STATEMENT OF WORK (SOW)
MOBILE UTILITIES SUPPORT EQUIPMENT (MUSE)
1400kW POWER PLANT REQUIREMENTS

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1.0 SCOPE

1.1 The Mobile Utilities Support Equipment (MUSE) Division, Port Hueneme exchange contract objective is to utilize existing resale and/or core value of twenty-eight (28) power plants to receive multiple 1400 kW power plants in exchange. The Contractor shall provide NEW, diesel engine driven, commercially available, self-contained and transportable power plants which will not be used as military tactical equipment. The power plants shall be rated at minimum of 1400 kW at 60 Hertz (Hz) Continuous Power (COP), 4160/3300 volts, three-phase, four-wire, wye, 60/50 Hz, 0.8 power factor (pf) lagging. The kW rating at 50 Hz shall be Contractor determined. The generator shall be a brushless-type with a permanent magnet (PMG) exciter. The power plant shall consist of a skid mounted, housed engine-generator unit, a skid mounted, housed switchgear-control unit, a skid mounted auxiliary unit and all necessary power cables, interconnecting control cables and piping required for operation and specified equipment.

1.2 This contract is from the effective date of the contract award and continues for a maximum period of two years or until delivery of the finished power plant(s). The following twenty-eight (28) total power plants are offered as an exchange (Detailed Description of Old Power Plants can be found in enclosure (2)):

-750kW (4160VAC/130Amp/60Hz) 5 power plants
-1500kW (4160VAC/260Amp/60Hz) 10 power plants
(includes control skid)
-2000kW (4160VAC/347Amp/60Hz) 7 power plants
(includes control skid)
-2500kW (4160VAC/430Amp/60Hz) 6 power plants
(includes control skid)

The government will transfer ownership of OLD generators in lots. The government will not complete the transfer of ownership of all twenty-eight (28) OLD units until the total quantity of NEW units, as specified on the prospective contract, has been accepted by the government.

Offerors will be required to submit a delivery schedule with their proposal detailing the following:

a. The milestones at which the Government will transfer ownership of the OLD generators to the offeror and

b. The makeup (quantity and type) of the lots that will be transferred at each milestone.

All twenty-eight (28) total power plants and associated collateral equipments must be removed from MUSE, at the Contractor’s own expense, within 3 months time of government acceptance of the last unit to be delivered. The government does not warrant that all items and

quantities of collateral equipment are present within each power plant's enclosure.

2.0 APPLICABLE DOCUMENTS (applicable to each power plant delivered under this contract)

2.1 Government Documents. The following documents form a part of this contract to the extent specified herein. Unless otherwise specified, the effective dates of all referenced documents shall be the dates referenced in the Department of Defense Index of Specifications and Standards (DODISS) in effect at the time of solicitation issuance.

Military:

MIL-STD-129P (w/Change 4), Department of Defense Standard Practice: Military Marking for Shipment and Storage, 19 September 2007

MIL-STD-461F, Department of Defense Interface Standard: Requirements for the Control of Electromagnetic Interference Characteristics of Subsystems and Equipment, 10 December 2007

MIL-STD-705C, Military Standard, Generator Sets, Engine Driven, Methods of Tests and Instructions, 24 April 1989 (Applicable to Table I tests only)

MIL-STD-889B, Military Standard: Dissimilar Metals, May 1993

MIL-STD-1472G, Department of Defense Design Criteria, Human Engineering, January 2012

MIL-F-16884J, Military Specification, Fuel Naval Distillate, 31 May 1995

MIL-T-5624R, Military Specification, Turbine Fuel, Aviation, March 1995

MIL-L-2104F, Military Specification, Lubricating Oil, Internal Combustion Engine, 11 march 1992 (Including Amendment-1, 28 September 1992)

MIL-PRF-009000K(SH), Performance Specification, Lubricating Oil, Shipboard Internal Combustion Engine, High Output Diesel, 27 April 2011.

Copies of the above document are available from the Defense Automated Printing Service, Standardization Documents Order Desk, (215) 697-6257/6396 or via their website: http://dodssp.daps.dla.mil.

Federal:

Title 23 Code of Federal Regulations, part 658, Federal Highway Administration, Department of Transportation

Title 29 CFR Part 1910, Occupational Safety and Health Administration (OSHA)

Title 40 Code of Federal Regulations, Part 63, National Emission Standards for Hazardous Air Pollutants for Source Categories

Defense Transportation Regulation (DTR), Department of Defense (DOD) Regulation 4500.9-R, Part VI, June 2002

FED-STD-H28A, Screw-thread Standards for Federal Services

Copies of the above document are available from the U.S. Department of Commerce, National Technical Information Services, 5285 Port Royal, Springfield, VA 22161 or via their website: http://public.transcom.mil

2.2 Other Publications. The following documents form a part of this contract to the extent specified herein. Effective dates of the referenced documents shall be the dates referenced in effect at the time of solicitation issuance.

COMMERCIAL:

American Society of Mechanical Engineers

ASME Y14.1 2005 (Rev 2010) Decimal Inch Drawing Sheet Size and Format

ASME Y14.100 2004 (Rev 2009) Engineering Drawing Practices

ASME Y14.2 2008 Line Conventions and Lettering

ASME Y14.3 2003 (Rev 2008) Multiview and Sectional View Drawings

ASME Y14.38 2007 Abbreviations and Acronyms for Use on Drawings and Related Documents

ASME Y14.4 1994 (Rev 2004) Dimensioning and Tolerancing

ASME Y14.44 2008 Reference Designations for Electrical and Electronics Parts and Equipment

ASME Y32.2.3 1949 (Rev 1999) Graphic Symbols for Pipe Fittings, Valves and Piping

ASME BPVC-VIII-1 2010 Section VIII-Rules for Construction of Pressure Vessels Division 1

American Welding Society (AWS)

AWS D1.1/D1.1M:2010 Structural Welding Code – Steel

AWS D1.2 Structural Welding Code – Aluminum

AWS D1.6 Structural Welding Code – Stainless

Institute of Electrical and Electronic Engineers (IEEE)

IEEE Std 1 (2000) General Principles for Temperature Limits in the Rating of Electric Equipment and for the Evaluation of Electrical Insulation

IEEE Std 43 (2000) Testing Insulation Resistance of Rotating Machinery

IEEE Std 100 (2000) Standard Dictionary of Electrical and Electronics Terms

IEEE Std 115 (2009) Guide for Test Procedures for Synchronous Machines, Part I — Acceptance and Performance Testing, Part II — Test Procedures and Parameter Determination for Dynamic Analysis

IEEE Std 142 (2007) Recommended Practice for Grounding of Industrial and Commercial Power Systems

IEEE Std 315 (1975) Graphic Symbols for Electrical and Electronics Diagrams (Including Reference Designation Letters)

IEEE Std 446 (1995) Recommended Practice for Emergency and Standby Power Systems for Commercial and Industrial Applications

IEEE Std C2 (2007) National Electric Safety Code

IEEE Std C37.21 (2005) Standard for Control Switchboards

IEEE Std C37.23 (2003; R2008) Standard for Metal-Enclosed Bus

IEEE Std C57.12.01 (1998: R2005) General Requirements for Dry-type Distribution and Power Transformers, Including Those with Solid-cast and/or Resin Encapsulated Windings

IEEE Std C57.13 (1993; R2008) Standard Requirements for Instrument Transformers

The Society for Protective Coatings (SSPC)

SSPC QP 3, (2000) Standard Procedure for Evaluating Qualifications of Shop Painting Applicators

2.3 References.

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NOTE: Issue date of references included in project specifications need not be more current than provided by the latest guide specification.

American Society for Testing and Materials International (ASTM)

ASTM B 8 - 11 Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft

ASTM B 117 - 11 Standard Practice for Operating Salt Spray (Fog) Apparatus

ASTM D 523 - 08 Standard Test Method for Specular Gloss

ASTM D 975 - 11 Diesel Fuel Oils

ASTM D 1200 - 10 Viscosity by Ford Viscosity Cup

ASTM D 2247 - 11 Standard Practice for Testing Water Resistance of Coatings in 100% Relative Humidity

ASTM D 2794 – 93 (2010) Standard Test Method for Resistance of Organic Coatings to the Effects of Rapid Deformation (Impact)

ASTM D 3276 - 07 Standard Guide for Painting Inspectors (Metal Substrates)

ASTM D 3359 - 09e2 Standard Test Methods for Measuring Adhesion by Tape Test

ASTM D 3925 – 02 (2010) Standard Practice for Sampling Liquid Paints and Related Pigmented Coatings

ASTM D 4417 - 11 Standard Test Methods for Field Measurement of Surface Profile of Blast Cleaned Steel

ASTM E 85, Surface Burning Characteristics of Building Materials

International Electrical Testing Association (NETA)

NETA ATS, Electrical Power Distribution Equipment and Systems

National Fire Protection Association (NFPA)

NFPA 30, Flammable and Combustible Liquids Code

NFPA 37, Standard for the Installation and Use of Combustion Engines

NFPA 70, National Electrical Code. Equipment shall be suitable for use in systems in compliance to Article 700, 701, and 702.

NFPA 110, Emergency and Standby Power Systems.

NFPA 255, Standard of Test Surface Burning Characteristics of Building Materials

National Electrical Manufacturers Association (NEMA)

NEMA ICS 18-2001 (R2007) Motor Control Centers

NEMA MG 1-2009, (R2010) Motors and Generators

NEMA MG 2-2007, Safety Standard and Guide for Selection, Installation, and Use of Electric Motors and Generators

NEMA TR 1-1993, (R2000) Transformers, Regulators and Reactors

NEMA WC 58-2005, (R2008) Portable and Power Feeder Cables for Use in Mines and Similar Applications

Underwriters Laboratories (UL)

UL 142, (2006) Standards for Steel Aboveground Tanks for Flammable and Combustible Liquids

UL 489, (2009) Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit-Breaker Enclosures

UL 506, (2008) Standard for Specialty Transformers

UL 508, (1999) Standard for Industrial Control Equipment

UL 508C, (2002; Rev thru 2004) Standard for Power Conversion Equipment

UL 723, (2008) Test for Surface Burning Characteristics of Building Materials

UL 891, (1998; Rev thru 2005) Switchboards

UL 1236, (2006) Battery Chargers for Charging Engine-Starter Batteries

UL 1437, (2006) Standard for Electrical Analog Instruments - Panel Board Types

UL 1561, (2011) Standard for Dry-type General Purpose and Power Transformers

MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS)

MSS SP-58 (2002) Pipe Hangers and Supports - Materials, Design and Manufacture

MSS SP-69 (2002) Pipe Hangers and Supports - Selection and Application

MSS SP-80 (2003) Bronze Gate, Globe, Angle and Check Valves

International Organization for Standardization (ISO)

ISO 8528 (2005) Reciprocating Internal Combustion Engine Driven Alternating Current Generator Sets.

All work performed shall conform to applicable sections of the latest revision of the preceding standards, in addition to industry standard practices.

3.0 GENERAL REQUIREMENTS

3.1 Power Plant Requirements. The Contractor shall provide fully operational product(s); completely packaged, medium voltage, transportable, power plant(s). Power plant(s) shall be NEW, provide utility grade generator protection and be driven by a commercially available diesel engine. Power plant capacity is determined by COP ratings as defined by ISO 8528, Part 1, Section 13.3.1. The power plant(s) shall be designed for continuous operation at rated output under conditions specified, to supply three-phase, three wire ungrounded service and three-phase, four wire grounded service at 4160/3300 volts (nominal), 900/750 rpm, 60/50 Hz, 0.8 pf lagging. The power plant(s) shall be designed for operation as a single unit (isolated load), in parallel with other power plants of like characteristics, or in parallel with commercial 60 or 50 Hz utility power (infinite bus). The short circuit rating of the power plant switchgear shall be 250 MVA at 4.16 kV. The power plant(s) shall be complete with accessories and auxiliary equipment as required to deliver fully functional power plant(s) and specified in the SOW. Other items normally supplied for the intended application and required for operation under conditions specified in this SOW shall be included.

3.1.1 The control system of the power plant(s) shall be UL 508 listed and labeled.

3.1.2 All power plant components shall be fully self-contained within a weatherproof enclosure.

3.1.3 Power plant engines shall meet the highest Environmental Protection Agency (EPA) Tier Level of current emissions requirements as original engine manufacturer best industry standards are capable to reach without the aid of any third party equipment or special fuel usage. The Contractor shall provide emissions compliant engine(s) as

per the application and category of the engine(s) provided. The engine emissions Tier level provided shall not be below Tier 2 for stationary application Limited Time Running Power (LTP) in accordance with ISO 8528-1.

3.1.4 The power plant shall be designed to provide automatic (mains failure), automatic base load (peak shaving) and manual operations in island and load sharing modes with similar power plants.

3.1.5 Provide factory and acceptance testing to include a forty-eight (48) hour load test at varying load and at 0.8 pf lagging 60 Hz followed by an eight (8) hour load test at varying load and at 0.8 pf lagging in the 50 Hz configuration (production power plant only). Generate comprehensive reports that reflect Original Equipment Manufacturer (OEM) certified test results.

3.1.6 Provide forty (40) hours of technician training to Government personnel and upon successful completion of the training, provide OEM recognized certification to support the finished product.

3.1.7 Provide, at a minimum, a twelve (12) month warranty for all equipment and components delivered under this contract, whether or not it is manufactured by the power plant manufacturer, so that there is one source for warranty and product service. The warranty shall begin upon the date of Government acceptance.

3.1.8 Each power plant shall be identical.

3.1.9 Each power plant shall be capable of LTP, Prime Power (PRP), and Continuous Power (COP) operations as described in ISO 8528-1. Each power plant performance class shall meet Performance Class G3 in accordance with ISO 8528.

3.1.10 Each power plant shall be capable of single step load pick up of 100% nameplate COP kW and power factor with the engine-generator set at operating temperature, less than or equal to 1500 feet above sea level in a 50 degree Centigrade ambient temperature.

3.1.11 Software, computer hardware, and interconnecting devices (cables, adapters, etc.) shall be provided to the Government to operate, adjust parameters, troubleshoot and monitor the power plant(s). The furnished software licenses shall be perpetual. Power plant(s) shall be able to operate and Government personnel shall be able to effectively perform adjustments to parameters in the field, without the need to purchase additional software. This paragraph excludes optional software or hardware upgrades.

3.2 <u>Description</u>

3.2.1 <u>Engine-generator Unit</u>. The engine-generator unit shall be a skid mounted, factory aligned (by the Contractor), housed unit complete with all components, parts, accessories and equipment

required for operation and as specified in this SOW. The engine-generator unit shall include, at a minimum, the following:

a. A diesel engine directly coupled to an AC generator
b. An engine starting system
c. An engine cooling system (except radiator(s))
d. An engine combustion air supply system (filtered)
e. An engine speed governing system
f. An engine exhaust system
g. An engine pre-lubrication/pre-heat system
h. Engine control and monitoring panel
i. Engine fuel system delivery and return system
j. Generator cooling system (filtered)
k. House ventilation system(s)
l. House lighting system(s)
m. Station power and lighting transformer
n. Motor control center

The engine and generator shall be mounted on a common skid base. Accessories and auxiliary equipment shall be mounted on the engine, the skid base, or as specified in this SOW. The engine-generator unit shall be designed to maximize free and clear space around the engine, engine accessories, and generator as a unit to allow for personnel access.

3.2.2 Switchgear-control Unit. The switchgear control unit shall be skid mounted, housed unit complete with all components, parts and accessories and equipment required to operate, control, and monitor the output of the generator, station power and outgoing power circuit and as specified in this SOW. The switchgear control unit shall include, at a minimum, the following:

a. Switchgear, including the power plant control center
b. Station power transformer(s)
c. Station power distribution panelboards
d. Control power system
e. Heating, ventilation, and air conditioning system(s)
f. House lighting system(s)
g. Battery and battery charging system(s)
h. Automatic transfer switch for shore and station power

3.2.3 Auxiliary Unit. The auxiliary unit shall be a skid mounted, housed unit complete with components, parts, accessories and equipment required for operation and as specified in this SOW. The radiator unit shall include, at a minimum, the following:

a. Radiator fan drive including electric motors, pulleys, fans and belts.
b. Disconnect switches as required by NFPA 70
c. Radiator(s).
d. Fuel day tank and fuel transfer system.
e. Air compressor and receiver tank.

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3.3 Weights and Dimensions. Shipping weights and dimensions shall not exceed the following:

Dimensions (inches)

	Weight (Lbs)	Length	Width	Height
Engine-generator Unit	80,000	360	102	138
Switchgear Control unit	25,000	192	102	138
Auxiliary Unit	25,000	360	102	138
Exhaust Silencer	(as required)	240	102	72

The weight of fuel, coolant, and lubricants other than what is required to preserve and/or protect the power plant during transport or storage and the weight of the exhaust silencer shall not be included in the shipping weight. The weight of control and power cables, shipping braces and tools stored or installed in the respective shipping locations as dictated by the configuration design shall be included in the shipping weight. The loading shall be distributed laterally and balanced with respect to the longitudinal centerline of each unit.

3.4 Production Power Plant. The Contractor shall furnish one complete power plant (Production Power Plant) for inspection, validation, and testing to verify contract compliance. After acceptance of the production power plant by the Government, the production power plant shall remain at the Contractor’s facility until required production unit testing is complete. The production power plant shall be used as the paralleling test unit for subsequent production units, and as a model to which other units can be compared to ensure that each power plant is identical. The first production power plant shall be complete to the extent necessary to allow proper demonstration of parallel operation and as specified in this SOW.

3.4.1 Restoration. The production power plant, prior to shipment, shall be restored to the original condition, at the time of Government acceptance, neglecting normal wear incurred during testing. The restoration shall include, as a minimum, paint touch-up or repainting as required and the installation of new lubricating oil and air intake filters.

3.5 Materials, Components, and Parts. Materials, components, and parts installed in, on, or as part of the power plant but not definitely specified shall be selected by the Contractor and meet the following requirements:

a. Standard commercial industrial products.
b. Installed in conformance with application and installation recommendations of the manufacturer and the manufacturer of the materials, components, and parts which they are installed in, on or near.
c. Identical so the materials, components and parts are interchangeable from one power plant to another.

d. Suitable for the extremes of pressure, temperature, mechanical stresses, voltage and current to which they might be exposed.
e. Suitable for the operational and maintenance environment in which they are located or may be subject to.
f. Capable of withstanding, without damage, the impacts generated by rail transit, as specified.
g. Not adversely affected by fluids and vapors to which they would likely be exposed to. This especially applies to gaskets, seals, and insulation (electrical, thermal, and sound).
h. New and unused, except as required for normal factory tests and for tests specified in this SOW.
i. Free from defects.
j. Not be furnished if they have been repaired or modified to correct deficiencies.
k. Conform to the requirements of this purchase description.
l. Be of current production and not scheduled for obsolescence by the manufacturer.

3.5.1 Manufacturer’s Recommendations. Materials, components and parts shall be installed using the application and installation recommendations and requirements of their manufacturer. Materials, components, and parts shall also be installed according to the recommendations and requirements of the manufacturer the materials, components, and parts they are installed in, on or near. Materials, components and parts shall not be installed where they may be adversely affected by the conditions of operation, maintenance, transportation and storage specified. Nonconformance with this requirement may constitute grounds for reinstallation of rejection of the materials, components, and parts concerned.

3.5.2 Interchangeability. Power plant(s) furnished under this SOW shall be identical. Materials, components, and parts shall be interchangeable from one power plant to another. Two or more materials, components, and parts of the same class, size, and type (form, fit and function) installed within, on or as part of a power plant shall be identical, interchangeable and of the same manufacturer. For example; control relays all from the same manufacturer.

3.5.3 Mechanical: General Requirements.

3.5.3.1 Hardware. Hardware shall be as follows with the number of different sizes to be kept as low as practical. Nuts, bolts, and screws shall have standard screw threads and heads as required by FED-STD-H28A. Non-standard screw threads and heads shall not be used unless approved by the Contracting Officer (KO) or authorized Navy Technical Representative (NTR).

3.5.3.1.1 Blind Hardware. A nut or bolt shall not be located such that it cannot be grasped by the thumb or forefinger of one person’s hand or by a common hand tool. The use of threaded type inserts

(similar to Nutsert (TM)) may be used for the mounting of switchgear components.

3.5.3.1.2 Sheet Metal Screws. Sheet metal screws shall NOT be used.

3.5.3.1.3 Hinges. All Hinges used throughout the power plant shall be constructed of corrosion proof metal.

3.5.3.1.4 Valves. Valves used throughout the power plant shall be ball or globe type and constructed of corrosion proof metal where practical.

3.5.3.2 Welding. Welding procedures shall conform to a nationally recognized code applicable to the materials being joined. Welding shall be accomplished by welders certified by the American Welding Society and fully cognizant of the code to which they are conforming to. Copies of the applicable codes shall be in the Contractor's possession. Surfaces to be welded shall be free from foreign matter which would be injurious to the weld. Welds shall be equal to or greater than the full design strength of the materials being joined. Welds shall retain the full design strength of the materials being joined. Welds shall transmit imposed stresses without permanent deformation or failure when subjected to proof or service testing. Structural welding shall conform to AWS D1.1/D1.1M:2010. Welds which, upon inspection by the Government, are found not to conform to the code to which they were welded shall be cause for rejection and contract testing will not commence until they are repaired. The engine manufacturer's standard welding procedures are acceptable in construction of the diesel engine and cataloged components.

3.5.3.3 Contact of Dissimilar Metals. Intimate contact of dissimilar metals which cause galvanic corrosion shall be avoided. When such contact cannot be avoided, interposing insulating material in conformance with MIL-STD-889B shall be provided to minimize the corrosive effect.

3.5.3.4 Assembly of Light Metal Alloys. Attachments to aluminum and magnesium alloys shall be by:

a. Machine bolts with nuts.
b. Steel bushings with tapped holes.
c. Stud bolts with National Coarse Threads on both ends which screw into aluminum or magnesium.
d. Helical-coil type threaded inserts.
e. Thread (coarse thread series) in the light metal alloy as permitted by the NTR.
f. Rivets for installing house surfaces (interior, exterior, roof, and ceiling).

3.5.3.5 Corrosion Resistant Metals and Treatments.

3.5.3.5.1 Metals. The following are the only corrosion resisting metals that will be acceptable:

a. Type 316 stainless steel
b. Copper
c. Aluminum alloys which do not contain more that 0.4 percent copper
d. Brass
e. Bronze
f. Beryllium-copper
g. Copper-nickel alloys
h. Nickel-copper alloys

3.5.3.5.2 Treatments. The following are the only corrosion resisting treatments that will be acceptable:

a. Sherardizing
b. Galvanizing
c. Electrodepositing with cadmium, chromium, copper, nickel, silver or zinc.
d. Aluminizing
e. Anodizing
f. Alonizing

3.5.3.6 Thermal and Sound Insulating Material. Thermal and sound insulating material used in power plant shall conform to the following requirements:

a. Non-hygroscopic, non-toxic and free from perceptible odors.
b. Resistant to attack by vermin, insects, rodents and fungus.
c. Unaffected by battery electrolyte or petroleum derivatives.
d. Maintain its shape, position and integrity under conditions of vibration and temperatures specified.
e. Protected from abrasion.
f. Replaceable in the field.
g. Fire retardant, with a flame spread rating of 75 or less, and a smoke developed rating of no more than 150 when tested in accordance with ASTM E 84.

3.5.3.7 Rigid Metal Piping and Fittings. Rigid metal piping and fittings shall be used throughout the power plant. Rigid metal piping and fittings shall be designated and installed to withstand vibration or deflection without damage. Rigid metal piping systems shall be designed to prevent air pockets (in liquid piping systems) and undrained, trapped liquids. Rigid metal piping shall be securely strapped and supported. Where required to isolate, prevent vibrations and resist shock, rigid metal piping shall be resiliently mounted. Pressure sensitive adhesive pads shall not be used. Do not use snap rings in conjunction with liquid lines containing petroleum products. Liquid piping systems shall have provision(s) for venting trapped air after repair or replacement of any component, part or subassembly. Drain piping shall terminate external to one common side of the power

plant at the skid base, be plugged with threaded pipe plug(s) and be the lowest point per respective system. Drain piping shall include normally closed, ¼ turn valves located internal to the power plant skid base. Drain lines for engine systems required to be open during operation shall not have valves.

3.5.3.8 Flexible Piping, Hoses and Fittings. Flexible piping, hoses, tubing and fittings shall be used in piping systems to:

a. Isolate vibrations
b. Allow for expansion and contraction
c. Provide ease of connection, installation and maintenance
d. Connect to engine cooling system to the radiator(s)

In no case will flexible piping or hoses make up the whole of the piping system. When used, flexible piping, hoses, tubing and fittings shall meet the following requirements:

a. Designed for the temperatures they are or may be subjected to in the particular system in which it is installed.
b. Designed for mediums that they will transport.
c. Have a bursting pressure rating not less than four times the maximum operating pressure of the system in which it is installed.
d. Shall be reinforced.
e. If exposed to sunlight, shall be rated for exposure to direct sunlight.

The installation of flexible piping, hoses, tubing and fittings shall prevent physical damage caused by mechanical movement or abrasion from adjoining components or structures under vibratory conditions during operation, maintenance or transit. Flexible piping, hoses, tubing and fittings shall be installed per the manufacturer’s recommendations and requirements for the operational and maintenance environments as specified in this SOW. Piping bends shall be free from kinks, creases and flattening. Piping runs and bends shall be parallel to the geometric lines of the power plant and the component(s) they are mounted to. Flexible hoses with synthetic liner and metal braid covering will be acceptable to use with fluids not adversely affecting the hose material. Pressure sensitive adhesive pads shall not be used for securing flexible piping or hoses. Do not use ordinary rubber, plastic or other unreinforced, unprotected or combustible tubing. Do not use brazed joints.

