MILITARY SPECIFICATION

GENERATOR SET, DIESEL ENGINE,

100 KW, 120-VOLT D. C., 1800 R. P. M.

1. SCOPE

1.1 This specification covers 100 kilowatt (kw.), 120-volt direct current (d. c.), lightweight, low magnetic signature diesel engine generator sets for Naval Shipboard use.

2. APPLICABLE DOCUMENTS

2.1 The following documents of the issue in effect on date of invitation for bids or request for proposal, form a part of the specification to the extent specified herein.

SPECIFICATIONS

FEDERAL

O-A-548	- Antifreeze, Ethylene Glycol, Inhibited.
FF-B-171	- Bearings, Ball, Annular (General Purpose).

MILITARY

MIL-R-196	- Repair Parts for Internal Combustion Engines, Packaging of.
MIL-B-857	- Bolts, Nuts and Studs.
MIL-S-901	- Shock Tests, H. I. (High Impact), Shipboard Machinery, Equipment and Systems, Requirements for.
MIL-E-917	- Electric Power Equipment, Basic Requirements for (Naval Shipboard Use).
MIL-D-1000	- Drawings, Engineering and Associated Lists.
MIL-D-1000/2	- Drawings, Engineering and Associated Lists.
MIL-V-1137	- Varnish, Electrical - Insulating (for Electro-Motive Equipment).
MIL-E-2036	- Enclosures for Electric and Electronic Equipment, Naval Shipboard.
MIL-R-2729	- Regulator Set, Voltage, A. C. Generator (Naval Shipboard Use).
MIL-G-3048	- Generator Set, Diesel Engine, Direct- and Alternating-Current (Naval Shipboard Use).
MIL-G-3111	- Generators, Electric, Direct-Current, Naval Shipboard Use.
MIL-J-5624	- Jet Fuel, Grades JP-4 and JP-5.
MIL-F-7194	- Filters, Engine Charge Air.
MIL-L-9000	- Lubricating Oil, Internal Combustion Engine, Diesel.
MIL-Q-9858	- Quality Program Requirements.
MIL-M-9868/1	- Microfilming of Engineering Documents, 35 mm, for Naval Ship Systems.
MIL-M-15071	- Manuals, Equipment and Systems.
MIL-E-15090	- Enamel, Equipment, Light Gray (Formula No. 11).
MIL-P-15137	- Provisioning and Technical Documentation for Repair Parts for Electrical and Mechanical Equipment (Naval Shipboard Use).
MIL-P-15328	- Primer, Pretreatment (Formula No. 117 for Metals).
MIL-M-15337	- Mufflers, Exhaust, Internal Combustion Engine.
MIL-H-15424	- Hand Tools, Packaging of.
MIL-C-15730	- Coolers, Fluid, Industrial, Naval Shipboard, Lubricating Oil, Hydraulic Oil, and Fresh Water.
MIL-S-16032	- Switches, Shipboard Alarm Systems.
MIL-T-16049	- Tachometers, Electrical, Self-Generating; Mechanical, Fixed Mounting and Hand Held; and Vibrating Reed.
MIL-C-16173	- Corrosion Preventive Compound, Solvent Cutback, Cold-Application.
MIL-E-16298	- Electric Machines Having Rotating Parts and Associated Repair Parts: Packaging of.

MILITARY (Cont'd)

MIL-P-16789 - Preservation, Packaging, Packing and Marking of Pumps General and Associated Repair Parts.
MIL-F-16884 - Fuel Oil, Diesel, Marine.
MIL-I-16910 - Interference Measurement, Electromagnetic, Methods and Limits.
MIL-M-17185 - Mounts, Resilient, General Specifications and Tests for Shipboard Application.
MIL-P-17286 - Propulsion and Auxiliary Steam Turbines and Gears (Including Repair Parts, Tools, Accessories and Instruments): Packaging of.
MIL-E-17555 - Electronic and Electrical Equipment and Associated Repair Parts, Preparation for Delivery of.
MIL-F-20042 - Flanges, Pipe Bronze (Silver Brazing).
MIL-F-20627 - Filter Assembly and Filter Elements, Fluid, Pressure, for Engines with Liquid Fuel Injection Systems.
MIL-F-20670 - Flanges, Pipe, Carbon Steel, 150 PSI, W. S. P. (for Naval Shipboard Use).
MIL-F-20707 - Filter Elements, Fluid, Pressure, Oil, Full Flow.
MIL-L-21260 - Lubricating Oil, Internal Combustion Engine, Preservative.
MIL-N-24129/1 - Nuts, Self-Locking (Plastic Insert), Hexagon, Regular Height, 250°F, Nickel-Copper Alloy.
MIL-N-24129/3 - Nuts, Self-Locking (Plastic Insert), Hexagon, Regular Height, 250°F, FS303 Corrosion-Resistant Steel.
MIL-N-25027 - Nut, Self-Locking, 250 Degrees F, 450 Degrees F and 800 Degrees F, 125 KSI FTU and 30 KSI FTU.

STANDARDS

MILITARY

MIL-STD-22 - Welded-Joint Design.
MIL-STD-130 - Identification Marking of U. S. Military Property.
MIL-STD-167 - Mechanical Vibrations of Shipboard Equipment.
MIL-STD-271 - Nondestructive Testing Requirements for Metals.
MIL-STD-278 - Welding and Allied Processes for Machinery for Ships of the United States Navy.
MIL-STD-701 - Preferred and Guidance Lists of Semiconductor Devices.
MS16142 - Boss, Gasket Seal Straight Thread Tube Fitting, Standard Dimensions for.
MS35802 - Filter Elements, Fluid Pressure Oil, Fluid Flow.

PUBLICATIONS

MILITARY

NAVSHIPS 250-660-35 - Manual for Design of Electrical Equipment with Small Stray Magnetic Field.
NAVSHIPS 0900-003-8000 - Surface Inspection Standards for Metals.
NAVSHIPS 0900-003-9000 - Radiographic Standards for Production and Repair Welds.

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

2.2 Other publications. - The following documents form a part of this specification to the extent specified herein. Unless otherwise indicated, the issue in effect on date of invitation for bids or request for proposal shall apply.

AMERICAN IRON AND STEEL INSTITUTE (AISI)
Steel Products Manual

(Application for copies should be addressed to the American Iron and Steel Institute, 150 East 42nd Street, New York, New York 10017.)

OFFICIAL CLASSIFICATION COMMITTEE
Uniform Freight Classification Ratings, Rules and Regulations.

(Application for copies should be addressed to Official Classification Committee, 1 Park Avenue at 33rd Street, New York, N. Y. 10016).

3. REQUIREMENTS

3.1 Diesel generator sets. -

3.1.1 The engine, generator, and accessories shall be of light-weight construction. Nonmagnetic materials shall be employed as specified in 3.2.1 and 3.6. The complete unit shall be mounted on a common sub-base of nonmagnetic construction. After installation in the ship, the unit may be mounted on sound isolation mounts; accordingly, the sub-base shall be suitable for support without further bracing or stiffening. Eyebolts or other means for lifting the complete unit shall be furnished. Suitable provision shall be made for temperature differentials between the engine and base.

3.1.2 Design. - The diesel generators shall be capable of satisfactory parallel operation in accordance with kilowatt load division requirements of MIL-G-3048.

3.1.3 The generator frame shall be rigidly connected to the flywheel housing by means of a bell housing.

3.1.4 The engine end of the generator shaft shall be piloted in the engine flywheel, or by other means, to maintain correct alignment of the armature and crankshaft.

3.1.5 Starting system. - A nonmagnetic hydraulic starting system shall be furnished complete in all respects and included as an integral part of the diesel engine. (See 3.2.12.)

3.1.6 Identification plate. - An identification plate of the type specified in MIL-G-3048 shall be furnished.

3.1.7 Weight and dimensions. - The engine and generator unit shall not exceed the weight and space requirements including space required for removal of generator and engine components, as follows:

(a) Height - 55 inches
(b) Length - 110 inches
(c) Width - 48 inches
(d) Weight - 3600 pounds

3.1.8 Stray magnetic fields. - The unit shall be so designed and constructed that under starting and all operating conditions, the unit will not exceed the stray magnetic field limit and requirements specified in the classified Amendment-1 to this specification.

3.1.8.1 All electrical equipment shall be designed to keep stray magnetic fields at a minimum by making the area of current loops as small as practicable and arranging adjacent loops so that their field will be in opposition. Current loops shall not enclose any magnetic material unless it is essential for proper performance of equipment.

3.1.8.2 Publication NAVSHIPS 250-660-35 should be used as a guide in designing the equipment to minimize stray fields. In addition, the following shall apply:

(a) Two pole machines shall not be used.
(b) Solid magnetic frames should be used; that is, no split frames.
(c) The outside of the magnetic structure should be a smooth figure of revolution. Protuberances of magnetic material should be avoided. Pole bolts should be recessed and, in general, every effort should be made to ensure that the outside of the magnetic structure is a smooth surface generated by revolving the arc of a curve about the axis of the machine.
(d) The number of interpoles should be the same as the number of main field poles.
(e) The number of turns in any field pole winding should be the same on each pole.
(f) All current carrying conductors in the generator should be arranged with the greatest of care to avoid uncompensated current loops.
(g) The cross section of circular frame should be uniform in thickness all around to within plus 1.0 percent.

3.1.8.3 D.C. control windings. - Any equipment that utilizes d.c. control windings shall be designed so that two d.c. windings or multiples of two are used. Each pair of d.c. control windings shall be oriented so that the magnetic field of one winding tends to cancel the field of the other.

3.1.8.4 Nonmagnetic materials. - Nonmagnetic materials used in the construction of the unit shall be as approved by the command or agency concerned. The maximum relative permeability of parts shall not exceed 2.0 after fabrication when measured in a field of 100 to 200 oersteds. If the contractor feels that a relative permeability requirement of 2.0 or less after fabrication cannot be met or is not feasible for any particular part or parts, he shall forward a detailed list of such parts (and reasons for non-compliance) at which time the command or agency concerned will decide whether a waiver can be granted.

3.1.8.5 Loop and plate areas. - In order to limit magnetic fields due to eddy currents induced by movement in the earth's field, loop and plate areas of high conductivity materials shall not exceed 5 square feet without specific Naval Ship Engineering Center (NAVSEC) approval. High conductivity materials are defined as materials having conductivity greater than 10 percent of the conductivity of copper. Where practicable, high conductivity loops may be broken by use of nonconducting inserts applied so as to provide at least two breaks per loop. Tables I through IV are applicable.

Table I - Permissible areas of electrically continuous loops in piping systems.

Material	Conductivity[1/]	Limiting area
	(Percent)	(Square feet)
Copper	100	40
Aluminum	40	80
Brass	25	120
Copper-nickel (90-10)	15	120
Copper-nickel (70-30)	5	No restrictions

[1/] Percentage of conductivity refers to the electrical conductivity of materials relative to copper. Common materials having conductivity greater than 10 percent of copper, aluminum, brass and bronze. Common metals having conductivity less than 10 percent of copper are steel (all types) and Monel.

Table II - Permissible areas of electrically continuous loops other than piping systems.

Conductivity of material (see footnote [1/] of table I)	Gross sectional area of material	Limiting area
(Percent)	(Square inches)	(Square feet)
Greater than 10	Greater than 10	5
Greater than 10	Less than 10	25
Less than 10	Any area	100

3.1.8.5.1 Plates of electrically conducting materials.

(a) If feasible, any plate of electrically conducting material whose area exceeds that given in table III should be divided and a resistive joint with a resistance greater than 1 ohm inserted between the parts.

(b) If it is not feasible to divide plates whose area exceeds that given in table III, the item should be reported to NAVSEC for individual consideration and approval prior to installation.

Table III - Permissible areas of plates of electrically conducting material.

Conductivity of material (see footnote 1/ of table I)	Thickness of plate	Limiting area
(Percent)	(Inch)	(Square feet)
Greater than 10	Greater than 0.15	5
Greater than 10	Less than 0.15	25
Less than 10	Any thickness	100

Table IV - Permissible sizes of boxes, lockers, and storage containers constructed of electrically continuous conducting material.

