes	3.4.14.4	4.5.4.13.4	X		
Group D (<u>Life</u>):					
Borescope inspection	3.7	4.5.5	X		
Preservative, packaging, packing and marking	5.1	4.5.6	X		

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

4.4 Conformance inspection. Conformance inspection 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. Unless otherwise specified (see 6.2), the sampling plan specified herein shall be used. See 6.4.1 for definitions of sampling inspection terms.

4.4.1.1 Lot information. An inspection lot shall consist of all engines of a single type, class, style, and part identification number (PIN) from an identifiable production period, from one manufacturer, from one manufacturing location, submitted at the same time for acceptance.

4.4.1.2 Sample. The sample for conformance inspection examination shall be randomly selected from the inspection lot in accordance with table VI.

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TABLE VI. Sampling plan for Conformance inspection.

Inspection lot size	Examination	
	Major	Minor
2 to 8	*	5
9 to 15	13	5
16 to 25	13	5
26 to 50	13	5
51 to 90	13	7
91 to 150	13	11
151 to 280	20	13
281 to 500	29	16
501 to 1200	34	19
1201 to 3200	42	23
3201 to 10 000	50	29
10 001 to 35 000	60	35
35 001 to 150 000	74	40
150 001 to 500 000	90	40
500 001 and over	102	40

*Indicates entire lot must be inspected (100% inspection).

4.4.2 Examination. The sample selected in accordance with 4.4.1.2 shall be examined and defects classified as specified in table VII (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 V.

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.

4.4.5 Conformance inspection test failure. Failure of the item to pass the conformance inspection tests shall be cause for the Government to refuse acceptance of the item.

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TABLE VII. Classification of defects.

Category	Defect	Method of examination
Critical	None	
<u>Major:</u>		
101	Assembly, incomplete (see 3.3).	Visual
102	Dimensions affecting interchangeability (see 3.3).	SIE ^{1/}
103	Linkage, improperly adjusted (see 3.3.1).	Visual
104	Leakage, excessive (see 3.4.1 and 6.4.2).	Visual
105	Identification marking, improper (see 3.6 and 3.6.1).	Visual
106	Faulty workmanship affecting performance (see 3.7).	Visual
<u>Minor:</u>		
201	Dimensions not affecting interchangeability (see 3.3).	SIE
202	Paint, improper application (see 3.5).	Visual
203	Faulty workmanship affecting appearance (see 3.7).	Visual

^{1/} SIE = Standard Inspection Equipment.

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 6.5.3). Testing of the bare engine, when specified with external electrical loading, shall be performed with a voltage regulator conforming to MIL-R-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 6.5.3). 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.

4.5.1 Materials and construction. Conformance to 3.2, 3.2.1, 3.3.1, 3.3.3 through 3.3.6, and 3.5 shall be determined by inspection of contractor records providing proof or certification that design, construction, processing, and materials conform to requirements. Applicable records

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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 3.3, 3.3.1, 3.4.1, and 3.5 through 3.7 shall be determined by examination for the defects listed in table VII. Examination shall be visual, tactile, or by measurement with standard inspection equipment (SIE).

4.5.3 Weight. To determine conformance to 3.3.2, the engine, including the generator or alternator, shall be weighed (dry weight).

4.5.4 Performance tests. The performance tests may be run concurrently with the break-in specified in 3.3.6. The engine performance shall be required under the following conditions:

- a. The engine speeds shall be governed as specified in 3.4.2.
- b. The engine shall function with external interface inputs as follows:

Fuel supply flow rate (minimum)	1400 lb per hour at 2400 rpm
Fuel supply pressure (minimum)	3 psi
Combustion air restriction (maximum)	20 inches (0.51 m) of water (1.5" Hg) at 2400 rpm
Intake air filter	Equal to the requirements of MIL-F-46736
Cooling airflow	24,000 cfm, approximate

- c. Diesel fuel conforming to A-A-52557, grade DF-2 shall be used. MIL-L-21260, type I (-10 to 115°F) (-23 to 46°C) and MIL-L-46167 (-65 to 0°F) (-54 to -18°C) shall be used.
- d. Lubrication oil conforming to the seasonal requirements of MIL-L-2104 or MIL-L-21260, type I (-10 to 115°F) (-23 to 46°C) and MIL-L-46167 (-65 to 0°F) (-54 to -18°C) shall be used.

4.5.4.1 Governor. To determine conformance to 3.4.2, a bare/basic engine (see 6.4.3) 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.

4.5.4.2 Gross hp. To determine conformance to 3.4.3, the engine shall be operated at 2400 to 2450 rpm at the full power setting. The corrected gross hp shall be calculated and recorded.

