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SUPERSEDING
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MILITARY 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 within US Army Tank-Automotive Command, Department of the Army, and is available 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.

1.2 Classification. This engine shall be 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.

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

AMSC N/A FSC 2815

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 Government documents.

2.1.1 Specifications and standards. Unless otherwise specified, the following specifications and standards of the issue listed in that issue of the Department of Defense Index of Specifications and Standards (DoDISS) specified in the solicitation form a part of this specification to the extent specified herein.

SPECIFICATIONS
FEDERAL

VV-F-800	- Fuel Oil, Diesel.

MILITARY

MIL-P-514	- Plate, Identification, Instruction and Marking Blank.
MIL-L-2104	- Lubricating Oil, Internal Combustion Engine, Tactical Service.
MIL-R-14368	- Regulator Assembly, Relay Assembly and Voltage Regulator Assembly; 24-Volt (Nominal Rating), 100 to 400 Ampere, Direct Current.

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	- Filler Element, Intake Air Cleaner: Dry Type.
MIL-A-62048	- Air Cleaners, Automotive: Heavy Duty, Dry Type (for Internal Combustion Engines).
MIL-R-62104	- Regulator, Engine Generator: Solid State, 28-Volt, 300 Ampere, Direct Current.
MIL-G-81322	- Grease, Aircraft, General Purpose, Wide Temperature Range, NATO Code Number.

STANDARDS
MILITARY

MIL-STD-105	- Sampling Procedures and Tables for Inspection by Attributes.
MIL-STD-129	- Marking for Shipment and Storage.
MIL-STD-130	- Identification of Marking of U.S. Military Property.
MIL-STD-193	- Painting Procedures and Marking for Vehicles, Construction Equipment and Material Handling Equipment.
MIL-STD-1184	- Electrical Components for Automotive Vehicles; Waterproofness Tests.
MIL-STD-1235	- Single- and Multi-Level Continuous Sampling Procedures and Tables for Inspection by Attributes.
MIL-STD-45662	- Calibration Systems Requirements.

2.1.2 Other Government drawings. The following drawings form a part of this specification to the extent specified herein.

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.

(Copies of specifications, standards, and drawings required by contractors in connection with specific acquisition functions should be obtained from the contracting activity or as directed by the contracting officer.)

2.2 Order of precedence. In the event of a conflict between the text of this specification and the references cited herein, the text of this specification shall take precedence. Nothing in this specification, however, shall supersede applicable laws and regulations unless a specific exemption has been obtained.

3. REQUIREMENTS

3.1 First article. Unless otherwise specified (see 6.2), the contractor shall furnish engines which shall be subjected to first article inspection (see 4.4). First article inspection samples, properly marked with identifying information, shall be representative of the units to be furnished to the Government. All subsequent engines delivered to the Government shall conform to these samples in all of their pertinent physical and performance attributes.

3.2 Materials. Materials shall be as specified herein, on applicable standards or drawings, and in applicable specifications (see 4.7.1).

3.2.1 Greases. Engine greases shall conform to MIL-G-81322, where applicable (see 4.7.1).

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 6.6.1).

3.3 Design and construction. Assembly shall be in accordance with the applicable drawings listed in 1.2 (see 4.7.2).

3.3.1 Accessories and equipment. Unless otherwise specified (see 6.2), all accessories and equipment shall be installed on the engine and properly adjusted. All electrical accessories and equipment, including wiring and electrical connections, shall conform to the applicable requirements of MIL-STD-1184 (see 4.7.1).

3.3.2 Weight. The engine (including the generator/alternator) shall weigh no more than 5025 pounds (lb) (dry weight) (see 4.7.3).

3.3.3 Oil seals. Oil seals shall conform to MIL-S-45005 (see 4.7.1).

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 4.7.1).

3.3.5 Climatic. The engine shall be suitable for operation under climatic categories 1 through 6 as defined in appendix A (see 4.7.1).

3.3.6 Break-in. The engine shall receive a break-in as specified in table I. During the break-in, the full power setting torque and horsepower curves shall be produced from readings taken at engine speed of 1800 to 2400 revolutions per minute (rpm). The following data shall be recorded on appropriate log sheets (see 4.7.1 and 6.2):

a. Full power setting governed speed.
b. Minimum power setting governed speed.
c. Speed range.
d. Gross horsepower.
e. Torque.
f. Fuel consumption.
g. Oil consumption.
h. Oil pressure.
i. Oil temperature.
j. Exhaust smoke density.

TABLE I. Break-in schedule.

Run number	Time (minutes)	Speed (rpm)	Torque (pound-feet)
1	10	Idle (700-750)	Warm up
2	15	1000	85
3	15	1400	440
4	20	1800	837
5	20	2200	1024
6	20	2400	1092
7	30	2400	1202
8	30	2400	Full power setting

Bare engine shall operate without generator.
Basic engine shall operate with alternator and field excitation only.

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.

TABLE I. Break-in schedule - Continued.

Run number	Time (minutes)	Speed (rpm)	Torque (pound-feet)
9	5	2400	Full power setting
10	5	2200	Full power setting
11	5	2000	Full power setting
12	5	1800	Full power setting

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

a. Fuel. Diesel fuel conforming to VV-F-800, 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 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 3.4.3 through 3.4.6 shall be met after correction of measured data to the following (using the correction factors specified in appendix B):

Dry air barometric pressure	29.92 inches mercury (Hg)
Turbocharger inlet air temperature	60°F (16°C)
Fuel temperature at the secondary fuel filter	60°F (16°C).