Conductivity of material (relative to copper)	Cross sectional area 2/	Thickness of material	Limiting area for face of box 1/
(Percent)	(Square inches)	(Inches)	(Square feet)
Greater than 10	10 to 48	0.25 to 2	5
Greater than 10	Less than 10	Less than 0.25	12
Less than 10	Less than 24	Less than 0.25	50
Less than 10	24 to 48	0.25 to 1	20

1/ The face of the box in table IV is that side having the largest electrically continuous conducting area.
2/ Determine cross-sectional area by product of "thickness of material" times "dimension of box perpendicular to the face selected as having the largest area.

General notes pertaining to tables I through IV:

1. A cube shaped frame shall be considered as a box of the same dimension as the frame, and table IV shall be used. The effective thickness of material shall be taken as the volume of material in the frame on a face spread throughout the entire face. The maximum thickness of the various faces shall be used as the effective thickness.

2. The limits in tables I through IV are for NON-ROTATING items and loops only. Plans and dimensions of rotation items shall be submitted to NAVSEC for approval.

3.1.8.6 Ferromagnetic materials. - Except for ball bearings and necessary magnetic circuits in electrical components no ferromagnetic materials shall be used without specific approval by NAVSEC. Nonmagnetic materials are defined as those materials having a permeability of less than 2.0 after fabrication.

3.1.8.7 Within 120 days from the date of the contract or order, a material list for the complete diesel generator set showing material used for each part shall be submitted to the command or agency concerned for approval.

3.1.9 Inclination. - The generator set shall be designed to operate satisfactorily and to maintain satisfactory lubrication without loss of oil or cooling water under the following conditions:

(a) When the ship is permanently trimmed down by bow or stern as much as 5 degrees from the normal horizontal plane.
(b) When the ship is permanently listed up to 15 degrees to either side of the vertical.
(c) When the ship is pitching 10 degrees up or down from the normal horizontal plane.
(d) When the ship is rolling up to 45 degrees to either side of the vertical.

3.1.10 Shock. - The complete generator set with all attached and detached accessories shall be designed to meet the requirements for grade A, type A, class I equipment of MIL-S-901 and as specified in 3.1.10.1 through 3.1.10.4.

3.1.10.1 Intended function. - The intended function of shockproof generator sets is to continuously deliver electrical power throughout and after application of shock in the magnitude experienced on shock test machines. Further, a shockproof generator set, when subjected to the above mentioned magnitude of shock shall not suffer damage to the extent that it creates a possible hazardous situation such as fire or injury to operating personnel or where shock damage would likely cause premature failure of major components (diesel, generator and excitation system) requiring immediate shutdown of the generator set to prevent such failures.

3.1.10.2 Acceptance of equipment shall be based on ability to perform its intended function as defined in 3.1.10.1; the magnitude of damage revealed during the post shock test inspection at the supplier's plant and corrective action proposed by the supplier where inspection reveals damage.

3.1.10.3 Generator sets and detached accessories shall successfully complete the shock test specified in 4.4.4.17 herein.

3.1.10.4 In addition to the requirements in MIL-S-901, the following requirements apply in designing equipment for class HI (High Impact) shock:

(a) Equipment sub-base holding-down bolt holes provided for securing equipment to the ship's structure shall be designed for use with nonfitted bolts conforming to grade 2, types I, II and III of MIL-B-857 and self locking nuts MIL-N-24129/1 and MIL-N-24129/3 conforming to MIL-N-25027. Maximum clearance between holding-down bolt holes and bolts shall not exceed the following:

Nominal bolt diameter	Maximum diameter of hole
3/4 inch or smaller	Nominal bolt diameter plus 1/32 inch
Larger than 3/4 inch	Nominal bolt diameter plus 1/16 inch

(b) Pipe threaded connections. - Taper pipe threaded connections between components of the generator set (including detached items) shall not be used unless specifically approved by NAVSEC. In general, pipe threaded connections shall not be used where failure of the connection could cause a major breakdown of the generator set or create a hazard to equipment located near the generator set (such as spraying the generator set or other equipment with oil or water) and where failure presents a hazard to operating personnel (such as a taper pipe threaded plug acting as a projectile upon failure under shock).

(c) The design may incorporate use of resilient mountings for instruments, gages, contactors and relays secured to the generator set package and for the diesel control panel. Resilient mounts shall conform to the requirements of MIL-M-17185.

3.1.11 In the construction of the engine-generator set and accessories, all screw threads tapped in aluminum to receive cap screws shall be protected by the installation of steel inserts. Studs should be used for frequently disassembled components where basic material is insufficient for inserts. Restriction against the use of taper pipe threads shall apply as follows for engines:

(a) All connections from the generator set to the ship systems, that is, exhaust, fuel inlet and return, and sea water supply and return.
(b) All connections to and between components of the hydraulic starting system.
(c) All threaded pipe.

Taper pipe threads are acceptable as follows:

(a) Exposed pipe plugs on the engine and accessories used to close core support holes and drilled passages, and plugs used to close unused optional connection and accessory.
(b) Pipe plugs internal to the engine.
(c) Threaded connections in the engine components and accessories used for tubing and flexible hose adaptors. This applies to self contained external systems such as the fuel pump,

filters and lubricating oil systems where adaptors are used in the fuel pump filters, cylinder heads, heat exchangers (coolers) and various housings. Taper pipe thread adaptors 3/4 inch or less in size for connecting tubing for remote reading temperature and pressure gages are acceptable. Taper pipe threads for water drain cocks are acceptable. Straight pipe threads shall conform to MS16142.

3.1.12 The design of all electrical equipment shall be approved by the command or agency concerned prior to manufacture.

3.1.13 The complete diesel generator set shall be painted in accordance with MIL-E-917.

3.1.14 Vibration. - The combined diesel generator set shall meet the requirements of type III and V of MIL-STD-167.

3.1.15 Parallel operation. - The diesel generator unit shall be designed for parallel operation and the necessary governor adjustments and regulator components shall be furnished.

3.1.16 Lifting means. - Eyebolts, lugs, holes or equivalent means shall be provided to permit lifting the generator set and attached accessories as a complete unit. Eyebolts or other means of lifting the individual components shall not be dependent upon lifting the assembled unit.

3.1.17 Welding and allied processes. - Welding and allied processes shall be in accordance with MIL-STD-278 and MIL-STD-22.

3.1.17.1 Taper pipe threads are not permitted in piping systems or between piping, machinery or valves except on specific approval of NAVSEC in the following areas:

(a) Pipe plugs in sizes of 3/4 inch and below used for applications where pressures do not exceed 50 pounds per square inch (psi). Plugs shall be seal welded or brazed, if possible.
(b) Instrumentation, controls, vent filling and drain connections where pressures are 50 psi and below and where fluids handled are neither toxic nor dangerous nor would cause atmospheric contamination and which would not cause, in the event of failure, a major breakdown of equipment nor create a hazard to the surrounding area, nor affect the operation of other vital equipment.

3.1.18 Generator mounting and coupling. - The generator shaft shall be provided with a forged on half coupling and shall be piloted in or connected to the combining gear through a flexible coupling. The generator frame shall have feet of ample size to accommodate hold-down bolts, dowels, and jackscrews as necessary, to assure attachment to the sub-base. The frame of the generator shall not extend below the lower face of the sub-base.

3.2 Diesel engine. - The diesel engines shall be as specified herein.

3.2.1 Nonmagnetic material. - Material with a magnetic permeability not greater than 2.0, in the finished condition, shall be employed in construction of the following:

(a) Cylinder block.
(b) Cylinder head.
(c) Flywheel housing.
(d) Flywheel (except ring gear).
(e) Flywheel housing adaptor.
(f) Oil pan.
(g) Front cover and engine support.
(h) Front cover (upper).
(i) Rocker covers.
(j) Exhaust manifold(s).
(k) Exhaust outlet flanges.
(l) Water connection(s) to exhaust manifold.
(m) Thermostat housing and adaptor.
(n) Water connection elbow (from heat exchanger).

(o) Water inlet elbow to block.
(p) Heat exchanger tank or shell, inlets, tube or element, covers, brackets and supports.
(q) Expansion tank.
(r) Sea water pump, adaptors and outlet.
(s) Oil cooler housing and element.
(t) Fresh water pump body, cover(s), pulleys, pulley idler and arm.
(u) End plate (rear).
(v) Crankshaft pulley.
(w) Cylinder block covers and clamps.
(x) Engine lifter brackets (front and rear).
(y) Flywheel housing hole covers.
(z) Oil pump body and covers.
(aa) Engine mounts.
(bb) Fuel pump (except high wear and load parts).
(cc) Fuel filter and brackets.
(dd) Camshaft pulleys.
(ee) Rocker shaft brackets.
(ff) Rocker arms (valve and injector).
(gg) Lube oil filter(s), brackets and adaptors.
(hh) Oil pump inlet and screen.
(ii) Crankcase breather.
(jj) Hydraulic starting system except bearings, shafting and other highly loaded and wear resistant parts.
(kk) Governor housing and covers.
(ll) Blower housings, rotors and drive supports.
(mm) Air inlet housing.
(nn) All external capscrews, hose clamps, bolts, studs, nuts and washers.
(oo) Miscellaneous tubes and piping.
(pp) Water manifold.
(qq) Exhaust muffler.

3.2.1.1 Deviations from the list specified in 3.2.1 shall be substantiated. The contractor shall submit with the preliminary installation drawing a certified itemized list of nonmagnetic part to be furnished. The list shall include the following:

(a) Part name
(b) Part number or drawing number or both
(c) Material
(d) Weight
(e) Box dimensions (L, W, H or diameter, L) magnetic parts only.

The list shall be totaled and shall include the ratio or nonmagnetic material to total dry weight of the engine. The list shall be submitted along with longitudinal and athwartship vertical cross section drawings. Magnetic material shall be shaded on the drawings.

3.2.2 Painting. - All external surfaces of ungalvanized ferrous metal nonworking parts, the operating temperature of which is 300°F. or less, shall be thoroughly cleaned and coated with one coat of pretreatment (formula No. 117 for metals) in accordance with MIL-P-15328, and two coats of equipment enamel, semigloss, class 2 of MIL-E-15090. Internal surfaces of the crankcase and oil pan shall not be painted or primed.

3.2.3 Rating. - The engine shall be capable of driving its generator to produce 100 kw. continuously and 110 kw. for 2 hours without injury to any part. The normal engine speed shall be 1800 revolutions per minute (r.p.m.).

3.2.3.1 Engine and rating. - The engine shall be of a type which has been satisfactory in Navy or commercial use at or comparable to the rating required. The engine shall be capable of continuous operation under standard operating conditions at the brake horsepower (BHp) and rpm specified without excessive exhaust smoke or temperature under the standard operating conditions specified in 3.2.3.1.1.

3.2.3.1.1 Standard operating conditions. - The following standard operating conditions shall be used for the design of the engine and accessories:

(a)	Ambient air temperatures	130°F.
(b)	Barometric air pressure (dry)	29 inches mercury (Hg).
(c)	Fresh water from engine	160°F. (minimum) - 180°F. (maximum).
(d)	Exhaust back pressure	1 inch (Hg).
(e)	Sea water inlet temperature	85°F. (maximum) - 35°F. (minimum).
(f)	Sea water outlet temperature	130°F. (maximum).
(g)	Lubricating oil from engine or in sump	160°F. (minimum) - 240°F. (maximum).
(h)	Lubricating oil to engine or in the gallery	225°F. (maximum).
(i)	Operating time between oil changes	100 hours (minimum).

3.2.4 Accessory equipment. - The engine shall be complete in all aspects and shall include engine driven fresh water pump, positive displacement sea water pump, lubricating oil pressure pump, hydraulic starting equipment, overspeed trip, governor, strainers, filters, coolers, mufflers and all necessary instruments with gage board.

3.2.5 Smokeless operation. - The engine exhaust shall not be excessive when the engine is operating at 5 percent in excess of rated load and normal r.p.m. and operating with fuel oil in accordance with MIL-F-16884. Lubricating oil shall be in accordance with MIL-L-9000.