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4.5.4.3 Torque. To determine conformance to 3.4.4, 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.

4.5.4.4 Fuel consumption. To determine conformance to 3.4.5, 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.

4.5.4.5 Oil pressure. To determine conformance to 3.4.6, the engine shall be operated at 2400 rpm with the oil temperature at 140 to 250°F (60 to 121°C) 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.

4.5.4.6 Intake manifold pressure. To determine conformance to 3.4.7, the engine shall be operated at 2400 rpm at the full power setting. The intake manifold pressure shall be measured and recorded.

4.5.4.7 Exhaust smoke density. To determine conformance to 3.4.8, 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 (0.91 m) from the turbocharger exhaust outlet flange and recorded.

4.5.4.8 Blow-by flow. To determine conformance to 3.4.9, the engine shall run at 2400 rpm at the full power setting with a blow-by flow meter or equivalent.

4.5.4.9 Manifold flame heater (if applicable). To determine conformance to 3.4.10, the engine shall be cranked and the manifold flame heater shall be checked if it has been energized. The results shall be recorded.

4.5.4.10 Air pressure. To determine conformance to 3.4.11, 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.

4.5.4.11 Water submergence. To determine conformance to 3.4.12, 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 inches (in) (1.52 m) 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 6.5.3) shall operate with field excitation only to the alternator, which shall operate at no load. The results shall be recorded.

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4.5.4.11.1 Water contamination. To determine conformance to 3.4.12.1, the water contamination in the lubricating oil shall be measured and recorded after the engine is subjected to the test specified in 4.6.4.11.

4.5.4.12 Endurance. To determine conformance to 3.4.13, the engine shall be subjected to an applicable test as follows.

4.5.4.12.1 First article. The engine shall be tested as specified in table VIII 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 (16°C) nor more than 100°F (38°C).
- c. Electrical loading:
 1. Bare engine (see 6.4.3). 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 6.4.3). 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).

4.5.4.12.1.1 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, inches of Hg.

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- d. Lubricating oil pressure, (main oil gallery), psi.
- e. Crankcase pressure, inches of water.
- f. Lubricating oil temperature, °F (sump).
- g. Blowby, cfm.
- 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 VIII).
- 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 4 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.

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4.5.4.12.1.2 Test cycle. The test cycle shall be as specified in table VIII.

TABLE VIII. 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

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TABLE VIII. First article endurance test cycle - Continued.

Period number	Period length (minutes)	Gross hp	rpm	Period number	Period length (minutes)	Gross hp	rpm
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
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			

4.5.4.12.2 NATO cycle. When specified (see 6.2), the test according to 4.6.4.12.1 shall not be required, and the first article test shall be the NATO cycle specified in 4.6.4.12.2.2. 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 (16°C) nor more than 100°F (38°C).
- c. The engine shall be operated with the same cooling airflow as prevailed during the full power setting (run number 8 of table I).
- d. Electrical loading:
 1. Bare engine (see 6.4.3). 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 6.4.3). 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).

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- f. After the break-in and before initiation of the test, the engine shall be borescope inspected and the condition of the cylinders recorded.

4.5.4.12.2.1 NATO endurance test results. During the NATO endurance test, 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 4 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 of that observed for the pre-test performance test specified in 4.5.4.12.2.1.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, inches or Hg.
 - 4. Lubricating oil pressure, (main oil gallery), psi.
 - 5. Crankcase pressure, inches of water.
 - 6. Lubricating oil temperature, °F.
 - 7. Blowby, cfm.
 - 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.

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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.

4.5.4.12.2.2 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:

<u>Period</u>	<u>Engine speed</u>	<u>Power</u>	<u>Endurance hours</u>
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	<u>0.5</u>
Total endurance			5.0

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

<u>Endurance hours</u>	<u>Electrical loading</u>	
	<u>-2, -2A, -2D, -2DR or -2DA engine</u>	<u>-2C or -2CA engine</u>
0-100	100 \pm 10 A	300 \pm 10 A
101-200	200 \pm 10 A	400 \pm 10 A
201-300	200 \pm 10 A	500 \pm 10 A
301-400	300 \pm 10 A	650 \pm 10 A

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4.5.4.13 Environmental tests.

4.5.4.13.1 Extreme temperature starting ability. To determine conformance to 3.4.14.1, the engine shall be subjected to the following tests:

- a. The engine shall be cold-soaked to an ambient temperature of -25°F (-32°C). 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 (-54°C), with the winterization kit preheating the cold-soaked batteries and lubricating oil to -25°F (-32°C). 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 (46°C) with exposure to maximum solar radiation until the lubricating oil reaches the maximum attainable temperature up to 250°F (121°C) measured at the main oil gallery (oil cooler outlet). Then the engine shall be stopped, and restarted.