3.5.3.9 Belt Drives. Drive belts shall be multi-“V” type, ganged, belt(s). A “Gates Power-band” is an example of this type of belt. V-belt drives shall be selected for continuous duty and conform to the Rubber Manufacturers Association (RMA), with a minimum service factor of 1.5. Idler pulleys shall be installed using the recommendations and requirements of the drive belt manufacturer.

3.5.3.10 Ease of Servicing, Operation and Maintenance. Parts, assemblies and accessories shall be arranged in the power plant to permit accessibility for adjustment, repair and replacement without disturbance to other elements in the power plant where practical. Maintenance, disassembly or assembly operations shall be accomplished by common tools. If special test equipment and/or tools are required for servicing, such items shall be furnished with the power plant. The engine-generator unit enclosure shall be readily removable without disconnecting components or systems except as specified. Pipe unions shall be used in fluid systems for ease of installation and removal of pumps and other components for repair, maintenance and replacement. Liquid reservoirs (e.g., fuel day tank, lubricating oil sump or coolant expansion tank(s)) shall drain to the exterior of the power plant. Hand access openings (except access openings to the exterior of the power plant) shall meet the requirements of MIL-STD-1472F where practical.

3.5.3.11 Fasteners

3.5.3.11.1 Fasteners, Mechanical. Each fastener (e.g., screw, stud or bolt) shall use lock-washers to prevent loosening due to vibration. Lock-washers, other than those on the engine and catalogued components, shall be captive on nuts, machine screws, cap screws or bolts when the nominal size is less than ¼ inch diameter. Fasteners and associated hardware (e.g., nuts and lock-washers) shall be made of corrosion resistant material or shall be provided with a corrosion resistant treatment as specified in Section 3.5.3.5. Unused length of threads or studs (or screws/bolts used as studs) shall not exceed the diameter of the stud except as required by component OEM for catalogued components. Do not use lock plates, locknuts, lock wire or castlellated nuts with cotter pins. Do not wedge, peen or stake parts which may require removal or adjustment. Do not use rivets as specified.

3.5.3.11.2 Fasteners, Electrical. Lock-washers shall be provided for each fastener used in making an electrical connection for components not catalogued by OEM. Each fastener, lock-washer and associated hardware shall be made of corrosion resistant material or shall be treated to be made corrosion resistant as specified in Section 3.5.3.5. Fasteners (bolts, screws and studs) shall not carry electrical current; they shall serve to secure electrical current carrying parts (e.g., lugs, terminals) in firm contact with each other. Where flow of current through a stud cannot be avoided, the stud and its associated hardware (e.g., nuts and lock-washers) shall be made of highly-conductive, corrosion resistive material. Studs shall not turn in their mountings when nuts are tightened or loosened to the required torque. Do not use lock-washers that depend on friction or spring action for this purpose. Unused length of thread on studs (or screws used as studs) shall not exceed the diameter of the stud except for catalogued components OEM.

3.5.4 Electrical: General Requirements

3.5.4.1 Electrical Components.

Electrical enclosures for items such as control panels, panelboards, etc., shall conform to the requirements of NEMA Type 4 enclosures. Enclosures that require additional protection, i.e., enclosures at or near engine oil and coolant systems shall be rated to the environment that it is configured within or as specified in this SOW. Electrical hardware used to route engine thermocouple wires may be excluded from this requirement, subject to prior approval by the NTR.

3.5.4.2 Buses, Bus Connections and Medium Voltage Cables. Power plant 4160/3300 volt buses shall be single, solid copper, with rectangular cross section and rounded edges to avoid high dielectric stresses. Ferrous metal shall not be used for carrying electrical current. Buses shall be non-segregated and shall be supported on high strength reinforced epoxy insulators. Bus shall meet the requirements of IEEE C37.23. Buses and bus connections shall have a continuous current rating as determined by the insulation rating (see Section 3.5.4.2.1), shall be rated no less than 600 amperes and momentary rating to withstand not less than 40,000 amperes/RMS current for 10 cycles on a 60 Hz basis (0.167 seconds) without damage to or permanent deformation of the metal or insulation. Each bus splice shall be made with either a splice plate of the same material as the bus or by a lap-type splice. Bus splices shall not cause undue stress on supports and shall ensure rigidity and pressure contact. The use of medium voltage cables in the power plant’s switchgear shall be limited to the potential transformer (PT) leads and cables associated with the power plant’s surge capacitors, lightening arrestors and station power transformer. In these applications, high voltage cables shall be routed and separated from adjacent conductors and ground to avoid dielectric stresses which may cause partial discharge (corona). Unsupported lengths of cable over three feet in length are shall not be acceptable. Sharp bends are not acceptable, and the minimum bending radius of cable shall conform to the respective cable manufacturer’s criteria. In all cases where high voltage cables are routed through metal walls, they shall be positively segregated from the walls and each other using insulating material of the appropriate voltage class.

3.5.4.2.1 Bus Electrical Insulation. 4160/3300 volt buses shall have an insulating covering that, by itself, will meet the insulation class requirement for 5kV and shall be rated for not less than 105 degrees Celsius. Electrical insulation for buses shall be non-hygroscopic, flame retardant, track resistant, low power factor, non-toxic, and resistant to attack by rodents, insects, mildew, and fungus. Bus connections shall be insulated with removable, molded insulation boots. Bus connections shall not be taped.

3.5.4.3 Wiring and Cable. Unless otherwise allowed or specified, wiring shall be in accordance with and conform to the applicable sections of ASTM B-8-11 and NFPA 70.

3.5.4.3.1 Wiring, Low Voltage (600 volts or less). Except as otherwise permitted or specified, the following requirements govern low voltage wiring. Wire shall be stranded, single conductor, copper with gray SIS insulation. For the purpose of this SOW, the use of type SIS wire shall meet the requirements of NFPA 70 for type XHHW-2 wire. Acceptable exceptions to the foregoing are as follows:

a. Strip heater wiring (generator and switchgear) shall be stranded, single conductor, copper, TFE insulated, terminated at the strip heater(s) using long barreled, un-insulated, crimp type, ring tongue lug.
b. Special purpose wiring (e.g., paired, shielded, calibrated, instrumentation, etc.) as required by unique components.
c. Other wire sizes and insulation provided as part of an off-the-shelf component wired by the component manufacturer.
d. Flexible cord suitable for the installed ambient temperature shall be used as a disconnecting means between the motor control center and the engine-generator unit lighting, receptacle and exhaust fan circuits as specified.

3.5.4.3.2 Wiring Methods. Wiring shall be located, installed and secured to prevent damage or deterioration that could result from contact with sharp corners and edges, pinching, twisting, sharp bends or fatigue, resulting from vibration or repeated bending. Wiring shall not transmit mechanical forces to electrical connections and terminals, and shall be located/installed to prevent contact with high temperature or moving parts, chemicals or fluids. Wiring not run in conduits shall be neatly bundled throughout cabinets and compartments. Wiring harnesses/bundles not run in wire-ways shall be secured to structural members at a minimum of every six inches of all bends. Nylon, self-locking clamps (not self-adhesive) shall be used for this purpose. Wire breakouts to terminals of components shall be at right angles to the wire bundle and shall present a neat, uniform appearance and shall be no shorter than four inches and not longer than eight inches. Wiring shall not be spliced or tapped at any point throughout the length of the run between terminations. Should any wire require a break or splice, it shall be made in a junction box with terminal strips/blocks mounted internally. No more than two wires shall terminate at a single connection point.

3.5.4.3.3 Wire Identification. Each wire over four inches in length shall be identified within two inches of its termination by a contrasting color “shrink sleeve” on which the identification code has been permanently, machine imprinted with contrasting characters. The wire identification shall be as large as practical, and shall not impair the characteristics of the wire insulation. The wire identification shall be identical to the engineering drawing convention. A different series of numbers or different color of the identification code shall be used to distinguish communication wiring, AC and DC circuitry. Circuit identifications on all power plants

shall be identical (i.e., standardized). Wiring diagrams and schematics shall reflect all wiring identification.

3.5.4.3.4 Electric Motors. Electric motors shall be totally enclosed, fan cooled (TEFC) or "Wash Down" rated. AC motors over ¼ HP shall be three phase, three wire, squirrel cage induction motors, 480 volt (nominal). DC motors shall be rated for 120 volts DC. AC and DC motors shall have a minimum service factor of 1.15. Electric motors shall conform in allowable temperature rise and marking to NEMA MG 1, at a 1.0 service factor.

3.5.4.3.5 Electrical Conduit and Fittings. Pull and junction boxes and conduit shall be used throughout the power plant as required by NFPA 70 and as specified below. Conduit terminations shall have insulated bushings and shall be properly reamed to eliminate any sharp edges. Liquid-tight flexible metallic conduit or cord as required by NFPA 70 may be used between junction boxes, electrical motors, pressure switches, temperature switches and other remote mounted equipment or components to prevent transmission of mechanical forces or vibration. Flexible liquid-tight metallic conduit shall not be used as the equipment grounding conductor for conduit runs. Metal conduits/raceways shall be solidly grounded (bonded) as per NFPA 70.

3.5.4.3.6 Terminal Lugs. Terminal lugs for conductors rated 600 volts or less, size AWG #10 or smaller, shall be of the insulated ring tongue, compression crimp type style unless supplied as part of a catalogued assembly. Terminal lugs for conductors size AWG #8 and larger, or which are rated for more than 600 volts shall be un-insulated, rectangular tongue, NEMA spaced two-hole style compression crimp type lugs unless supplied as part of a catalogued assembly. Compression crimp type lugs shall be installed using the proper manufacturer required tools. All terminal lugs shall be installed using the proper manufacturer recommended tools. Terminal lugs shall be the proper size for both the conductor and the terminal stud or bolt. Except in cases where the conductor size is AWG #6 or smaller, any medium voltage connection which is not suitable for two-hole terminal lugs shall be modified to accept NEMA spaced two-hole lugs unless supplied as part of a catalogued assembly.

3.5.4.3.7 Terminal Blocks. With the exception of connections made at electric motors, all connections shall be made at component terminations or at NEMA rated terminal blocks (strips) securely mounted to and within enclosures. Terminals on components or terminal blocks shall not have more than two lugs attached to any single terminal. Terminal blocks shall be individually labeled (i.e.; TB-1, TB-2, etc.) and each terminal block position shall be sequentially numbered (1 through number of positions) on a marking strip. Wiring diagrams and schematics shall include terminal board connections. Lettering size shall be as large as practical. Connections made inside integral junction boxes for electric motors shall be made by splicing motor lead pigtails as specified by the motor manufacturer and this SOW. Each splice shall be covered with a reusable, UL listed

wire connector. Contractor shall provide 10% additional spare NEMA rated terminal board terminals except as provided as part of catalogued equipment installed.

3.5.4.3.8 Medium Voltage Wiring and Cable. Medium voltage wire and cable shall be single conductor, unshielded, stranded copper with type XLP insulation and jacket rated for 5kV/8kV and 105 degree Celsius conductor temperature. Cable ends shall be terminated using compression crimp lugs. NEMA spaced two-hole lugs shall be used on wire and cable size AWG #6 and larger.

3.5.4.3.9 Medium Voltage Wire and Cable Routing. All single conductor medium voltage cables shall be routed and separated to avoid contact with each other, adjacent medium voltage cables and ground. Single conductor medium voltage cables shall not be bundled with or pass within six inches of any low voltage wiring. Where passage through walls or current transformers is required, provisions shall be made to isolate the cable from the wall or sides of the current transformer(s). The minimum bending radius of the cable shall conform to the respective cable manufacturer’s criteria, or NFPA 70, whichever is the most restrictive. Cables routed from the generator shall be supported on reinforced stand-off insulators at the appropriate intervals to elevate cables from potentially oily or wet surfaces.

3.5.4.3.10 Medium Voltage Wire and Cable Identification. Marking shall be provided approximately two to four inches from each termination using a contrasting color, heat shrink sleeve and a contrasting color, machine imprinted permanent characters as large as practical in height. All markings shall be perpendicular to the wire.

3.5.4.4 Instrument Transformers. Current and potential transformers used for instrumentation, controls and relaying shall meet the requirements of IEEE C57.13 and shall be rated by the manufacturer for operation at 60 and 50 Hz. Potential transformers used in circuits at the generator output potential shall be of the 5kV insulation class.

3.5.4.4.1 Current Transformers. Current transformers shall be the doughnut (window) type. With the exception of the current transformer on the generator neutral, current transformers rated for the generator output potential shall be rated as required by the coordination study and shall be capable of withstanding the short circuit current supplied by the generator without saturation detrimental to security of protective relay operation. The current transformer on the generator neutral used to operate the ground fault relay shall be connected in a wye configuration, shall be of the accuracy class required by the coordination engineer and shall be rated to operate at 60 and 50 Hz.

3.5.4.4.2 Potential Transformers. Potential transformers shall be rated not less than 1.5 times the burden to which they are connected, shall have a 120 volt secondary, shall be connected open-delta line to

line, shall be the accuracy class as required by the coordination engineer and shall be rated to operate at 60 and 50 Hz.

3.5.4.5 Limit Switches and Pushbuttons. Limit switches shall be the sealed type. Pushbuttons shall be the heavy duty type and oil-tight.

3.5.4.6 Control Relays. Relays for control and alarm circuitry (other than protective relays) and emergency lighting shall be the totally enclosed or hermetically sealed type. Time delay relays, if used, shall be the solid state, electronic type. Open type (telephone) relays shall not be used.

3.5.4.7 Resistors and Rheostats. Tapped resistors shall be used in preference to the adjustable (slide wire) type. Where adjustable resistors are used, the wire shall be of sufficient size to prevent damage though corrosion at the contact point. Rheostats and potentiometers shall be of the wire wound type located only in ventilated areas and not less than three inches from adjacent wiring components.

3.5.4.8 Semiconductor Devices. Semiconductor devices shall be the hermetically sealed type. Except for zener diodes and as specified, semiconductor devices shall have peak repetitive voltage ratings equal to the peak transients to which they may be subjected to in the power plant. In addition, semiconductor devices shall be capable of withstanding or protected against transient voltage and current peaks experienced during testing. The use of circuits which require semiconductor devices matched or paired characteristics is prohibited. This specification shall not apply to OEM catalogued devices such as; engine controller, power plant controller and multifunction protective relay.

3.5.5 Gasket Materials. Gasket material used for weather proofing shall be closed cell, ozone proof, resistant to sunlight, chemicals, petroleum derivatives, moisture and vapors encountered in a marine environment. Backing adhesives shall be equally immune to degradation. Where used to provide a weatherproof seal on removable panels, doors or access covers, gasket material shall cover the entire mating surface with no gaps or breaks. Corner joints shall either be continuous or be joined in such a manner as to prevent a through path for wind driven rain. Gasket material thickness shall be selected as required to provide a minimum of 25% compression deflection of the material with no greater than 15 pounds per square inch (psi) surface pressure. The use of silicone sealants or other compounds to provide supplementary sealing in addition to gasketing is prohibited. The non-adhesive side of the gasket material shall be coated with a long lasting release agent such as Teflon (if not already provided by the product manufacturer) to prevent sticking and tearing when panels, doors or access covers are opened or removed.

3.6 Safety Requirements.

3.6.1 General Safety. Aspects of the power plant design and configuration shall comply with all criteria of the Occupational Safety and Health Standards, Part 910, Chapter XVII of Title 29 of the Code of Federal Regulations (29 CFR 1910) effective on the date of contract award. The power plant design and configuration shall conform to the criteria of MIL-STD-1472 Section 3.15 "Hazards and Safety" et seq. The following subparts and sections of 29 CFR 1910 contain criteria which are specifically applicable.

a. Subpart D	"Walking-Working Surfaces"
b. Subpart E	"Means of Egress"
c. Subpart H	"Hazardous Materials"
Sect. 1910.106	"Flammable and Combustible Liquids"
d. Subpart J	"General Environmental Controls"
Sect. 1910.144	"Safety Color Code for Marking Physical Hazards"
Sect. 1910.145	"Specifications for Accident Prevention Signs and Tags"
e. Subpart M Equipment"	"Compressed Gas and Compressed Air
Sect. 1940.169	"Air Receivers"
f. Subpart N	"Materials Handling and Storage"
g. Subpart O	"Machinery and Machine Guarding"
Sect. 1910.212	"General Requirements for All Machines"
Sect. 1910.219	"Mechanical Power Transmission Apparatus"
h. Subpart S	"Electrical"

3.6.1.1 Personnel Safety. Location on and within the power plant that could be occupied by operating and maintenance personnel (hereinafter referred to as "personnel") shall comply with the applicable requirements of 29 CFR 1910, Subparts D and E. Exterior doors shall have provisions for opening from inside, even when locked from the outside. Any location within the power plant where personnel could reasonably be expected to enter during operation of the power plant shall have at least two means of egress, remote from each other and arranged to minimize the possibility that both may be blocked by any one fire or other emergency condition. Exit aisle-ways shall be configured to provide headroom of not less than 80 inches between walking surface and any projection from the ceiling.

3.6.1.2 Physical Hazard Identification. Physical hazards throughout the power plant shall be color coded in accordance with the criteria of 29 CFR 1910.144. Danger signs, caution signs, directional signs and informational signs shall be installed in appropriate and conspicuous locations throughout the power plant in accordance with the criteria of 29 CFR 1910.145.

3.6.1.3 Equipment Guards. Parts and components subject to high operating temperatures, energized electrically or moving, which present a hazard to operating personnel, shall be insulated, enclosed or guarded. Equipment guards shall not impair the proper functioning

of any part of the power plant. Shafts and shaft couplings shall have guards of rigid construction to prevent bodily contact with the shaft or coupling. Equipment guards shall be readily removable.

3.6.2 Insulation Matting. Insulation matting shall be provided for the switchgear control unit floor. Matting shall be a minimum of 30 inches wide and of sufficient length to cover the entire floor area between the switchgear-control house doors. Should the medium voltage disconnects be located in an area of the switchgear-control house other than the path covered by this matting, additional matting shall be rolled and stored in the switchgear-control unit during shipment. Insulation matting shall have a minimum dielectric strength of 10,000 volts. Switchgear-control unit doors shall be capable to open fully as specified in this SOW with insulation matting in place for normal operation.

3.6.3 Noise Exposure. Any location within or around the power plant exterior at which the noise level exceeds 85 dBA, (when measured on a standard sound level meter at microphone heights of both three and five feet above the walking or standing surface), and which could possibly be occupied by personnel during power plant operations, shall have conspicuous warning signs as follows:

"WARNING NOISE AREA – MAY CAUSE HEARING LOSS
USE PROPER EAR PROTECTION"

The power plant design shall minimize peak sound pressure level exposure hazards to operating personnel as practical.

3.6.4 Fire Prevention. Liquid petroleum systems shall be arranged such that neither liquids nor vapors can escape and create hazardous flammable conditions by:

a. Aspiration into the engine air intake system
b. Aspiration into the windings of motor or the generator
c. Exposure to arcing electrical contacts
d. Contact with surfaces at or above the auto-ignition temperatures of the fuels or lubricants specified.

Connection points in the fuel and lubricating oil system piping and components are potential sources of leaks, therefore, surfaces which are at or above the auto-ignition temperatures shall be spray/drip isolated from all such potential leak sources. Vent lines for liquid petroleum tanks and sumps shall have flame arrestor caps located inside the engine-generator unit and shall discharge vapors outside the power plant. Flame arrestor caps shall be approved by Underwriters Laboratories, Inc.

3.6.5 Fire Resistance. Insulation adhesives, vapor barrier material and associated items shall have a flame-spread rating not higher than 75 and a smoke developed rating not higher than 150. These ratings shall be determined by Method of Test of Surface Burning

Characteristics of Building Materials, NFPA 255, ASTM E84 or UL 723. Flame-proofing treatments subject to deterioration due to the effects of moisture or high humidity are not acceptable. Perishable or corrosive treatments shall not be employed to impart flame resistance.

3.7 Performance Requirements.

3.7.1 Environmental and Operational Requirements. When equipped with all required accessories, the power plant shall start and operate continuously under the following conditions.

3.7.1.1 Without Use of the Engine Preheat System. The power plant shall start and accept 100% of rated load within ten minutes or engine manufacturer's time required, under the following conditions:

a. At ambient temperatures from -25 to 110 degrees Fahrenheit at mean sea level (msl) and any possible relative humidity.
b. With 4.5 inches (plus or minus 0.5 inch) of wind driven rain per hour impinging on the power plant at angles from vertical to 45 degree from vertical without water entering the power plant.
c. With the engine-generator skid base of the power plant in planes from level to two inches from level.
d. At any altitude from sea level to 5000 feet above msl.

3.7.1.2 With Use of the Engine Preheat System. The power plant shall start and accept 100% of rated load within 30 seconds under the following conditions:

a. After the power plant has been in standby status with the engine preheat system in operation for not less than 12 hours.
b. At ambient temperatures to and including minus 25 degrees Fahrenheit at msl and any possible relative humidity.
c. At all other conditions specified in Section 3.7.1.1, "Without use of the engine preheat system".

3.7.2 Marine Environment. The power plant shall operate, continuously and intermittently, under conditions of humidity and salt aerosols (both dry and wet) that could be encountered at seaside locations on docks or piers without degradation of performance or durability.

3.7.3 Operating. The power plant shall be capable of operating without abnormal wear or damage:

a. Continuously at rated output at any ambient temperature from -25 to 110 degrees Fahrenheit at any altitude from msl to 5000 feet above msl.
b. Continuously for a minimum of 8,000 hours without having to perform unscheduled maintenance, overhaul or replacement of components or parts other than routine servicing and

adjustments during scheduled maintenance intervals as recommended by the engine manufacturer.

c. As specified in (a), (b) and (c) above, under the conditions specified in 3.7.1.1 and 3.7.1.2.

3.7.4 Fuels and Lubricants. The power plant shall meet the requirements at loads up to and including rated overload when operating on diesel fuels conforming to grades DF-1, DF-2 or MIL-F-16884J, grade DF-M except that the sulfur content may be up to 1.5 percent. Components of the engine and fuel system shall be capable of operating continuously on turbine fuel conforming to MIL-T-5624R, grade JP-5. The engine shall operate continuously using lubricating oil conforming to MIL-L-2104F and MIL-PRF-009000K(SH). The equipment technical manuals shall contain explicit instructions and cautions for operators and maintenance, including monitoring total base number when using high sulfur fuels or the need for special fuel additives.

3.7.5 Environmental Emissions.

3.7.5.1 Exhaust Emissions. Power plant engines shall meet the highest Environmental Protection Agency (EPA) Tier Level of current emissions requirements as original engine manufacturer best industry standards are capable to reach without the aid of any third party equipment or special fuel usage. The Contractor shall provide emissions compliant engine(s) as per the application and category of the engine(s) provided. The engine emissions Tier level provided shall not be below Tier 2 for stationary application Limited Time Running Power (LTP) in accordance with ISO 8528-1.

3.7.5.2 Noise Emissions. Noise emissions from the power plant shall not exceed an average A-weighted sound pressure level of 85 dB at a distance of 25 feet from the engine-generator and auxiliary units under any conditions of operations specified.

3.7.6 Diesel Engine Performance. The diesel engine shall have the brake horsepower to provide a continuous power plant output of a minimum of 1400 kW at 60 Hz while supporting the power plant internal parasitic loads under all conditions specified. Examples of power plant internal parasitic loads that the engine must be capable of supporting while providing a power plant net output of 1400kW are radiator fan drive(s), heating, lighting, battery charger, fully loaded control power transformer(s) and losses due to generator inefficiency. The model of diesel engine to be furnished shall meet the requirements for successful performance in stationary electric generation service as described in Section 14.3.

3.7.6.1 Frequency Regulation, Stability and Transient Response. Frequency regulation, stability and transient response shall meet or exceed ISO 8528 Performance Class G3.

3.7.7 Operating Speed. The power plant shall be dual frequency rated and operate in both frequencies as described in this statement

of work. The rated operating speed of the power plant shall be 900 revolutions per minute (rpm) for 60 Hz operation and 750 rpm for 50 Hz operation. The power plant shall run at speeds up to and including 990 rpm for a period of not less than five minutes without damage.

3.7.8 Flexural Vibrations. The power plant shall be free from damaging flexural vibrations, i.e., vibrations which occur at a speeds which maximum stress in the crankshaft from flexural vibration exceeds the limitations of the power plant design.

3.7.9 Torsional Vibrations. The power plant shall be free from damaging torsional vibrations, i.e., vibrations at which maximum stress in the crankshaft from torsional vibration exceeds the limitations of the power plant design.

3.7.10 Engine-generator Unit Vibrations. The design of the skid base and its interface with the power plant's diesel engine shall allow dissipation of engine vibrations through the skid base to the surrounding are such that excessive vibrations are not retained within the engine-generator unit. For the purposes of this requirement, excessive vibrations are defined as vibrations produced by the diesel engine at any speed from idle to rated speed under loading conditions from no load to rated overload, which:

a. Exceed the engine manufacturer's criteria for vibrations under these operating conditions.
b. Could cause damage to the engine ancillary mechanical and electrical components such as, but not limited to, the AC generator, piping, gauges, relays, pressure and temperature switches (or alter their settings), motors and pumps.

A vibration survey shall be conducted on each power plant under conditions of engine idle, no load at rated speed and under loading conditions of 25%, 50%, 75%, 100% and 110% of rated load to verify conformance with this requirement.