3.4.1 Leakage. The engine shall not leak fluid more than the degree defined as "droplet" (see 4.7.2 and 6.5).

3.4.2 Governor. The engine governor shall limit the engine speed as follows (see 4.7.4.1):

Idle	700 to 750 rpm
Speed (no load)	2600 to 2660 rpm
Speed (full load)	2400 to 2450 rpm
Auxiliary drive operation (AVDS1790-2DR only)	1750 to 1800 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 4.7.4.2).

3.4.4 Torque. The engine shall develop the torques specified in table II at the full power setting (see 4.7.4.3).

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 4.7.4.4).

TABLE III. Fuel consumption.

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

3.4.6 Oil consumption. The engine shall consume not more than 0.0075 lb of grade 30 lubricating oil conforming to MIL-L-2104 or MIL-L-21260 per gross hp per hour when at the full power setting with the engine oil temperature at 140 to 250°F (60 to 121°C) measured at the main oil gallery (oil cooler outlet) (see 4.7.4.5).

3.4.7 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 4.7.4.6).

3.4.8 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 (dry barometer reading). Variations between left and right banks shall not exceed 4 inches Hg (see 4.7.4.7).

3.4.9 Exhaust smoke density. The exhaust smoke density (see 6.4) 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 4.7.4.8).

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

3.4.10 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 4.7.4.9).

3.4.11 Manifold flame heater. The manifold flame heater shall ignite and sustain burning within the manifold without interruption for at least 15 seconds (see 4.7.4.10).

3.4.12 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 4.7.4.11).

3.4.13 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 4.7.4.12).

3.4.13.1 Water contamination. After the engine is submerged in water as specified in 3.4.13, there shall be not more than 2 percent water contamination by volume in the lubricating oil (see 4.7.4.12.1).

3.4.14 Endurance. The engine shall retain 90 percent of the rated power after being subjected to a 400-hour endurance test cycle, operating in an operating profile scenario (see 4.7.4.13).

3.4.15 Environmental.

3.4.15.1 Extreme-temperature starting ability. The engine shall start under the following conditions (see 4.7.4.14.1):

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 (-15°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).

3.4.15.2 High-temperature operation. Engine temperatures shall not exceed the following limits throughout the speed ranges of the engine (see 3.4.2) when operating at the full power setting with an air inlet temperature of 115°F (46°C) (see 4.7.4.14.2):

a. Lubricating oil temperature [measured at the main oil gallery (oil cooler outlet)].	250°F (121°C)
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)

3.4.15.3 Low pressure. The engine shall output not less than 75 percent of the rated power during exposure to ambient conditions equivalent to altitudes up to 8000 feet (2438 m) (see 4.7.4.14.3).

3.4.15.4 Grades and slopes. The engine shall operate satisfactorily on longitudinal grades up to 60 percent (31.0°) and on lateral slopes up to 36 percent (19.8°) with no evidence of faulty lubrication, cooling, fuel supply, or leakage (see 4.7.4.14.4).

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 4.7.1 and 4.7.2).

3.6 Identification marking. Parts requiring identification shall be identified in accordance with MIL-STD-130 and the requirements of the specific product drawings (see 4.7.2).

3.6.1 Nameplates. Unless otherwise specified on applicable drawings (see 6.2), the nameplate, data and instruction plates shall conform to MIL-P-514 (see 4.7.2).

3.7 Workmanship. Manufacturing techniques shall not cause the degradation of inherent engine reliability and durability (see 4.7.2 and 4.7.5).

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for inspection. Unless otherwise specified in the contract or purchase order (see 6.2), the contractor is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified in the contract or purchase order, the contractor may use his own or any other facilities suitable for the performance of the inspection requirements specified herein, unless disapproved by the Government. The Government reserves the right to perform or witness any of the inspections set forth in the specification where such inspections are deemed necessary to assure supplies and services conform to prescribed requirements.

4.1.1 Responsibility for compliance. All items must meet all requirements of sections 3 and 5. The inspection set forth in this specification shall become a part of the contractor's overall inspection system or quality program. The absence of any inspection requirements in the specification shall not relieve the contractor of the responsibility of assuring that all products or supplies submitted to the Government for acceptance comply with all requirements of the contract. Sampling in quality conformance does not authorize submission of known defective material, either indicated or actual, nor does it commit the Government to acceptance of defective material.

4.1.2 Inspection equipment. Unless otherwise specified in the contract (see 6.2), the supplier is responsible for the provision and maintenance of all inspection equipment necessary to assure that supplies and services conform to contract requirements. Inspection equipment must be capable of repetitive measurements to an accuracy of 10 percent of the measurement tolerance. Calibration of inspection equipment shall be in accordance with MIL-STD-45662.

4.2 Classification of inspection:

a. First article inspection (see 4.4).
b. Quality conformance inspections (see 4.5).
    1. Examination (see 4.5.2).
    2. Acceptance tests (see 4.5.3).
c. Control tests (see 4.6).