4.5.4.13.2 High temperature operation. To determine conformance to 3.4.14.2, the engine shall be operated at the maximum GCBHP (see table II) with a maximum air inlet temperature of 115°F (46°C). The lubricating oil temperature shall be measured at the main oil gallery (oil cooler outlet), and the exhaust gas temperature at each cylinder port.

4.5.4.13.3 Low pressure. To determine conformance to 3.4.14.3, the engine shall be operated at the following ambient conditions:

<u>Elevation (feet)</u>	<u>Pressure (inches of Hg)</u>	<u>Temperature</u>
3000	26.8	115°F (46°C)
4000	25.8	108°F (42°C)
5000	24.9	100°F (38°C)
6000	24.0	97°F (36°C)
7000	23.1	93°F (34°C)
8000	22.2	90°F (32°C)

4.5.4.13.4 Grades and slopes. To determine conformance to 3.4.14.4, the engine shall be operated for not less than 30 minutes in each position of forward and backward inclinations of 60% (31.0°) and of left and right inclinations of 36% (19.8°).

4.5.5 Borescope inspection. To determine conformance to 3.7, the engine shall be borescope inspected and the condition of the cylinders recorded.

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4.5.6 Preservation, packaging, packing, and marking. To determine conformance to 5.1, preservation, packaging, packing, and marking shall be inspected in accordance with 4.6.1 and 4.5.2.

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.

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., revision letter, and date (see 1.2 and 3.3).
- c. Issue of DoDISS to be cited in the solicitation, and if required, the specific issue of individual documents referenced (see 2.2.1).
- 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 3.3.1).
- f. If nameplates will be other than as specified (see 3.6.1).
- 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. If sampling plan for conformance inspection is other than as specified (see 4.4.1).

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- j. If the first article test will be the NATO cycle (see 4.5.4.12.2).
- k. Packaging requirements (see 5.1).
- l. 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:

<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 smoke should be made against a white background within 3 ft (0.91 m) of the exhaust outlet (see 3.4.8).

6.4 Definitions.

6.4.1 Sample inspection terms.

- a. Classification of defects. A classification of defects is the enumeration of possible defects of the unit of product classified according to their seriousness. A defect is any nonconformance of the unit of product with specified requirements. Defects will normally be grouped into one or more of the following classes: critical, major and minor defects. Also, defects may be grouped into other classes, or into subclasses within these classes.
- b. Critical defects. A critical defect is a defect that judgment and experience indicate would result in hazardous or unsafe conditions for individuals using, maintaining, or depending upon the product, or a defect that judgment and experience indicate is likely to prevent performance of the tactical function of a major end item such as a ship, aircraft, tank, missile, or space vehicle.
- c. Critical defective. A critical defective is a unit of product which contains one or more critical defects and may also contain major and/or minor defects.
- d. Defective. A defective is a unit of product which contains one or more defects.

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- e. Formation of lots or batches. The product will be assembled into identifiable lots, sublots, batches, or in such other manner as may be prescribed (see 1). Each lot or batch will, as far as is practicable, consist of units of product of a single type, grade, class, size, and composition, manufactured under essentially the same conditions, and at essentially the same time.
- f. Lot or batch. The term lot or batch will mean “inspection lot” or “inspection batch”, i.e., a collection of units of product from which a sample is to be drawn and inspected and may differ from a collection of units designated as a lot or batch for other purposes (e.g., production, shipment, etc.).
- g. Lot or batch size. The lot or batch size is the number of unites of product in a lot or batch.
- h. Major defect. A major defect is a defect, other than critical, that is likely to result in failure, or to reduce materially the usability of the unit or product for its intended purpose.
- i. Major defective. A major defective is a unit of product which contains one or more major defects, and may also contain minor defects but contains no critical defect.
- j. Minor defect. A minor defect is a defect that is not likely to reduce materially the usability of the unit of product for its intended purpose, or is a departure from established standards having little bearing on the effective use or operation of the unit.
- k. Minor defective. A minor defective is a unit of product which contains one or more minor defects but contains no critical or major defect.
- l. Presentation of lots or batches. The formation of the lots or batches, lot or batch size, and the manner in which each lot or batch is to be presented and identified by the supplier will be designated or approved by the responsible authority. As necessary, the supplier will provide adequate and suitable storage space for each lot or batch, equipment needed for proper identification and presentation, and personnel for all handling of product required for drawing of samples.
- m. Representative sampling. When appropriate, the number of units in the sample will be selected in proportion to the size of sublots or subbatches, or parts of the lot or batch, identified by some rational criterion. When representative sampling is used, the units or product in the sample is the sample size.
- n. Sample. A sample consists of one or more units of product drawn from a lot or batch, the units of the sample being selected at random without regard to their quality. The number of units or product in the sample is the sample size.
- o. Sampling plan. A sampling plan indicates the number of units of product from each lot or batch which are to be inspected (sample size or series of sample sizes) and the criteria for determining the acceptability of the lot or batch (acceptance and rejection numbers).