3.2.6 Torsional vibration. - Torsional vibration shall be in accordance with MIL-STD-167.

3.2.7 Inclination. - The engine shall be designed to operate in accordance with the requirements of this specification and without loss of oil and connecting rod or timing gear slipping when inclined under requirements of 3.1.9.

3.2.8 Lubrication system. - The engine sump shall be provided with an oil level indicator, filling opening, and an accessible drain connection or a hand pump to empty all accumulations of oil.

3.2.8.1 Lubricating oil filters. - Lubricating oil filters shall be of the full flow type accepting elements conforming to MIL-F-20707 and MS35802. Relief valves may be internal and shall be so designed that sump sediment will not discharge into the engine oil system when starting a cold engine.

3.2.8.2 An oil cooler, using fresh water as cooling medium, shall be supplied for each engine. The cooler shall be in accordance with MIL-C-15730 except that hose connections are acceptable. Plate or plug-in core type coolers are acceptable. Coolers shall be either engine or sub-base mounted.

3.2.8.3 Lubricating oil. - Lubricating oil shall conform to Military symbol 9250 of MIL-L-9000, for ambient conditions above 20°F. The same grade or symbol number of lube oil shall be used in the engine, accessories, transmission and generator. Engines shall be provided with an oil level indicator, filling opening and accessible sump pump to drain or clean the engine oil pan.

3.2.9 Cooling systems. - The engine shall be provided with a heat exchanger for cooling the circulating water, using sea water as cooling medium. The cooler shall be in accordance with MIL-C-15730 except that hose connections are acceptable. Plate or plug-in core type coolers are acceptable.

3.2.9.1 Temperature control. - The temperature of the engine circulating water shall be controlled automatically by means of a thermostatic valve.

3.2.9.2 Operating temperature. - The fresh and sea water pumps, coolers and thermostatic valve shall be of ample capacity to maintain the lubricating oil and cooling water temperatures within the following range:

(a) Sea water inlet temperature: Maximum 85°F., minimum 35°F.
(b) Lubricating oil operating temperature: Maximum 240°F., minimum 160°F.
(c) Cooling water from engines: Maximum 180°F., minimum 160°F.

3.2.9.3 Water pumps. - Fresh water pumps shall be of the centrifugal type. Sea water pumps shall be of the positive displacement type.

3.2.9.4 Drainage. - Means for complete drainage of the engine cooling water and sea water systems shall be provided.

3.2.9.5 Gaskets and packing. - Gaskets and packing in the cooling water system shall be of material resistant to deterioration when anti-freeze compound conforming to O-A-548 or preservative compound conforming to MIL-C-16173 and MIL-L-21260.

3.2.10 Fuel system. - Engines shall be suitable for operation on diesel fuel corresponding to MIL-F-16884 or grade JP-5 of MIL-J-5624. The fuel system shall include the following:

(a) Positive displacement type supply pump.
(b) Relief valve connected to discharge to pump suction or supply tank.
(c) Filters.
(d) Strainers.
(e) Necessary piping, valves and fittings.

3.2.10.1 Fuel filter and strainer. - The filter elements shall conform to MIL-F-20627. The filter shall be installed between the engine driven fuel pump and injection pump. Strainers, primary or secondary, shall be of the simplex metal edge type, with 0.003 -0.0035 inch spacings, enclosed manual cleaning knives and sediment drain valves. The strainer case shall be of brass, bronze or other metal which is not readily corroded by sea water contaminated fuel oil.

3.2.11 Regulating governor. - The engines shall be provided with a governor incorporating a speed-droop mechanism, adjustable from 0.5 to 5 percent of rated speed. The governor shall be capable of holding the engine speed constant to within plus or minus 0.5 percent of operating speed for any constant value of load between 10 percent load and full load. The response of the governor shall be such that upon sudden change (one step) from no load to full load and full load to no load, the maximum speed deviation from normal shall not exceed 7 percent. In addition, the speed shall return to and remain within 1 percent of the final steady-state speed in not more than 5 seconds following the change in load. The governor shall incorporate a 115 volt (d.c.), speed changing motor to provide for remote speed control of the engines.

3.2.11.1 Overspeed trip governor. - The engine shall be provided with a manual resetting overspeed governor, of the trip type, which will shut off fuel or air to the engine when the speed exceeds 115 percent of normal operating speed.

3.2.12 Starting system. - A hydraulic starting system shall consist of a hydraulic starter motor and all accumulators, reservoirs, control valves, filters, pressure regulators, pressure gages and pumps necessary to make the system self-contained and non-dependent on any other ship system. This starter system shall be properly adapted to the engine and of adequate capacity to provide 5 consecutive starts from one full pressure accumulation of the starting system oil (pump inoperative). A hand operated pump shall be provided for use during cold ship start-up or emergencies. It shall be practical for one operator to pump up full pressure (from zero pressure) within 5 minutes. Equipment and material used in the hydraulic starting system shall be specifically approved by NAVSEC. The contractor shall also furnish a complete description of tests and quality assurance criteria for the accumulators. Accumulators shall be of a type which will quickly relieve the pressure when the shell becomes initially distorted as a result of an impending rupture. The accumulators shall not explode or fragment if rupture does occur. In addition the external surfaces of the accumulator shall be primed with a zinc dust coating and painted with a compatible marine paint. A silastic or other suitable water resistant compound should be used to seal the external meeting edges of endcaps and housing to reduce the possibility of crevice corrosion. The sealing compound must be of a type which is resistant to water penetration but will not interfere with the required pressure relief features. In order to prevent susceptibility to stress corrosion and insure non-magnetic properties B and W CROLOY-18-185 and AISI stainless steels shall be obtained in the solution annealed condition. Stainless steels shall be of the free machining type. All accumulators shall be liquid penetrant and radiographically inspected in accordance with MIL-STD-271, prior to assembly. Acceptance standards shall be NAVSHIP 0900-003-8000, grade I for liquid penetrant inspection and NAVSHIP 0900-003-9000 grade I for radiographic inspection. The following applies to system and accumulator design.

(a)	Working pressure	3000 psi
(b)	Proof pressure	6000 psi
(c)	Accumulator burst pressure	12000 psi
(d)	Fuse blow-out pressure	4700 psi ± 300 psi

Accumulator shall be mountable in any position and mounting clamps shall be located to avoid shell distortion.

3.2.13 Air intake system. - The engine blower or intake air header shall be fitted with an air silencer and suitable filter or screen. Engines shall be provided with a filter in accordance with MIL-F-7194. The filter is required for installations where a three way valve is installed to permit engines to take air from either the engine room or the weather. The filter and elements shall be designed to withstand a uniformly distributed pressure of 5 p. s. i. over the entire surface of the element. The area of the filter element shall be such that the air velocity at the face of the filter does not exceed 2000 feet per minute, or the pressure drop across the clean filter be more than 4 inches of water at rated output. A manbmeter or signal device shall be connected across the element to indicate when cleaning is required. The filter housing shall be installed at an angle perpendicular to or less than 90 degrees to the direction of air flow in order that impinging dirt will drop to the bottom of the duct on the upstream side of the filter element.

3.2.13.1 Blower and air receivers. - Means shall be provided for draining pockets in the blower housing and air receiver where oil or water may accumulate.

3.2.14 Exhaust system. - The exhaust manifold shall be water cooled and provided with flange connection and a straight threaded companion flange. An air cooler is required for turbocharged engines.

3.2.14.1 Exhaust muffler. - A muffler in accordance with type A of MIL-M-15337 shall be furnished.

3.2.15 Alarm connections. - The supplier shall provide a 3/8-inch i. p. s. thread connection at the remote end of the lubricating oil distribution system, for later installation of a low lubrication oil pressure alarm contact maker. Space for installing a high temperature contact maker actuating bulb 4-1/2 inches long with 1/2 inch i. p. s. thread, in the cooling water outlet header from the engine shall be provided. The holes shall be closed with pipe plugs. The holes shall be satisfactory for use with alarm switches in accordance with MIL-S-16032.

3.2.16 Instruments and gages. - Engines shall be equipped with instruments specified in 3.2.16.1 and 3.2.16.3. Gages or thermometers which are mounted on the gage board shall be of the flush mounted type. No stem mounted gages are permitted. Gages shall be 3-1/4 inch in diameter.

3.2.16.1 The following instruments and gages shall be furnished:

(a) Oil pressure to engine gage.
(b) Fresh water to engine temperature gage.

3.2.16.2 An electric type tachometer in accordance with type IC/EFB of MIL-T-16049 shall be furnished. The scale range of all tachometers shall be at least 25 percent greater than engine rated speed.

3.2.16.3 Gage board. - All instruments shall be installed on a gage board mounted on the engine near the controls. The board shall be secured by means of vibration and shock isolating fittings to the engine.

3.2.17 Emergency shutdown device. - Engines shall be provided with an emergency shutdown device, operable by a pull cable, which will trip the fuel racks or shut-off the air and stop the engine within 60 seconds. The pull cable will be furnished by the installing activity and shall be operable from a location adjacent to the access to engine compartment. The device shall be of a type which requires manual resetting before the engine can be restarted. Normal engine shutdown shall be separate.

3.2.18 Guards and shields. - Guards and shields shall be furnished as specified in 3.2.18.1 and 3.2.18.2.

3.2.18.1 Guards. - Guards for protection of personnel shall be provided for flywheels and other exposed moving parts. Where there are no feasible means for attaching the guard to the equipment, they shall be provided by the installing activity.

3.2.18.2 Shields. - All hot machinery surfaces shall be shielded or lagged so that no external surface of the machinery shall exceed a temperature of 450°F. All fuel and lubricating oil lines or fittings, including gage lines, shall be located or shielded so that any leaks cannot drip or spray on exhaust system components.

3.2.19 Timing marks. - Means shall be provided to permit checking of valve and injection pump timing.

3.2.20 Crankshaft. - Nuts on coupling flange bolts shall be accessible and locked or keyed in place. Provision shall be made on the free end of the crankshaft for attaching a torsiograph drive.

3.2.21 Designating and marking. - Engines, components and parts shall be marked for identification in accordance with MIL-STD-130. Engines shall be provided with an identification plate secured to the engine in a visible location preferably on the cylinder block. Identification plates shall be of metal and shall show the following:

(a) Engine type
(b) Serial numbers
(c) Federal stock numbers
(d) Contract number
(e) Model number
(f) R. P. M.
(g) BHp
(h) Rotation
(i) Bore
(j) Stroke

3.2.22 A plate with an arrow showing the direction of rotation shall be secured to the engine.

3.2.23 Repair parts shall be marked with the manufacturer's part number by casting, stamping or etching. Where it is not practical to mark parts by any of these methods, the parts shall be identified by tags or printed description on the package.

3.2.24 Accessibility. - Engine attached accessories such as pumps, blowers, coolers, filters, strainers and silencers, shall be designed and secured in such a manner as to permit maximum accessibility to the accessories and the engine.

3.2.25 Piping systems. - Engine attached piping shall be strapped and supported by the engine structure to prevent vibration and resist shock. Pipe couplings of the hose type or lengths of nonmetallic composition tubing may be used when installed in a visible and accessible location. Takedown joints in fuel systems shall be kept to a minimum to reduce leaks. Navy type flanges for steel or nonferrous piping and fittings shall conform to MIL-F-20670 or MIL-F-20042, as applicable.

3.2.26 Aluminum parts. - Aluminum parts, other than pistons, blowers and fuel pumps, shall be protected from corrosion by one of the following methods:

(a) Exterior parts to be painted shall be anodized or treated with corrosion resistant chemical film.
(b) Exterior parts to be left unpainted shall be anodized.
(c) Interior parts in contact with oil do not require treatment.
(d) Interior parts not in contact with oil, shall be anodized or treated with a corrosion-resistant chemical film.

3.2.26.1 Threaded holes in aluminum intended for bolts or screws for components or accessories normally removed or disassembled during routine maintenance or inspection shall have steel inserts. Where insufficient basis metal exists, studs may be used without inserts.