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

Air temperature 55°F (13°C) to 91°F (33°C)

4.4 First article inspection. First article inspection shall be performed on preproduction or initial production samples as specified herein. 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 that 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.

4.4.1 Preproduction inspection. When specified (see 6.2), the preproduction sample shall consist of one engine. Preproduction inspection shall consist of inspection as specified in table V.

4.4.2 Initial production inspection. Unless otherwise specified (see 6.2), the Government shall select 1 from the first 10 engines produced under the production contract for initial production inspection. Initial production units shall be inspected as specified in table V.

4.4.3 First article inspection failure. Test item deficiencies during, or as a result of, the first article inspection shall be cause for rejection of the items 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 inspection are similarly deficient unless evidence satisfactory to the contracting officer is furnished by the contractor that they are not similarly deficient. 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.

TABLE V. Classification of inspections.

Title	Requirement	Inspection	First article	Quality conformance		
				Examination	Acceptance 100%	Control
Materials and construction	3.2, 3.2.1, 3.3.1, 3.3.3 thru 3.3.6, and 3.5	4.7.1	X		X	X
Defects (see table II)	3.3, 3.4.1, 3.6 thru 3.7	4.7.2	X	X		
Weight	3.3.2	4.7.3	X			
Leakage	3.4.1	4.7.2	X		X	X
Governor	3.4.2	4.7.4.1	X		X	X
Gross horsepower	3.4.3	4.7.4.2	X		X	X
Torque	3.4.4	4.7.4.3	X		X	X
Fuel consumption	3.4.5	4.7.4.4	X		X	X
Oil consumption	3.4.6	4.7.4.5	X		X	X
Oil pressure	3.4.7	4.7.4.6	X		X	X
Intake manifold pressure	3.4.8	4.7.4.7	X		X	X
Exhaust smoke density	3.4.9	4.7.4.8	X		X	X
Blow-by flow	3.4.10	4.7.4.9	X		X	X
Manifold flame heater	3.4.11	4.7.4.10	X		X	X

TABLE V. Classification of inspections - Continued.

Title	Requirement	Inspection	First article	Quality conformance		Control
				Examination	Acceptance 100%	
Air pressure	3.4.12	4.7.4.11	X		X	X
Water submergence	3.4.13	4.7.4.12	X			X
Water contamination	3.4.13.1	4.7.4.12.1	X			X
Endurance	3.4.14	4.7.4.13	X			
First article	3.4.14	4.7.4.13.1	X			
NATO cycle	3.4.14	4.7.4.13.2	X			
Control	3.4.14	4.7.4.13.3	X			X
Extreme temperature starting ability	3.4.15.1	4.7.4.14.1	X			
High temperature	3.4.15.2	4.7.4.14.2	X		X	X
Low pressure	3.4.15.3	4.7.4.14.3	X			
Grades and slopes	3.4.15.4	4.7.4.14.4	X			
Borescope inspection	3.7	4.7.5	X		X 1/	
Preservation, packaging, packing and marking	5.1	4.7.6	X		X	

1/ This test shall be performed only on engines selected in accordance with a sample plan determined by the Government.

4.5 Quality conformance inspection.

4.5.1 Sampling.

4.5.1.1 Lot formation. An inspection lot shall consist of all the engines of one type and part number, from an identifiable production period, from one manufacturer, submitted at one time for acceptance.

4.5.1.2 Sampling for examination. Samples for quality conformance examination shall be selected in accordance with general inspection level II of MIL-STD-105 or MIL-STD-1235.

4.5.2 Examination.

4.5.2.1 Acceptable quality level. Each sample selected in accordance with 4.5.1.2 shall be examined to determine conformance to the following acceptable quality levels (AQL) on the basis of percent defective:

Classification	AQL
Major	1.0
Minor	2.5

4.5.2.2 Classification of defects. For examination purposes, defects shall be classified as listed in table VI.

TABLE VI. Classification of defects.

Category	Defect	Method of examination
Critical	None	
Major	AQL 1.0% Defective	
101	Assembly, incomplete (see 3.3).	Visual
102	Dimensions affecting interchangeability, out of tolerance (see 3.3).	SIE 1/
103	Linkage, improperly adjusted (see 3.3).	Visual
104	Leakage, excessive (see 3.4.1 and 6.5).	Visual
105	Identification marking, improper (see 3.6 and 3.6.1).	Visual
106	Faulty workmanship affecting performance (see 3.7).	Visual
Minor	AQL 2.5% Defective	
201	Dimensions not affecting interchangeability, out of tolerance (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.

4.5.3 Acceptance tests (100 percent). Each engine shall be subjected to the tests specified in table V.

4.6 Control tests. Control tests shall be conducted on one engine per month from each lot of units consecutively produced. The engine shall be subjected to the tests specified in table V.

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

4.6.2 Disposition. Engines subjected to control tests may be delivered as items under the terms of the contract if they meet all requirements.

4.7 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 6.3). Testing of the bare engine, when specified with external electrical loading, shall be performed with a voltage regulator conforming to MIL-R-14368 or MIL-R-62104 in the generator electrical circuit.

b. Unless otherwise specified herein, AVDS1790-2C and -2CA engine testing shall be performed on a basic engine (see 6.3). 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 generator electrical circuit.

4.7.1 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 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.