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- p. Time of sampling. Samples may be drawn after all the units comprising the lot or batch have been assembled, or samples may be drawn during assembly of the lot or batch.

6.4.2 Leakage. The following definitions will be used for leakage (see 3.4.1 and 4.4.2).

- 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 cubic centimeter.

6.4.3 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.

6.5 Materials definitions.

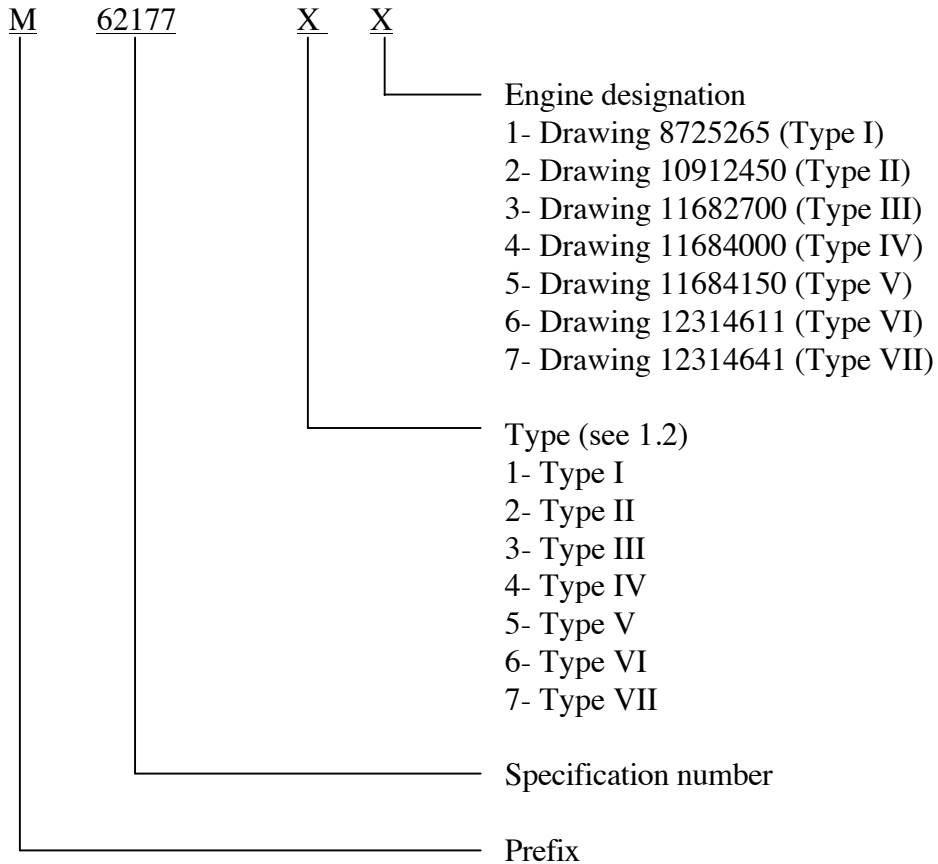
6.5.1 Recovered materials. “Recovered materials” means materials that have been collected or recovered from solid waster (see 6.5.2).

6.5.2 Solid waste. “Solid waste” means (a) any garbage, refuse, or sludge from a waste treatment plant, water supply treatment plant, or air pollution control facility; and (b) other discarded material, including solid, liquid, semisolid, or contained gaseous material resulting from industrial, commercial, mining, and agricultural operations, and from community activities. It does not include solid or dissolved material in domestic sewage, or solid or dissolved material in irrigation return flows or industrial discharges which are point sources subject to permits under

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section 402 of the Clean Water Act, (33 U.S.C. 1342 et seq.), or source, special nuclear, or byproduct material as defined by the Atomic Energy Act of 1954 (42 U.S.C. 2011 et seq.) (Source: Federal Acquisition Regulations, section 23.402).

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



6.7 Subject term (key word) listing.

Blowby
 Compression-ignition
 Fuel
 Horsepower
 Internal-combustion

6.8 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.

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Custodian:
Army - AT

Preparing Activity:
Army - AT

Review Activity:
DLA - CS

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