3.2.27 Magnesium alloys. - Magnesium alloys shall not be used.

3.3 Generators. - Generators shall conform to MIL-G-3111 and MIL-E-917 except as otherwise specified herein:

3.3.1 The generator shall have the following classification:

Type	D.c.
Primer mover	Diesel engine
Rating:	
Voltage	120 volts d.c.
Kilowatt capacity	100 kw. continuous and 110 kw for 2 hours
Speed	1800 r.p.m.
Enclosure	Dripproof, protected
Type of bearing	Sleeve or ball (see 3.3.2)
Ambient temperature	50°C
Insulation	Class B, F, or H
Parallel operation	Required
Starting	Hydraulic
Winding	Shunt or stabilized shunt
Distribution system	Two wire

3.3.2 If a ball bearing is employed, it should be a double shielding type in accordance with FF-B-171 with grease lubrication. Adequate grease seals shall be provided and the lubrication system so designed that grease will not leak into the generator under any operating conditions.

3.3.3 Electrical insulation. - Insulation systems shall be class B, F, or H and shall conform to MIL-E-917. The number of impregnations of each type of generator shall conform to the minimum requirements of the manufacturer's detail insulation drawings as approved by the command or agency concerned for that specific type generator. In any case, there shall be not less than three complete and independent impregnations of any electrical winding. One impregnation shall be defined as one complete cycle of treatment and curing (such as one immersion and one baking) by a recognized method. However, the brushing or spraying method shall not be considered as one of the required impregnations unless it is applied as the final coat of varnish. All insulated windings shall receive at least two of the required impregnations after the windings have been installed on the corresponding machine subassemblies. Except as otherwise specified herein, all insulated electrical windings shall receive at least one of the required impregnations before assembly on machine parts. Impregnation before assembly on machine parts will not be required for windings which are to be inserted in semi-enclosed slots or other windings where the method of installation or the insulation system used is such as to make this preliminary impregnation impractical. In such cases, all required impregnations shall be made after the windings are installed on the machine parts. The use of solventless impregnating varnish may preclude the use of a subsequent varnish dip and bake and shall be subject to command or agency approval.

3.3.4 Painting. -

3.3.4.1 Exterior. - Except for shafts and identification plates, exterior surfaces of the generator shall be painted in accordance with MIL-E-917.

3.3.4.2 Interior. - Electrical insulation, surfaces in contact with lubricating oil or grease, commutators, brushes, bearings, and bearing surfaces shall not be painted. Also, peripheries of rotors and any other rotating part of the machine from which centrifugal force may cause the paint to be thrown on the winding when the machine is operating at rated load and speed and at normal temperature, shall not be painted; insulation varnish conforming to MIL-V-1137 may be applied to such parts. All other parts that are not corrosion-resisting (see MIL-E-917 for listing of corrosion-resisting materials and treatment) shall be painted in accordance with MIL-E-917 except that one coat of enamel of light color will be sufficient.

3.3.5 Generator capacity rating. - The kilowatt rating shall be the net power available for continuous use.

3.3.6 The inherent generator voltage regulation may exceed the voltage regulation requirements of MIL-G-3111 provided that the combined unit voltage regulation (without the use of voltage regulators) specified in MIL-G-3048 can be maintained by employing an isochronous governor on the engine, and provided a combined unit voltage regulation (from no load to full load) of 2.0 percent can be maintained by employing automatic voltage regulators. The generator inherent regulation, however, shall not exceed 12 percent drop on load increases (no load to full load) and 8 percent rise on load reduction (full load to no load) when load is either applied or removed in one step.

3.4 Control equipment. -

3.4.1 Generator field rheostat. - Generator field rheostats shall be of the adjustable, step by step type and shall conform to MIL-G-3048.

3.4.2 Voltage regulator. - An automatic voltage regulator shall be provided with each generator and shall have the following classification:

Type of control	Direct acting rheostatic or static
Enclosure	Dripproof
Ambient temperature	50° C
Degree of shockproofness	Class HI shock in accordance with MIL-S-901
Circuit control	Generator field
Operation	Parallel
Compensation for parallel operation	Differential cross current
Regulators per generator	One main

3.4.2.1 Performance requirements. -

3.4.2.1.1 Steady-state voltage regulation band. - The voltage regulator set shall maintain the voltage on the generator with which it is intended to operate within the following steady-state voltage regulation band with the generator operating at any load from no load to rated load:

Droop of two lines	Separation of two lines	Mounting of regulator
Zero	2.0 percent	Normal
Zero	4.0 percent	450 degrees from vertical any direction

3.4.2.1.1.1 The requirements of 3.4.2.1.1 need not hold during the class HI shock test, but shall be maintained after the class HI shock test without adjustment. The voltage maintained by the regulator after any or all blows of the shock test shall be not more than 3.0 percent above or below the voltage held before the shock test.

3.4.2.1.2 Generator overload. - The voltage regulator shall provide necessary excitation control to maintain generator voltage within plus or minus 3.0 percent of rated voltage with the generator operating at 125 percent of rated current.

3.4.2.1.3 Range of voltage adjustment. - The voltage adjusting means furnished shall be capable of changing the voltage from 3.0 percent below to 7.0 percent above rated voltage in steps of not more than 0.5 percent of rated voltage at any load from no load to full load.

3.4.2.1.4 Range of manual control. - The manual control means shall be capable of changing the generator voltage from 3.0 percent below to 7.0 percent above rated voltage in steps of not more than 0.5 percent of rated voltage at any load from no load to full kw. load with generator fields cold and also with generator fields hot.

3.4.2.1.5 Parallel operation of generators. - Parallel operation is required and the following shall apply: With each generator under the control of its intended voltage regulator and with the differential cross current compensation inoperative, the generators shall operate satisfactorily in parallel under load conditions varying from 20 to 100 percent of rated load for both increasing and decreasing load within the following limits:

(a) Generators of equal rating: The difference in current supplied by any one generator from that supplied by any other generator shall not exceed 10.0 percent of the full load current of one generator.
(b) Generators of different rating: The current supplied by any one generator expressed as a percentage of the total system load shall not differ from the generator rating expressed as a percentage of the total system by more than 10.0 percent.

3.4.2.2 The regulator control element shall be mounted in a dripproof enclosure in accordance with MIL-E-2036 and designed for bulkhead mounting. The associated control equipment (such as automatic manual switch and voltage adjusting unit) shall be suitable for switchboard mounting. The automatic manual transfer switch shall incorporate a means to prevent opening the generator field circuit during transfer from automatic to manual control, or vise versa. The transfer switch shall also incorporate a disconnect for the cross current connection between regulators such that the cross current coil will be disconnected under manual control.

3.4.2.3 The voltage regulator shall be of the direct acting rheostatic or the static type. The direct acting rheostatic type is one which varies resistance connected in the generator field circuit by mechanical action of a voltage sensitive element such as a solenoid or magnetic torque element. The static type is one which supplies the generator excitation and controls the generator output voltage through a completely static arrangement of rectifiers, resistors, capacitors, reactors or transformers.

3.4.2.3.1 Voltage regulators in combination with the generator shall have characteristics which will be compatible with the performance requirements for the complete generator set as specified herein.

3.4.2.3.2 Where a static system is furnished, semiconductor devices (rectifiers, voltage regulator diodes, voltage reference diodes, transistors, and so forth) shall be selected from MIL-STD-701. Semiconductor devices shall be individually replaceable.

3.4.2.3.3 Use of electron tubes is not permitted.

3.4.2.3.4 Enclosures for voltage regulators shall be of the dripproof type.

3.4.2.3.5 In addition to the tests normally conducted at the manufacturer's plant, tests on the voltage regulator after it is installed with the generator set shall include: insulation resistance, dielectric, steady state load voltage regulation, voltage adjustment, voltage variation and recovery time when applying and removing full rated load at the generator set output terminals in one step, and heating.

3.4.2.3.6 Capacitors shall be paper dielectric fixed capacitors of the extended foil construction or be the dry electrolytic aluminum foil fixed capacitor type.

3.4.2.3.7 Rheostats and switches shall be suitable for the application. In addition to tests at the manufacturer's plant, tests on rheostats and switches after they are installed in the generator set shall include, dielectric, insulation resistance, heating and operational tests to confirm that they perform in control circuits as required.

3.5 Nonmagnetic material. - In order to keep the magnetic signature of the equipment at a minimum, nonmagnetic material shall be employed in the construction of the following parts:

(a) Generator
  (1) Shaft (where not used in the magnetic circuit)
  (2) End frames
  (3) Ventilating covers
  (4) Fan and driving disk assembly
  (5) Commutator Vee rings
  (6) Brushholder studs
  (7) Mounting feet
  (8) Frame (where not used in the magnetic circuit)
  (9) All nuts and bolts, lifting eyes and miscellaneous hardware
(b) Regulator and rheostats
  (1) All enclosures and covers
  (2) All mounting hardware, actuating shafts, handles, identification plates and nuts and bolts

3.6 Drawings. -

3.6.1 Electrical. - Drawings for all electrical equipment shall be furnished in accordance with MIL-D-1000/2 as follows:

(a) Type II master drawings for the generator, and excitation and voltage regulation system. Contents of drawings shall be as specified in MIL-E-917, MIL-G-3111, MIL-R-2729, (as a guide), as applicable. Drawings use categories are A, B, D, G, H and I of MIL-D-1000.

(b) Type III certification data drawings for the generator, and excitation and voltage regulation system.

3.6.2 Engine and accessories. - Drawings of production or existing parts, components or equipment applicable to the contract or order shall consist of manufacturer's commercial shop drawings.

3.6.2.1 Approval of drawings. - After award of contract and within the time specified in the contract or order, the prime contractor shall submit prints of installation drawings of the engine, detached components and accessories (including the hydraulic starting system components) to NAVSEC or agency concerned for approval. The drawings shall be submitted with the combined unit drawings.

3.6.2.2 Microfilm of drawings. - A set of engine drawings shall be furnished and shall consist of microfilm on reels of all installation and assembly drawings together with detail drawings of parts for each component, except accessories exempted herein. Drawings of items on Qualified Products Lists and standard hardware such as bolts, nuts, washers, cotter keys and similar items that are fully described in bills of material, and drawings of pieces used in the fabrication of a welded part shall not be included in the microfilm. Microfilm shall be in accordance with MIL-M-9868/1. Engine microfilm shall be separate. Microfilm requirements for driven components shall be as specified in the unit specification. All engines shall be included on one set of reels.

3.6.2.2.1 A microfilm index of drawings, listing manufacturer's drawing numbers, name of drawing and microfilm frame number of each drawing, shall be submitted for approval prior to actual microfilming. Drawings shall be arranged as component groups headed by the assembly drawing. The index shall be preceded by a summary list of drawings showing installation drawings and component assembly drawings, and list the applicable index sheets. Detail microfilm drawings are not required for following list of accessories:

(a) A cross-section drawing with Bill of Material is sufficient for the following items:
  (1) Regulating and overspeed governors.
  (2) Lube oil strainer.
  (3) Lube oil filter.
  (4) Thermostats or temperature regulators.
  (5) Hydraulic starting system.
  (6) Air intake filter/silencer.
  (7) Pneumatic control devices.
  (8) Fuel oil filter.
  (9) Mufflers.
  (10) Coolers.

(b) An outline drawing will suffice to complete drawing requirements for the following accessories:
  (1) Tachometer.
  (2) Tachometer generators.
  (3) Pressure gages.
  (4) Thermometers.
  (5) Pyrometers.
  (6) Thermocouples.
  (7) Flexible exhaust hose.
  (8) Expansion tanks.
  (9) Valves (relief, safety, throttling, regulating, reducing, and similar types).
  (10) Mechanical controls.

3.6.3 Combined unit installation drawings. - Installation drawings for the combined diesel generator sets shall be furnished in accordance with type II of MIL-D-1000/2. Drawing use categories are A, B, and G of MIL-D-1000 and shall contain the following information:

(a) Dimensional outline drawings of the generator set.
(b) Location and details of all connections to the ship's piping and electrical systems.
(c) Foundation bolting details.
(d) Clearances required for removing parts such as cylinder heads, piston liners and so forth.

(e) Diagrammatic sketches of piping systems, indication pipe sizes, type of connections, relative location of coolers, filters, valves, strainers, thermometers, gages, alarm devices, and quantity, pressures and temperatures of oil, air and water.