3.7.11 Generator Performance. The generator, as an integral part of the power plant, shall be connected for 4160Y/2400 volts to produce 1400 kW at 0.8 pf lagging at 60 Hz and 3300Y/1905 volts to produce a Contractor determined kW at 0.8 pf lagging at 50 Hz. The generator shall have an efficiency of 95% or greater at rated load.

3.7.11.1 Generator Performance Standards. The generator performance standards shall meet or exceed ISO 8528 Performance Class G3.

3.7.12 Short Circuit. The generator and exciter-regulator system shall be capable of withstanding, without damage, a 30 second single phase line-to-line, single phase line-to-neutral and three phase short circuit at the generator's output terminals, under the conditions specified in NEMA MG 1, and at a value not less than 300% of rated output current.

3.7.13 Parallel Operation. With respective generator control systems adjusted to the same frequency regulation (speed droop) value, but not less than 3% and with reactive load compensation of the respective voltage regulators adjusted to the same value, but not less than 2%, and with a system load at 0.8 pf lagging, varied between 20-100% (and vice versa) of combined rating of the connected power plants, any two like power plants operating in parallel shall divide the load as follows:

a. Real Power Division. The difference between the individual kW outputs shall at no time be greater than 5% of the lesser individual kW output of one power plant.
b. Power Exchange. At any constant system load, power exchange between power plants shall not exceed 3% of the rating of one power plant. Power exchange is the difference between the maximum and minimum power output of one power plant for constant system load conditions as determined from oscillographic measurements.
c. Reactive Power Division. The difference between the reactive kilovolt-amperes (kVAR) supplied shall at no time be greater than 5% of the kW rating of one power plant. (For the above requirement, the initial system load, both kW and kVAR, shall be equally divided between power plants. Thereafter, no adjustment shall be made to the generator control system or other components at either power plant as the system load is varied.)

3.7.14 Transportability. The skid mounted power plant, (engine-generator unit, auxiliary unit and switchgear-control unit) complete with accessories, when properly prepared for transit, shall be suitable for national highway transport by low-bed trailer, rail transport or surface shipment by sea vessel. The technical manual and shipment preparation procedure shall contain explicit instructions for the preparation and shipment under all specified modes of transportation. The shock, impact vibration and oscillating loads generated by the modes of transport, including the loads generated by handling operations of loading and unloading shall be considered for the tie down devices as well as for the blocking and bracing provisions. Blocking and bracing devices shall be permanently installed as required within and shall not interfere with operations and or maintenance of the power plant. The above factors shall also be considered in the selection, location, mounting and stability of all components of the complete skid mounted, housed power plant.

3.7.14.1 Rail Transportation. With the engine-generator, auxiliary and switchgear-control units, complete with accessories, loaded on railroad cars (standard bolster springs and standard pocket draft gear) in accordance with Association of American Railroads (AAR) standard practice, each power plant shall withstand the rough handling which would normally be encountered in cross-country rail transportation. The power plant shall withstand, without damage or

permanent deformation, longitudinal acceleration measured at the floor of the power plant of 3.5g, plus or minus 5%.

3.7.14.2 Water Transportation. The engine-generator, auxiliary and switchgear-control units, complete with accessories, resting on the skids and tied down on the deck or in the hold of a sea-going cargo vessel, shall withstand, without damage, the shock from rolling and pitching normally experienced in water transportation. Water transportation shall include transport by ship or barge, operating over any type of waterway. For design purposes, conditions of inclination in any direction from the horizontal shall be assumed as follows:

a. Permanent ship trim/list of five degrees
b. Momentary pitch/roll of 30 degrees

3.7.15 Storage. The power plant, when drained and preserved in accordance with the instructions in the equipment technical manuals, shall not be damaged by storage in temperatures from -22 to 155 degrees Fahrenheit at any possible relative humidity within range.

3.8 Skid Base. The power plant shall have three separate skid bases, one for the engine generator unit, one for the switch-gear control unit and one for the auxiliary unit. The skid bases shall be fabricated of hot rolled structural I-beams, channels and angles. Each skid base shall support the weight of its respective unit on the ground by the outermost (from the center of each unit) I-beams of the skid base. A minimum of two inches of ground clearance from the bottom of the skid base and between the outermost I-beams of each skid base shall be provided. The top level of the skid base shall be uniformly level throughout the length and width. Each skid base shall have the structural strength to maintain the alignment of the power plant components within their respective tolerance limits as determined by the manufacturers of the components under any static or dynamic stress conditions to which the power plant may be subjected to during operation or testing. Each skid base shall be enclosed, except for drain provisions and the interconnecting cable access opening, with steel sheet(s) with a nominal thickness of 0.07474 inch (U.S. revised standard gage No. 14) or greater. Provisions shall be incorporated to completely drain engine oil and coolant from the side of the skid bases. Each skid base shall have, on all four corners, corrosion proof metal grounding plates welded to the outer I-beam web. The size of the grounding plates shall be adequate to carry the available ground fault current of the power plant and shall have holes drilled to facilitate connection of two, two-hole, NEMA spaced lugs. Each skid base shall have interconnection receptacles as specified.

3.8.1 Skid Base, Engine-generator Unit. The skid base for the engine-generator unit shall be fabricated from not less than four hot rolled structural steel I-beams running the length of the unit. The skid base shall be composed of a main skid and sub-skid. The main skid shall consist of the I-beams on the perimeter of the skid base

which shall support the weight of the engine-generator unit on the ground. The sub-skid shall consist of the inner I-beams, which shall support the engine, engine accessories and generator. Forged steel hose flanges to connect the engine cooling system to the radiator(s) shall be provided. The flanges shall be welded to the engine end of the engine-generator unit skid base and below the house floor line to facilitate removal of the house. Cast iron hose flanges shall not be used. The skid base design shall be submitted to the engine manufacturer for approval. Certification that the skid base is acceptable to the engine manufacturer shall be provided to the NTR.

3.8.1.1 Floor, Engine-generator Unit. Floor decking at the top of the skid base shall be level, unobstructed and uniform throughout the engine-generator unit. The floor of the unit shall be reinforced to support the installed equipment complete with auxiliaries, accessories and tools. The floor shall have a non-skid surface. Floor deckplates shall be hinged with corrosion proof metal hinges on one side and secured on the opposite side with fasteners with recessed handles. The handle shall also function as a device used to lift the deck plate. Deckplates shall be constructed of diamond plate corrosion proof metal.

3.8.1.2 Entrance Steps. Entrance steps shall be mounted to the outer I-beam of the skid at each of the floor entrances to the engine-generator and switchgear-control unit. The entrance steps shall be the width of the door where they are installed, not less than ten inches deep, and shall provide an intermediate step between ground level and the level of the respective unit’s interior floor. The standing surface of the step shall have a non-skid surface. All entrance steps shall be removable and provisions shall be provided for securing the entrance steps, either in place or under deckplates of the engine-generator unit, during shipment and storage of the power plant. House entrance steps shall be capable of supporting a minimum of 300 lbs.

3.8.2 Skid Base, Switchgear-control Unit. The skid base for the switchgear-control unit shall have adequate strength to prevent excessive stresses in the installed equipment during operation and transportation. The skid base shall be designed to allow for convenient entry for the interconnecting cables and power cables (see Section 3.11.3.10) into the switchgear. Cable entrances shall be weather tight in all shipment, operation and storage configurations. The skid base shall allow for adequate storage of interconnecting cables, power cables and required tools and equipment associated with the power plant.

3.8.2.1 Floor, Switchgear-control Unit. Floor decking at the top of the skid base shall be level, unobstructed and uniform throughout the switchgear-control unit. The floor of the unit shall be reinforced to support the installed equipment complete with auxiliaries, accessories and tools. The floor shall have a non-skid surface and be constructed of corrosion proof, non-skid metal. Access

to storage compartments under the floor shall be configured by deckplates with corrosion proof metal hinges on one side and secured on the opposite side with fasteners with recessed handles. The handle shall also function as a device used to open and lift the deck plate compartments. A means to lock the deck plate doors in the open position shall be provided. The power plant switchgear assembly shall not be welded to the switchgear-control skid or floor.

3.8.3 Skid Base, Auxiliary Unit. The skid base for the auxiliary unit shall have the strength to eliminate harmful stresses that could cause damage or misalignment of components during operation or transport. Misalignment of components shall not exceed the tolerance limits recommended by the component's manufacturer. Flanges identical to those specified in Section 3.8.1 shall be installed for engine cooling system to auxiliary unit interconnecting hoses. The skid base shall provide a means for mounting and securing cooling system, fuel system and compressed air system interconnecting hoses for storage or shipment.

3.8.3.1 Floor, Auxiliary Unit. Floor decking at the top of the skid base shall be constructed of corrosion proof metal and uniform throughout the auxiliary unit. Floor decking at the top of the skid base shall be pitched at no more than one degree from horizontal to allow water run-off. The floor of the auxiliary unit shall be metal reinforced to support installed equipment, complete with auxiliaries, accessories and tools. The floor shall have a non-skid surface.

3.8.4 Lifting and Tie-down Attachments. The engine-generator, switchgear-control unit and auxiliary units shall have lifting and tied-down attachments. All units of the power plant shall be lifted from their respective skid bases. All unit skids shall be capable of lifting by crane and by MUSE portable lifting jacks. Four lifting plugs shall be provided for one complete power plant. The lifting plugs shall be the same configuration as the latest Government owned lifting plugs to facilitate lifting by the portable jacks. A means of securing the lifting plugs for shipment and storage shall be provided on the auxiliary unit. The set of four lifting plugs shall be capable of lifting each unit of the power plant. See enclosure (4) for MUSE portable lifting jack and lifting plug specifications.

3.9 Housings, General. Houses are required for the engine-generator unit and switchgear-control unit. The house for each unit of the power plant shall fully enclose the top, sides and ends of the respective unit. Each house enclosure shall be weatherproof, wind load rated at 150 mph and dustproof as per engine and generator manufacturers' recommendations and requirements. Under no circumstance shall water penetrate the housings during power plant operations as specified in Section 3.7. Housings shall be constructed of aluminum. Do not use wood or wood by-products. Except as otherwise specified, the housings shall be the standard housings regularly furnished by the manufacturer for power plants of comparable size and type. Interior and exterior panels, structural parts and

other materials and components used in the house construction shall meet or exceed in strength and quality the corresponding material regularly furnished by the manufacturer in commercial or similar type construction. Each house shall have thermal insulation minimum thickness of at least 1.5 inches. The insulation shall have an R value of not less than 15. The insulation shall be constrained to prevent sagging or bulging. Each outside door shall have a raised threshold and seals.

3.9.1 Openings in Housings. The location of intake, exhaust and ventilation openings shall be designed to prevent recirculation of exhaust/ventilation air into the intake air. All openings shall have provisions to prevent the entry of wind-driven rain, snow and sleet into the housings. Each opening in the vertical wall shall be provided with a rain hood built from the same material as the house. Each rain hood shall have a main panel hinged on the top and shall have side panels hinged to the main panel. The rain hoods shall fold to serve as shipping covers to prevent wind-driven rain, snow, sleet, rodents, vermin and sand from entering the housings. Do not use louvers.

3.9.2 Lighting. Each house shall have an AC lighting system and DC emergency lighting system conforming to the following requirements:

a. Be operational and complete with circuit breaker lighting panels, lighting fixtures with lamps to include globe or diffuser guards, wall switches and wiring.
b. Provide interior, wall mounted, industrial grade switches located adjacent to each entrance door and 48 inches from the floor.
c. Designed and installed to remain intact and undamaged while encountering vibrations, shocks and impacts while in operation, transportation and storage.

3.9.2.1 AC Lighting System(s). The AC lighting system shall conform to the following requirement:

a. Be powered from the station power system at 120 volts.
b. Shall maintain an average minimum level of illumination of 30 foot-candles on a horizontal plane 30 inches above the floor.

3.9.2.2 DC Emergency Lighting System(s). The DC emergency lighting system shall conform to the following requirements:

a. Be powered from the 120 volt DC control and emergency power system.
b. Use vapor proof, guarded light fixtures.
c. Clearly illuminate each path to house exits without obstruction.
d. Activate automatically when there is loss of the AC station power system.

e. Deactivate after 30 minutes, or upon re-energization of the AC station power system.
f. Maintain an average minimum level illumination of 10 foot-candles on a horizontal plane 30 inches from the floor.

3.9.3 Access Doors. The switchgear-control and engine-generator units shall have access doors to allow personnel to perform maintenance, repairs, testing and operation of the power plant. The doors shall be commercially available or fabricated by the house manufacturer, industrial type, heavy duty exterior doors with a three point latching mechanism. The overall thickness of the doors shall be the same thickness of the house walls on which they are installed. Do not use wood or wood by-products in the construction of personnel doors. Outside access doors shall open to the outside (except the switchgear-control unit personnel doors) of the house and suitable hardware with which to retain them in their open position shall be mounted on the housings exterior wall, adjacent to the doors. Gaskets shall be installed on the door frames to prevent the entrance of rain, sand and fine dust as per the manufacturers' recommendations and requirements of the equipment installed within the interior of the power plant houses. Exterior doors shall have provisions for opening from the inside, even when locked from the outside. Engine-generator unit doors shall accommodate the repair, removal and replacement of normally serviced engine and generator components.

3.9.4 House, Engine-generator Unit. The engine-generator unit house shall provide a weather-tight enclosure for the engine-generator unit. Wood shall not be used in the construction of the house appurtenances. The sides, ends and roof of the engine-generator compartment shall have acoustical installation installed to meet sound attenuation requirements of Sections 3.5.3.6 and 3.7.5.2. The roof shall have a two degree slope from the horizontal plane to allow for water runoff. The roof shall have the strength to support a roof-mounted engine exhaust silencer and weight of maintenance personnel (500 lbs for personnel). Seams and joints shall be waterproof by using gaskets or caulking compounds. Preparation of the house for removal shall be limited to the following:

a. Disconnecting the house from the skid base.
b. Disconnecting the exhaust outlet flange.
c. Disconnecting of lighting, receptacle and exhaust fan circuits from the house as specified. (The Government prefers cord and plug connections for these circuits)
d. Collapsing rain hoods, removing the exhaust silencer or other external obstructions as dictated by the design.

3.9.4.1 Receptacles, Engine-generator Unit. The engine-generator unit shall have four AC duplex electrical outlet receptacles. The receptacles shall be located on the interior sidewalls, adjacent to the left and right front and left and right rear of engine. The AC receptacles shall be two pole, polarized grounding type, rated for 120 volts, 20 amperes, conforming to NEMA WD 1, GFCI and shall be

energized from the AC station power system at 120 volts. The receptacles shall be wall mounted in a horizontal position, 18 inches above the floor, with box and cover suitable for wet locations. An individual circuit breaker shall be provided for the receptacle circuit.

3.9.4.2 Openings, Engine-generator House. The engine-generator house shall have openings on the rear (generator end) wall for the intake of air for engine combustion, generator cooling and house ventilation. The engine-generator house shall have openings on the front (engine end) wall for expelling air from the house by exhaust fans. These openings in the engine-generator house walls shall have collapsible rain hoods as specified in Section 3.9.1. There shall also be an opening in the roof of the house to allow for connecting the engine exhaust system to the exhaust silencer. Additionally, a single removable roof hatch shall be provided into the roof design allowing for major engine component replacement without removing the entire house assembly. All penetrations shall be configured to negate any intrusion of snow, sleet, rain, sand or fine dust. A weathertight corrosion proof metal removable cover shall be provided to cover the exhaust outlet if the exhaust silencer is not installed for shipping or storage.

3.9.4.2.1 Engine Combustion Air. An engine-generator mounted filter system shall be provided which shall be capable of 125% of the required quantity of air, in cubic feet per minute, under loading conditions specified. Disposable, pleated paper type filter elements shall be mounted in a manner that will provide removal and replacement of filters by maintenance personnel. Filter elements shall be either manufactured by the engine manufacturer or certified, as to their acceptability, by the engine manufacturer. Oil or oil bath filters shall not be used. The air filter system shall be mounted and braced using bolted support members in a manner that is capable of withstanding, without damage, shocks which may result during the modes of transport specified. A vacuum switch shall be provided to sense the combustion air intake pressure downstream of the filter system and provide a visual and audible alarm to the power plant control system when the air filter system reaches an unacceptable level of vacuum as recommended by the engine manufacturer.

3.9.4.2.2 Generator cooling air. The generator cooling air shall be filtered as specified by the generator manufacturer and under all conditions specified. Engine-generator house filters that meet this requirement shall be acceptable.

3.9.4.2.3 Generator Cooling Air Exhaust. Cooling air from the generator shall be discharged into the engine-generator house. The generator cooling air exhausted from the generator shall be removed from the house by exhaust fans mounted on the front (engine end) wall. Generator cooling air exhaust shall not be permitted to re-circulate into the generator cooling air inlet.

3.9.4.2.4 Engine-generator Unit Ventilation Air Intake. Cleanable/reusable filter assemblies shall be incorporated into the design of the house openings in the rear (generator end) wall of the engine-generator unit. The filter assemblies shall allow 125% of the engine-generator cooling air required. The filter elements shall be corrosion proof, safely secured in place to protect operating personnel and removable from the engine-generator house.

3.9.4.2.5 Engine-generator Unit Ventilation. The engine-generator house shall have not less than two wall mounted, electric motor driven air exhausters complete with all controls. With the doors to the house closed, the air exhausters shall expel the required amount of air to remove the heat radiated from the engine, generator and accessories to maintain the interior wall temperature five feet above the floor to within 20 degrees Fahrenheit of the outdoor ambient temperature. The air exhausters shall be bolted to the inside front (engine end) wall of the engine-generator house. There shall be two control circuit breakers for the exhaust fans, one circuit breaker for each fan. A motor control center for the exhaust fans shall be mounted at or near the exhaust fan end of the unit. The exhauster fans shall operate as follows:

a. One fan shall operate automatically whenever the engine is running.
b. The second fan shall be controlled by an adjustable thermostat located at or near the exhaust fan end of the unit and operate whenever the engine is running.

The ventilator air exhaust fans shall be powered from the 480 volt AC station power supply.

3.9.4.3 Outside Personnel Doors, Engine-generator Unit. The engine-generator unit shall have a minimum of four outside personnel doors as specified in Section 3.9.3. The doors shall be placed to enable maintenance, testing and operation of the power plant.

3.9.5 House, Switchgear-control Unit. The switchgear-control unit house shall provide a weathertight enclosure for the switchgear-control unit. The house shall be designed to provide convenient connection for the interconnecting cables and power cables (see Sections 3.11.3.4 and 3.11.3.10) into the switchgear. A removable, corrosion resistant metal and gasketed flange plate or plates shall be provided for weathertight interconnecting cable pin and sleeve connections. Flange plate(s) shall be conspicuously located on rear of the switchgear-control unit and bolted to the skid base. A means to provide weathertight power cable entry and exit shall be provided. Power cable entry and exit shall be located on rear of the switchgear-control unit at the skid base providing the shortest possible cable run to the switchgear-control unit power cable termination points. The house shall have two personnel entrance doors, one at each end wall and located near the wall adjacent the free standing switchgear, thereby providing a straight passageway through the house. The design

of the doors and their interface with door frames shall be such that wind-driven rain does not accumulate on the interior floor of the switchgear-control unit. Each door shall swing inward on an arc of not less than 105 degrees.

3.9.5.1 Gasket for Joining Units. Each switchgear-control unit house, in addition to seals required for each opening, shall have gaskets around the door openings to provide a weather-tight seal when two or more units are joined end-to-end. The weather-tight seal shall be retained with a maximum misalignment between adjacent units, both vertical and horizontal, of one inch. Joining unit gaskets shall not be mounted to the switchgear control unit enclosure. They shall be stored under the switchgear floor and provisions for installation provided.

3.9.5.2 Switchgear Access. Access to the rear of the switchgear shall be provided by hinged doors and access panels. All components of the switchgear shall be accessible for maintenance, repair, testing or replacement. Hinged doors shall be mounted to the switchgear house. Switchgear rear access panels shall be gasketed and bolted to the free standing switchgear. Mounting provisions for access panels shall provide alignment pins for ease of removal and installation of access panels. All mounting hardware shall be accessible for removal with hand tools. A separate panel or panels shall be provided for access to each section of the switchgear.

3.9.5.3 Cable Storage. The switchgear-control unit house shall have provision for the storage and transport of the interconnecting control and power cables to be furnished with the power plant.

3.9.5.4 Switchgear Heaters. A minimum of one switchgear strip heater shall be provided for each switchgear section. Strip heaters shall be controlled by adjustable thermostat(s)/humidistat(s) located in an accessible location for operating personnel. Power for the strip heater circuit shall be energized from the 240 volt, AC station power system. A single circuit breaker shall be used for isolation of the strip heater circuit. Switchgear heater shall be 240 volt AC rated, but supplied by 120 volt AC.

3.9.5.5 Environmental Control. The house shall have an electrically powered, commercially available, heating, ventilation and air conditioning (HVAC) unit. The HVAC unit shall be able to maintain an interior temperature of 77 degrees Fahrenheit under all conditions specified in Section 3.7.1. The HVAC unit shall be complete with controls and shall be energized from the AC station power system. The HVAC unit shall be flush mounted to the switchgear-control unit house and shall not protrude beyond the house external dimensions. The supporting structure/members shall support the HVAC unit in all conditions specified. A removable flexible condensation drain hose shall be provided and shall allow for plumbing from the HVAC unit to the ground level.

3.9.5.6 Operator Work Table. The switchgear-control unit shall have a metal operator's work table. This table shall not be less than 48 inches long, 24 inches deep and 36 inches above the floor surface. The configuration of this work table shall not impede any operator operation or personnel ingress/egress within the switchgear-control unit.

3.9.5.7 Telephone Connection Point. The switchgear-control unit shall have a telephone connection point near the operator work table consisting of an outlet box and furnished with an RJ45 connector and cover. The telephone connection point shall be connected and wired through conduit, to a weatherproof telephone connection located at the interconnecting cable connection flange at the skid base.

3.9.5.8 Tools and Parts Storage Cabinet. The switchgear-control unit shall have a metal cabinet for storage of tools and parts. The cabinet shall be mounted integral to the switchgear and shall be the same height as the switchgear enclosure. The cabinet shall not be less than 30 inches wide and 24 inches deep and shall have not less than three adjustable height shelves. The storage cabinet door shall be vertically hinged and shall swing through an arc of not less than 170 degrees. The cabinet door shall be lockable with a key at the open/close handle. The cabinet shelves shall have the structural strength to support a minimum of 100 lbs per shelf. The cabinet shall be securely bolted to the skid base structural members.

3.10 Mechanical – Power Plant.

3.10.1 Diesel Engine. The engine shall be 900/750 rpm, diesel, liquid cooled, two stroke and vertical "V" type, designed for continuous duty service. The engine shall be the engine manufacturer's standard product, complete with all components and auxiliaries necessary for full operation. The requirement to provide the engine manufacturer's standard product shall not prevent the furnishing of special/optional engine components, such as exhaust valves, cylinder liners or bearing inserts in order to enable continuous engine operation using fuels and lubricants specified in Section 3.7.4. The use of more than one engine (tandem drive) to meet the performance requirements for the power plant is not acceptable. The use of external mechanical and electrical devices such as an auxiliary compressed air source or frequency sensitive relays whose sole purpose is to enable the engine to respond to sudden changes from no load to rated load without initiating underfrequency trip of the generator circuit breaker or loss of excitation is not acceptable.

3.10.2 Engine Lubricating Oil System. The engine lubricating oil system shall consist of the following components as required by the OEM, but not limited to, and along with the associated piping, valves, controls, instruments, alarms, gauges and safety devices necessary for engine and personnel safety:

a. Engine driven, positive displacement oil pump(s)

b. Lubricating oil strainer(s)
c. Lubricating oil filter assembly
d. Turbocharger oil filter(s)
e. Lubricating oil cooler(s)
f. Electrically driven lubricating oil circulating pumps for engine preheat, turbocharger pre-lube and post-lube and engine pre-lube (see Section 3.10.5.1)

Engine lubricating oil during operation, pre-heat and pre-lube shall be filtered through the lubricating oil filter assembly before entering the engine. The lubricating oil filter assembly shall have replaceable elements and provisions for draining the oil (except from canister-type cartridge filters) to the engine oil sump by the force of gravity when the engine is not operating. The lubricating oil cooler shall be a heat exchanger which uses engine coolant to decrease the temperature of the lubricating oil. With the engine operating at 110% of rated load and an external ambient temperature of 122 degrees Fahrenheit, the lubricating oil cooler, in conjunction with the engine's cooling system, shall have adequate capacity to cool the lubricating oil to the optimum temperature recommended by the engine manufacturer for safe engine operation. Elements of the lubricating system shall be manufactured by or be acceptable to the engine manufacturer.

3.10.2.1 Manual Pre-lube. Provisions and procedures to manually pre-lube the engine shall be provided. The manual pre-lube configuration shall be in accordance with engine manufacturer's specifications.

3.10.3 Fuel System. The engine fuel system shall consist of the following components, but not limited to, and along with associated piping, valves, controls, alarms, fittings, gauges and auxiliaries necessary to assure adequate fuel supply to the engine under conditions specified.

a. Fuel tank
b. Automatic/manual fuel tank control
c. Engine driven fuel pump
d. Manually operated priming pump (if required)
e. Screw-on (spin-on) fuel filter(s) with selectable duplex configuration to allow filter replacement during power plant operations
f. Fuel injection system
g. External bulk fuel connection
h. Electric motor driven fuel transfer pump

The fuel system shall conform to NFPA 37. Elements of the fuel system shall be manufactured by or acceptable to the engine manufacturer. All fuel piping and fittings shall be constructed of corrosion proof metal with exception of the flexible interconnection supply and return lines connected between the auxiliary unit and engine-generator unit.