4.7.2 Defects. Conformance to 3.3, 3.4.1, 3.6, 3.6.1, and 3.7 shall be determined by examination for the defects listed in table VI. Examination shall be visual, tactile, or by measurement with SIE.

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

4.7.4 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 at 2000 cubic feet per minute (cfm), approximate
Intake air filter	Per MIL-F-46736 and MIL-A-62048
Cooling airflow	24 000 cfm, approximate.

c. Diesel fuel conforming to grade VV-F-800, grade DF-2 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.

4.7.4.1 Governor. To determine conformance to 3.4.2, a bare/basic engine 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.

4.7.4.2 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.

4.7.4.3 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 shall be calculated and recorded.

4.7.4.4 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.

4.7.4.5 Oil consumption. To determine conformance to 3.4.6, the corrected oil consumption shall be recorded during break-in period number 8 of table I. For the initial production test, the time period shall be 120 minutes.

4.7.4.6 Oil pressure. To determine conformance to 3.4.7, 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.

4.7.4.7 Intake manifold pressure. To determine conformance to 3.4.8, the engine shall be operated at 2400 rpm at the full power setting. The intake manifold pressure shall be measured and recorded.

4.7.4.8 Exhaust smoke density. To determine conformance to 3.4.9, 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 feet (0.91 m) from the turbocharger exhaust outlet flange and recorded.

4.7.4.9 Blow-by flow. To determine conformance to 3.4.10, the engine shall be run at 2400 rpm at the full power setting with a blow-by flow meter or equivalent. The results shall be recorded.

4.7.4.10 Manifold flame heater. To determine conformance to 3.4.11, the engine shall be cranked and the manifold flame heater shall be checked if it has been energized. The results shall be recorded.

4.7.4.11 Air pressure. To determine conformance to 3.4.12, 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.

4.7.4.12 Water submergence. To determine conformance to 3.4.13, the engine shall be operated for 30 minutes while submerged in water (fresh water or 4 percent by volume salt water) to a depth of 60 inches (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 shall operate with field excitation only to the alternator, which shall operate at no load. The results shall be recorded.

4.7.4.12.1 Water contamination. To determine conformance to 3.4.13.1, the water contamination in the lubricating oil shall be measured and recorded after the engine is subjected to the test specified in 4.7.4.12.

4.7.4.13 Endurance. To determine conformance to 3.4.14, the engine shall be subjected to an applicable test as follows.

4.7.4.13.1 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 (16°C) nor more than 100°F (38°C).

c. Electrical loading:

1. Bare engine (see 6.3). 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 6.3). 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 cylinders, valves, and pistons shall be recorded.

4.7.4.13.1.1 Documentation. The following data shall be recorded at the end of each 10 minute or longer period of the 20-hour cycle, and just prior to each stopping of the engine (emergency stops excluded):

a. Engine speed, rpm.
b. Engine power, gross hp.
c. Intake manifold pressure, inches of Hg.
d. Exhaust manifold pressure, inches of Hg.
e. Lubricating oil pressure, (main oil gallery), psi.
f. Crankcase pressure, inches of water.
g. Lubricating oil temperature, °F (sump).
h. Blowby, cfm.
i. Fuel flow, lb per hour.
j. Fuel pressure after secondary fuel filter, psi.
k. Fuel temperature at secondary fuel filter, °F.
l. Air temperature at air cleaner inlet, °F.
m. Test cell ambient air temperature, °F.
n. Specific oil consumption, lb per gross hp-hour, at period numbers 42 and 87.
o. Generator/Alternator, volts and amperes.

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	46	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	1400	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
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			

The following additional data shall be recorded:

p. Barometric pressure of test cell - once each 4-hour period.
q. Exhaust smoke density - once each 50-hour period, plus or minus 5 hours.

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

4.7.4.13.2 NATO cycle. When specified (see 6.2), the test according to 4.7.4.13.1 shall not be required, and the first article test shall be the NATO cycle specified in 4.7.4.13.2.2. 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 6.3). 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 6.3). 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).

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

4.7.4.13.2.1 Documentation. During the test, the engine performance and other characteristics shall be monitored and inspected, and the data shall be measured and recorded as follows:

a. Pre- and post-test performance. Before and after the test, a corrected performance test curve (see figure 1 for a sample) shall be plotted from measurements taken at a minimum of seven speed settings in both ascending and descending order, the seventh setting being at the rated speed. The speeds to be run include 1200, 1400, 1600, 1800, 2000, 2200 and 2400 rpm. Part power setting data shall be recorded at 85, 70, 50 and 25 percent of the full power setting corrected gross hp at each respective speed.

b. Oil consumption. The quantity of oil in the engine at the idle period of each 5-hour cycle shall be measured and recorded. Oil consumption in lb per hour shall be calculated from this data.