(f) Data table as necessary to clearly describe all equipment, including capacities of pumps and blowers at rated speed, rated BHP, BMEP, RPM, type numbers, ratings (volts, amperes, rpm, kw, torque and so forth), name of manufacturer, and identification plate data of starting equipment.

(g) Outline drawings of all detached accessories.

(h) Centers of gravity of engine, generator, and of the combined diesel generator set.

(i) Location and size of lifting means.

(j) Weight of complete set (wet and dry), individual component and detached accessory weights and weights of magnetic material.

(k) A complete wiring diagram showing the location of all components, terminal boards, and all terminal markings.

(l) Any additional information required for the proper installation and operation of the equipment furnished.

3.6.3.1 In addition to the drawings specified in 3.6.3, to permit planning of installation on sound isolation mounts if desired, the following information shall be furnished on a drawing entitled "Mount Installation Design Data", or in tabular form on the combined unit installation drawing:

(a) The normal and maximum operating speed range from no load to full load.

(b) Total weight of the mounted assembly in the operating condition. The weight should include weight of sub-base, service fluids, piping, and all attached accessories.

(c) Location of the unit center of gravity in at least 2 planes.

(d) The moments of inertia and products of inertia of the mounted unit about three mutually perpendicular axis with the origin of the unit center of gravity, and the orientation of the axis indicated with respect to the equipment and the ship.

(e) The natural frequencies (in c.p.s.) of the unit.

(f) The type of approved Navy mount used in performance of the calculations.

(g) List of assumptions made in calculating natural frequencies.

3.6.4 Drawings for shipbuilding activities. -

3.6.4.1 Two blueprint copies of all outline and assembly drawings of the complete unit and major components (such as generator, exciter, and regulator) and unattached accessories shall be forwarded to shipbuilding activities as designated by the command or agency concerned at the same time (and each time) they are submitted to the command or agency for approval. These drawings shall be stamped preliminary until final approval action has been taken.

3.6.4.2 One complete set of reverse reading vandykes of all applicable mechanical and electrical detail and component drawings shall be furnished to a shipbuilding activity designated by the command or agency concerned.

3.6.5 Preliminary drawings for approval. - The contractor shall submit to the ordering activity the required number of black and white or blueprints of preliminary drawings as specified (see 6.1). Preliminary installation drawings shall consist of the drawings required by 3.6.3 in sufficient detail to enable the building yards to properly plan the installation and machinery arrangement. Preliminary assembly and detail

drawings shall consist of the drawings required by the applicable component specifications for design approval and release for manufacture and shall include those areas for which there are detail requirements in the applicable specifications.

3.6.6 Final drawings. - Final drawings shall consist of black and white prints and microfilm as specified (see 6.1), and shall consist of all installation, assembly, and detail drawings showing all data required by the specifications.

3.7 Manuals. - Manuals shall conform to type I of MIL-M-15071. The following equipment, as applicable, shall be covered in the manual:

(a) Diesel engine and associated accessories

(b) Generator.

(c) Excitation and voltage regulation system.

(d) Starting equipment.

(e) Temperature indicating and other alarm equipment.

(f) Heat exchangers.

(g) Parts lists.

(h) Complete and comprehensive alignment instructions for the entire plant. The instructions shall cover original alignment procedure, with maximum limits for radial and axial deviation, and information for alignment checks after installation. A machinery layout sketch showing locations of measurements, and space for recording measurements shall be provided.

3.7.1 Manuals shall contain reduced size prints of the combined unit installation drawings and all finally approved drawings for electrical equipment. In addition, copies of the first unit test results for the generator, excitation and regulation system, and the combined diesel generator set shall be included.

3.7.2 The manual shall contain all information required for a complete understanding of the construction and operation of the engine generator, voltage regulator and associated equipment. It shall also contain information on maintenance and overhaul which shall be as complete as necessary for use by a well equipped machine shop to maintain and overhaul the engine generator, voltage regulator and associated equipment without assistance by the manufacturer. The manuals shall have a comprehensive index referring to drawings, diagrams, and photographs as required. A listing of engine parts, and manufacturer's part numbers shall be provided.

3.7.3 A parts manual section shall be furnished and may be bound with the combined unit.

3.7.4 The engine section of the manuals shall include a table of normal clearances, diameters and thicknesses for new parts and maximum allowable clearances and wear limit for wearing parts. The data shall be furnished for all wearing parts. Torque settings of important nuts shall also be listed.

3.7.4.1 In lieu of a separate chapter or sections, the manual covering detailed description of parts should also include maintenance instructions for the part. The chapter on maintenance should concern only the complete engine assembly. Manuals shall contain separate installation drawings for engines and combines units.

3.7.5 Preliminary manuals. - Preliminary manuals shall be submitted to the command or agency concerned for approval prior to printing of final manuals. Preliminary manuals shall contain all the information required by MIL-M-15071 with the exception of photographs and referenced drawings.

3.7.6 Final manuals. - Final manuals shall be as required by MIL-M-15071 and 3.7.5 and as finally approved by the command or agency concerned.

3.7.7 Preliminary and final manuals shall be furnished in quantities specified (see 6.1).

3.8 Onboard repair parts and special tools. - Onboard repair parts and special tools (Special tools are defined as those tools not listed in the Federal Supply Catalog (copies of this catalog may be consulted in the office of the Government inspector)) shall be furnished in accordance with the individual equipment specifications (on the basis of two per ship) as follows:

(a) Engine	3.8.1
(b) Generator	MIL-G-3111
(c) Excitation and voltage regulation system	MIL-R-2729(as guide)

3.8.1 Engine onboard repair parts and tools. - The list of onboard repair parts shown in table V is furnished for guidance in preparing technical documentation as specified in the contract or order. Parts expressed as percentages are based on the total number of that part or component required for each unit.

Table V - Onboard repair parts and tools

Part designation	Quantity
Cylinder head assembly	1
Connecting rods, complete with bolts, nuts and bearings	1
Piston assembly complete with rings, bushings, wrist pin and retainers	1
Cylinder liners	1
Piston rings	25 percent
Wrist pin	1
Crankpin bearing shells	25 percent
Main bearing shells each size	2 sets
Main bearing bolts	2
Thrust bearing shells	1 set
Exhaust valves	6
Air inlet valves	3
Springs, inlet valve	3
Springs, exhaust valve	3
Valve guides, keys and locks	25 percent
Fuel injectors or nozzles	25 percent
Fuel injector spray tips	50 percent
Fuel injector needles and guides	25 percent
Fuel injector pump assembly or unit injector	25 percent
Fuel pump plungers and barrels	25 percent
High pressure fuel lines	8
Fuel filtering elements	200 percent
Lube oil filtering elements	200 percent

Table V - Onboard repair parts and tools, cont'd

Part designation	Quantity
Camshaft bearing of each size	1
Governor regulating complete	1
Governor overspeed complete	1
Lubricating oil pressure pumps complete	1
Lube oil scavenging or piston cooling pump complete	1
Fresh water pump complete	1
Sea water pump complete	1
Fuel oil supply pump	1
Tachometer	1
Gages (one of each type and size)	1
Safety and relief valve parts for each type and size valve	1
Gear accessory drive (small)	1
Blower or turbocharger	1
Springs, assorted sizes (sets)	1
Bushings, wearing parts (sets)	2
Cooler parts	See MIL-C-15730
Gaskets, packing and seal (sets)	1
Ball and roller bearings each size	1
Assorted nonstandard bolts and nuts	1
Thermostatic valve	1
Electrolysis protectors	50 percent
Hose connections	50 percent
V-belts	50 percent

3.8.2 Special tools. - Special tools shall consist of nonstandard gages, seating tools, reamers, pullers, templates and wrenches required for disassembly, repair and assembly of engine parts. One set of special tools is required for each engine room. Special tools are those tools not listed in the Federal Supply Catalog (copies of this catalog may be consulted in the office of the Government inspector).

3.8.3 Onboard and stock repair parts lists. - Onboard and stock repair parts lists and list of special tools shall be furnished in accordance with MIL-P-15137.

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for inspection. - Unless otherwise specified in the contract or purchase order, the supplier is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified, the supplier may utilize his own facilities or any commercial laboratory acceptable to the Government. The Government reserves the right to perform 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 Quality program requirements. - The supplier shall provide and maintain a quality program acceptable to the Government for the supplies covered by this specification. The program of quality control shall be in accordance with MIL-Q-9858.

4.2 Test agenda. - A complete test agenda shall be submitted to the command or agency concerned for approval at least 120 days prior to the start of any tests. The agenda shall list all the tests to be conducted on all assembled units and components under the contract or order and shall indicate the place where each test is to be conducted. The agenda shall also include a listing of all instrumentation to be used, its sensitivity, and the means and frequency of calibration.

4.2.1 Test data. - Test data for the first engine on any contract or order shall be forwarded to the command or agency concerned via the Government inspector for approval. Test data shall be submitted on supplier's test forms or on large sheets with lines for folding to 8 by 10-1/2 inches for fitting. Each test report form should be identified by the number of this specification and each test by the test paragraph number. The dynamometer output of the engine shall be such as to insure that the identification plate output as specified in the contract or order can be obtained under standard conditions. The dynamometer output necessary to satisfy this requirement shall be determined using the following formula:

$$BHP_d = \frac{BHP_n}{\frac{P_s}{P_o}\sqrt{\frac{T_o}{T_s}}}$$

4.2.1.1 All temperature and pressure readings necessary for complete evaluation of the engine performance, including ambient room temperature, barometric pressure and relative humidity, shall be entered for all runs of sufficient duration for engine conditions to become stabilized. All additions of lubricating oil and oil changes shall be recorded.

4.2.1.2 Readings of instruments shall be recorded at intervals not exceeding 1 hour. When a phase of a test is of such short duration that operating temperature cannot be stabilized, no reading is required.

4.2.1.3 Fuel used during the tests shall have a maximum octane number of 52. Fuel consumption shall be corrected for the difference in high heat value of fuel actually used during the test and the standard 19, 350 British thermal unit (B. T. u.) per pound.

4.2.1.4 The exhaust back pressure at the engine exhaust outlet for rated load and speed shall be 1 inch Hg.

4.2.1.5 The test data recorded shall be submitted in tabular form and in the form of curves as follows:

(a) Specific fuel consumption in pounds per BHP hour, fuel consumption in pounds per hour, exhaust gas temperature, injection pump rack position (if practical), and air box pressure versus BHP.

(b) Fuel consumption at no load in pounds per hour versus speed.

(c) With BHP as the ordinate and rpm as the abscissa, draw line of constant fuel consumption.

(d) To determine the control of the load limiter, (when applicable) on engine output, a curve of maximum BHP or BMEP versus rpm for the operating range of the engine shall be furnished.

4.3 Examination. -

4.3.1 Electrical equipment. - Electrical equipment shall be examined in accordance with the applicable specifications prior to assembly with the engine.

4.3.2 Combined engine generator sets. - Each generator set shall be subject to a thorough examination to ascertain that the material, design and workmanship are in conformance with the requirements of this specification. Such items as welding, machining, surface finish, mounting of components, accessibility of parts requiring servicing, generator air gaps, enclosures, overall weight and dimensions, exterior painting, alignment, clearances, piping and connections shall be checked for conformance with drawing and design requirements. Bolts, nuts and other connectors shall be examined for tightness and security against vibration. Special attention shall be given to the lube oil system including sumps, coolers, strainers, filters and bearing bracket reservoirs, to assure that the system has been thoroughly cleaned of dirt, metal chips and so forth, that internal surfaces normally exposed to oil have not been painted, and that proper provision has been made to seal the system during shipment and initial installation.

4.3.3 Repair parts. - All repair parts shall be subjected to a careful examination to assure that the materials, workmanship, and finish are first-class in every respect and that the parts are in full conformance with the manufacturer's approved drawings. The object of the examination is to determine if the repair parts are duplicates of those used in the generator set. If the inspector has any reason to doubt the ready interchangeability of the repair parts with the original parts, he may require a suitable demonstration of such interchangeability.

4.4 Tests. - Engines shall be assembled with all parts and accessories and tested as specified in 4.4.1 through 4.4.1.3.1. During the tests, the engine cooling water shall be treated to prevent corrosion.