Isolation valves shall be provided at the interconnection fuel supply lines on both the auxiliary skid and engine-generator skid.

3.10.3.1 Fuel Tank. The fuel tank shall be constructed of a double wall steel tank of not less than 600 gallons capacity and be constructed and reinforced for seismic zones. The fuel tank and installation shall conform to NFPA 37 and UL 142, including a vent and overflow to the exterior of the housing. The fuel tank shall be mounted to the auxiliary skid. The fuel tank shall have suitable fittings to enable connection to the engine driven fuel pump, priming pump (if required) and the fuel transfer system. The fuel pump suction line shall draw fuel not less than one inch above the bottom of the tank. The fuel tank shall have fuel level switches to automatically control the fuel transfer system. The fuel tank shall have a visual fuel level gauge in a conspicuous location to indicate the quantity of fuel in the tank from full to empty (100-0%). The fuel tank shall have drain piping at the lowest portion of the tank to include piping, valve, plug and terminate at the exterior dimension of the auxiliary skid. The relative positions of the fuel tank and fuel system piping to the engine shall not allow fuel leakage in the piping to the engine, either by a positive head on the piping or by a siphon effect. All external fuel tank piping, fittings and valves shall be constructed of corrosion proof metal.

3.10.3.2 Fuel Transfer Control System. The fuel transfer pump shall be an electric motor driven, TEFC, outdoor rated, rotary, positive displacement pump with a minimum capacity of 25 gallons per minute. The inlet (suction side) of the fuel transfer pump shall be connected to a suitable fitting and mounted near the fuel tank near the edge of the skid base. The inlet fitting shall have an American National taper pipe female thread and a pipe plug installed. A manual fuel shutoff valve and “Y” strainer shall be installed in the incoming fuel line before the fuel transfer pump. The fuel transfer pump shall be controlled by the fuel tank control system. The fuel transfer motor control system shall meet the requirements of NFPA 70. The fuel tank control shall provide automatic fill and manual (hand) fill controls. The fuel transfer pump shall discharge through a fuel tank control system AC solenoid valve to the fuel tank. The solenoid valve shall close when a high fuel level condition exists and open when there is a low fuel level condition. Check valves shall be installed to prevent back flow of fuel if the solenoid valve fails or leaks.

3.10.3.2.1 Fuel Transfer Control System Indication and Operation. The following fuel transfer control system indication and operation shall be provided:

a. Low fuel level; visual indication at the power plant controller and starts fuel transfer pump.
b. Critical low fuel level; visual indication at power plant controller, audible alarm and initiates a power plant shutdown.

c. High fuel level; visual indication at power plant controller, audible alarm and closes fuel solenoid valve, shuts off fuel pump.
d. Critical high fuel level; visual indication at power plant controller, audible alarm, fuel solenoid closes, fuel pump shuts down and initiates a power plant shutdown.
e. Fuel in rupture basin; visual indication at power plant controller, audible alarm, fuel solenoid valve closes and initiates a power plant shutdown.
f. Fuel pump on, visual indication at the power plant controller.

3.10.4 Engine Cooling System. The engine cooling system shall have a completely jacketed cooling system consisting of the following components, but not limited to, and along with the associated piping, valves, fittings, auxiliaries, controls, instruments, alarms, gauges and safety devices necessary for the engine and personnel safety:

a. Electric motor driven fan(s)
b. Fan drive belt(s)
c. Engine driven coolant circulating pump(s)
d. Radiator(s), galvanized
e. Expansion tank(s)
f. Automatic coolant temperature control

Operation of the radiator fan drive(s) shall be automatically initiated as part of the engine start sequence; and deactivation of the fan drive(s) shall be automatically initiated as part of the engine shutdown sequence. The assembly of the electric motor pulley, idler pulley, fan pulley and drive belts shall be equipped with a bolted metal guard which encloses the entire assembly and will prevent personnel injury. The idler pulley shall be adjustable to facilitate belt removal and allow adjustment of belt tension in the fan drive system. The radiator fan(s) guarding shall meet the requirements of Section 3.6. Guards shall be removable for maintenance and repair. Particular attention shall be paid to the selection of materials and the assembly of the radiator fan guard with consideration to the pulsations, vibrations and high velocity air it will be subject to during operation. The engine cooling system shall be suitable for use with water, ethylene glycol or propylene glycol solutions. Flexible hoses for connecting the engine cooling system (and vent lines if necessary) to the radiator(s) shall meet the following requirement.

a. Provide the ability to locate the auxiliary unit a minimum of 25 feet from the engine-generator unit within a 180 degree arc from the front (engine end) of the engine-generator unit.
b. Have at each end, identical forged steel flanges to mate with the flanges on the engine-generator skid (see 3.8.1) and the auxiliary skid (see Section 3.8.3).
c. Hose to flange connections shall provide the ability to remove/replace/repair the interconnecting hoses without disconnecting the mating flanges by securing the hose to flange connection with compression-type hose clamps.

d. Cooling system isolation valves shall be provided at the interconnection supply and return points on the auxiliary skid and engine-generator skid.

3.10.4.1 Engine Coolant Circulating Pump(s). Direct engine-driven coolant circulating pump(s) shall be furnished with the engine. The pump(s) shall have ample capacity to circulate the required flow of coolant through the engine jacket, lubricating oil cooler, and radiator to reject the total heat necessary from the engine under conditions specified. The pump(s) shall be designed for the total dynamic system head required for the engine operation in ambient temperature and altitudes specified.

3.10.4.2 Radiator(s). The radiator(s) and radiator support structure shall be galvanized. The radiator(s) inlet, discharge and vent(s) piping shall enter and exit above the radiator skid base, on the same side as the interconnecting cable connections. The radiator(s) shall be sized to reject 110% of heat required by the engine manufacturer to be removed from the engine and its auxiliary equipment in continuous duty operation under the following conditions:

a. Supplying the internal power plant parasitic loads and 100% of the power plant rated output (1400 kW)
b. An ambient temperature of 110 degree Fahrenheit
c. An altitude of 5000 feet
d. Using a 50% propylene glycol solution as the coolant medium
e. A maximum coolant inlet temperature to the radiator(s) of 200 degrees Fahrenheit

Pressure drop through the radiator(s) shall not exceed 80% of engine cooling system OEM requirements when circulating the maximum required flow through the radiator(s). A switch shall be provided to give an audible and visual alarm at the power plant controller upon loss of radiator cooling air flow.

3.10.5 Engine Pre-heat System. The engine shall have a complete pre-heat system of the following, but not limited to and along with all necessary piping, valves and controls to enable the engine to start and accept load under the conditions specified:

a. Coolant immersion heater(s)
b. Coolant circulating system
c. Pre-heat lubricating oil circulating pump(s)

The pre-heat engine coolant shall be circulated through the lubricating oil cooler, engine and back to the coolant immersion heater by use of an electrically driven water pump or by convection flow, depending on the cooling system design. The coolant immersion heater shall be thermostatically controlled to operate between maximum and minimum temperature limits, as recommended by the engine manufacturer, to maintain coolant and lubricating oil at temperatures which will not cause engine damage when started and operated. The

lubricating oil shall be circulated as required by the engine OEM to enable recommended oil pre-heat temperature. The engine pre-heat system shall be electrically interlocked with the engine control system such that, under normal operating conditions, the engine is prevented from accelerating above idle speed until the engine lubricating oil temperature reaches the engine manufacturers required temperature. This setting shall be adjustable and a pre-heat temperature gauge at the engine-generator control panel shall be provided. The power plant controller shall provide a visual and audible alarm if the pre-heat temperature is not within specified settings.

3.10.5.1 Lubricating Oil Circulating Pump(s). The lubricating oil circulating pump(s) shall be a positive displacement type pump. The lubricating oil circulating pump shall circulate lubricating oil for the engine pre-heating and shall circulate filtered oil for the engine pre-lubrication prior to starting (unless specifically recommended against by the engine manufacturer) and turbocharger pre-lube and post-lube where applicable. If a turbocharger pre-lube and post-lube circulating pump is required as recommended by the engine manufacturer, it shall be a separate system (pump and circuit) from the engine pre-lube/pre-heat system. Both engine and turbocharger oil circulation control systems shall have controls for automatic operation and manual operation. The controls shall be located at the engine control panel, provide visual and audible alarms to the local and remote power plant controllers if the systems are not operating and be configured to be a permissive function as required by the engine manufacturer. In automatic mode, both circulating systems shall operate continuously. All lubricating oil circulating system piping, fittings and valves shall be constructed of corrosion proof metal. Piping, valves, contactors, pressure switches, wiring and other devices necessary to enable operation of the lubricating oil circulating system as described shall be provided.

3.10.5.2 Back-up Lubricating Oil Circulating Pump. A 120 volt, DC powered lubricating oil pump shall be installed to provide oil circulation of the turbocharger lubricating system if the AC turbocharger lubricating system fails. If required or recommended by the engine OEM, the back-up pump shall be hydraulically paralleled with the AC turbocharger oil circulating pump. Operation of the back-up pump shall be initiated by the following conditions:

a. Loss of AC pump discharge pressure within 30 seconds after engine shutdown.
b. Activation of the pre-lube circuit when the engine is not running and loss of AC circulating pump discharge pressure for the duration of the pre-lube cycle.
c. Initiation of a start cycle with loss of AC pump discharge pressure until engine begins to run.

The DC circulating pump shall be de-energized under the following conditions:

a. Adequate AC pump discharge oil pressure.
b. Adequate engine oil pressure.
c. Opening the DC circuit breaker for the pump in the DC control panel.

The back-up pump shall be a positive displacement pump that is capable of circulating the same capacity as the AC lubricating oil circulating pump, and a 120 volt DC motor energized from the 120 volt DC control power system. The back-up oil circulation control systems shall have controls for automatic operation and manual operation. The controls shall be located at the engine control panel, provide visual and audible alarms to the local and remote power plant controllers if the system is not operating correctly. In automatic mode, if the AC oil circulating pump has failed for any reason described, the DC circulating systems shall operate continuously. All back-up lubricating oil circulating system piping, fittings and valves shall be constructed of corrosion proof metal. Piping, valves, contactors, pressure switches, wiring and other devices necessary to enable operation of the back-up pump as described shall be provided.

3.10.6 Engine Exhaust System. The engine exhaust system shall include the exhaust piping, silencer, fittings, expansion joints and rain cap to discharge the exhaust gas to the outside atmosphere. Exhaust pipe extension shall be provided to vent the exhaust gases in a vertical direction at not less than four feet above the roof of the engine-generator unit. The rain cap shall be counterbalanced to provide ease of opening when the engine is started and to assure positive closure when the engine is not operating. The exhaust system shall have a roof mounted, industrial type silencer and shall be removable for transport.

3.10.7 Engine Starting System. The engine shall have a pneumatic starting system that will allow cranking and startup of the engine under all conditions specified in Section 3.7. The pneumatic starting system shall consist of the following along with the associated piping, valves, controls, fittings and gauges.

a. Air compressor
b. Air receiver
c. Heavy duty engine starting motor(s)
d. Pressure regulator(s)
e. Automatic condensation receiver condensation drain system
f. Maintenance/service compressed air system
g. Other components recommended or required by the engine OEM

All compressed air system piping and fittings shall be sized to accommodate the pressure and capacity as specified. Compressed air piping and fittings shall be constructed of corrosion proof metal or suitable steel with exception of the interconnection supply line connected between the auxiliary skid and engine-generator skid.

Isolation valves shall be provided at the interconnection air supply piping points on the auxiliary skid and engine-generator skid.

3.10.7.1 Air Compressor. A complete factory assembled, industrial type, outdoor use, pressure lubricated with replaceable filter air compressor capable of filling the air receiver tank within 15 minutes to the required pressure for engine starting shall be provided and shall discharge to an air receiver. The air compressor and receiver shall be located and attached to the auxiliary skid. The air compressor shall be equipped with a low and high end un-loader assembly, balanced flywheel and intake air filter assembly of the cleanable and/or replaceable dry type, as provided by the air compressor manufacturer for the intended service. The air compressor shall draw air from the atmosphere. The air compressor shall be driven by an electric motor. The horsepower of the electric motor shall be the minimum required for operation of the air compressor, as required by the compressor manufacturer, to pressurize the air receiver as required. A three position control switch shall enable the selective operation of the air compressor in automatic, hand (manual) and off. The air compressor control switch shall be mounted in the switchgear-control house and labeled “AIR COMPRESSOR”. The switch positions shall allow air compressor operation in the following modes; “automatic” – a motor controller shall automatically start and stop the air compressor electric motor through the use of a pressure switch set to an acceptable range to provide adequate air pressure for starting the engine, “manual” – the air compressor electric motor shall start the air compressor at any pressure and stop at the high pressure limit of the pressure switch, “off” – the air compressor control circuit shall be open and not operate in automatic or manual. Additionally, the local and remote power plant controllers shall provide a visual indication when the air compressor motor is operating and a visual and audible alarm if the working air start pressure is below its required operational limit. The working pressure of the pressure switch shall be as required in Section 3.10.7.2.

3.10.7.2 Air Receiver. The air receiver for the air compressor shall have sufficient capacity after being fully charged to provide not less than three consecutive normal engine cranking cycles, with a 15 second rest period between cranking cycles. A normal cranking cycle is the duration of time that the air receiver will be required to provide compressed air to the engine starting mechanism to start the engine being furnished. This duration of time shall be as established by the engine manufacturer. Calculations for sizing the air receiver and determining the pressure when fully charged shall consider the pressure drops during the first and second cranking cycles such that the pressure in the receiver at the end of the second cranking cycle is sufficient to allow the third cranking cycle under conditions specified in Section 3.7.1.1. The air receiver shall be designed for a working pressure of not less than two times the maximum working pressure required by the engine starting air pressure calculation, shall be constructed of welded steel plate, shall conform to the standards of the ASME BPVC-VIII-1 and shall bear the ASME code

stamp. A pressure gauge with a range of 150% of working pressure shall be installed at the air compressor outlet and shall indicate the pressure in the air receiver. The air receiver shall be provided with safety valve(s), fittings, gauges, pressure regulators (if required) and associated items required for operation including a manual bottom blow-down valve located near the skid base exterior. The air receiver shall be located and mounted to the auxiliary skid adjacent to the air compressor. Provisions shall be provided to connect an external compressed air supply to the air receiver. The air receiver outlet pipe shall have an isolation valve located near the tank before any down-stream devices or components in the compressed air system.

3.10.7.3 Maintenance Compressed Air. The power plant shall have a maintenance compressed air system, complete with three quick-disconnect, socket coupler type outlets and, pressure reducing regulators, one blow gun, one air hose (50 ft in length and rated for two times the working pressure of the air system), piping, isolation valves and fittings. Pressure reducing regulator valves shall be provided with the outlet pressure able to be manually adjusted from 0-150 psi. Two quick-disconnect, socket coupler type outlets and pressure reducing regulators located at the front and on both sides of the engine shall be provided in the engine-generator unit and one quick-disconnect, socket coupler type outlet and pressure reducing regulator located near the air receiver on the auxiliary skid. The maintenance compressed air system on the engine-generator skid shall have an isolation valve located at the point where it is connected into the air start system and immediately before each quick disconnect coupler.

3.10.8 Engine Turning (Barring). The power plant shall be furnished with a removable, pneumatic motor-driven, engine turning (barring) device that is a separate system from the engine starter(s) system. The device shall meet the following requirements:

a. Utilize compressed air from the air start system or maintenance air system.
b. Be rated for the operating pressure of the air start system.
c. Have an engine barring speed of 0.75 to 1.25 rpm.
d. Use 120 volts DC for control power.
e. Mode of operation to be electrically controlled by a “LOCAL-REMOTE-RUN” selector switch located on the engine control panel.
f. Be remotely operated by a flexible electrical cord from either side or end of the engine or generator. The electrical cord shall have a control box at one end and a quick disconnect plug on the other end. A mating receptacle meeting the requirements of Section 3.11.3.10.1 shall be mounted on the engine control panel.
g. Operate by pressing a pushbutton switch (one located on the engine control panel and one located on the control box end of the remote cord) for the time that the pushbutton is depressed.

h. The engine start circuit and engine barring circuit shall be electrically interlocked to the engine starting motor(s) and be disabled when the barring mechanism is engaged. The local and remote barring and engaging circuit shall be disabled when the starter motor(s) are engaged, the engine run circuit is energized or the engine is operating. The local and remote control circuits shall be electrically interlocked by the engine control panel mode selector switch, so that when the selector switch is in “LOCAL” position, the local barring circuit is enabled and when the selector switch is in the “REMOTE” position, the remote barring circuit is enabled. Both barring circuits shall not be capable of being energized at the same time.
i. The barring mechanism shall automatically engage the flywheel when the selector switch is put in either the local or remote position, and the engine is not turning.
j. The power plant controller shall provide a latched visual and audible alarm whenever the barring motor is engaged.
k. Be capable of turning the engine (without damage) even if cylinder test valves, if equipped, are closed.
l. All engine start functions shall be disabled when the barring system is enabled.
m. The barring motor shall have a means to manually lock the engagement component that drives the flywheel.
n. The engine shall be capable of operating as described with the barring mechanism installed or removed.
o. A manually operated isolation compressed air valve shall be provided to isolate the barring system from the air start system.

3.10.9 Engine Safety and Protective Devices. The engine shall have safety and protective devices which, when actuated, will provide configurable visual and audible indications at the local and remote power plant controllers. The set points of the safety and protective devices shall be as recommended by the engine manufacturer. The following conditions shall be monitored by protective devices which will simultaneously trip the generator circuit breaker, activate the local and remote power plant controller audible and visual alarm systems to include a configurable shutdown; i.e.: immediate shutdown, adjustable time delayed cooldown before engine stoppage, etc. The protective devices shall cause engine shutdown if the condition occurs and remain configurable by qualified personnel.

a. Engine overspeed
b. Low lubricating oil pressure
c. Low engine oil level
d. High crankcase pressure
e. Low coolant level
f. High coolant temperature
g. Low coolant pressure
h. High lubricating oil temperature
i. Critical low fuel level

j. Emergency stop pushbutton
k. Engine overload

The following conditions shall be monitored by safety devices which activate the local and remote power plant controller configurable alarm systems if any condition occurs. (The alarm system shall allow latching or unlatching alarms, audible or non-audible and visual alarms)

a. Low lubricating oil pressure (activated above the set point of the low lubricating oil pressure shutdown device).
b. High lubricating oil temperature (activating below the set point of the high lubricating oil temperature shutdown device).
c. Low start air pressure.
d. High coolant temperature (activated below the set point of the high coolant temperature shutdown device.
e. High intake air filter vacuum.
f. High fuel pressure (sensing device installed in fuel line, before fuel filters).
g. Low coolant level (activated above the low coolant level shutdown device).
h. Fuel tank rupture basin leak (activated from fuel system controller).
i. High fuel level (activated from fuel system controller).
j. Low fuel level (activated from fuel system controller).
k. Low pre-lube pressure
l. Low turbocharger lube pressure, if recommended or required by the engine manufacturer
m. Low pre-heat temperature
n. 24 DC power supply failure (redundant 24 volt power supplies)
o. Power plant controller communications failure
p. AC power failure
q. Check engine (engine controller)

Other engine safety and protective devices recommended or required by the engine manufacturer shall be furnished. The circuitry of the engine safety and protective devices shall provide a “fail safe” system, such that failure of any safety or protective device or loss of DC control power will trip the power plant circuit breaker and immediately shutdown the engine. Do not use blocking diodes in the fail safe circuits. If the power plant engine controller is capable of providing specified outputs, it is permissible and preferred by the Government to utilize the engine controller outputs to provide power plant controller inputs for safety and protective device control and annunciation in place of switches.

3.10.9.1 Temperature Switches. Engine temperature switches, if used, (e.g. lube oil, coolant, etc.) shall be industrial grade and designed for use in high vibration areas. Each switch shall have a “snap action” type operator with an adjustable differential and perform one function (a separate switch is required for each set

point). Temperature switches shall be installed in thermo-wells, to accommodate removing a sensing component for testing/calibration without draining the fluid of the system.

3.10.9.2 Pressure Switches. Engine pressure switches, if used, shall be mounted in an enclosure adjacent to, but not separated from the engine control panel. The pressure switch and engine control panel enclosures shall be physically connected and located in the front (engine end) of the engine-generator unit. Pressure switches monitoring a common pressure in a system (e.g., engine lube oil, coolant, fuel, etc.) shall be connected by readily removable flexible hoses to a common manifold. The enclosure mounting provisions shall isolate vibrations as per pressure switch manufacturer recommendations and requirements.

Gauges to monitor engine systems shall meet the following requirements:

a. Be connected by flexible hoses to the pressure switch enclosure common manifold(s) for the mediums being monitored.
b. Be not less than 3.5 inch dial size.
c. Be flush mounted, rear connection type.
d. Have metal cases with integral mounting flanges.
e. Have white dials with black graduations and markings.
f. Be furnished with snubbers to minimize erratic pulsations.
g. Have dial scales that cover an arc of not less than 250 degrees.
h. Have an indicting range scaled such that the nominal pressure or temperature measured is 2/3 to 3/4 of full scale, or as recommended by the engine manufacturer.
i. Have dull black indicating pointers of unembellished design.
j. Have clear glass dial covers, free from blemishes, which prevent entry of dust.
k. Be dry-type. Do not use liquid type gauges.
l. Have an accuracy class of plus or minus 0.5% of full scale.
m. Pressure gauges shall be calibrated to read psig/kPa. Temperature gauges shall be calibrated to read in degrees Fahrenheit/Celsius.

3.10.9.3 Pressure Switch Enclosure Indicating Instruments.

3.10.9.3.1 Lubricating Oil Pressure Indicator. The lubricating oil pressure indicator shall indicate the pressure of the lubricating oil supply within the engine or as recommended by the engine manufacturer.

3.10.9.3.2 Lubricating Oil Temperature Indicators. One lubricating oil temperature indicator shall indicate temperature of the lubricating oil leaving the engine. Another lubricating oil temperature indicator shall show the temperature of the engine oil flowing into the engine or as recommended by the engine manufacturer.

3.10.9.3.3 Coolant Temperature Indicators. One coolant temperature indicator shall the temperature of coolant leaving the engine. Another coolant temperature indicator shall show the temperature of coolant flowing into the engine.

3.10.9.3.4 Fuel Pressure Indicators. The fuel pressure indicators shall indicate the pressure differential across the fuel filter(s) and shall be measured by one pressure gauge. An additional pressure gauge shall measure the from fuel pressure that is delivered to the injection system of the engine.

3.10.9.3.5 Starting Air Pressure Indicator. The starting air pressure indicator shall show the pressure of the air supply to the engine starting system.

3.10.9.3.6 Engine Manifold Pressure Indicator. The engine manifold pressure indicator shall show the manifold pressure of the air being furnished to the diesel engine cylinders. The operating range of the indicator shall be as recommended by the engine manufacturer. The indicator shall monitor air box pressure and labeled as such.

3.10.9.3.7 Crankcase Pressure Manometer. A crankcase pressure manometer shall be furnished and installed if required or recommended by the engine manufacturer. The manometer shall be the clean-out head type to enable cleaning and filling the manometer tube without disconnecting the piping to the manometer head. The indicating range shall be as recommended by the engine manufacturer and shall be calibrated to read directly in inches and tenths of water. The crankcase pressure manometer may be mounted on the side of the pressure switch enclosure.

3.10.9.3.8 Engine Lubrication Oil Filter Pressure Differential Indicator. The pressure differential across the lubricating oil filter assembly shall be measured by one pressure gauge.

3.10.10 Engine Control Panel. The engine-generator unit shall contain an engine control panel from which complete operation of the engine and power plant can be accomplished. The engine control panel shall be physically connected and mounted adjacent to the pressure switch enclosure. The engine control panel shall be isolated from any piping, hoses and tubing containing any liquids. The engine control panel shall be metal enclosed, NEMA type 12X, UL listed and labeled or third party certification provided, complete with controls and indicating instruments. The engine control panel enclosure and pressure and temperature switch enclosure, if required, shall be mounted using vibration isolation devices to isolate the engine control panel from vibrations during power plant operation. Indicating instruments and controls mounted on the engine control panel shall include those specified. All instruments and controls shall be clearly labeled in a consistent manner and be conspicuously located. Other indicating instruments and controls recommended by the engine manufacturer or the manufacturer of the power plant shall be

included and directly affected by a switch shall be located directly above the switches. For example, the exhaust pyrometer located directly above its selector switch. Detailed layout drawings of the engine control panel shall be provided to the NTR for review as specified in Section 3.17.1.1.1.

3.10.10.1 Engine Control Panel Controls. The engine control panel shall contain a remote power plant controller with visual display, audible devise(s), switches, indicating lights and pushbuttons for complete control of the engine and power plant. Controls that shall be provided, but not limited to, are as follows with required operator label(s):

a. Engine idle/rated switch, “IDLE/RATED”.
b. Emergency stop pushbutton, “EMERGENCY STOP”.
c. Alarm silence device, “ALARM SILENCE”.
d. Engine normal/maintenance mode switch, “NORMAL/MAINTENANCE MODE”, if this cannot be accomplished from the power plant controller. (allows for cranking with air starters for cylinder blow-down)
e. Engine barring device selector switch, “LOCAL/REMOTE/RUN”.
f. AC engine pre-lube switch with “press-to-test” indicating lights, “AC ENGINE PRE-LUBE – HAND/OFF/AUTO”.
g. AC turbocharger pre/post-lube switch with “press-to-test” indicating lights, if required by engine manufacture, “AC TURBOCHARGER PRE/POST-LUBE – HAND/OFF/AUTO”.
h. DC turbocharger pre/post-lube switch with “press-to-test” indicating lights, if required or recommended by engine manufacturer, “DC TURBOCHARGER PRE/POST-LUBE – HAND/OFF/AUTO”.
i. Remote power plant controller.