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 4.7.4.13.2.1.a. The details of any adjustments made shall be recorded. Then the engine output shall be calculated and recorded.

e. Data. The following data shall be recorded at the end of period numbers 2, 4, 5, and 6 of the test:

1. Engine speed, rpm.
2. Engine power, gross hp.
3. Intake manifold pressure, inches of Hg.
4. Exhaust manifold pressure, inches of Hg.
5. Lubricating oil pressure, (main oil gallery), psi.
6. Crankcase pressure, inches of water.
7. Lubricating oil temperature, °F (sump).
8. Blowby, cfm.
9. Fuel flow, lb per hour.
10. Fuel pressure after secondary fuel filter, psi.
11. Fuel temperature at secondary fuel filter, °F.
12. Air temperature at air cleaner inlet, °F.
13. Test cell ambient air temperature, °F.
14. Specific oil consumption, lb per gross hp-hour, at period numbers 42 and 87.
15. Generator/Alternator, volts and amperes.

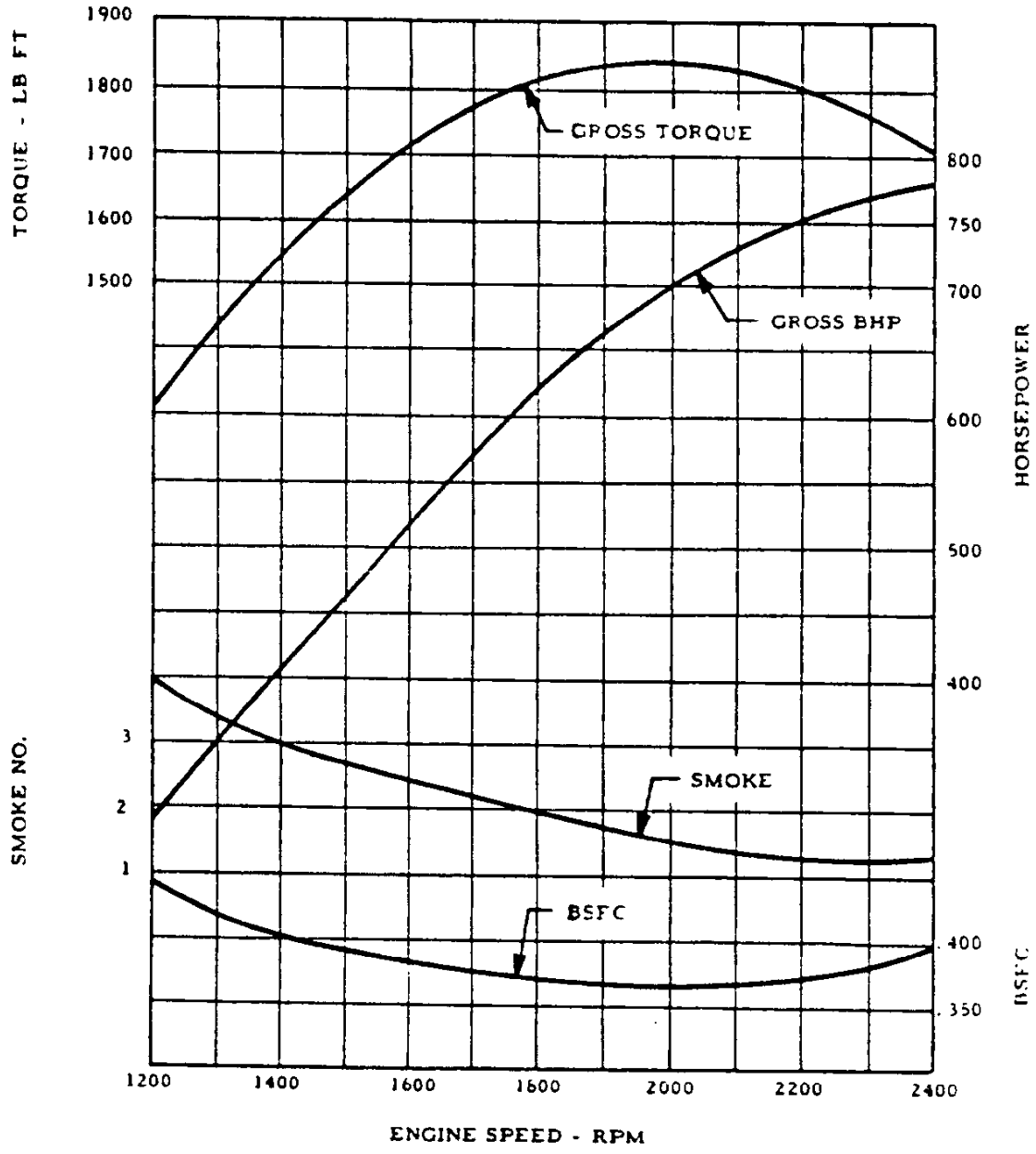

FIGURE 1. Sample of a full power setting performance curve.

The following additional data shall be recorded:

16. Barometric pressure of test cell - once each 4-hour period.
17. Exhaust smoke density - once each 50-hour period, plus or minus 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.

g. Disassembly. At the completion of the post-test performance test specified in 4.7.4.13.2.1.a, the engine shall be disassembled and visually inspected for evidence of wear or stress, and the results recorded.

4.7.4.13.2.2 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 (In percentage of full power setting gross hp at respective speed)	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

Electrical loading

Endurance hours	-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

l. Gross hp at a given rpm shall be the specified percentage of the corrected gross hp from the power run (see 4.7.4.13.2.1.a) and shall be calculated as follows:

Gross hp = Maximum corrected gross hp at given rpm (from figure 1) multiplied by the specified percentage maximum corrected gross hp.