4.4.1 First production engine performance tests. - In addition to the tests specified for the combined unit (see 4.4.3), tests shall be made on the first application of a new engine by the command or agency concerned. Where a supplier has conducted first production engine performance tests in accordance with the requirements of this specification and the equipment has been accepted by the command or agency concerned a test report of the previous tests, will be acceptable in lieu of actual tests. For the purpose of the 1000 hour endurance test, the continuous test rating in horsepower shall be equivalent to that required for 100 kw with the generator efficiency for the generator actually furnished.

4.4.1.1 Endurance test. - The first engine shall be run for 125 eight hour cycles as follows:

(a) 2 hours at rated load
(b) 1 hour at 85 percent load
(c) 10 minutes at minimum idling load
(d) 1 hour and 50 minutes at rated load
(e) 10 minutes at minimum idling load
(f) 30 minutes operation at 50 percent load
(g) 10 minutes at minimum idling load
(h) 10 minutes at 85 percent load
(i) 1 hour and 50 minutes at 110 percent rated load
(j) 10 minutes shutdown (minimum between each cycle).

Engines may be shutdown, as required, between each complete cycle or full cycles may be run on a continuous basis.

4.4.1.1.1 During the endurance test (see 4.4.1.1), the fuel consumption and exhaust gas temperatures for runs not less than 1/2 hour shall be recorded; fuel pump rack setting, if available, shall be recorded for all test loads.

4.4.1.2 Fuel consumption. - Fuel consumption tests of 1/4 hour duration with sufficient time intervals between each run for stabilization of operating conditions, shall be made on engines at 100, 90, 70, 50 and 30 percent rated speed for each load of 0, 40, 80, 100 and 110 percent BHP at rated speed. If the engine cannot be operated continuously at 30 percent rated speed, the lowest safe operating speed shall be substituted. For speeds below rated speed, 100 percent BHP shall be defined as maximum BHP which the engine can carry safely with a clear exhaust.

4.4.1.3 Post trial examination. - After completion of all tests, the engine shall be disassembled and examined. For this purpose, all cylinders shall be opened, pistons pulled and the cylinder bores, pistons,

piston rings, wrist pins, and crankpin bearings examined for defects and measured for wear after crankshaft deflection has been recorded. Gear train covers and all crankcase covers shall be removed for examination of internal parts. The engine shall be barred over during examination to determine extent of backlash in gear trains. The gear, shall be examined and measured for wear. Mating surfaces of gears and all bearings shall be checked for distress such as pitting and galling. Excessive wear, broken or damaged parts, scored cylinders, burned valves or signs of severe stress or excessive wear will cause rejection of the unit. A complete report shall be submitted to the command or agency concerned.

4.4.1.3.1 Special tools furnished with the engines shall be tried out on the engine during the post trial examination (see 4.4.1.3) before examination can be considered complete.

4.4.1.4 Duplicate engine tests. - Production engines, duplicates of one which has been satisfactorily tested (see 4.4) shall be tested in accordance with the manufacturer's standard production procedure.

4.4.2 Electrical equipment. - Generators and excitation and voltage regulation systems, shall be tested in accordance with MIL-G-3111, MIL-R-2729, as applicable, and as specified herein.

4.4.2.1 Radio interference. - Radio interference tests shall be conducted on a complete generator set in accordance with MIL-I-16910.

4.4.3 First unit tests for combined diesel generator sets. - The first combined diesel engine generator set including attached and unattached accessories of each size and design offered for delivery shall be subjected to the first unit tests specified in table VI. No first unit tests will be required thereafter, as long as identical designs are offered or design changes are minor and do not effect performance, provided the Government is satisfied that quality controls are being maintained. If duplicate units tests reveal variations beyond a normal manufacturing tolerance, the Government may require that any, or all of the first unit tests be conducted on a particular engine generator set to demonstrate that it conforms to the requirements of this specification. The tests shall be conducted with all the intended electrical equipment and attached and unattached accessory equipment.

Table VI - Test for combined diesel generator sets

Description of tests	Applicable paragraph	First unit Tests	Duplicate unit tests
Generator air gap	4.4.4.1	X	X
2 hour preliminary run	4.4.4.2	X	X
5 hour continuous test	4.4.4.3	X	---
Mechanical balance	4.4.4.4	X	X
Governor tests	4.4.4.5	X	X
Range of speed changer	4.4.4.6	X	X
Brush examination	4.4.4.7	X	X
Generator voltage (manual control)	4.4.4.8	X	---
Effectiveness of enclosure	4.4.4.9	X	---
Torsiograph	4.4.4.10	X	---
Lubrication	4.4.4.11	X	X
Starting	4.4.4.12	X	---
Inclined operation	4.4.4.13	X	---
Weight and center of gravity	4.4.4.14	X	---
Parallel operation	4.4.4.15	X	---
Endurance tests	4.4.4.16	---	---
Mechanical shock test	4.4.4.17	X	---
Stray field test	4.4.4.18	X	---

4.4.3.1 Duplicate unit tests. - All duplicate combined diesel engine generator sets shall be subjected to the duplicate unit tests specified in table VI.

4.4.3.2 Test reports. - All first unit test data for combined diesel engine generator set shall be approved by the command or agency concerned prior to shipment of the equipment. Three copies of all first

unit test data shall be forwarded to the command or agency concerned for approval. A table of contents shall be included and list each test required by table VI. No special test format will be required; however, each test shall be prefaced by the name of the test and applicable test paragraph as indicated in table VI. This data submitted shall be copies of the actual data taken on the test floor and shall not be retyped data. The forms used shall allow sufficient columns for instrument corrections and necessary calculations. The Government inspector shall sign the cover sheet of the test report and note thereon the number of test sheets verified. Duplicate unit tests shall be approved by the Government inspector. After approval, 3 copies shall be forwarded to the command or agency concerned for information and file.

4.4.4 Test procedures. -

4.4.4.1 Generator air-gap. - The minimum air-gap shall be measured by suitable steel feelers or gages. The measurements shall be made for each pole, with at least one of the measurements made at the bottom.

4.4.4.2 Two hour preliminary run. - The generator set shall be operated at full load for 2 hours to bring it up to or near its operating temperature. During this period the general operation of the set shall be observed and any necessary adjustments shall be made.

4.4.4.3 Five-hour continuous test at full load. - Immediately following the test specified in 4.4.4.2 the generator set shall be operated at full load for 5 hours. The following data shall be taken at 30 minute intervals during the test and shall be recorded on approved test record forms:

(a) Time.
(b) Ambient temperature.
(c) Fuel consumption.
(d) Engine fuel oil pressure.
(e) Engine lubricating oil pressure.
(f) Engine lubricating oil temperature.
(g) Water temperature.
(h) Speed of engine.
(i) Generator bearing temperatures.
(j) Volts
(k) Current, line.
(l) Generator frame temperature.
(m) Kw

4.4.4.3.1 At the conclusion of the 5 hour period (see 4.4.4.3), temperatures of the rotating components of the generator shall be measured and shall be recorded immediately upon shutdown.

4.4.4.4 Mechanical balance. - The mechanical balance shall be observed during the progress of all tests. Any unusual noises, excessive vibration, or other indication of mal-function shall be cause for rejection of the unit. Vibration readings in mils double amplitude should be taken on the engine(s), combining gear, coupling, and generator bearing brackets or shafts, and recorded.

4.4.4.5 Governor tests. -

4.4.4.5.1 Steady state speed regulation. - Generator sets shall be tested as follows for steady state speed regulation:

(a) At no load, and with manual or automatic control of generator excitation, the generator set shall be adjusted to rated speed.
(b) The load shall be changed in 10.0 percent increments from no load to 100 percent load and back to no load. At each point, the voltage shall be adjusted to rated value and the speed shall be recorded.
(c) The speed regulation curve shall be plotted and furnished as part of the test date.

4.4.4.5.2 Steady state governing speedband. - At 0, 25, 50, 75 and 100 percent rated load, the steady state governing speedband shall be observed and recorded. The method of measuring the speedband shall be satisfactory to the command or agency concerned.

4.4.4.5.3 Momentary underspeed and overspeed. - Momentary underspeed and overspeed tests shall be conducted as follows:

(a) The generator set shall be adjusted to rated speed, voltage, and load. Rated load shall then be removed in one step.
(b) The generator set shall be operated at rated speed, rated voltage, and no load. A 100 percent resistance load shall then be suddenly applied in one step.
(c) Readings of overspeed, underspeed, and recovery time shall be recorded. The method of measuring the speed changes and recovery time shall be approved by the command or agency concerned. During these tests, manual or automatic control of generator excitation may be used. If manual control is used, the no-load voltage for the underspeed test shall be set at 105 percent of rated voltage.

4.4.4.5.4 Overspeed trip. - During the overspeed trip test, the regulating governor shall be inoperative. The engine speed shall be increased above rated speed until the overspeed trip acts to determine the r. p. m. at which the engine shall be shutdown.

4.4.4.6 Range of speed changer. - Range of speed changer test shall be conducted as follows:

(a) At no load and with manual control of generator excitation, the generator set shall be adjusted to rated speed and voltage. Operate the speed changer so that the speed is at the minimum specified value. Record speed. Operate the speed changer so that the speed is at the maximum specified value. Record speed at rate of change from minimum to maximum speed.
(b) At 100 percent load and with manual control of generator excitation, the generator set shall be adjusted to rated speed and voltage. Operate the speed changer so that the speed is at the minimum specified value. Record speed. Operate the speed changer so that the speed is at the maximum specified value. Record speed and rate of change. The load and voltage may be maintained at rated values when measuring maximum speed.

4.4.4.7 Brush examination. - During all tests, the performance of brushed should be noted at each load point. Particularly, it should be noted if any injurious sparking occurs when the entire load is dropped or applied in one step.

4.4.4.8 Generator voltage under manual control. - Tests shall be conducted as follows with the generator field cold. The voltage regulator shall be made inoperative by positioning the manual-automatic voltage regulation switch in the manual position.

(a) Operate the unit at a speed corresponding to no load. Adjust the manual control so that the voltage is at the minimum specified value. Record voltage and speed. Adjust the manual control so that the voltage is at the maximum specified value. Record voltage and speed.
(b) Operate the unit at no load, and adjust the voltage to the minimum specified value. Add load and adjust the voltage, speed, and load until the unit is operating at the minimum specified voltage with rated load. Record voltage, current, and speed.
(c) Reduce the voltage and load to rated voltage and no load. Adjust the voltage to the maximum specified value. Add load and adjust voltage, speed, and load until the unit is operating at the maximum specified voltage with rated load. Record voltage, current, and speed.

4.4.4.9 Effectiveness of enclosure. - Enclosure tests shall be conducted in accordance with MIL-E-2036 on the electrical portion of the generator set, where it is evident that the effectiveness of any enclosure has been altered by assembly as a part of the generator set.

4.4.4.10 Torsiograph test. - Generator set shall be tested in accordance with type III requirements of MIL-STD-167.

4.4.4.11 Lubrication. - Satisfactory performance of the lubricating system shall be determined by a careful observation and general examination of the parts. Limitation of the generator bearing temperatures, as specified in MIL-G-3111 shall not be exceeded. This test may be made at no-load provided the bearing load is not influenced appreciably by the load condition of the generator. Lubricant similar to that required for service operation shall be used.

containing identification. The specimen shall be mounted in the

4.4.4.12 Starting tests. -

4.4.4.12.1 Cold start. - Prior to conducting the cold start test the diesel generator set shall have been shutdown for at least 12 hours. Cold water, at a temperature not exceeding 35°F, shall be circulated through the engine for not less than 1 hour or until the outlet temperature of the water does not exceed 38°F. The engine shall start, continue operating, and be capable of providing rated voltage at the generator terminals within 10 seconds after the starting mechanism is set in operation.

4.4.4.12.2 Normal starting. - Immediately following the cold start test (see 4.4.4.12.1) five consecutive starts shall be made under normal ambient conditions. The average time required to start the unit, and the minimum starting r.p.m. shall be determined. The engine shall fire and continue operating within 5 seconds after the starting mechanism is engaged.