Control switches, indicating lights and pushbuttons shall be of the same manufacturer. Each switch, its positions and each pushbutton shall be permanently identified by its label on an escutcheon plate as indicated above.

3.10.10.1.1 Engine Idle/Rated Switch. The engine idle/rated switch shall allow a manual means of changing engine speed from idle to rated and vice versa in a manual operating mode only. The power plant control scheme shall ignore the position of the idle rated switch if the power plant is set in any automatic mode. An unlatched visual alarm shall be indicated on the local and remote power plant controllers when the idle/rated switch is in the idle position, “ENGINE IN IDLE MODE”. In either position of idle or rated, failure of lubricating oil pressure to reach the necessary level within a specified period of time, as determined by the engine manufacturer, shall cause immediate engine shutdown.

3.10.10.1.2 Emergency Stop Pushbutton, Engine-generator Unit. The emergency stop pushbutton shall cause an immediate engine shutdown by stopping the fuel supply to the engine and removing power to the engine controller or engine governor actuator. Operation of the

emergency stop pushbutton shall automatically trip the generator circuit breaker (GCB). A latched visual and audible alarm shall be indicated at the local and remote power plant controllers when the engine control panel emergency stop pushbutton is depressed, “E-STOP ENGINE PANEL”. The emergency stop pushbutton shall be a red mushroom head pushbutton and conspicuously marked “EMERGENCY STOP”.

3.10.10.1.3 Alarm Silence. The alarm silence device, external or integral to the power plant controller as determined by the Contractor, shall provide a means to silence any active audible alarm whether latching or unlatching. An unlatched visual alarm shall be indicated on the local and remote power plant controllers when the alarm silence device is activated, “ALARM SILENCE ENGINE PANEL”.

3.10.10.1.4 Engine Normal/Maintenance Mode Switch. The engine normal/maintenance mode shall provide a manual means of switching to and from normal engine operating mode and maintenance mode. Maintenance mode shall provide a means to crank the engine while positively preventing engine starting. A latched visual and audible alarm shall be indicated on the local and remote power plant controllers when the mode switch is in the maintenance position, “ENGINE IN MAINTENANCE MODE”. This shall allow for cylinder blow-down only and shall not start the engine.

3.10.10.1.5 Engine Barring Device Selector Switch. The engine barring switch shall provide the functionality as describe in Section 3.10.8. A latched visual and audible alarm shall be indicated on the local and remote power plant controllers when barring selector switch is in the “LOCAL” or “REMOTE” position, “ENGINE IN BARRING MODE”.

3.10.10.1.6 AC Engine Pre-lube Switch. The AC engine pre-lube switch shall operate the engine pre-lube system as describe in Section 3.10.5.1. A hand-off-auto switch shall be utilized with two, press-to-test, green pilot lamps used to indicate that the engine pre-lube motor is in hand or auto mode. The indicating lights shall be energized from the motor starter associated with the engine pre-lube motor.

3.10.10.1.7 AC Turbocharger Pre/Post Lube Switch. The AC turbocharger pre/post-lube switch, if installed, shall operate the AC turbocharger pre/post-lube system as describe in Section 3.10.5.1. A hand-off-auto switch shall be utilized with two, press-to-test, green pilot lamps used to indicate that the AC turbocharger pre/post-lube motor is in hand or auto mode. The indicating lights shall be energized from the motor starter associated with the AC turbocharger pre/post-lube motor.

3.10.10.1.8 DC Turbocharger Pre/Post Lube Switch. The DC turbocharger pre/post-lube switch, if installed, shall operate the DC turbocharger pre/post-lube system as describe in Section 3.10.5.2. A hand-off-auto switch shall be utilized with two, press-to-test, green pilot lamps used to indicate that the DC turbocharger pre/post-lube

motor is in hand or auto mode. The indicating lights shall be energized from the motor starter associated with the DC turbocharger pre/post-lube motor.

3.10.10.2 Engine Control Panel Indicating Instruments.

3.10.10.2.1 Electric Tachometer. The tachometer system shall consist of a magnetic pick-up, connecting leads and a solid-state indicating instrument calibrated to read directly in rpm. The indicated speed range shall be 0 to 1200 rpm with an accuracy of plus or minus 1% of full scale.

3.10.10.2.2 Running Time Meter. The running time meter shall be a non-resettable, mechanical type meter and shall show the total of engine running time from 0 – 99999.9 hours, then repeat.

3.10.10.2.3 Exhaust Pyrometer. The exhaust pyrometer system shall enable selective indication of exhaust gas temperature from each cylinder of the engine and, if engine is turbocharger furnished, at the turbocharger turbine inlet. The exhaust pyrometer shall consist of thermocouples, interconnecting leads and an indicating instrument with a selector switch. The instrument shall read directly in degrees Fahrenheit. The components of the pyrometer system shall be compatible and suitable for measuring the temperature of the engine exhaust gases. Thermocouple wiring shall be run in separate conduit. Additionally, all pyrometer data shall be indicated at the power plant controller and remote power plant controller.

3.10.10.2.4 Alarm Horn. The engine control panel shall have an alarm horn to provide an audible signal if any power plant alarm or abnormality occurs. The alarm horn shall be identical to that installed on the switchgear control unit power plant control panel (see 3.11.3.1.3).

3.10.10.2.5 Engine Panel Remote Power Plant Controller. The engine control panel shall have a visual display and control panel utilized to indicate power plant status, annunciate alarms and control power plant operations. This device shall provide identical functionality of the power plant controller located in the switchgear-control unit. The engine panel remote power plant controller shall indicate, but not limited to, all conditions stated in Section 3.10.10.

3.10.10.2.6 Indicating devices. Alarm horn, pilot lights, power plant controller and the engine panel mounted power plant remote controller as described shall provide a complete and safe means for qualified operators to complete maintenance, repair, operating and testing of the power plant.

3.11 Electrical: Power Plant.

3.11.1 Generator. The generator shall be a form wound, synchronous, rotating field, self excited, 2/3 pitch, fan cooled, self ventilated AC generator. The generator shall have a drip proof frame and filter assembly if required. The generator shall conform to ANSI C50.10, ANSI C50.12 and NEMA MG1. The generator shall be rated 60 and 50 Hz and windings shall be brought out through six terminals and connected for 4160Y/2400 volts (60Hz) and 3300Y/1905 volts (50Hz) configurations. Conductor material shall be copper. The insulation system shall be vacuum pressure impregnated (VPI), NEMA class H. The generator temperature rise shall be 80 degrees Celsius at 1400 kW at 60Hz. The generator shall be capable of operation to supply three-phase, three or four-wire, grounded or ungrounded electric systems. The generator shall have not less than six embedded, Resistance Temperature Detectors (RTDs) installed in accordance with the requirements of ANSI C50.10. Generator bearing RTD(s) shall be provided. All generator RTDs shall be wired to and status indicated at the generator multifunction relay. The generator field shall have amortisseur windings. The generator shall have strip heater(s) energized from the station power system to prevent condensation under all conditions specified. The strip heaters shall be rated for four times the wattage recommended by the generator manufacturer at 240 volts. The strip heaters shall be energized at 120 volts from the AC station power system. If a pedestal mounted generator is furnished, it shall be driven directly from the engine crankshaft through a flexible coupling. The flexible coupling shall compensate for minor misalignment between the engine and generator without causing injurious stresses on the connected equipment. The flexible coupling shall also allow for movement of the shafts resulting from expansion, contraction and thrusting. If the generator is mounted directly on the engine, it shall be driven from the engine crankshaft through a direct, rigid coupling.

3.11.1.1 Generator Construction. The generator shall have a rigid, welded steel frame to support and maintain alignment of all parts of the generator. Mechanical jacking devices for lifting and lowering the generator from the four corners of the generator frame shall be permanently installed on or within the skid base. The same type of mechanical devices, also permanently installed at the four corners of the generator shall be used to move the generator laterally and from side to side and end to end of the engine-generator skid. The generator shall be properly aligned with the engine, as per engine and generator manufacturer specifications. The generator stator laminations shall be high grade silicon steel, pressure clamped and assembled to retain laminations in position for all test, transient and operating requirements specified, and to prevent flaring of end lamination teeth. The generator design and construction shall have been proven in actual service at the ratings and speeds specified. The only acceptable components to be mounted on the generator are connection boxes for strip heaters, RTDs, exciter connections and generator cooling air filter assemblies.

3.11.1.2 Mechanical Balance. The generator shall be mechanically balanced in accordance with NEMA MG1. With the generator coupled to the engine within the power plant, operating at rated speed and voltage, at any load from no load to 110% rated load, the peak-to-peak vibration amplitude shall not exceed 0.006 inches. The vibration amplitude shall be measured in all three axes (vertical, longitudinal and transverse) at the bearing housing or on the generator frame adjacent to the bearing housing.

3.11.1.3 Cable Terminal Box. A cable terminal box shall be provided to facilitate safe connection of cables to conduct generator output power to the switchgear in the switchgear-control unit. The terminal box shall be mounted under the deck plates at the rear (generator end) of the engine-generator skid base. The terminal box shall be constructed of corrosion proof sheet metal, not less than 0.1046 inch (U.S. revised standard 12 gauge) nominal thickness and shall have a hinged cover. The cover shall be designed to prevent (without a gasket) entry of liquids spilled on the floor. The inside face of the cover shall be insulated. The insulation shall withstand a power frequency test voltage of 19 kV for one minute. The terminal box shall have epoxy stand-off insulators rated for not less than 5kV nominal, 60kV basic insulation level (BIL) with provision for terminating the generator output cables. A copper bus bar mounted on stand-off insulators shall be used to connect each generator output to the corresponding interconnecting power cable. The six generator leads shall be readily separable from the copper bus bar for insulation testing. The generator output cables and interconnecting power cables shall have NEMA two-hole spaced lugs. The copper bus bar shall accommodate the NEMA two-hole spaced lugs. Each cable, generator output or interconnecting cable, shall mount separately and independent of the other cables to its corresponding bus bar. Each generator neutral lead (T4, T5 and T6) shall be routed through differential protective relay current transformers mounted in the terminal box. The generator neutral leads shall mount separately and independently to a common copper bus bar. The terminal box shall have one grounded bus for connection of the ground leads of the shielded cable terminations. The terminal box shall be electrically bonded to the skid base of the engine-generator unit.

3.11.2 Excitation System. The excitation system shall consist of an automatic voltage regulator, accessories and wiring required to provide excitation and control of the generator output voltage under operating conditions as specified this SOW and meet the requirements of ISO 8528 G3.

3.11.2.1 Exciter. The exciter shall be mounted integral to the generator and shall be brushless type with VPI NEMA class H insulation.

3.11.2.2 Pilot Exciter. The pilot exciter shall be a permanent magnet generator (PMG) with VPI NEMA class H insulation. The PMG

shall provide power to the automatic voltage regulator for operational and testing requirements as specified.

3.11.2.3 Automatic Voltage Regulator. The voltage regulator shall be solid state and shall automatically control the generator output voltage as specified. The reference voltage shall be 3 phase, true RMS and shall be obtained from the potential transformers in the switchgear-control unit. The voltage regulator shall enable adjustment of the generator output voltage while the power plant is operating by means of the local or remote power plant controllers. The voltage regulator shall enable parallel operation and shall have the ability to automatically share reactive load through the local and remote power plant controllers.

3.11.3 Switchgear. The generator output shall be fed through and controlled by a dead front, free standing, indoor type, metal enclosed switchgear assembly. Switchgear shall be three-phase, four-wire (with neutral), rated 5 kV, 60/50 Hz, 60 kV BIL, 600 amp continuous and braced for short circuit at 1.25 times the worst case fault current as determined by the coordination study. At minimum, enclosed interconnect switchgear conforming to NEMA (1) gasket requirements shall be used. The construction, assembly and test of the switchgear assembly shall conform to the requirements of ANSI C37.20.1, ANSI C37.20.2, UL 891, NEMA PB1 and NEMA SG5. Assembly and mounting of components shall be in a logical sequence, separated by voltage class. Incoming and outgoing power cable supports shall be provided. All electrical assemblies and wiring methods applied shall be incorporated in accordance with best industry standards. The switchgear assembly shall be adequately braced to the skid base of the switchgear-control unit remaining intact and undamaged while encountering shocks or impacts during modes of transport as specified. The switchgear assembly shall not be welded to the switchgear-control skid or floor. All components of the switchgear shall be suitable for operation at 60 and 50 Hz. It shall be acceptable for the Contractor to provide two sets of components for 60 and 50 Hz where required. The front panels to the switchgear assembly shall be vertically hinged and have a positive means of securing and locking in the closed position. The front panels shall be able to swing open through an arc of 105 degrees without interrupting operation of the other front panels. Each front panel shall be lockable at 90 degrees of its arc of travel. Each front panel shall be pinned or doweled, in addition to being hinged mounted, to prevent future panel door misalignment and ease of removal. Lighting fixtures shall be furnished with industrial guards and shall be centrally located on the ceiling of the switchgear-control unit. Two wall mounted switches shall be located inside the switchgear-control unit located adjacent to each door and shall control all AC lighting. The switchgear sections shall have electric strip heaters, complete with thermostats, energized by 120 volt AC, to prevent condensation under conditions specified. The strip heaters shall be rated for four times the wattage required at 240 volts.

3.11.3.1 Power Plant Control Center. The front panels of the switchgear assembly shall provide all power plant control devices. The generator circuit breaker (GCB) and load disconnect switch front panels shall not have power plant control devices. The power plant control switchboard shall allow complete control of the power plant in all modes of operation. The control switchboard panels shall conform to IEEE Std C37.21. The control switchboards shall include the controls and indicating instruments specified in the following sections. Other indicating instruments and controls recommended by the generator manufacturer of the manufacturer of the power plant shall be included with prior approval of the NTR. Indicating instruments directly affected by the operation of a switch shall be located directly above the switch(s). For example, the generator voltmeter and ammeter above their respective phase selector switch. Detailed layout drawings of the power plant control center shall be provided to the NTR for review as specified in Section 5.1.2.

3.11.3.1.1 Power Plant Control Center Controls. The power plant control center shall contain switches, pushbuttons and other control devices for complete control of the power plant. Each control device shall have the number of poles required for the specific application. Selector and control switches shall be enclosed, rotary and cam operated switches. Controls that shall be provided are described as follows. Each control shall be permanently identified by an escutcheon plate as to its function as indicated.

3.11.3.1.1.1 Power Plant Controller. The power plant shall be provided with a single power plant controller. The power plant shall have an engine speed governing system that is controlled by the power plant controller and engine controller. Electric control power for the power plant controller shall be provided from the 24 volt DC control power system. The power plant controller shall be compatible and have the ability to automatically load share through externally connected canbus with Woodward 3500 generator controllers. A remote power plant controller shall be provided and located at the engine control panel. The remote power plant controller shall provide same functionality of the main power plant controller located in the switchgear-control unit. The power plant controller shall control speed, voltage, kW, KVAR and pf as specified in Section 3.1.4.

3.11.3.1.1.2 Generator Circuit Breaker Control. The GCB shall be controlled via the power plant controller. The GCB shall be capable of manual pushbutton control to open and close in manual mode only. The power plant controller shall open and close the GCB in any automatic mode. GCB opening and prevent closing GCB status shall be displayed on the power plant controller display screen.

3.11.3.1.1.3 Voltmeter Selector Switch. The voltmeter selector switch shall enable the selection of a line-to-line voltage on either the generator side or load side of the GCB. The voltmeter selector switch shall be an eight position, maintained contact selector switch. The selector switch shall have a pointed, knurled operating handle and

an escutcheon plate clearly marked to show each switch position and the word “VOLTMETER”. The vertical up and vertical down positions shall be marked “OFF”. The right side of the escutcheon plate shall be marked “BUS”; the left side of the escutcheon plate shall be marked “GENERATOR”. The three positions on each side, between the vertical up and down positions, shall be marked “A-B”, “B-C” and “C-A” respectively.

3.11.3.1.1.4 Engine Idle/Rated Switch. An engine idle/rated switch shall be furnished and shall allow a manual means of changing engine speed from idle to rated and vice versa in a manual operating mode only. The power plant control scheme shall ignore the position of the idle rated switch if the power plant is set in any automatic mode. An unlatched visual alarm shall be indicated on the power plant controller when the idle/rated switch is in the idle position, “ENGINE IN IDLE MODE”. In either position of idle or rated, failure of lubricating oil pressure to reach the necessary level within a specified period of time, as determined by the engine manufacturer, shall cause immediate engine shutdown.

3.11.3.1.1.5 Emergency Stop Pushbutton, Switchgear-control Unit. The emergency stop pushbutton shall cause an immediate engine shutdown by stopping the fuel supply to the engine, shutting off power to the engine controller and actuator if provided. Operation of the emergency stop pushbutton shall automatically trip the generator circuit breaker. A latched visual and audible alarm shall be indicated at the power plant controller when the engine control panel emergency stop pushbutton is depressed, “E-STOP SWG-CONTROL PANEL”. The emergency stop pushbutton shall be a red mushroom head pushbutton and conspicuously marked “EMERGENCY STOP”

3.11.3.1.2 Power Plant Control Center Indicating Instruments. The power plant control center shall contain instruments which provide constant monitoring of the power plant’s systems. Indicating instruments that shall be provided are meters and indicating lights as described in the following sections. The indicating instruments shall be switchboard type, semi-flush and shock resistant mounted. Indicating instruments shall have an indicating range such that the nominal value measured by the instrument will read within 66.7% to 75% of full scale in the power plant 60 Hz configuration. The accuracy of each indicating instrument shall be plus or minus 2.0% of their respective full scale. Each meter and gauge shall be 4.5 inch square with a black metal cover. The covers for the dial faces of the meters and gauges shall be clear plastic free from blemishes. The dial face covers shall prevent the entry of dust but shall also be removable. Each meter and gauge shall have a dial face pointer. The dial faces shall be white with black graduations and markings. The range of the dial face scales shall cover an arc of 250 degrees or greater. The indicating pointers shall be dull black. The meters and gauges shall conform to UL 1437 and shall be made by the same manufacturer. Indicating instruments affected by the operation of switch(s) shall be located directly above that instruments switch(s). Each indicating

instrument shall be bench tested for proper operation prior to installation in the power plant. Calibration shall be in accordance with the recommendations of the manufacturer of the specific instrument or meter and shall be performed no less than six months prior to testing. Each indicating instrument shall be permanently identified by an escutcheon plate as to its function.

3.11.3.1.2.1 Voltmeter. The voltmeter shall be connected, through the voltmeter selector switch, to indicate the line-to-line voltage on the generator side of the GCB and load side of the load disconnect switch. The voltmeter shall be transformer rated for 150 volts and shall have a 0-5 kV scale.

3.11.3.1.2.2 Indicating lights. Indicating lights mounted on the power plant control panel shall include those specified in the following sections. Each indicating light shall be complete with a spherical lens of the color specified for the respective application. Each indicating light shall be rated for the voltage of the circuit in which it is connected.

3.11.3.1.2.2.1 Generator Circuit Breaker Indicator Lights. The GCB indicator lights shall indicate whether the GCB is opened or closed. The GCB indicator lights shall consist of two indicating lights with one red and one green colored lens. The indicator lights shall be connected in the GCB control circuit so the green light will illuminate when the GCB is in the “OPEN” position and the red light will illuminate when the GCB is in the “CLOSED” position. The red light shall also indicate that the GCB trip circuit is electrically continuous. The indicator lights shall be mounted side-by-side in a horizontal plane directly above the GCB cubicle and provide press-to-test feature.

3.11.3.1.2.2.2 Load Disconnect Switch Indicator Lights. The load disconnect switch (LDS) indicator lights shall indicate whether the LDS is opened or closed. The LDS indicator lights shall consist of two indicating lights with one red and one green colored lens. The indicator lights shall be connected at the LDS position switch so the green light will illuminate when the LDS is in the “OPEN” position and the red light will illuminate when the LDS is in the “CLOSED” position. The red light shall also indicate that the LDS position switch is electrically continuous. The indicator lights shall be mounted side-by-side in a horizontal plane directly adjacent to the GCB indicating lights and provide press-to-test feature.

3.11.3.1.2.2.3 Generator and Bus Voltage Indicating Lights. The generator and bus voltage indicating lights shall indicate generator and bus voltage whenever voltage is present on the generator side (Generator) and load side (Bus) of the GCB. These indicating lights shall be three phase, three indicating lights, for the generator and bus. Each light shall indicate voltage per phase and shall be switched between bus or generator via the voltmeter selector switch. The indicator lights shall be mounted side-by-side in a horizontal

plane, centered, directly below voltmeter and above voltmeter switch and provide press-to-test feature.

3.11.3.1.3 Power Plant Controller Alarms. All power plant alarms shall be presented by the local and remote power plant controllers and generator multifunction protection relay. The alarms shall be configurable to be clearly visual, audible, latching or unlatching in any configuration. Any visual alarm shall be displayed at the local and remote power plant controllers or multifunction generator protection relay. Any audible alarm shall be controlled by the power plant controller that electrically operates a horn with sufficient sound intensity to be heard over the noise of the operating power plant. The alarm system shall have the following sequence of events upon activation of an alarm condition by monitoring or protective device:

a. The audible alarm sounds and the respective visual alarm displays on the power plant controllers or generator protective relay display screen.
b. Manually depressing an alarm silence pushbutton (external or integral to the power plant controller as determined by the Contractor, the audible alarm silences and the visual alarm remains.
c. Once the alarm condition has been corrected, the audible and visual alarm remains (if latched) or the audible and visual alarm extinguishes (if unlatched).
d. Manually activating the alarm acknowledge device on the power plant controller or generator multifunction relay, the alarm extinguishes and resets.

The following power plant abnormal conditions shall be indicated by the alarm systems and visually displayed as specified:

Engine alarm conditions:
1) Engine overspeed
2) Low lubricating oil pressure
3) High crankcase pressure
4) Low coolant level
5) High coolant temperature
6) Low coolant pressure
7) High lubricating oil temperature
8) Critical low fuel level
9) Emergency stop pushbutton (engine-generator unit)
10) Emergency stop pushbutton (switchgear-control unit)
11) Engine overload
12) Low lubricating oil pressure (activated above the set point of the low lubricating oil pressure shutdown device)
13) High lubricating oil temperature (activating below the set point of the high lubricating oil temperature shutdown device)
14) Low start air pressure

15) High coolant temperature (activated below the set point of the high coolant temperature shutdown device.
16) High intake air filter vacuum
17) High fuel pressure (sensing device installed in fuel line, before fuel filters)
18) Low coolant level (activated above the low coolant level shutdown device)
19) Fuel tank rupture basin leak (activated from fuel system controller)
20) High fuel level (activated from fuel system controller)
21) Low fuel level (activated from fuel system controller)
22) Low pre-lube pressure
23) Low turbocharger pre/post lube pressure
24) Low pre-heat temperature
25) 24 DC power supply failure (redundant 24 volt power supplies)
26) Power plant controller communications failure.
27) AC power failure
28) Check engine (engine controller)
29) Other alarm conditions as recommended by the engine manufacturer

Generator alarm conditions:
1) Overcurrent (50/51)
2) Overfrequency (81O)
3) Underfrequency (81U)
4) Reverse power (32)
5) Phase differential (87)
6) High generator winding temperatures (RTDs) (49)
7) High generator bearing temperature (RTD)
8) Ground fault (50G)
9) Undervoltage (27)
10) Overvoltage (59)
11) Overload
12) GCB trip

3.11.3.1.3.1 Alarm Silence. The alarm silence device, external or integral to the power plant controller as determined by the Contractor, shall provide a means to silence any active audible alarm whether latching or unlatching. An unlatched visual alarm shall be indicated on the local and remote power plant controllers when the alarm silence device is activated, “ALARM SILENCE SWG-CONTROL PANEL”.

3.11.3.1.4 Generator Protective Devices. Generator protective devices shall be utility grade, flush mount, microprocessor type and shall include, but are not limited to, the items specified in the following sections. The generator protective devices shall trip the generator circuit breaker, sound audible alarms and indicate the power plant abnormality on the protective relay and local and remote power plant controllers. Each generator protective device shall be bench tested for proper operation prior to installation in the power plant. The

bench test shall be in accordance with the recommendations of the manufacturer of the specific device and the testing results shall be forwarded to the NTR for approval.

3.11.3.1.4.1 Multi-function Generator Protection Relay. The power plant shall be equipped with a fully functional, utility grade, multi function protective relay, to include over current (51V), frequency (81 O/U), reverse power (32), over voltage (59), under voltage (27), generator temperature (49), ground fault (51G), emergency shutdown/lock out (86), phase sequence (47), generator percent differential (87G) and synchronizing check (25).

3.11.3.1.4.2 Neutral Grounding Reactor. The power plant shall have a neutral grounding reactor which will limit the maximum phase current on any short circuit to a value which does not exceed 300% of rated generator output. The neutral grounding reactor shall also be sized to maintain an “effectively grounded” system in accordance with IEEE Std 142.