2. The gross hp at a given rpm shall be used without application of any correction factors to obtain the required observed (or dynamometer) hp to set the engine operating point. The required observed hp is the gross hp at a given rpm minus the fan hp and the electrical hp for the same rpm (see table XIII of appendix B).

3. The 0 percentage power shall be at the minimum observed hp obtainable on the dynamometer.

4.7.4.13.3 Control. Each engine selected in accordance with 4.6 shall be tested as specified in table VIII for 50 hours. The test shall be conducted under the following conditions:

a. Running time less than 30 minutes shall not be toward the fulfillment of endurance hours.

b. After the initial warm-up, and with the engine temperatures stabilized, all deviant settings shall be reset before the test is begun.

c. For the -2C and -2CA engines, the even numbered runs will use a power setting of "as required" in place of "minimum" and an engine speed of 900-925 rpm in place of 700 rpm.

d. Electrical loading:

1. Bare engine (see 6.3). A bare engine shall have a 300 A dc generator installed with an applicable voltage regulator. The generator shall operate at 100 $\pm$ 10 A throughout the test.

2. Basic engine (see 6.3). A basic engine, with the applicable voltage regulator, shall have its generator (alternator) operated at 200 $\pm$ 10 A throughout the test.

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

TABLE VIII. 50-hour control endurance test cycle.

Period number	Time (minutes)	Power setting	Speed (rpm)
1	60	1/2	2000
2	30	minimum	700
3	90	full	2400
4	30	minimum	700
5	120	1/2	2000
6	30	minimum	700
7	120	full	2400
8	60	minimum	700
9	300	full	2400
10	60	minimum	700
11	300	full	2400
12	60	minimum	700
13	300	full	2400
14	60	minimum	700
15	300	full	2400
16	60	minimum	700
17	300	full	2400
18	60	minimum	700
19	300	full	2400
20	60	minimum	700
21	300	full	2400

4.7.4.13.3.1 Documentation. During the test, the engine performance and other characteristics shall be monitored and inspected, and the data shall be measured and recorded as follows:

a. Oil consumption. During run number 21 of the test, the oil consumption shall be measured and recorded.

b. Water submergence. At the conclusion of the break-in (see 3.3.6) test, the engine shall be subjected to the test specified in 4.7.4.12, and the results recorded.

c. Disassembly. At the completion of the test, the engine shall be disassembled and visually and dimensionally (as required) inspected for evidence of wear or stress, and the results recorded.

d. Data. The following data shall be recorded at a minimum of 1-hour intervals during the test, except barometric pressure and wet and dry bulb temperatures, which shall be taken at 4-hour intervals. The data shall be obtained under stabilized operating conditions, with the engine coupled to a dynamometer or other absorption device:

1. Engine speed, rpm.
2. Engine power, gross hp.
3. Intake manifold pressure, inches of Hg.
4. Exhaust manifold pressure, inches of Hg.
5. Lubricating oil pressure, (main oil gallery), psi.
6. Crankcase pressure, inches of water.
7. Lubricating oil temperature, °F (sump).
8. Blowby, cfm.
9. Fuel flow, lb per hour.
10. Fuel pressure after secondary fuel filter, psi.
11. Fuel temperature at secondary fuel filter, °F.
12. Fuel temperature at injector pump, °F.
13. Test cell ambient air temperature, °F.
14. Specific oil consumption, lb per gross hp-hour (see 4.7.4.13.3.1.a).
15. Barometric pressure of test cell.
16. Exhaust smoke density.
17. Air temperature at turbocharger inlet, °F.
18. Air pressure at turbocharger inlet.
19. Generator/Alternator, volts and amperes.

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

4.7.4.14 Environmental tests.

4.7.4.14.1 Extreme temperature starting ability. To determine conformance to 3.4.15.1, 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.

4.7.4.14.2 High temperature operation. To determine conformance to 3.4.15.2, the engine shall be operated at the full power setting throughout the speed ranges of the engine 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.

4.7.4.14.3 Low pressure. To determine conformance to 3.4.15.3, the engine shall be operated at the following ambient conditions:

Elevation (feet)	Pressure (inches of Hg)	Temperature
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)

4.7.4.14.4 Grades and slopes. To determine conformance to 3.4.15.4, the engine shall be operated for not less than 30 minutes in each position of forward and backward inclinations of 60 percent (31.0°) and of left and right inclinations of 36 percent (19.8°).

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

4.7.6 Preservation, packaging, packing, and marking. To determine conformance to 5.1, preservation, packaging, packing, and marking shall be inspected in accordance with 4.7.1 and 4.7.2.

5. PACKAGING

5.1 Preservation, packaging, packing, and marking. Preservation, packaging, packing, and marking for the desired level shall be in accordance with the applicable packaging requirements specified by the contracting authority (see 6.2).

6. NOTES

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 Ordering data. Procurement documents should specify the following:

a. Title, number, and date of this specification.
b. Title, number, and date of applicable drawings.
c. If first article samples are not required (see 3.1).
d. If all accessories and equipment shall not be installed on engines and adjusted (see 3.3.1).

e. Type of log sheet to record break-in data (see 3.3.6).
f. If nameplates shall be other than as specified (see 3.6.1).
g. If responsibility for inspection shall be other than as specified (see 4.1).
h. If responsibility for inspection equipment shall be other than as specified (see 4.1.1).
i. If inspection conditions shall be other than as specified (see 4.3).
j. If preproduction inspection is required (see 4.4.1).
k. If initial inspection is not required (see 4.4.2).
l. If the first article test shall be the NATO cycle (see 4.7.4.13.2).
m. Selection of applicable level and packaging requirements (see 5.1).