4.4.4.13 Inclined operation. - The inclination test shall be made with the unit running at rated speed with or without load for at least 30 minutes in each of the following positions:

(a) Shaft inclined, forward end down 5 degrees.
(b) Shaft inclined, forward end up 5 degrees.
(c) Shaft horizontal, base inclined to right 15 degrees.
(d) Shaft horizontal, base inclined to left 15 degrees.

4.4.4.13.1 During the tests of 4.4.4.13, the lubricating oil sump(s) shall be filled to the maximum operating level. It shall be ascertained that the mechanical balance is as good as it was in the horizontal position, that there is no pounding or grinding of the bearings, that the lubrication is satisfactory, and that there is no leakage of oil or cooling water.

4.4.4.14 Weight and center of gravity. - The generator set and all detached accessories shall be weighed dry. The center of gravity for the generator set shall be determined by actual measurement. If measurement of the complete generator set is not feasible, its center of gravity shall be calculated using weights and center of gravity figures for components obtained by actual measurement.

4.4.4.15 Parallel operation. - With each generator set operating at rated voltage and at a speed corresponding to approximately 20 percent load, the engine governors shall be adjusted for equal percentage division of load equal to approximately 20 percent of the combined kilowatt rating of the paralleled generators. No further adjustment of the governor and rheostats shall be made for the duration of the test. The load shall be varied from 20 to 100 percent of the combined kilowatt rating of the two paralleled generators in four approximately equal steps and back to 20 percent load in the same manner. The speed, live voltage, line current, kilowatt load, field voltage and field current of each generator at each load point shall be recorded.

4.4.4.16 Endurance test. - The first engine shall be run for 125 eight hour cycles as follows:

(a) 2 hours at rated load.
(b) 1 hour at 85 percent load.
(c) 10 minutes at minimum idling load.
(d) 1 hour and 50 minutes at rated load.
(e) 10 minutes at minimum idling load.
(f) 30 minutes at 85 percent load.
(g) 10 minutes at minimum idling load.
(h) 10 minutes at 85 percent load.
(i) 1 hour and 50 minutes at 110 percent rated load.
(j) 10 minute shut down.

4.4.4.17 Mechanical shock (see 6.1). - The complete diesel generator set shall be tested in accordance with the requirements of the Appendix to this specification.

4.4.4.18 Stray field test (see 6.1). - Stray field test shall be in accordance with Confidential Amendment. At least 45 days prior to the date of the scheduled test, the command or agency concerned shall be notified so that arrangements can be made to witness the test, if desired.

5. PREPARATION FOR DELIVERY

5.1 Domestic shipment and early equipment installation and for storage of onboard repair parts. -

5.1.1 Diesel generator set. -

5.1.1.1 Preservation and packaging. - Preservation and packaging which may be the supplier's commercial practice, shall be sufficient to afford adequate protection against corrosion, deterioration and physical damage during shipment from the supply source to the using activity and until early installation.

5.1.1.2 Packing. - Packing shall be accomplished in a manner which will insure acceptance by common carrier at the lowest rate and will afford protection against physical or mechanical damage during direct shipment from the supply source to the using activity for early installation. The shipping containers or method of packing shall conform to the Uniform Freight Classification Ratings, Rules and Regulations or other carrier regulations as applicable to the mode of transportation and may conform to the suppliers commercial practice.

5.1.1.3 Marking. - Shipment marking information shall be provided on interior packages and exterior shipping containers in accordance with the contractor's commercial practice. The information shall include nomenclature, Federal stock number or manufacturer's part number, contract or order number, contractor's name and destination.

(5.1.2 Onboard repair parts.- Mechanical and electrical repair parts shall be preserved, packaged and marked in accordance with MIL-R-196, MIL-P-16789, MIL-E-16298 or MIL-E-17555, as applicable. Tools shall be preserved and packaged in accordance with MIL-P-17286 or MIL-H-15424, as applicable. Repair parts and special tools shall be packed in accordance with 5.1.1.2.

5.2 Domestic shipment and storage or overseas shipment requirements. - The requirements and levels of preservation, packaging, packing and marking for shipment shall be specified by the procuring activity (see 6.1).

5.2.1 The following provides various levels of protection during domestic shipment and storage or overseas shipment, which may be required when procurement is made.

5.2.1.1 Preservation and packaging. -

5.2.1.1.1 Diesel generator set. -

5.2.1.1.1.1 Level A. -

5.2.1.1.1.1.1 Engines, accessories and attached reduction gears. - Engines, accessories and attached reduction gears shall be preserved and packaged in accordance with type IV, method II of MIL-E-10062 to the extent specified.

5.2.1.1.1.1.1.1 Lubricating oil, fresh and sea water systems. - Preservative type P-10, grade 2, in accordance with MIL-L-21260, shall be used throughout the engine and gear, fresh water, sea water and lubricating oil systems in lieu of the P-2, P-3 and P-9 preservatives specified in MIL-E-10062. In addition the fresh water system shall be drained and completely dried with warm air prior to preservation. If it is impractical to perform a drying out procedure, the cooling system shall be flushed with a soluble oil conforming to MIL-I-19841, which will emulsify the water and remove it on draining. The system shall then be flushed with the specified preservative.

5.2.1.1.1.1.1.2 Fuel oil system. - Preservative type P-10, grade 2 shall be used throughout the fuel system. A substitute, satisfactory to the command or agency concerned, may be used for those fuel systems where passages and orifices are so small as to prevent pumping of type P-10 throughout the system. Injectors shall not be removed from engines for the purpose of preservation.

5.2.1.1.1.1.1.3 Valve mechanism. - Access covers shall be removed and all surfaces within the valve compartment, including rocker mechanisms, valve stems, springs, guides, push rods and the inside face of the cover plate shall be coated with P-10 preservative.

5.2.1.1.1.1.1.4 Transmission and transfer case. - Transmission and transfer case and any other gear trains not lubricated by the main engine lubricating system shall be drained of lubricant and all surfaces within the housing coated with P-10.

5.2.1.1.1.1.1.5 Generators, and voltage regulators. - Generators and voltage regulators shall be preserved and packaged level A in conformance with MIL-E-16298, MIL-P-16018 and MIL-E-17555, as applicable. When the size and mounting of the generator attached to the engine does not permit enclosure of the generator within a water-vapor-proof barrier as required in a method II package, the alternate method of packaging may be used.

5.2.1.1.1.1.1.6 Sealing. - All inlet and outlet openings to the engine and accessories shall be covered with barrier material conforming to grade A of MIL-B-121, and a blank flange of mild steel, tempered hard board or fully waterproof plywood. On openings up to 2-1/2 inch diameter, plastic plugs or caps may be used in lieu of barrier material and blank flanges.

5.2.1.1.2 Detached instruments and accessories. - Detached instruments and accessories shall be preserved and packaged level A in accordance with MIL-R-196, MIL-E-17555 or applicable instrument or accessory specification.

5.2.1.2 Packing. -

5.2.1.2.1 Diesel generator sets. -

5.2.1.2.1.1 Level A. - Each set and attached accessories shall be individually packed in sheathed crates conforming to MIL-C-104. Units shall be anchored, blocked and braced within the shipping container to resist damage and shock during shipment and storage. The anchoring, blocking and bracing of crate contents and closure of crates shall be in conformance with the appendix of MIL-C-104.

5.2.1.2.1.2 Detached instruments and accessories. - Detached instruments and accessories shall not be packed in the same box with repair parts or special tools. Detached instruments and accessories shall be packed separately and secured in the engine shipping crate. The containers shall conform to any of the following at the option of the contractor:

PPP-B-576	Class 1
PPP-B-585	Class 1 or 2 use
PPP-B-591	Domestic
PPP-B-601	Domestic
PPP-B-621	Class 1
PPP-B-636	Domestic
PPP-B-640	Class 1

Box closure shall be in accordance with the applicable box specification or appendix thereto. The gross weight of containers shall not exceed the weight limitations of the applicable box specifications.

5.2.1.2.1.3 Marking. -

5.2.1.2.1.3.1 Special marking. - All engines preserved level A shall be tagged as follows:

> "The fluid system of this engine has been preserved with type P-10 preservative. No special de-preservation procedures are required with the exception of fresh water system. De-preservation of the fresh water system shall be in accordance with Publication 0901-941-0020."

5.2.1.2.1.3.2 Shipping containers. - Shipping container shall be stencilled as follows:

CAUTION: This equipment may be damaged unless unpacking instructions are carefully followed; unpacking instructions are located (state where located).

5.2.1.2.1.3.3 Additional marking. - In addition to any special marking requirements, interior packages and exterior shipping containers shall be marked in accordance with MIL-STD-129.

5.2.1.2.1.4 Unpacking instructions. - In addition to any special marking required by the contract or order, unpacking instructions of equipment shall be provided to prevent possible damage during removal. When practical, one set of these instructions shall be placed in a sealed waterproof envelope prominently marked "Unpacking Instructions" and securely affixed to the outside of the shipping container in a protected location. If the instructions cover a set of equipment packed in multiple containers, the instructions shall be affixed to the number one container of the set.

5.2.1.2.1.5 Manuals. - Manuals shall be packaged and packed in accordance with MIL-M-15071.

5.2.1.2.1.6 Drawings. - Drawings shall be packaged and packed for the level specified in accordance with MIL-D-1000/2.

5.2.2 Repair parts. - Repair parts shall be preserved and packaged level A; packed level A, B or C and marked in accordance with 5.1.2.1).

6. NOTES

6.1 Ordering data. - Procurement documents should specify the following:

(a) Title, number and date of this specification.
(b) Hydraulic pumping unit (see 3.1.1.1).
(c) Preliminary drawings required for approval (see 3.6.5).
(d) Type of final drawings (see 3.6.6).
(e) Number of preliminary and final manuals required (see 3.7.7).
(f) Arrangements to be considered for stray field and shock tests specified in the appendix and confidential amendment (see 4.4.4.17, 4.4.4.18, 6.1.1 and 6.1.2).
(g) Preservation, packaging, packing and marking required, if other than specified in 5.1 (see 5.2).

6.1.1 Stray field test. - The following should be considered in connection with stray field tests:

(a) Preservation, packaging and shipment to and from the test activity.
(b) Tests and any redesign resulting therefrom.
(c) Furnishing of representatives to supervise installation of equipment, initial checkout, and operation of the equipment during the test.
(d) Furnishing the test activity drawings of the equipment, as necessary, to provide complete installation data.
(e) Furnishing the test activity all required information regarding the method of operating the equipment during the test, and the required support services, such as loading, cooling water, lube oil, fuel oil, and so forth.

6.1.2 Shock tests. - The following should be considered in connection with the shock tests:

(a) Preservation, packaging and shipment of equipment to and from the shock testing activity.
(b) Shock tests and any repair or redesign resulting from the shock tests.
(c) Post shock test teardown, examination, repair, modification and testing of the shock tested equipment at the suppliers plant.
(d) Furnishing of suppliers representatives to supervise installation of equipment and initial check-out at the shock testing activity.
(e) Furnishing the shock testing activity drawings of the equipment as necessary to provide complete installation data including weights and centers of gravity of the set and detached accessories.
(f) Furnishing to the test activity all required information regarding the method of operating the equipment during the test and what capacities of electric power, cooling water, lube oil, fuel oil, and so forth, will be required.
(g) Furnishing of information to the test activity as to when equipment will be delivered for test. In addition, the command or agency concerned shall be notified at least 45 days in advance of scheduled tests so that arrangements can be made to witness the test if desired. The supplier shall submit, along with the notification, an equipment data sheet covering the equipment to be tested and containing the information shown in the Appendix.

APPENDIX

REQUIREMENTS FOR HIGH-IMPACT
(H. I.) SHOCK EQUIPMENT

10. SCOPE

10. 1 This appendix covers the high-impact shock test requirements for 100 kw, d. c. diesel generator sets.

20. APPLICABLE DOCUMENTS

20. 1 The following documents of the issue in effect on date of invitation for bids or request for proposal, form a part of this appendix to the extent specified herein.

SPECIFICATION

MILITARY

MIL-S-901 - Shock Tests, H. I. (High-Impact); Shipboard Machinery, Equipment and Systems, Requirements for.