3.11.3.1.4.3 Lighting Arrestors and Surge Capacitor. The power plant shall have lighting arrestors and a three phase surge capacitor to provide protection in case the power plant is subject to impulse voltage either from directly connected, exposed overhead lines or transmitted power through transformers. The lighting arrestors shall be station class for use with machine circuits. Lighting arrestors and capacitors shall be rated for 4160 volts wye connected at 60 Hz and shall also be provided for 3300 volts wye at 50 Hz. The devices shall be mounted inside the switchgear assembly. The lightning arrestors shall be electrically connected to the load side of the load disconnect switch. The surge capacitor shall be connected to the generator side of the GCB.

3.11.3.2 Generator Circuit Breaker (GCB). The switchgear shall have a GCB in a metal enclosed compartment. The GCB shall be a three pole, vacuum, stored energy, draw-out type, rear connected, electrically operated AC power circuit breaker. The GCB shall be rated for not less than 600 amperes continuous, 5 kV, 60/50 Hz, 350 megavolt ampere (MVA) symmetrical interrupting capacity, 58,000 amperes closing and latching capability, five cycle interrupting time and conform to ANSI C37.04, C37.06, C37.010 and C37.11. Manual operating capabilities shall be provided. The GCB shall have three distinct positions relative to the compartment: connected, test and disconnected. The GCB shall have integral mechanical interlocks to ensure that the circuit breaker is in the OPEN position before it can be moved into the connected or disconnected position. Do not use key type interlocks. The GCB shall have a contact wear indicator, circuit breaker operations counter, spring charge/discharge indicator and circuit breaker position indicator. The GCB shall be connected to the generator output leads, before the load disconnect switch. The differential protective relay current sensing transformers shall be located between the GCB and the load disconnect switch. When paralleling, the power plant with other like power sources, the

closing circuit of the GCB shall be electrically interlocked with the power plant synchronizing device and must verify that the generator is synchronized with the bus (load side of the GCB) before the GCB can be closed. The GCB shall be capable to close onto a dead bus (by bypassing the synchronizing device) when the load side of the GCB is de-energized. The GCB shall have undervoltage release (UVR) and 10% spare secondary outputs to include 52a, 52b and bell alarm contacts. The physical location of the GCB in the power plant control center in relation to adjacent walls and other components in the switchgear-control unit shall be such that the GCB can be fully and readily removed from its compartment and have space on all sides for the performance of maintenance as recommended by its manufacturer. This space requirement shall not supersede the dimensional requirements of Section 3.3. A circuit breaker test cord shall be provided to enable electrical closing and tripping of the GCB for maintenance and testing purposes, when the GCB is removed from the cubicle. Necessary tools/dollies, etc, to facilitate removal of the circuit breaker shall be furnished if required by the design. The circuit breaker shall have provisions to block and brace it for the modes of transportation as specified in this SOW and recommended by the GCB manufacturer.

3.11.3.3 Disconnecting Switch. The switchgear-control unit shall have a load disconnecting switch in a metal-enclosed compartment. The disconnecting switch shall be a three-pole, single-throw, manual, group operated, load-rated interrupting/disconnecting switch. The load disconnect switch shall be rated for not less than 600 amperes continuous, 5 kV, conforming to ANSI C37.30. The load disconnect switch shall be installed to completely isolate the power circuit of the power plant from the outgoing load terminals. The load disconnect switch shall have provisions to lock it in the OPEN position only. The load disconnect switch enclosure shall be equipped with a viewing window to allow personnel to visually confirm its position. A factory option load disconnect auxiliary switch shall be provided for indicating lights as specified in Section 3.11.3.1.2.2.2.

3.11.3.4 Provision for Generator Output Cables. Power plant output power cables shall be routed through the switchgear enclosure to the skid base. The skid base shall provide a hydrophobic, dielectric cable entrance seal for the load cables to prevent rodent, insect, water and dust entry. Terminals located on the load side of the load disconnect switch shall accommodate two bolt, NEMA spaced, terminal lugs. Provisions shall be made for grounding the cable shielding from the cable terminations and securing the cable. Provisions for clamping the cables shall be adaptable for use with the cables provided or multi-conductor cables of the same size. Free space shall be provided to facilitate the installation of cable termination kits. Terminals shall be permanently marked, including their application as generator power terminals. Alternate methods of cable entrance may be considered but are subject to approval by the NTR.

3.11.3.5 Generator Neutral Link. The power plant shall have a removable generator neutral link to allow for grounded through neutral

grounding reactor or ungrounded generator neutral. The generator neutral link shall be copper and shall have a current carrying capacity not less than the current carrying capacity of the generator neutral conductor. The neutral link shall be readily accessible. An instruction plate identifying the conditions under which the generator neutral shall be grounded or ungrounded shall be permanently mounted adjacent to the neutral link. Provisions shall be made for storage of the generator neutral link in the area adjacent to where it is normally installed.

3.11.3.6 Station Power. The power plant shall have an AC electrical power system (station power system) supplying power for lighting and electrical powered auxiliaries of the power plant. Two utilization voltages shall be incorporated into the station power plant system to accommodate for different power loads. The voltages shall be three-phase, three-wire 480 volts, nominal, for major power loads and single-phase, three-wire 120/240 volts, nominal for lighting and small power loads. The station power system shall consist of the following along with wiring and accessories required to provide complete operable systems:

a. 4160 to 480 volt transformer, with 5 kV disconnecting device
b. 480 volt station power distribution panelboards
c. 480 to 120/240 volt transformer(s)
d. 120/240 volt panelboards
e. Protective devices (fuses, circuit breakers, etc., as required by NFPA 70)
f. Automatic transfer switch (ATS), 480 volt, three-pole

3.11.3.6.1 Station Power Transformers. The transformers to supply power at 480 volts and 120/240 volts shall be dry and outdoor type and shall conform to IEEE C57.12.01, NEMA TR1, UL 506, UL 508 and UL 1561 as per voltage class and application. The insulation system of the station power transformer shall be vacuum pressure impregnated (VPI). Transformers shall be connected to provide the required voltages as follows:

a. One, three-phase 4160Y/2400 to 480 volt three-phase delta, 60/50 Hz rated, transformer with taps that are adjustable to plus or minus 5% shall be installed in the switchgear to provide 480 volt, three-phase, three-wire power to the 480 volt station power panelboard through a circuit breaker and ATS (see Sections 3.11.3.6.2 and 3.11.3.6.4). The transformer medium voltage windings shall be dual fed with a kirk-key interlock system to allow only one source to provide power at a time. The medium voltage windings shall be connected to generator output switchgear bus before the GCB and at the load side of the switchgear disconnecting switch. Both connections shall be connected through current limiting fuses and three-pole single-throw, manual, group operated, kirk-key interlocked, non-load interrupting disconnect switches. The connection shall provide the ability to for the transformer to

power the 480 volt station power without closing the GCB with the power plant in operation and provide the ability to feedback the ATS if the power plant is connected to an energized, 4160 volt bus.

b. One, three-phase delta 480/120-240 volt single-phase, three-wire, 60/50 Hz rated, transformer with taps that are adjustable to plus or minus 5% shall be installed in the switchgear-control unit to provide single phase 120/240 volt power to the 120/240 volt station power panelboard. The transformer high voltage winding shall be connected, through a circuit breaker, to the 480 volt station power panelboard located in the switchgear.

c. One, three-phase delta 480/120-240 volt single-phase, three-wire, 60/50 Hz rated, transformer with taps that are adjustable to plus or minus 5% shall be installed in the engine-generator compartment to provide single phase 120/240 volt power to the 120/240 volt station power panelboard located in the motor control center. The transformer high voltage winding shall be connected, through a circuit breaker, to the motor control center 480 volt bus.

d. Center taps of the 120/240 volt transformer windings shall be grounded.

Transformers shall be rated 125% of the total connected load. Calculations certifying that the load calculations for transformers shall be submitted in accordance with Section 3.16.1.1.

3.11.3.6.2 Station Power Panelboards. The station power panelboards shall be completely metal enclosed, factory assembled, circuit breaker panelboards rated for 60/50 Hz. These panelboards shall be UL listed. The panelboards shall have branch circuit breakers of the proper rating and number of poles to supply power to power plant auxiliaries plus not less than two spare three pole, 480 volt, 30 ampere, and four spare single-pole, 120 volt, 20 ampere branch circuit breakers. Branch circuit breakers supplying receptacles shall be combination circuit breakers and ground fault circuit interrupters. The internal components of the station power panelboards shall be removable from the front of the panelboards. Each station power panelboard shall have a main circuit breaker. All panelboards shall have a circuit breaker schedule that clearly identifies the circuit that it protects to include a circuit breaker number.

3.11.3.6.2.1 Low Voltage Molded Case Circuit Breakers. Panelboard circuit breakers shall be ambient compensated, bolt-in type, molded case circuit breakers conforming to UL 489. The molded case circuit breakers shall be made by the same manufacturer. Overcurrent and overload protection shall be applied as required by NFPA 70. The use of fuses for overcurrent protection shall also be acceptable. All fuses shall be made by the same manufacturer.

3.11.3.6.3 External Shore Power. The station power system shall have provision for the supply of 480 volt, three-phase, three-wire delta

power to the station power system from an external shore power source. The external shore power supply circuit shall have 125% of the ampacity to provide power for the total connected station power loads. The equipment shall consist of a metal, corrosion resistant, power inlet pin and sleeve type plug and receptacle connector, conductors, conduit and circuit breaker. The external shore power circuit breaker shall be connected to the ATS emergency source connection point. The external shore power circuit breaker shall be located adjacent to the station power circuit breaker and located near the 480 volt station power panelboard.

3.11.3.6.4 Automatic Transfer Switch (ATS). The power plant shall be provided with an ATS that automatically switches 480 volt three phase source power between station power and shore power. The ATS shall be rated for 125% capacity of the connected load. The ATS shall be 480 volt, three-phase, three-pole, 60 and 50 Hz rated. The ATS shall be provided with a programmable controller that monitors voltage (overvoltage and undervoltage) and frequency (overfrequency and underfrequency) at both sources, provides configurable transfer setpoints with adjustable transfer and re-transfer delays and provides visual power source status. The ATS control shall be a “utility to utility” type, programmable such that source one or source two can serve as the preferred source. The external shore power source shall be connected to the emergency source connection point and the station power source shall be connected to the normal source connection point of the ATS.

3.11.3.7 Motor Control Center. A motor control center shall be installed in engine-generator unit. The motor control center shall contain, at a minimum, 120 volt AC and 120 volt DC distribution panels, circuit breakers and all motor controllers (for motors, jacket water heaters, etc.). The motor contactors shall be controlled by 120 volts AC. Control circuits, power and motor contactors shall conform to NEMA ICS 18, shall be from the same manufacturer. The motor overload relays and motor overload heating elements shall be part of the contactor assembly. Motor overload elements shall be connected in series with motors. Do not use current transformers for motor overloads. The motor control center shall be NEMA type 4, free standing metal enclosure and UL listed. The front of the motor control center shall be a vertically hinged panel. The motor control center shall have quick disconnect twist lock plugs and receptacles for engine-generator house wiring from the motor control center to the engine house structure to ease house removal. The motor control center shall be braced to withstand the shocks encountered and the vibrations to which it will be subjected to during engine operation. The 480 volt transformer to supply 120/240 volts may be located inside the motor control center.

3.11.3.8 Grounding System. A power plant grounding system shall be provided to ensure personnel safety and conform to NFPA 70. The grounding system shall consist of a copper ground bus rated at 125% of short circuit capacity determined by the coordination study and

interconnecting grounding conductors as required and to ensure that each power plant component, including the housings and skid bases of each unit are connected through a low impedance path to the ground bus and ground. The ground bus shall be connected to the four ground plates locates on the skid base corners of all units.

3.11.3.9 Control and Emergency Power. The power plant shall have a 120 volt DC (nominal) control and emergency power system and a 24 volt DC (nominal) control power system. The control and emergency power system shall be an ungrounded system. The control and emergency power system shall consist of storage batteries, a battery charging system, a DC panelboard and necessary wiring, fittings and accessories. The control and emergency power system shall have the capacity to supply the DC power required for operation of the power plant under conditions specified. Battery bank isolation switches shall be provided to interrupt the DC system at source for maintenance. Connections shall be made to prevent any current flow with open switches.

3.11.3.9.1 Storage Batteries. Heavy duty Valve Regulated Lead Acid (VRLA) batteries shall be provided and installed in the power plant to comprise a 120 volt nominal, 100 amp hour, DC power source. The batteries shall be firmly secured in a battery rack, located in the switchgear-control unit and positioned so that the batteries may be inspected and/or tested without removing individual batteries. The battery rack and battery straps shall be manufactured by the manufacturer of the batteries provided. Batteries shall not be installed under the generator set, or on the engine/generator structure steel base assembly. The battery rack shall conform to NEC 480.8(A) and include all interconnecting cables, straps and incoming DC load cables with lugs. Provisions shall be made to prevent the accumulation of gases generated during battery charging in the switchgear-control unit by venting to the exterior of the power plant. Provisions shall be made to protect the batteries from damage or discharge from accidental dropping of tools or other heavy objects.

3.11.3.9.2 Battery Charging System. A heavy-duty industrial type, three-phase, 480 volt, 60/50 Hz rated, wall-mounted battery charger shall be installed in the switchgear-control unit. The battery charger shall be designed for continuous full load operation. The battery charger shall have sufficient cooling capacity for ambient temperatures up to and including 110 degrees Fahrenheit. The output current and voltage of the battery charger shall be filtered, sized to the battery manufacturer requirements and recommendations and fed to the batteries through a circuit breaker located in the battery charger. The battery charger shall have visual indication of DC voltage and amperage of the required rating to monitor battery charger output. The battery charger shall include, but not limited to, the following:

a. Automatic overload and short circuit protection (current limiting), AC and DC

b. Serve as a “battery eliminator” or power supply
c. Automatic DC voltage regulation, plus or minus 0.5%
d. Adjustable float and equalize
e. Adjustable equalizing timer
f. Tropicalized
g. Protection from accidental shorting at terminals
h. Protection from reverse connection to batteries
i. The enclosure for the battery charger shall be constructed of corrosion resistant material and shall be suitably protected against corrosion
j. Temperature compensation
k. Mean time between failure (MTFB) not less than 100,000 operating hours
l. Point to point wiring diagram to include installed wire markers
m. Low Low DC voltage alarm/shutdown
n. Low DC voltage alarm
o. High DC voltage alarm
p. High High DC voltage alarm/shutdown
q. Loss of AC alarm/shutdwon
r. Common (summary) alarm

All battery charger alarms/shutdowns shall be pulled to and indicated at the power plant controller or generator multifunction protection relay.

3.11.3.9.3 Panelboard, DC. The DC panelboard shall be located in the switchgear-control unit and shall be a two-wire, circuit breaker panelboard in a metal enclosure and rated for the DC voltage of the control and emergency power system. The panelboard shall be a complete, factory assembled unit, shall be UL listed and shall have a main circuit breaker, main bus (mains) and branch circuit breakers as required. The main circuit breaker and panelboard mains shall be rated for not less than 125% of the maximum demand, in amperes, of the connected load. The panelboard shall have each branch circuit identified. The panelboard shall have a minimum of two spare branch circuit breakers of the same rating as the emergency lighting circuit breaker(s). The panelboard internal components shall be panel mounted, removable from the front, with the line and load connections accessible from the front of the panelboard.

3.11.3.9.4 24 Volt DC Control Power. 24 volt DC control power shall be provide from parallel redundant power supplies that are fed from the 120 volt DC panelboard. The 24 volt power supplies shall be identical and one power supply shall be capable of providing 125% of the connected load in the event of a single power supply failure. The 24 volt power supplies shall have a fixed 24 volt DC output and output ripple shall be less than 150mV. Short circuit and overload protection shall be provided for each power supply.

3.11.3.10 Power and Control Cables. Power cables shall be heavy-duty, copper conductor, portable cables suited for direct burial or

laying on the earth surface. Control cables shall conform to NFPA 70 and shall be rated for conductor operating temperature of 90 degrees Celsius in wet or dry locations. Power cables shall be extra-flexible cables and shall conform to NEMA WC 58. Power cables shall be rated for conductor operating temperature of 90 degrees Celsius in wet or dry locations. The load on any conductor rated for 600 volts or less shall not exceed the allowable ampacity of NFPA 70. The load on any conductor rated for more than 600 volts shall not exceed the allowable ampacity recommended by the cable manufacturer for direct burial conductors. Permanent, legible markings on each cable shall identify the application on the power plant. All power and control cables shall have proper terminations as per amperage rating and manufacturer recommendations.

3.11.3.10.1 Interconnecting Cables. The interconnecting cables between the engine-generator unit, switchgear-control unit and auxiliary unit shall be as specified in the following paragraphs. The length of each cable shall be adequate to interconnect between the three power plant units with the switchgear-control unit located not less than 50 feet from the rear (generator end) of the engine-generator unit and the auxiliary unit 25 feet in front (engine end) of the engine-generator unit. The interconnecting cables shall enter the switchgear through metal, corrosion resistant, pin and sleeve connection receptacles located on the side of the skid base. Each end of the interconnecting cables (except the generator output power cables) shall have metal, corrosion resistant, pin and sleeve type, connector plugs. The engine-generator unit, switchgear-control unit and auxiliary unit shall have mating connector receptacles with protection against the entrance of dirt and moisture, both with and without the connector plug fastened in its respective receptacle. The receptacles on the engine-generator unit shall be mounted to the exterior of the skid base, just below the house floor line on the generator end of the unit (for interconnecting cables to the switchgear-control unit) and on the engine end of the unit (for interconnecting cables to the auxiliary unit) and shall be of the weatherproof type. The receptacles on the auxiliary unit shall be mounted to a weatherproof enclosure located near the coolant, fuel and air piping connections. All receptacles for each unit shall be mounted to a common, removable corrosion proof metal plate. The receptacle plates shall be gasketed and sealed from moisture and dirt when properly installed to the skid base. All receptacles shall be labeled with their respective interconnecting cable identification. Disconnection or removal of any receptacles to remove the power plant houses is unacceptable. Different type or configuration connectors or indexing means shall be used to mitigate the possibility of installation error. All interconnecting cables shall be rated for outdoor, wet locations. Storage for interconnecting and external power cables shall be provided in the switchgear-control unit.

3.11.3.10.2 Generator Output Power Cables. The generator output power cables shall consist of three, single conductor, 5kV/8kV insulated, shielded, phase cables and one single conductor, 2kV,

insulated, non-shielded, neutral cable. The generator output cables shall be rated for a 105 degrees Celsius temperature rise over 40 degrees Celsius ambient in free air, and one single conductor, stranded copper, non-shielded, cross-linked polyethylene, neutral cable. The phase cables shall be 60/50 Hz rated and ampacity rating shall be 125% of power plant LTP rating at 50 Hz, 3300 volts and in accordance with coordination study. The neutral cable shall be sized the same as phase cables. Each end of each power cable shall have a NEMA spaced, two-hole, bolted-type terminal lug. Each phase cable shall be a single conductor (non-concentric neutral), shielded cable rated for not less than 5kV. Each end of each phase cable shall have a standard, readily available, shielded type, cold-shrink cable termination kit including stress cone and grounding adapter. Each phase cable shall be permanently indentified at both ends to minimize the possibility of installation error.

3.11.3.10.3 Control Cables. The control cables between the engine-generator unit, switchgear-control unit and auxiliary unit shall be multi-conductor control cables. The control cables shall provide for, but not limited to, all control, instrumentation, safety devices, generator RTDs, alarm circuits, inter-plant communications required between power plant units and communication cable recommended by the power plant controller manufacturer. Additionally the Contractor shall provide not less than 12 spare conductors properly identified and terminated at a single terminal board in each respective unit.

3.10.3.10.4 Station Power Cables. The station power cables (480 volt AC, three-phase and 120 volt AC single-phase shall be multi-conductor type with the capacity to supply power to the total connected loads as required by NFPA 70.

3.11.3.10.5 Station Control and Emergency Power Cable. The cable used for station control and emergency power supply from the switchgear-control unit to the engine-generator unit and engine-generator unit to auxiliary unit shall be multi-conductor cable. The cable shall have the capacity to supply the required DC power to the power plant units under conditions specified.

3.11.3.10.6 Grounding Tie Cable. The grounding tie cable to connect between the grounding plates of the engine-generator unit, switchgear-control unit and auxiliary unit shall be 1/0 AWG, flexible-stranded and covered.

3.11.3.10.7 Paralleling Cables. One paralleling/load sharing control cable used to communicate with like power plants shall be provided with each power plant. This cable shall be 50 feet in length and as recommended by the power plant controller manufacturer.

3.12 Identification, Marking and Information. The power plant shall be identified, marked and have information and instruction plates as specified. Plates shall be photo-etched on corrosion proof metal not

less than 0.030 inches in thickness. These plates shall be permanently affixed to the power plant with corrosion proof metal hardware not less than 0.125 inch in diameter except in the case of instrument and control identification which shall be phenolic.

3.12.1 Identification Plate. Each unit of the power plant shall have a plate, mounted in a conspicuous exterior location on the skid base and containing the following information: POWER PLANT, identification number (Government provided), serial number, manufacturer's name/company, date of manufacture, contract number, length, width, height, cube, dry weight, engine manufacturer and model number, generator manufacturer and model number and power plant rating data (voltage, kW, frequency, power factor). In addition, the plate shall have a place for the Government inspectors stamp and date of inspection. Plates will be furnished by the NTR.

3.12.2 Information Plates, Instruction Plates and Markings. The power plant shall have information plates, instruction plates and markings to enable proper and safe operation, under conditions specified and to identify each component for the purposes of troubleshooting. The plates and markings shall include, but are not limited to, the items specified in the following sections.

3.12.3 Instrument and control identification. Each instrument and control device (relays, switches, valves, meters, indicators, receptacles, etc) shall be identified by a white phenolic nameplate. The identification plate shall have 0.250 inch black markings that will remain legible throughout the life of the equipment. Components mounted on panel, cubicle or cabinet doors shall also be identified on the rear of the doors by the use of industrial grade, weatherproof, stick-on type labels or nameplates.

3.12.4 Grounding Plates. A metal identification plate at each grounding plate shall be marked "GROUND" with 0.250 inch letters.

3.12.5 Electrical Outlet Receptacle Plate. A white phenolic plate at each 120 volt AC electrical outlet receptacle shall be marked "120 VOLTS AC" with 0.250 inch black letters.

3.12.6 Safety Plates and Signs. The power plant shall have safety signs and plates to indicate and define specific hazards to power plant operators, maintenance personnel and other personnel in or near the power plant. The plates and signs shall be of the following types: danger signs, caution signs, safety instructions, directional signs and informational signs. The hazards for which plates and signs are to be provided and the details of each, (size, configuration and colors) shall be selected by the Contractor and shall be subject to prior approval by the NTR. The plates and signs shall conform to CFR 1910.145 and as specified in Section 3.6

3.12.7 Lifting Diagram. A stainless steel plate mounted in a conspicuous location on the exterior of the engine-generator unit,

switchgear-control unit and auxiliary unit shall have a lifting diagram for its respective unit. The diagram shall indicate the applicable unit showing the following:

a. The center of gravity and weight of the applicable unit properly prepared for shipment.
b. The recommended arrangement of lifting slings with spreader bars as required for each unit.
c. The location of each lifting point to lift each unit.
d. The location and capacity of each tie-down device. The identification of the tie-down devices shall clearly indicate that the devices are intended for tie-down only on the transportation carrier during shipment.

3.12.8 Battery Connection Diagram. A white phenolic plate with black letters and mounted adjacent to the battery bank shall have a connection diagram and instructions for installing batteries, energizing battery charger and shall read: “See Battery Charger Manufacturer Publication Number (manufacturer provided number) for Proper Charging Voltage.”

3.13 Cleaning, Treatment and Coating. With the exception of the engine-generator, switchgear, control and electrical panels, surfaces normally coated in good commercial practice shall be cleaned, treated and coated as specified.

3.13.1 Cleaning. Metal surfaces to be coated shall be cleaned to ensure they are free from oil, grease, welding slag and spatter, mill scale, products of corrosion, dirt and any other foreign substance and in accordance with the coating system manufacturer requirements and recommendations.

3.13.2 Treatment. Immediately after cleaning and before any rust or other contamination results, metal surfaces including aluminum, shall be treated with a primer pre-treatment coating to ensure adhesion of the coating system in accordance with the coating system manufacturer requirements and recommendations.

3.13.3 Coating System. All surface preparation and paint application is to comply with paint manufacturers requirements and recommendations, Society of Protective Coating (SSPC) (formerly Steel Structures Painting Council) guidance, and requirements as stated in this contract. The exterior power plant coating system shall be a marine grade 5-10 year life paint that is suitable for pier-side environments. The coating system shall be prepared and applied by an SSPC QP3 qualified application system. Primer for application to all substrates shall be selected and applied as required and recommended by the coating system manufacturer immediately after cleaning and treating. The color of the finish coats on the housing exteriors shall be ANSI 61 gray. All roofs shall have a coating which allows for expansion, contraction and resistance to weather and ultraviolet rays. The engine-generator unit roof shall have a walk-on skid

resistant surface for personnel safety. The exterior finish coat shall have a dry film thickness (DFT) of not less than nine mils or thickness required by the coating system manufacturer, whichever is greater. Except for the surfaces which will experience high heat, interior components of the engine-generator unit and the switchgear-control unit shall be coated with a coating system identical to the exterior walls omitting the clear cover coat; however, minimum DFT shall be five mils. Interior walls and ceilings shall be coated with a white semi-gloss polyurethane paint system. The interior finish coat shall have a DFT of five mils. Data plates shall not be coated. All surfaces of all metal parts not already coated or plated with a protective coating shall be primed and painted. Coatings shall be free from runs, sags, orange peel, holidays or other defects. Painting of hoses, clamps, wiring harnesses, and other non-metallic service parts shall not be acceptable. Fasteners used shall be corrosion resistant, and designed to minimize marring of the painted surface when removed for normal installation or service work. Corrosion proof metal components and devices shall not require a coating system. Coating system DFTs shall be as specified unless greater thicknesses are recommended by the coating system manufacturer. Air and surface temperatures and humidity for coating application shall be as recommended by the coating system manufacturer. Failure to achieve an adhesion classification of four or greater as defined in ANSI/ASTM D3359 shall require re-application of the coating system to the degree necessary to achieve satisfactory test results.