6.3 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.

6.4 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 feet (0.91 m) of the exhaust outlet (see 3.4.9).

6.5 Leakage definitions. The following definitions shall be used for leakage (see 3.4.1 and 4.5.2.2).

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.

6.6 Materials definitions.

6.6.1 Recovered materials. "Recovered materials" means materials that have been collected or recovered from solid waste (see 6.6.2).

6.6.2 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 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).

6.7 Subject term (key word) listing.

Compression-Ignition
Diesel
Engine
Internal-Combustion

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

APPENDIX A

CLIMATIC CONDITIONS

10. SCOPE

10.1 Scope. This appendix defines the climatic environments in which this engine is intended to operate. The engine shall be capable of operating safely and efficiently, without preparation or modification, in these environments. This appendix is a mandatory part of the specification. The information contained herein is intended for compliance.

20. APPLICABLE DOCUMENTS

This section is not applicable to this appendix.

30. CLIMATIC CONDITIONS

30.1 Wet-warm. Wet-warm conditions are found under the canopy of heavily forested tropical areas. In part of the area, these conditions may occur on several days during any month of the year (nonseasonal), and in the rest of the area, these conditions may occur seasonally, but on several days in at least 4 months of the year.

30.2 Wet-hot. Wet-hot conditions, characterized by high temperatures accompanied by high humidities and intense solar radiation, are found in the open in tropical areas. These are the same general areas where wet-warm conditions are found, but in the open rather than under the forest canopy. In part of the area, wet-hot conditions may be experienced during any month of the year, while in the rest of the area these conditions occur seasonally, but in at least 4 months of the year. Wet-hot conditions may be experienced at higher latitudes outside of the area designated as wet-hot, only for short periods in a season of 3 months or less.

30.3 Humid-hot coastal desert. Humid-hot conditions are limited to the immediate coast of bodies of water having a high surface temperature, i.e., the Persian Gulf and the Red Sea. These areas experience the highest water vapor amount associated with air near the ground reported anywhere in the world.

30.4 Hot-dry. Hot-dry conditions are found in the deserts of Northern Africa, the Middle East, West Pakistan and India, Southwest United States and Northern Mexico and Australia.

30.5 Intermediate hot-dry. Intermediate hot-dry conditions are found throughout the world extending outward from the areas of hot-dry conditions in the United States, Mexico, Africa, Asia and Australia. Also, they are found in Southern Africa, Southern Spain, and in Southern Asia during the dry seasons in the areas of seasonal wet-dry conditions.

30.6 Intermediate cold. Intermediate cold conditions are found only in the Northern Hemisphere and on high latitude occurrence of very low temperatures.

30.7 Environmental factors. Environmental factors for each of the above climatic conditions are listed in table IX.

TABLE IX. Environmental factors.

Climatic category	Operating conditions		Storage and transit conditions	
	Ambient air temperature °F (°C)	Ambient relative humidity (percent)	Induced air temperature °F (°C)	Induced relative humidity (percent)
1 Wet-warm	Nearly constant 75 (24)	95 to 100	Nearly constant 80 (27)	95 to 100
2 Wet-hot	78 (26) to 95 (35)	74 to 100	90 (32) to 160 (71)	10 to 85
3 Humid-hot coastal desert	85 (29) to 100 (38)	63 to 90	90 (32) to 160 (71)	10 to 85
4 Hot-dry	90 (32) to 115 (46)	5 to 20	90 (32) to 160 (71)	2 to 50
5 Intermediate hot-dry	70 (21) to 110 (43)	20 to 85	70 (21) to 145 (63)	5 to 50
6 Intermediate cold	-5 (-20) to -25 (-32)	Tending toward saturation	-10 (-23) to -30 (-34)	Tending toward saturation

APPENDIX B

ENGINE PERFORMANCE CORRECTION

10. SCOPE

10.1 Scope. This appendix supplies the formulas and tables for calculating the corrected gross horsepower, corrected torque, corrected gross specific fuel consumption, and gross specific oil consumption of the engine. This appendix is a mandatory part of the specification. The information contained herein is intended for compliance.

20. APPLICABLE DOCUMENTS

This section is not applicable to this appendix.

30. PERFORMANCE CORRECTION FORMULAS

Horsepower and torque shall be corrected to 60°F and 29.92 inches Hg using the following formulas:

Corrected torque = observed torque x CF_p x CF_t x CF_f

Corrected net bhp = observed brakehorsepower (obs. bhp) x CF_p x CF_t x CF_f

Corrected gross bhp = corrected net bhp + fan hp

Where:

$$\text{Observed bhp} = \frac{2\pi LNW}{33\,000} = \frac{LNW}{5252}$$

L = length of torque arm in feet.
N = rpm of dynamometer shaft.
W = force in lb at length L.