PUBLICATIONS

MILITARY

NAVSHIPS 250-423-30 - Shock Design of Shipboard Equipment, Dynamic Analysis Method.
NAVSHIPS 250-423-31 - Shock Design of Shipboard Equipment, Interim Design Inputs for Submarine and Surface Ship Equipment.

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

30. REQUIREMENTS

30. 1 The requirements of MIL-S-901 shall apply, except as otherwise specified herein.

30. 2 Diesel generator sets, complete with all attached and detached accessories shall meet the requirements of grade A, class I of MIL-S-901.

30. 3 Intended function. - The intended function of shockproof generator sets is to continuously deliver electrical power conforming to required performance requirements throughout and after being subjected to shock of the magnitude experienced during shock tests or as determined by the design criteria specified in NAVSHIPS 250-423-30 and NAVSHIPS 250-423-31. Further, a shockproof generator set, when subjected to shock shall not suffer damage to the extent that it creates a possible hazardous situation such as fire or injury to operating personnel or such as to result in likely failure of major components if the set is not immediately shutdown for corrective action to prevent such failures. Minor damage, however, which may result in the need for certain checks or preventive maintenance on a "soon as convenient basis" will be permissible as specifically approved by the command or agency concerned.

30. 4 Design. -

30. 4. 1 Generator sets and detached accessories shall be designed for and shall successfully complete the shock tests specified herein.

30. 4. 2 Generator set sub-base hold-down bolt holes provided for securing equipment to the ships foundation shall be designed for use with non-fitted bolts. Maximum clearance between bolt holes and bolts shall not exceed the following.

Nominal bolt diameter	Maximum diameter of hole
3/4 inch or smaller	Nominal bolt diameter plus 1/32 inch.
Larger than 3/4 inch	Nominal bolt diameter plus 1/16 inch.

30.5 Generator set acceptance. -

30.5.1 Acceptance of generator set and accessory designs which have been subjected to shock tests shall be based on the ability of the equipment to perform its intended function during and after the tests, the magnitude of damage revealed during post shock test examination at the supplier's plant and the corrective action proposed by the supplier where the examination reveals damage. A detailed report of the examination along with the suppliers proposals for shock hardening (if necessary) shall be forwarded to the command or agency concerned for review. Approval of the results of the shock tests, the manufacturer's examination, and the manufacturer's corrective action taken by the command or agency concerned shall constitute acceptance of the design.

40. QUALITY ASSURANCE PROVISIONS

40.1 General requirements. - Generator sets and detached accessories shall be subjected to and successfully pass the shock tests as specified herein.

40.2 Method of test. -

40.2.1 Shock tests shall be conducted in accordance with grade A, type A of MIL-S-901 and as follows: All required performance (first unit) tests shall have been satisfactorily completed prior to any shock testing.

40.2.2 The generator set package (prime mover, gear (if used), generator, sub-base and all attached accessories) and any detached accessories needed to control and operate the set shall be shock tested as a principal unit.

40.3 Equipment mounting during test. -

40.3.1 Shock tests shall be conducted as described in MIL-S-901.

40.4 Test procedure. - Shock tests shall be conducted in accordance with MIL-S-901 and 40.4.1 and 40.4.2.

40.4.1 Equipment need not be operated or energized during first blow of each three groups (two blows per group) series. Prior to each blow, however, the generator set shall be run at rated speed and voltage, no load, for a period of time necessary to determine that all components are functioning normally. The generator set shall be operated at rated speed and voltage, no load during the last blow of each group. The equipment shall be examined for damage after each blow. Correction of minor damage during the progress of tests will be permitted and the test may proceed to the next level of shock after the minor damage is corrected. Major damage shall be cause for rejection and suspension of tests until such time as the suppliers proposed corrective action is approved by the command or agency concerned. In such cases, after corrective action is completed, re-test will be required starting at the test level which caused the damage. The decision as to whether damage is minor or major shall be made by the representative(s) of the command or agency concerned at the test site. In case of disagreement, the matter shall be referred to the command or agency concerned for final decision.

40.4.2 Instrumentation and measurements during the tests shall be as follows:

(a) Velocity pickups, high speed movies, instrumentation for monitoring set operation, and provision for remote shutdown shall be installed.
(b) Initial start-up and check-out shall be conducted under guidance of the manufacturer.
(c) During the last blow an oscillograph recording shall be made showing generator output voltage and frequency characteristics from a time beginning with 5 seconds before the blow until 30 seconds after the blow.
(d) Scribe lines or punch marks shall be used to indicate exact location of all major attached accessories and components (such as blowers, pumps, generator feet, end covers and so forth) prior to shock tests so that any relative motion during shock blows can be measured and recorded.
(e) Generator shaft run-out shall be measured before starting test and after each blow.
(f) Air-gap measurements shall be taken before start of tests and after each blow.

(g) Crankshaft deflection shall be checked prior to start of test and after each blow, if feasible (measurement to be made by the vendor's representative).
(h) With the set operating at rated speed, first order vibration levels shall be measured with a vibration pick-up in the X, Y and Z directions before and after each shot.
(i) Insulation resistance and dielectric strength shall be measured prior to start of testing and after final blow.
(j) A thorough visual examination shall be made after each blow and any indications of movement or distortion recorded.
(k) Additional instrumentation shall be provided by the testing activity as required.

40.5 Post shock test examination and reports. -

40.5.1 After completion of shock tests, the equipment shall be returned to the suppliers plant for a complete teardown and examination for damage. Upon receipt in the suppliers plant, prior to removal from the carrier, the equipment shall be given a visual examination to assure that no damage has occurred during transit. The equipment shall then be removed and the components shall be examined to determine runability of the set. If the examination reveals no damage which would prohibit full power operation, the set shall be installed on a test stand and operated at full load for a minimum of 5 hours. Engine and electrical equipment performance shall be monitored and recorded during the load run. Upon completion of the load run, the set components shall be disassembled part by part, making visual examination dimensional checks of parts and clearances as necessary, recording damage, evidence of shifting, rubbing, momentary contacts and so forth. Piping and coolers shall be given hydrostatic tests for evidence of any leaks.

40.5.2 A detailed report of the examination and tests shall be prepared and 5 copies shall be submitted to the command or agency concerned for approval. The report shall include:

(a) The results of the examination and tests in detail.
(b) Photographs to show damaged parts and relative movement of parts.
(c) The suppliers recommendations for design improvements to "Shock harden" the equipments.

40.6 Disposition of shock tested equipment. -

40.6.1 Unless otherwise specified in individual equipment specifications, shock tested equipment will be acceptable for delivery under a contract or order provided the following requirements are met:

(a) All damage resulting from shock tests is corrected. The method of correction shall be approved by the command or agency concerned.
(b) All bearings shall be replaced where examination reveals obvious but minor damage. Where major damage to bearings is discovered appropriate redesign corrective action shall be taken.
(c) Any design improvements necessary to "Shock harden" are incorporated in the unit.
(d) The reworked unit is given the duplicate unit tests of 4.4.1.4 and the applicable individual equipment specification, the results are satisfactory and shown to be consistent with results of tests taken previously and on other identical units.

50. ARRANGEMENTS FOR SHOCK TESTING

50.1 Light weight and medium weight tests of accessory items (if used). - Shock tests utilizing the light weight or medium weight shock test machines may be made at any commercial or Government activity having an approved test machine. The supplier shall make arrangements for such tests direct with the activity of his choice. A list of such activities having approved shock test machines in the area of the supplier's plant may be obtained by written request to the command or agency concerned.

60. MARKING

60.1 Equipment which meets the requirements specified herein shall include the following marking on the combined-generator set installation drawing and on the detached accessory assembly drawings:

(a) Class of shockproofness.
(b) Reference to shock test reports and approval letter or shock design calculations and approval letter.
(c) Type of mounting fixture used.

EQUIPMENT DATA SHEET

1. EQUIPMENT _____
2. IDENTIFICATION PLATE RATING _____
3. SERVICE _____
4. MANUFACTURER: ENGINE _____
   GENERATOR _____
5. PLACE OF MANUFACTURE: ENGINE _____
   GENERATOR _____
6. MODEL NO.: ENGINE _____ GENERATOR _____
7. DIESEL GENERATOR SET OUTLINE DRAWING _____
8. SECTIONAL ASSEMBLY DRAWING: ENGINE _____
   GENERATOR _____
   SUBBASE _____
9. TECHNICAL MANUAL NO. _____
10. CONTRACT OR PURCHASE ORDER NO. _____
11. WEIGHT: DRY WET
    ENGINE: _____
    GENERATOR: _____
    SUBBASE: _____
    TOTAL _____
12. SET OVERALL SIZE: Length _____ Width _____ Height _____
13. HEIGHT OF CENTER OF GRAVITY ABOVE BOTTOM OF BASE _____
14. APPLICABLE SHIPS _____ NO. PER SHIP _____
15. SERIAL NO. OF EQUIPMENT:
    TO BE TESTED: ENGINE _____
    GENERATOR _____
16. LIST OF DETACHED ACCESSORIES TO BE TESTED WITH GENERATOR SET
    (List accessory, assembly drawing number, and whether deck or bulkhead mounting.)
17. SCHEDULED DATE(S) DELIVERY TO SHIPBUILDER:
18. SCHEDULED TEST _____ LOCATION _____

Figure 1 - Equipment data sheet

19. HAS EQUIPMENT EVER BEEN SHOCKTESTED?_____

20. SHOCK TEST REPORT NO._____RESULT_____

Figure 1 - Equipment data sheet, cont'd.

RETAINER SHEET

MIL-G-24260(SHIPS)

MILITARY SPECIFICATION

GENERATOR SET, DIESEL ENGINE

100 KW, 120 VOLT D. C., 1800 RPM (U)

1. Amendment-1 to this specification contains information of a CONFIDENTIAL nature and is issued only upon specific request to the Naval Supply Depot, 5801 Tabor Avenue, Philadelphia, Pennsylvania 19120. When requesting copies, state the purpose for which required.

Preparing activity:
Navy - SH

FSC 6115

SPECIFICATION ANALYSIS SHEET

Form Approved Budget Bureau No. 119-R004

INSTRUCTIONS

This sheet is to be filled out by personnel either Government or contractor, involved in the use of the specification in procurement of products for ultimate use by the Department of Defense. This sheet is provided for obtaining information on the use of this specification which will insure that suitable products can be procured with a minimum amount of delay and at the least cost. Comments and the return of this form will be appreciated. Fold on lines on reverse side, staple in corner, and send to preparing activity.

SPECIFICATION

ORGANIZATION	CITY AND STATE

CONTRACT NO	QUANTITY OF ITEMS PROCURED	DOLLAR AMOUNT
		$

MATERIAL PROCURED UNDER A

☐ DIRECT GOVERNMENT CONTRACT ☐ SUBCONTRACT

1. HAS ANY PART OF THE SPECIFICATION CREATED PROBLEMS OR REQUIRED INTERPRETATION IN PROCUREMENT USE?

A. GIVE PARAGRAPH NUMBER AND WORDING

B. RECOMMENDATIONS FOR CORRECTING THE DEFICIENCIES

2. COMMENTS ON ANY SPECIFICATION REQUIREMENT CONSIDERED TOO RIGID

3. IS THE SPECIFICATION RESTRICTIVE?

☐ YES ☐ NO IF "YES", IN WHAT WAY?

4. REMARKS *(Attach any pertinent data which may be of use in improving this specification. If there are additional papers, attach to form and place both in an envelope addressed to preparing activity)*

SUBMITTED BY *(Printed or typed name and activity)*	DATE

DD FORM 1 APR 63 1426 REPLACES NAVSHIPS FORM 4863, WHICH IS OBSOLETE

FOLD

DEPARTMENT OF THE NAVY
NAVAL SHIP ENGINEERING CENTER
WASHINGTON, D. C. 20360

OFFICIAL BUSINESS

POSTAGE AND FEES PAID
NAVY DEPARTMENT

COMMANDER, NAVAL SHIP ENGINEERING CENTER
FEDERAL AND MILITARY DOCUMENTS &
DOD STANDARDIZATION BRANCH
DEPARTMENT OF THE NAVY
WASHINGTON, D. C. 20360

FOLD