The painting process shall result in a coating which meets the following requirements:

a. Gloss, per ASTM D523, 80% plus or minus 5%.
b. Gloss retention after one year shall exceed 50%.
c. Crosshatch adhesion, per ASTM D3359, 4B-5B.
d. Impact resistance, per ASTM D2794, 120-160 inch-pounds.
e. Salt Spray, per ASTM B117, 1000+ hours.
f. Humidity, per ASTM D2247, 1000+ hours.
g. Water Soak, per ASTM D2247, 1000+ hours.

3.14 Exterior Markings. Include exterior markings (lettering, numbering, and decals) as shown below, affixed to the right and left side of each power plant unit with an enclosure. Lettering and numbering shall be black vinyl, UV protection, marine grade and four inches high. The Government will identify the MUSE registration number, and provide the MUSE decals for each power plant. Identification shall be as follows:

DEPARTMENT OF THE NAVY
NAVAL FACILITIES ENGINEERING COMMAND

MOBILE UTILITIES SUPPORT EQUIPMENT
DIESEL POWER PLANT
MP-XXXXX

Prior to final inspection, the Contractor shall attach identification markings, safety signs, and decals. All safety and warning decals shall be seven by ten inches adhesive type, marine grade, with Ultra Violet (UV) resistant rating of five years minimum and shall be placed at means of entrance or egress.

3.15 Physical Hazard Color Coding. Physical hazards, both within the power plant and external to the power plant, shall be color coded conforming to CFR 1910.144 and Section 3.6.

3.16 Technical Data. Technical data shall be furnished in accordance with the contract data requirements list and the requirements specified.

3.16.1 Design Data. Design data shall be provided by the Contractor. The design information disclosure and the technical content of this data shall enable the Government procurement activity to verify the Contractor's systems, power plant design, equipment and component selections will result in a power plant which conforms to the specifications and performance requirements of this purchase description.

3.16.1.1 Design Data, Calculations and Analysis. Design data, calculations and analysis shall be provided by the Contractor and shall verify the adequacy of the power plant to start and operate as specified under all conditions specified. The content of the overall submission will be dictated by design. The types of information required are as follows:

a. Cooling system calculations verifying the adequacy of the power plant's radiator(s).
b. Development of all electrical and mechanical engine parasitic loads to include power plant transformer load calculations.
c. Engine vibration data and skid base design data.
d. Calculations verifying and adequacy of the power plant pneumatic system.
e. Calculations verifying the adequacy of the diesel engine along with certification from the engine manufacturer that the engine furnished is approved for its intended application.
f. Short circuit and protective device coordination study with resultant device set-points in both 60 and 50 Hz power plant configurations.

3.16.1.2 Descriptive Literature. Descriptive literature (Manufacturer's literature) shall be provided by the Contractor for all operating components and equipment associated with the power plant. Electrical components containing no moving parts, such as transformers, terminal boards, fuses, etc. are nevertheless classified as operating components. As a minimum, descriptive literature shall be provided for each mechanical and electrical item and shall provide enough technical detail (ratings, application data, specifications and parts identification) to determine that they meet or exceed all Section 3 requirements. This type of literature will be required for inclusion in the technical manuals for the power plants (see Section 3.16.4.1). It is therefore suggested that the Contractor make efforts during the parts procurement to obtain literature which will satisfy both the design submittal requirements and the technical manual requirements.

3.16.2 Quality Assurance Data. Quality assurance data shall be provided by the Contractor as specified.

3.16.2.1 Inspection System Documentation. An inspection system program plan shall be prepared by the Contractor and submitted to the Government as described in Section 5.1.1.

3.16.2.2 Test Procedure and Instructions. Specific, detailed, step-by-step test procedures and instructions shall be developed by the Contractor and submitted to the Government for all tests required under the provisions of Section 6.4. A separate and distinct test procedure shall be prepared by the Contractor for each test required by the contract. Each procedure shall include the following (in addition to items specified in block ten of the Data Item Description referenced in the Contract Data Requirements List):

a. Where applicable, verification of start-up, operating and shutdown procedures as specified in Section 6.4.2 of the SOW shall be included.
b. Test equipment connection diagram(s) shall be developed and provided by the Contractor and shall indicate the test equipment and connections required; the diagram(s) shall clearly define the point of application for inputs and indicate output conditions and points of measurement.
c. Sample data sheets shall be provided for each test showing the maximum or minimum tolerance or limit allowable under the SOW or MIL-STD-705C.

3.16.2.3 Test Reports. Test reports shall be prepared and submitted by the Contractor to the Government for the production power plant and each production power plant pursuant to the requirement of this SOW. Each test report shall fully document the results of tests performed on the power plant to which it pertains and shall demonstrate conformance with maximum or minimum tolerances allowable under this

SOW. Test reports shall also include the engine manufacturer's factory test reports and as built tolerances and measurements.

3.16.2.4 Validation Record. A validation record shall be prepared and submitted by the Contractor to the Government prior to Production Testing pursuant to the requirement of this SOW. The validation record is documentation from the Contractor assuring that all Contractor developed operation, maintenance and test procedures have been verified by actual performance prior to verification, Government witness testing and acceptance by the Government.

3.16.3 Provisioning Technical Documentation. Provisioning technical documentation and supplementary provisioning technical documentation shall be prepared by the Contractor and submitted to the Government at the critical design review meeting as described in Section 5.1.3.

3.16.4 Equipment Technical Documentation. Equipment technical documentation shall be provided by the Contractor. This documentation shall consist of the manuals, as-built drawings and associated lists specified. The collective technical content of this documentation shall be adequate to enable Government operating, maintenance, overhaul, storage and transportation activities to accomplish the following:

a. Preservation and packaging for transportation under all specified modes.
b. Transportation, handling and inspection for in-transit damage.
c. Siting selection and preparation.
d. Power plant installation and preparation for operation under all ambient conditions and operating circumstances specified.
e. Operations and routine maintenance.
f. Operations and maintenance under special circumstances including the use of high sulfur and blended bio-diesel fuels.
g. Comprehensive troubleshooting, corrective maintenance and repairs.
h. Preservation for long-term storage.
i. Major overhaul, rehabilitation and/or rebuild of the power plant and its systems, components and equipment.
j. Positive identification (for acquisition purposes) of all components, assemblies, sub-assemblies, parts and materials comprising the power plant and /or used in conjunction with the power plant(s). (Bill of Materials)

Development of this documentation will necessarily be ongoing until submission and approval of final drawings and technical manuals. The Contractor shall compile, maintain and posses a current master original of this documentation throughout the complete cycle of the contract. Periodic submissions of data, as required, shall be made available from the master to include any and all changes up to time of submission.

3.16.4.1 Manuals, Equipment Technical. Equipment technical manuals shall be provided by the Contractor and shall conform to the technical content requirements of section 3.16.4. The content of the technical manuals shall be accurate and complete. Separate submittals of equipment technical manuals shall be made as described subsequently. There shall be two main submittals: as-built technical manuals and final technical manuals. Complete sets of as-built technical manuals shall be provided to the Government for use during the production inspection and testing at which time the manuals shall be verified using the production. The Contractor shall check and coordinate all elements of the as-built technical manuals and review them for accuracy, completeness and compliance with contract requirements prior to submission to the Government. The revision level of the as-built technical manuals submittal shall be up to date as the time of the production inspection. Discrepancies found in the as-built technical manuals submittal during production inspection and testing shall be corrected immediately and revised manuals provided. Complete sets of the final technical manuals shall be provided to the Government for review prior to acceptance. The Contractor shall check and coordinate all elements of the final technical manuals and review them for accuracy, completeness and compliance with contract requirements prior to submission to the Government. Discrepancies found in the final technical manuals submittal shall be corrected immediately and revised manuals provided. A master original of the equipment technical manuals shall be maintained by the Contractor throughout the development cycle of the power plant. Manual submittals to the Government shall be reproduced from this master original. Reproduction technique, binding and paper stock (except final manuals) may be selected by the Contractor and shall be suitable for the intended use provided legibility is maintained. The Contractor shall provide two complete hard sets of technical manuals for each power plant provided. Copies of the final manual shall be reproduced from the master original on white 32 pound ledger stock. All pages of the commercial literature in the final manual shall be reproduced on white 32 pound ledger paper stock or original commercial literature shall be provided for each manual. Reproduced commercial literature shall meet or exceed the legibility and quality of the original commercially produced literature. All pages in the final manual shall be securely bound in appropriate sized king post type binders with durable, rigid covers of material that is resistant to water and oils. The binder covers and splines shall be permanently imprinted in a color which contrasts the binder cover with, as a minimum, an equipment description (i.e.; 1400kW DIESEL POWER PLANT, MP-XXXXX) and the contents of the individual volume, as applicable. Individual binder content shall be no less than 75% and no more than 90% of binder capacity. Single volumes of final manuals shall be limited to four inches in overall thickness. All descriptive information, procedures and guides developed specifically by the Contractor or its subcontractors for the power plant shall be printed double-sided in the final manuals on 8.5 by 11 inch, 32 pound, white ledger paper. Engineering drawings shall be printed one side on white 32 pound ledger paper stock 11 by 17 inches and folded down to 8-1/2 x 11 inch

paper with the title block visible on the right hand side when installed into described binders. The Contractor shall also include one electronic copy of the complete technical manual to include drawings in AutoCAD format. The electronic data shall be developed in MS Windows/MS Office Professional or editable Adobe PDF and AutoCAD software, to the maximum extent practicable, as to provide the Government a means to manipulate the contents in the event of future upgrades or modifications.

3.16.4.1.1 Content and Format. The manual shall contain ten sections, as follows:

a. Section I: General Description
b. Section II: System/Equipment Description
c. Section III: Installation Instructions
d. Section IV: Operating Instructions
e. Section V: Maintenance Instructions
f. Section VI: Preparation for Shipping and Storage
g. Section VII: Bill of Materials
h. Section VIII: Engineering Drawings
i. Section IX: Manufacturers' Literature
j. Section X: Miscellaneous

The technical manual shall have an index of subjects and an index of figures by pages in each volume. Except for the manufacturers' literature section, each page shall be identified by two numbers; the first shall correspond to the section number and the second shall be a sequential number indicating the page in that section. Each section shall be divided by a reinforced tabbed card stock divider. Additional drawings, illustrations, figures and tables shall be provided within each section as required to clarify the written narrative. The technical manual shall contain information as required to fully portray equipment. Emphasis shall be placed on providing guidelines and instructions to enable the power plant to be installed, operated and maintained efficiently, safely and reliably under all specified conditions, with specific instruction on shipment, blocking/bracing and packing/unpacking. The technical manual shall contain the following data. Make-up and content of each section shall be as follows:

k. Section I, General Description.

1) Brief and concise description of power plant ratings, systems with simplified one-line drawings (both electrical and mechanical) to include engine fluid types and quantities, power plant weight and dimensions and lifting diagrams

l. Section II, System/Equipment description.

1) Detailed description of all power plant systems and components with detailed drawings (both electrical and mechanical)

m. Section III, Setup and Installation.

1) Site selection and preparation.
2) Setting up instructions with illustrations and/or figures and with step-by-step checklist.
3) Installation instructions with step-by-step checklist.
4) System fluid filling capacities and procedures, any mechanical alignments required.
5) Charts/lists showing quantities of lubricant, coolant, etc. that are required.

n. Section IV, Operation

1) Operating instructions shall contain step-by-step procedural instructions in clear and concise language to allow the power plant to be placed in service under each of the operational modes single unit (island), parallel with like units (load sharing), parallel with an infinite bus (utility base load), emergency mains failure and under ambient temperature conditions specified. Particular attention shall be paid to pre-start checks under all the specified ambient conditions. New pre-start checklists shall indicate the position of valves, circuit breakers, switches and controls for each of the operational modes specified. Operations of the basic machine shall include requirements associated with engine idling, minimum temperatures required to accelerate the engine to rated speed and assume load and minimum load restrictions as recommended by the engine manufacturer to maintain the plant in reliable condition. Operator service requirements during operations shall include comprehensive log sheet(s) for the recording of all necessary plant mechanical and electrical function parameters and observations on an hourly basis and based on a 24 hour clock.

o. Section V, Maintenance.

1) Maintenance, (preventive and corrective) servicing and repair instruction shall clearly, concisely and categorically treat all power plant mechanical and electrical systems, and where applicable, major components of systems. All systems shall be described through the use of procedural instructions, sequence of operations, circuit logic, mechanical and electrical schematics and wiring diagrams to allow maintenance personnel to comprehend and properly maintain the power plant’s systems. Troubleshooting guides shall address each of the various power plant alarm and shutdown conditions and shall cite

circuits and/or components and checks in a descending order from “most probable cause” to “least probable cause”. Supplemental troubleshooting guides and techniques shall address abnormal power plant conditions (i.e., excessive lube oil consumption, excessive vibration, noisy cylinder, excessive smoke, etc.) which may not provide alarms but which do, or eventually will, adversely affect engine performance.

p. Section VI, Preparation for Shipping and Storage.

1) Shipping and storage instructions with step-by-step checklist with drawings and/or figures of shipping braces, covers, etc. that is necessary for protection during storage and shipment under all specified modes of transportation described in this SOW.
2) Preservation instructions, including long-term storage (more than 30 days).
3) Receiving, handling and inspections for in-transit damage.

q. Section VII, Bill of Materials.

1) The Bill of Materials shall list each item supplied in the power plant. The bill of materials shall be provided in the following format:

Components/parts organized by vendor in alphabetical order. Vendor component/parts listed in alphabetical order. Vendors with numerous items shall have subdivisions divided into descriptive categories that are in alphabetical order. Also including manufacturer, source of components/parts, contact information and URL if available.

r. Section VIII, Engineering Drawings.

1) Drawings shall include all “As-Built” engineering drawings reduced to 11 by 17 inches folded to 8.5 by 11 inches, complete with index. Drawings shall be folded such that all title block information is face up when install in technical manual binders.

s. Section IX, Manufacturers’ Literature.

1) Commercial literature for all individual plant components shall be provided and separated by manufacturer by individual alpha-numerical tabs. Manufacturers’ literature shall be arranged in sequential alphabetical order. Each tab shall correspond to the alphanumerical designation contained in the Bill of Materials (Section VII). In cases where the manufacturer is the supplier of more than one type of component (e.g., circuit breakers and meters), that manufacturer’s tab will further be divided alphabetically

into descriptive categories. The first page following each tab shall list all parts under that tab in alphanumerical order with description and other reference numbers as included in the Bill of Materials Section. The manufacturer's complete address, phone number, website, etc., shall also be included at the upper right hand corner of this page. A second page shall proceed the above and be titled "Revisions" and contain four vertical columns labeled, "Item", "Revised Part Number", "Date" and "Signature". Commercial literature shall include manuals, brochures, catalog cut sheets, maintenance bulletins, drawings and illustrated parts breakdown to enable either technical or supply personnel to make accurate identification of all and provide all manufacturers' application data, installation, troubleshooting and preventive and corrective maintenance instructions. If promotional literature is provided which portrays several models, types, etc., a bold red arrow shall be used to indicate the correct item used. Particular emphasis shall be placed on providing renewal parts lists and information necessary to order replacement parts for all components.

t. Section X, Miscellaneous.

1) Condensed versions of test procedures developed by the Contractor (see Section 3.15.2.2).

3.17 Requirements of Engineering Drawings and Associated Lists.

3.17.1 Submittals of Engineering Drawings and Associated Lists. Separate submittals of engineering drawings and associated lists shall be made as described subsequently. Engineering drawings and associated lists shall conform to the Requirements for Engineering Drawings and Associated Lists paragraph and the requirements stated. There shall be three main submittals: Design Review Drawings Submittals, As-built Drawings Submittal and Record Drawings Submittal. The submittals shall reflect the progression of engineering drawings from (1) design to (2) production inspection to (3) record drawings when the production run has been completed. Content, accuracy and completeness requirements are the same for all three submittals; however, the submittals may differ in revision levels and shall differ in kind reproduction required. Engineering drawings shall be certified as specified in the Certification by Registered Professional Engineer paragraph.

3.17.1.1 Design Review Drawings Submittals. Complete sets of engineering drawings shall be provided for design review. The design review drawings submittal shall provide engineering drawings as described in Section 5.1.1. The Contractor shall check and coordinate all elements of the drawings and review them for accuracy, completeness and compliance with contract requirements prior to submission for Government review. The submittal shall include parts

lists as described in the Parts Lists section. The design review drawings submittal shall be 11 by 17 size drawings. The Contractor shall take prompt corrective action on all discrepancies found during the review by the Government; the engineering drawings and parts lists shall be revised and redrawn as appropriate and new prints submitted for review.

3.17.1.1.1 Detailed Layout Drawings Submittal. Detailed layout drawings as described in Section 5.1.2 and showing the location of all components mounted on and within the power plant control center, the engine control panel enclosure and the pressure switch enclosure, if used, including a development showing all meters, protective relays and engine-generator controls to be mounted on the control panel(s) shall be provided to the NTR for approval prior to the start of assembly. The Government reserves the right to modify component placement of proposed panel layout where it is considered necessary to facilitate ease of operation when the power plant is placed into service.

3.17.1.2 As-built Drawings Submittal. Complete sets of as-built engineering drawings and parts lists shall be provided for use by the Government during the production inspection at which time the drawings shall be proved to the production. The revision level of the as-built drawing submittal shall be up to date at the time of the production inspection. The as-built shall include parts lists as described in the Parts Lists paragraph. Discrepancies found in the as-built drawing submittal during the production inspection shall be corrected immediately and prints of newly revised drawings provided for review. Prints of subsequent revisions shall be furnished as made and released, so that at any time thereafter throughout the life of the contract the Government will have complete and current prints of all engineering drawings and parts lists. As-built print submittals shall be 11 by 17 inch drawings.

3.17.1.3 Record Drawings Submittal. Record drawings shall be provided and spare parts lists as described in the Parts Lists paragraph. Record Drawings be processed from engineering drawings and parts lists that are accurate, complete and incorporate all revisions to show the condition of the last unit manufactured during the production run. Prints of engineering drawings required by the Technical Data section shall be made from the engineering drawings described. In the event of late design or hardware changes or late discovery of errors in the drawings and parts lists, engineering drawings and parts lists provided under Record Drawing and Technical Data sections shall be replaced with corrected drawings. One copy of record engineering drawings, additional to the technical manual requirement, shall be printed on 34 by 24 inch D-size flat paper, stored in a print roll with a label on the outside displaying all pertinent contract data. Engineering drawings shall be produced in accordance with ASME Y14.100.

3.17.1.4 Data List. A data list of engineering drawings and spare parts lists shall be provided with all drawing submittals. The data list shall include, at a minimum, drawings size, drawing number, sheet number, revision letter and drawing title shall be stated for each entry.

3.17.2 Existing Engineering Drawings and Associated Lists. Existing engineering drawings and associated lists prepared prior to the award of this contract are acceptable if they meet the following requirements:

a. Provide the required information for level 2 engineering drawings.
b. Are identified by name and address of design activity, drawing nomenclature, drawing (part) number in accordance with this contract.
c. Drawing practices and symbols used (including the use of legends and explanations for non-standard symbols) are such that their intent and interpretation are clear and unambiguous.
d. Drawings have been prepared to scale, have standard revision blocks, margins contain reference zoning and lettering conforms to requirements of ASME Y14.2.
e. Do not contain information unrelated to this contract.
f. Have legibility and reproductive quality conforming to the Legibility, Contrast and Reproductive Quality Section.
g. Are certified with stamp and signature of a registered professional engineer as specified in the Certification by Registered Professional Engineer Section.

3.17.3 Requirements for Engineering Drawings and Associated Lists. Engineering drawings and associated lists shall conform to ASME 14.100 and ASME 14.2 and the requirements stated; these requirements shall apply to drawings by the Contractor and to drawings by all subcontractors. Nonconforming engineering drawings and parts lists shall be revised or redrawn to conformance. Mono-detail drawings and parts lists shall not be used. Sketches and free hand drawings will not be accepted. All engineering drawings shall be prepared to scale except for diagrammatic drawings, tabulated drawings and the scale or scales shall be shown on the drawings. The layout of drawings shall avoid crowding of diagrams, assemblies, details, callouts, dimensions, legends and notes. Prints of engineering drawings and other graphic data provided by the Government and which the Contractor intends to include in the technical manuals shall be re-drawn to the requirements of this SOW. Prints of engineering drawings shall be provided as required by the Submittals of Engineering Drawings and Associated Lists Section and by the Technical Data Section.

3.17.3.1 Certification by a Registered Professional Engineer. Each engineering drawing shall be stamped and signed near the title block by a professional engineer who is registered in the primary discipline covered by that drawing. Provision shall be made for certification so

that no data on the drawings are obscured. This certification shall be specific to this contract.

3.17.3.2 Technical Content of Engineering Drawings and Associated Lists. The technical content and level of detail of engineering drawings and associated lists shall be coordinated with other technical data and shall supply all information necessary for the Government to conclusively determine that engineering drawings and associated lists adequately and accurately portray the systems, assemblies, devices and functions required by this contract.

3.17.3.3 Types of Engineering Drawings and Associated Lists. Drawing types selected shall include the following types, as a minimum, for the power plant and for each power plant device, assembly, major item of equipment and for each electrical system and subsystem and for pneumatic and fluid systems:

a. Parts Lists
b. Detail Drawings
c. Assembly Drawings
d. Control Drawings
e. Installation Drawings
f. Elevation Drawings
g. Schematic or Elementary Diagrams, including Ladder Logic for all control systems
h. Connection or Wiring Diagrams
i. Interconnection Diagrams
j. Single-line or One-line Diagrams
k. Three-line Diagrams
l. Piping Diagrams
m. Plan Drawings
n. Wiring Lists
o. Wiring Harness Drawings
p. Cable Assembly Drawings
q. Shop Drawings (Fabrication Drawings) for all skid bases and shipping braces

3.17.3.4 Legibility, Contrast and Reproductive Quality. Engineering drawings and associated lists shall be of such clarity that subsequent reproductions can be made. The scaled sized and arrangements of diagrams, assemblies, detail, symbols and lettering shall allow them to be easily readable when reduced in size for inclusion in the technical manuals.

3.17.3.5 Engineering Drawing Sheet Size and Format. Engineering drawing sheet size and format shall be in accordance with ASME Y14.100. All engineering drawings included in the technical manuals shall be the 11 by 17 inch, C-size standard flat sheet. The format shall include standard ASME title block, revision block and zoning. A space no smaller than 3 inches, immediately below the revision block, shall be reserved for additional revisions. Paper size may be larger

when the drawings are generated by computer, but the format, content and size requirements shall be met.

3.17.3.6 Parts Lists. Parts lists shall be provided for all drawings and shall be included with each submittal of engineering drawings. Parts lists may be either integral with or separate from the drawings to which they apply. Both integral and separate parts lists shall contain the information and column entries required, as a minimum. When parts lists are separate, a note "SEE SEPARATE PARTS LIST" shall be located above the title block of the parent engineering drawing. Separate parts lists shall be identified with the letters "PL" followed by the identifying drawing number of the assembly drawing to which it applies. Parts lists may be prepared in the Contractor's standard format provided the following information is included in the lists: Contractor's name, contact number, Contractor's CAGE number (if applicable), parts list number, revision letter, list title, sheet number, find or item number, quantity required, manufacturers part or identifying number, short title or designation letters, description and set points or operating characteristics.

3.17.3.7 Line Conventions Lettering. Line conventions and letter shall conform to ASME Y14.2. Lines and lettering shall be opaque. Lines of the same type shall present a uniform appearance. Arrowheads shall be symmetrical about leaders and dimension lines and shall be filled as shown in ANSI Y14.2. Where drawings such as circuit breaker control schematics contain lower case lettering, the lower case lettering size shall be based on lettering a minimum of 0.180 inch high. Boldface lettering fonts produced by lettering devices, paste-up, press-on and lettering machines shall not be used on engineering drawings. Lettering for 8.5 by 11 inch and 11 by 17 inch separate parts lists shall be a minimum of 12 pitch.

3.17.3.8 Multi and Sectional View Drawings. Multi and sectional views shown on engineering drawings shall be in accordance with ASME Y14.3.

3.17.3.9 Dimensioning and Tolerance. Dimensioning and tolerance shall be in accordance with ASME Y14.5.

3.17.3.10 Mechanical Symbols and Diagrams. Mechanical and piping symbols shall conform to ASME Y32.2.3. Symbols used on a drawing and not referenced in ASME Y32.2.3 shall be explained by a note or legend on the drawing. A separate drawing shall be explained by a note or legend on the drawing. A separate drawing shall be prepared for each system diagram. Diagrams shall depict all components within each system. Diagrams shall differentiate main (or normal) and secondary and/or tertiary flow path by the use of heavy and light lines; a system of arrows shall indicate flow directions throughout the diagrams. Complete supplementary information such as set-points, capacities and functional information shall be provided on each system diagram.