When the length of the beam arm is 1.75 feet and the scale has a constant of 3, the formula becomes:

$$\text{Observed bhp} = \frac{LNW}{5252} = \frac{(1.75 \times 3)\,NW}{5252} = \frac{\text{beam} \times N}{1000}$$

Where:

Corrected net bhp = obs. bhp x correction factor

Where:

Correction factor = $CF_p \times CF_t \times CF_f$

CF_t = temperature correction factor at the turbocharger inlet, table X.

CF_p = barometric pressure correction factor at the turbocharger inlet, table XI.

CF_f = temperature correction factor for the fuel at the secondary fuel filter, table XII.

Cooling fan hp: table XIII.
Alternator hp: table XIV.
Generator hp: table XV.

Where:

Corrected gross bhp = corrected net bhp + fan hp

Where:

Corrected brake specific fuel consumption (bsfc) shall be calculated as follows:

$$\text{Corrected bsfc} = \frac{\text{observed fuel flow (lb per hour)} \times CF_f}{\text{corrected gross bhp}}$$

Where:

Brake specific oil consumption (bsoc) shall be calculated as follows:

$$\text{bsoc} = \frac{\text{observed oil consumption (lb per hour)}}{\text{corrected gross bhp}}$$

40. PERFORMANCE CORRECTION FACTORS

40.1 Correction factors. Tables X to XV provide factors for correction of observed performance to standard conditions.

APPENDIX B

TABLE X. Air entrance temperature correction.

Temperature (°F)	Correction factor	Temperature (°F)	Correction factor	Temperature (°F)	Correction factor
60	1.00000	80	1.01100	100	1.02200
61	1.00055	81	1.01155	101	1.02255
62	1.00110	82	1.01210	102	1.02310
63	1.00165	83	1.01265	103	1.02365
64	1.00220	84	1.01320	104	1.02420
65	1.00275	85	1.01375	105	1.02475
66	1.00330	86	1.01430	106	1.02530
67	1.00385	87	1.01485	107	1.02585
68	1.00440	88	1.01540	108	1.02640
69	1.00495	89	1.01595	109	1.02695
70	1.00550	90	1.01650	110	1.02750
71	1.00605	91	1.01705	111	1.02805
72	1.00660	92	1.01760	112	1.02860
73	1.00715	93	1.01815	113	1.02915
74	1.00770	94	1.01870	114	1.02970
75	1.00825	95	1.01925	115	1.03025
76	1.00880	96	1.01980	116	1.03080
77	1.00935	97	1.02035	117	1.03135
78	1.00990	98	1.02090	118	1.03190
79	1.01045	99	1.02145	119	1.03245

APPENDIX B

TABLE XI. Air entrance pressure correction (static pressure as measured in a 6-inch diameter tube within 3 inches of the compressor inlet).

Inches Hg	Correction factor	Inches Hg	Correction factor
29.92	1.0000	28.95	1.0114
29.90	1.0003	28.90	1.0120
29.85	1.0009	28.85	1.0126
29.80	1.0015	28.80	1.0132
29.75	1.0021	28.75	1.0137
29.70	1.0027	28.70	1.0143
29.65	1.0032	28.65	1.0149
29.60	1.0038	28.60	1.0155
29.55	1.0044	28.55	1.0161
29.50	1.0050	28.50	1.0167
29.45	1.0056	28.45	1.0173
29.40	1.0062	28.40	1.0178
29.35	1.0067	28.35	1.0184
29.30	1.0073	28.30	1.0190
29.25	1.0079	28.25	1.0196
29.20	1.0085	28.20	1.0202
29.15	1.0091	28.15	1.0207
29.10	1.0097	28.10	1.0213
29.05	1.0102	28.05	1.0219
29.00	1.0103	28.00	1.0225

APPENDIX B

TABLE XII. Fuel temperature correction.

Temperature (°F)	Correction factor	Temperature (°F)	Correction factor
60	1.000	83	1.023
61	1.001	84	1.024
62	1.002	85	1.025
63	1.003	86	1.026
64	1.004	87	1.027
65	1.005	88	1.028
66	1.006	89	1.029
67	1.007	90	1.030
68	1.008	91	1.031
69	1.009	92	1.032
70	1.010	93	1.033
71	1.011	94	1.034
72	1.012	95	1.035
73	1.013	96	1.036
74	1.014	97	1.037
75	1.015	98	1.038
76	1.016	99	1.039
77	1.017	100	1.040
78	1.018	101	1.041
79	1.019	102	1.042
80	1.020	103	1.043
81	1.021	104	1.044
82	1.022	105	1.045

APPENDIX B

TABLE XIII. Fan hp to be used for correcting engine gross hp.

rpm	hp
2520	125.0
2400	108.0
2200	83.2
2000	62.5
1800	45.6
1600	32.0
1400	21.4
1200	13.5
1000	7.8
900	5.7

TABLE XIV. Alternator hp to be used for correcting engine gross hp for types III and VI engine configurations.

Alternator output of 27-31 V dc	hp correction to engine load
290-310 A	15
390-410 A	20
490-510 A	25
650 A	32

TABLE XV. Generator hp to be used for correcting engine gross hp for types I, II, IV, V, and VII engine configurations.

Generator output at 27-31 V dc	hp correction to engine load
90-110 A	5.8
190-210 A	11.6
290-310 A	17.3

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