3.17.3.11 Welding Symbols. Welding symbols shall be in accordance with ANSI/AWS A2.4 together with terms and definitions in accordance with AWS A3.0.

3.17.3.12 Abbreviations. Abbreviations shall be in accordance with ASME Y14.38. Abbreviations used on a drawing and not referenced in ASME Y14.38 shall be explained by a legend on the drawing and subject to approval by the NTR.

3.17.3.13 Electrical and Electronics Diagrams. Electrical and electronics diagrams, connection diagrams and interconnection diagrams shall be prepared in accordance with ASME 14.44. Graphic symbols use on electrical and electronics diagrams shall be in accordance with IEEE Std 315. Symbols used on a drawing and not referenced in IEEE Std 315 shall be defined by a legend on the drawing. The size of symbols use shall be uniform and proportionate to the drawing size for legibility after reduction in size for the technical manuals.

3.17.3.13.1 Schematic and Connection Diagrams. The arrangement of diagrams shall yield maximum clarity and legibility. Particular attention shall be paid to size, spacing and legibility of terminal designations, contact designations and circuit breaker ratings. In order to prevent crowding of schematic diagrams, separate drawings shall be used to depict control, alarm, AC, DC and motor control circuits. Where more than one drawing is required to complete a schematic, the break point for continuation of the schematic shall be chosen to both divide the circuit at a logical point and to spread equally the necessary graphic information. Except for circuits such as bridge-type rectifiers, lines of diagrams shall run parallel and perpendicular with the sheet format and with a minimum of line crossings. Wire numbers on schematic diagrams shall be shown either above or to the right of the line and terminal number shown either below or to the left of symbol terminals.

3.17.3.13.2 Schematic Diagrams of Control Circuits. Schematic diagrams and control circuits shall be prepared in either a horizontal “ladder” style; that is, they shall be drawn with two parallel lines representing main and return with all coils, contacts, timers, time delay relays and other parts shown in circuits between and perpendicular to these lines. All lines drawn between these two lines shall be sequentially numbered from top to bottom. These line numbers shall be used as a reference for control sequence explanations, graphic and written.

Relay coils on schematics shall indicate:

a. Relay functional abbreviation.
b. All coil connection points (pin or terminal) identified.
c. The line number on which each set of contacts used can be found. The line numbers of “Normally Closed” relay contacts shall be underlined. If relay contacts are on another drawing, a note shall cite the drawing number and zone on

which the contacts are shown, if on a drawing without a numbered ladder.

Relay Contacts on schematics shall indicate:

a. Contacts in their coil de-energized state.
b. Contact connection points (pin or terminal number).
c. The respective relay coil function designation.
d. The line number on which the coil is located. If the relay coil is on another drawing, a not shall cite the drawing number and zone on which the coil is shown, if not on a drawing with a numbered ladder.
e. Time setting of time delay relays and the mode of operation, i.e., time delay drop out or time delay pick up.

3.17.3.13.3 Control Switch Internal Connection Diagrams. Control switch internal connection diagrams shall be provided, located adjacent to the area of the schematic where each switch is used. These diagrams shall provide the following information:

a. Functional designation.
b. Contact shown with the switch in the position of no applied operating force or, for a switch which may be in one of two more position with no operating force applied, a note shall identify the switch position shown in the diagram.
c. Contact connection point by terminal number (or wire number if terminals are unnumbered).
d. The line number on which each set of contacts used is located.
e. All unused sets of contacts.

Switch contacts on the schematics shall show:

a. Switch functional abbreviation.
b. Contact purpose (such as “Auto”, “Start”, “Stop”, “On”, “Off”, “Hand”, etc.).
c. Contact connection point terminal number if used.

3.17.3.14 Identification of Engineering Drawings and Associated Lists. Each individual engineering drawing and associated list shall be marked with the name and address of the Contractor and the contract number. When continuation sheet title blocks are used for multiple sheet drawings as shown in ANSI Y14.1, the contract number shall be shown near the title block. Each engineering drawing and associated list shall show both the sheet number and number of sheets in the set.

3.17.3.15 Drawing Numbers. Drawing numbers shall be assigned to all engineering drawings and to separate parts lists by the Contractor. Fractional and Roman Numerals shall not be used.

3.17.3.16 Revision of Engineering Drawings. Revisions of engineering drawings shall be recorded by revision level in the revision block, except that the “crossing out” method shall not be used on drawings to

be included in the technical manual. Revisions may be recorded by providing the revised, redrawn drawing, identically numbered, preceding the older revision level.

4.0 QUALIFICATIONS OF CONTRACTORS

4.1 The Contractor shall provide all labor, supervision, tools, materials, facilities, transportation, and weight-handling equipment required to meet the specifications of this SOW.

4.2 The Contractor shall inspect, test, label, and install the various associated equipment and components in accordance with manufacturer’s recommendations, referenced specifications, and all other terms and conditions of the contract.

4.3 The Contractor shall provide all management oversight to meet performance, cost, and schedule objectives in accomplishing all work related to this contract.

4.4 All work shall be performed by skilled crafts persons of the appropriate trade. All work shall be done in accordance with the Contractors’ best practices, industry consensus standards and codes, and this contract.

4.5 The Contractor shall ensure quality of the work. The Contractor’s work effort shall result in a product that is reliable in the field and acceptable by the Government as demonstrated by inspection, testing, and quality conformance inspections.

4.6 For the general work force, the Contractor shall use journeyman level technicians to either effect work or directly supervise the work of non-journeyman level technicians. The Contractor shall maintain a 1 to 3 ratio of journeymen level to non-journeyman level technicians.

KEY PERSONNEL
Quality Management Personnel
Quality Control Inspectors
Shop Supervisors
Project Managers
Journeyman Level Technicians
OEM Certified Technicians

4.7 All surface preparation and coating shall be performed in accordance with SSPC standards. Preparation and coating shall be performed in accordance with the coating manufacturer’s instructions and requirements and SSPC good painting practice.

4.8 All welding shall be performed by an American Welding Society Certified Welder. A machinist certified by a state or nationally accredited institution shall perform all machine work. Evidence of certifications must be submitted to the KO with Contractor’s proposal.

The Contractor shall maintain a file with all welding certifications for any personnel welding for this contract. This file shall be kept current to reflect any changes in personnel.

4.9 Only OEM certified power generation technicians shall work on engine or generator control systems. Technician certifications shall be submitted with the Contractors proposal.

5.0 DESIGN REVIEW MEETINGS AND GOVERNMENT INSPECTIONS

5.1 The Government and the Contractor shall hold four design review meetings.

5.1.1 The first meeting shall be the Post Award meeting which shall be held at the Governments facility in Port Hueneme, CA. At this time the Government and Contractor shall review all submittal documents, and shall agree upon the general layout of each power plant and major components. This meeting shall be held within forty-five (45) business days after award of contract. Contractor shall provide four sets of the following information required for the Post Award meeting for review in portable document format (PDF):

a. Manufacturer’s product literature and performance data, sufficient to verify compliance to specification requirements.
b. The Contractor shall furnish information showing manufacturer’s model numbers, dimensions and weights for the engine, generator, enclosure, and major auxiliary equipment.
c. A paragraph by paragraph specification compliance statement, describing the differences, if any, between the specified and the proposed equipment.
d. Inspection system plan.
e. Manufacturer's certification of prototype testing of engine and generator.
f. Manufacturer's published warranty documents.
g. Engineering drawings showing plan and elevation views with certified overall dimensions and weight as well as wiring interconnections.
h. Interconnection wiring diagrams showing all external connections required; with field wiring terminals marked in a consistent point-to-point manner.
i. Manufacturer's installation instructions.
j. Manufacturer's published de-rating information.
k. All drawings and wiring schematics must be available in AutoCAD format and all component catalog cut-sheets must be available in PDF format.

5.1.2 The second meeting shall be a 25% design review of each power plant, the component make up and overall layout of each power plant and shall be held no later than thirty (30) business days after the Post Award meeting. This meeting shall be held at the Contractor’s facility.

5.1.3 The third meeting shall be a critical design review of the power plant's drawings and component list, which shall take place no more than thirty (30) business days after the 25% design review meeting. The critical design review meeting shall be held at the Government's facility in Port Hueneme, CA.

5.1.3.1 The Contractor shall be 50% completed with engineering drawings of the power plant at the time of this meeting. This is to include the plan and elevation drawings (all four sides) of the power plant, a simple one-line and three-line drawing, control drawings, and the proposed component list of parts and accessories for the power plant.

5.1.4 The fourth meeting shall be the final design approval of each power plant delivered under this contract, which shall take place no more than thirty (30) business days after the critical design review meeting. This meeting shall be held at the Contractor's facility. The final approved design shall be strictly adhered to during the construction of each power plant.

5.1.4.1 At this time the Contractor shall be 100% complete with all engineering drawings and component parts list.

5.1.5 During the course of the design stages, if for any reason the Contractor is not prepared with the required items per design review meeting, the Contractor shall give the government prompt notification, and a projected date when the documentation will be available for review.

5.1.6 During the design approval stages of the power plant, the Contractor shall **NOT** proceed with construction until all design drawings and components are approved by the Government. Approval of all drawings by the Government is for content and concept ONLY. Accuracy of the drawings shall be the sole responsibility of the Contractor.

5.2 The Government shall perform on site progress inspections. The Contractor shall host the Government once every two weeks for not less than one hour at the principal place of performance. Principle places of performance of work include, but not limited to the power plant, skid bases, engine, alternator, radiator(s), switchgear and enclosures manufacturing places of performance.

6.0 QUALITY ASSURANCE PROVISIONS

6.1 Inspection.

6.1.1 Responsibility for Inspection. The Contractor is responsible for the performance of all inspection requirements specified in Section 6.0. The Contractor may use its' own or any other facilities suitable for the performance of inspection

requirements specified, unless disapproved by the Government. The Contractor shall furnish test equipment and personnel to conduct testing. Costs incurred for testing shall be the responsibility of the Contractor. The Government reserves the right to witness any of the inspection set forth where such measures are deemed necessary to assure that supplies and services conform to the specified requirements. The Government also reserves the right to perform any inspections or testing not set forth in this document but deemed necessary to assure that supplies and services conform to the specified requirements.

6.1.2 Inspection Failure and Corrective Action. Failure of any power plant including its constituent materials, parts, assemblies and components to meet the requirements in this contract shall be case for rejection of the item being inspected until the deficiency is corrected and the inspection that revealed the deficiency is performed again. Deficiency correction and re-inspection shall be the responsibility of the Contractor and shall be accomplished at no cost to the Government. Corrective measures which alter a component or system that has successfully passed previous inspections shall be cause for re-performing these inspections; such re-inspections when required, shall be the responsibility of the Contractor and shall be accomplished at no cost to the Government. An inspection failure of any power plant may constitute grounds for refusal by the government to accept any power plant until the deficiency has been corrected in all power plants previously accepted by the Government under the same contract. The Government reserves the right to reject any power plant for non-conformance with any requirement of this SOW, even though not performing a test directly related to the specific requirement. The Contractor inspection records for each power plant shall describe:

a. Malfunction, evidence of damage, failure or adjustment other than adjustments permitted in this purchase description and the applicable test methods which occur during the examination and tests.
b. The cause of the malfunction, damage or failure and reason for the adjustment.
c. The corrective action taken or required.

6.2 Classification of Inspections. The inspection requirements specified are classified as follows:

a. Production power plant inspections.
b. Quality conformance inspections.

6.2.1 Production Power Plant Inspection. Inspections shall be performed on the production power plant. These inspections shall include the examinations specified in Section 6.3 and tests specified in Section 6.4 and Table I. The Government shall witness production power plant inspections. During the inspection process, the power plant shall be in its standby configuration, i.e., properly leveled with fuel, coolant and lubricating oil systems filled to full

operational capacity. External 480 volt power shall be provided to the power plant allowing operation of the power plant lighting, heating and fluid circulation systems. Production power plant inspections shall proceed as follow:

a. Examination performed by the Contractor without Government witnesses.
b. Contractor gives NTR 15 days advanced notice of intent to perform examination and testing for Government witnesses.
c. Examination performed by the Contractor and witnessed by Government representatives for verification of production power plant as being ready for test.
d. Production power plant test performed by Contractor personnel and witnessed by Government representatives.

In addition to the examination witnessed by the NTRs, a verification of parts manuals will be accomplished by a comparison of at least fifteen components from each power plant system with the appropriately identified component in the parts manual. Components shall be randomly selected by the NTR immediately prior to the comparison.

Components selected shall not include major components such as radiator(s), engine, generator, exciter, voltage regulator or battery charger. Failure of any component within the system to agree with the parts manual shall be grounds for repeating that system component comparison. The discovery of any disagreement between a power plant component and the parts manual, although not included in the fifteen randomly selected components, or where a specific requirement has been compiled with, the Contractor will be responsible to make the necessary corrections to be verified during the production testing, inadequate or inaccurate information revealed during examination shall be cause for withholding approval of the power plant for testing.

6.2.2 Quality Conformance Inspections. Quality conformance inspections shall be performed on each production power plant. These inspections shall include the examination specified in Section 6.3 and the tests specified in Section 6.4 and Table I. Additionally, each power plant shall be compared with the production plant and as-built drawings for the purpose of determining conformance to the requirements Section 3.5.2.

6.3 Examinations. Each power plant including its constituent materials, parts, assemblies and components shall be examined by the Contractor for conformance with the requirements of this SOW. Equipment technical manuals shall be examined by the Contractor for conformance with the requirements of this SOW. Examination of the equipment technical manuals shall include procedures (i.e., operating, packing, transporting, maintenance, servicing, parts identification, repair instructions, etc.). As-built drawings shall be examined shall be examined by the Contractor for accuracy in depicting the production power plant as built. Non-conformance with any specified requirement or the presence of any defects shall constitute an inspection failure.

6.4 Testing.

6.4.1 Test Prerequisites. Tests shall be conducted in accordance with MIL-STD-705C and test plan as specified. Test instruments shall be suitable to measure the value to be recorded and calibrated at regular intervals not exceeding six months. Calibration of each test instrument shall be proven by a sticker (on the instrument) or letter of certification documenting who performed the calibration, date of the calibration and date that next calibration is due. Instruments shall be calibrated at the frequencies at which they are used. Direct reading instruments shall have an accuracy of 0.5% and shall be connected to indicate in the most accurate portion of their range. Except where otherwise specified, oscillograph response shall not be less than 3,000 cycles per second. When recording meters are specified for any part of a test, turn on the recording meters prior to starting the warm-up period of the power plant and record continuously for the duration of the test. The testing of power plant(s) shall NOT be initiated prior to complete assembly of the power plant(s) This shall include calibration of set points for relays, pressure and temperature protective devices and switches. Tests shall be conducted with the power plant properly sited, installed and operated according to the procedures developed by the Contractor. Power plant operational tests shall not be conducted on railroad cars or other transportation mediums. Tests shall be performed using DF2, using lubricating oil conforming to MIL-L-2104F and in accordance with the engine manufacturer’s requirements and recommendations. Tests shall be conducted using the interconnecting cables to be delivered with the power plant. The use of an external DC power supply in lieu of power plant batteries shall not be permitted. All tests shall be conducted in both power plant configurations (4160Y/2400 volts at 60 Hz and 3300Y/1905 volts at 50 Hz grounded service). Where differences exist between this SOW and MIL-STD-705C, the SOW test requirements shall govern.

6.4.2 Procedures Verification. Procedures developed by the Contractor for installation, operation (except parallel operation with an infinite bus), maintenance, shipment preparation and testing of the power plant shall be verified by successful accomplishment of the procedures during testing of the production power plant. Except where otherwise allowed, the procedures are to be followed step-by-step, performed by Contractor personnel and witnessed by Government representatives. Any deviation from an established procedure will require re-definition and a subsequent execution of the procedure. Failure of a procedure to achieve the desired end result or failure of the power plant to operate as designed shall be cause for modification and complete repeat of the procedure prior to completion of production tests. Testing of production power plants shall not commence prior to acceptance of test procedures except for parallel tests of the production power plant using the first production power plant.

STATEMENT OF WORK (SOW)
MOBILE UTILITIES SUPPORT EQUIPMENT (MUSE)
1400kW POWER PLANT REQUIREMENTS

NOTES:

Power Plant Tests: Power plant tests shall be performed on each power plant as specified in Table I. The Government shall witness all power plant tests. With the exception of generator high potential tests (see note 3), power plant tests shall not be initiated until the power plant has been completely assembled. The sequence of testing shall be at the Contractor's option with the following exceptions:

a. The endurance test (see note 5) shall be the final test performed on the production power plant.
b. The performance test (see 6.4.8) shall be the final test performed on all production power plants.

Environmental testing under the full range of environmental conditions specified in the SOW will not be required. The Contractor shall demonstrate in writing, supplemented by design data and calculations, that the power plant and its component systems are designed and constructed to conform to the full range of environmental criteria specified in this SOW. Power plant tests specified may be connected under local ambient environmental conditions prevailing in the geographic vicinity of the Contractor's production and/or test facilities at the time of the test. The test reports shall include calculated corrections extrapolating the test results from the actual ambient test conditions to the conditions prescribed in the criteria being tested.

Note 1: Written certification that duplicate generators which have been successfully tested in accordance with the required tests, along with copies of certified test reports, will be accepted in lieu of performing tests. Tests that have been performed in accordance with IEEE Std 115 are considered equivalent to the required tests for the purpose of certification. In testing for or certification of direct axis transient and sub-transient reactances, time constants shall be included.

Note 2: Insulation resistance shall be taken for the generator stator and rotor for baseline data only. Insulation resistance test voltages shall be in accordance with IEEE Std 43 and manufacturers requirements and recommendations. The minimum insulation resistance shall be as recommended by the generator manufacturer.

Note 3: High potential test shall be performed on all generators. Tests may be performed at generator manufacturer's facilities in lieu of Contractor's facilities provided that current ANSI/IEEE Std 95, NEMA Std MG-1 and NETA ATS is adhered to in conducting test. If Contractor elects to have tests performed by generator manufacturer, the Government shall be so advised and reserves the right to witness all high potential testing of generators. Pass/fail of the high potential test shall be determined by the generator manufacturer's criteria.

Note 4: Each production power plant shall be tested in parallel with the production power plant. The test shall determine the proper operation of all parallel operation controls and devices, including the reverse power and synchronizing protective devices. Check for proper kW and kVAR division at 25%, 50%, 75%, 100% and 110% of the combined rating of the two power plants. Sudden changes in load shall not exceed 25% of the combined rating of the two power plants. Each power plant shall operate satisfactorily at each load step for not less than 15 minutes. The Contractor developed operating procedures of the equipment technical manual for paralleling with like units shall be followed for verification during the parallel test of the production power plant.

Note 5: The endurance run shall include a 48 hour load test at varying load and at 0.8 pf lagging in the 60 Hz configuration followed by an eight (8) hour load test at varying load and at 0.8 pf lagging in the 50 Hz configuration. The eight (8) hour load test shall be conducted after the 48 hour test. The time duration required to re-configure the power plant to 50 Hz shall be determined by the Contractor. Run No. 4 of the 60 Hz load test shall be performed during the hottest part of the day. In method 690.1d, paragraph 690.1.3.2.1(b), delete “Method 640.1” and substitute “Method 640.4a”. Also, delete paragraph 690.1.3.2.3(c).

The cyclic load schedule at 60 Hz shall be as follows:

Run No.	Rated Output %	Endurance Hours
1	50	10
2	25	4
3	100	12
4	110	2
5	100	20

The cyclic load schedule at 50 Hz shall be as follows:

Run No.	Rated Output %	Endurance Hours
1	25	1
2	50	1
3	100	3
4	110	2
5	100	1

a. Unscheduled test stoppages which occur as a result of failure or abnormal function of a component of the power plant being tested shall be categorized and handled as follows:

1) Generator rotor (including windings, laminations, balancing weights, shafting and bearings), stator (including windings, core laminations, frame bearing housings and mounting/alignment devices) and/ or generator over-temperature alarm causing GCB trip – stoppages which result from problems with these components shall invalidate the

entire elapsed portion of the 48/8 hour test, necessitating a restart from "time zero" after corrective action has been approved by the NTR and accomplished by the Contractor.

2) Diesel engine internal components (includes pistons, valves, piston rings, connecting rods, crankshaft, bearings and gears), engine-driven pumps and blower(s), engine over-temperature alarm (oil and/ or coolant) causing GCP trip, loss of engine oil, fuel or coolant pressure and/or turbocharger – stoppages which result from malfunction or failure of these components shall invalidate the entire elapsed portion of the 48/8 hour test, necessitating a restart from "time zero" after corrective action has been approved by the NTR and accomplished by the Contractor.

3) Other components of the power plan's primary power train (includes diesel engine components not noted in (2) above) and the exciter, voltage regulator, speed regulation system, power plant control system and instrumentation – stoppages which result from malfunction or failure of these components shall invalidate the elapsed portion of the 48/8 hour test, necessitating a restart from "time zero" after corrective action has been approved by the NTR and accomplished by the Contractor.

4) Other power plant components (includes all components not categorized under (1), (2) or (3) above) – stoppages which result from malfunction of failure with these components shall be evaluated jointly by the Contractor and a NTR as to the effect of the problem on the validity of the test increment in progress. The Contractor shall be required to issue a written statement as to probable cause(s) and intended corrective action. An NTR will then advise the Contractor whether the test may be continued from the point of interruption or must be restarted.

b. <u>Improper functioning of a power plant component which does not result in an unscheduled stoppage</u> – such instances of abnormal operations shall be evaluated jointly by the Contractor and NTR. The Contractor shall be requested to issue a written statement as to probable cause(s) and intended corrective action. The Contractor will not be instructed to re-run any portion of the testing at this time; if the Government later determines that grounds exist to invalidate any portion of elapsed testing, the Contractor will be so notified by the NTR. (Note: All maintenance actions performed by the Contractor during a scheduled shutdown for "normal maintenance" will be subject to review under the provisions of this guideline.)

c. <u>Variations from the contract prescribed loading schedule which occur as a result of problems with the Contractor's load</u>

bank(s), reactors and/or test instruments – if this occurs, an unscheduled stoppage shall be permitted, the problems corrected and the test continued from the point of interruption. It is required, however, that the 100% and 110% loading steps be run consecutively and without interruption; other variations from the contract prescribed loading schedule will be permitted under such circumstances. (See paragraph 4.e)

d. Unscheduled stoppages which occur as a result of accidental operator error – such stoppages shall not invalidate any elapsed testing unless accompanied by another testing irregularity categorized elsewhere in these guidelines. Running out of fuel is not an example of operator error. In instances of accidental stoppages, the power plant shall be restarted immediately and the test continued from the point of interruption. (See Note 5.e)

e. The contract prescribed 60 Hz load test schedule includes sequential loading steps of 12 hours at 100% load (PRP) followed by two hours at 110% load. It is critical that these loading steps be run consecutively and without interruption. Therefore, if an unscheduled stoppage occurs during or between these loading steps and the test is permitted to continue from the point of interruption, the load schedule for the remainder of the test increment must be adjusted to provide for consecutive and uninterrupted performance of the 100% loading steps.

6.4.3 Telephone Influence Factor. The balanced telephone influence factor and residual component telephone influence factor shall be taken from the alternator data sheet and determined in accordance with IEEE Std 115.

6.4.4 Cooling System Test. A hydrostatic pressure test shall be performed on the jacket water cooling system at 1.5 times the maximum working pressure of the system, but less than 5 psig. The pressure shall be maintained for a minimum of two hours without a drop in pressure. Failure to achieve the desired results shall require repair of the leak and repeat of the test. Caulking (e.g., Permatex) or peening of welds shall not be permitted for repair of leaks. If a non-pressurized system is used, vents shall be plugged or capped for the test.

6.4.5 Alarm System Test. The alarm system shall be tested for correct operation and the indication of all power plant abnormalities to verify conformance to the specified requirements (see Section 3.11.3.1.3) including simulation of high generator temperature GCB tripping (see Section 3.11.1).

6.4.6 Diesel Engine Exhaust Emissions. The Contractor shall provide engine manufacturer’s certified exhaust emissions data for

each diesel engine. Data shall be submitted with test reports (see Section 3.16.2.3)

6.4.7 Noise Surveys. Noise survey tests shall be conducted to verify conformance to the requirements Sections 3.6.3 and 3.7.5.2. The ambient background noise level shall be at least 10 dB below the specified noise level criteria being tested.

6.4.8 Performance Test. The performance test for each production power plant shall be conducted after all tests have been completed. The performance run shall consist of not less than eight (8) hours of continuous operation of the power plant at loads as follows:

a. One hour at 25% rated load
b. One hour at 50% rated load
c. Three hours at 100% rated load
d. Two hours at 110% rated load
e. One hour at 100% rated load

All loads shall be at 0.8 power factor. If the power plant is stopped for any reason prior to completion of the performance run, the entire eight (8) hour run shall be completed. Malfunction, erratic performance or failure of any component shall require that the power plant be stopped.

6.4.9 Power Cable Testing. Perform insulation resistance testing on all power cables in accordance with current ANSI/IEEE Standard 43 and NETA ATS. All power cable testing shall be completed before any power plant load testing is performed.

6.4.10 Preparation for Delivery Inspection. The preservation, packaging, packing and marking of each power plant shall be inspected to verify conformance to the requirements of Section 6.

7.0 GOVERNMENT FURNISHED MATERIALS/INFORMATION (applicable to each power plant delivered under this contract)

7.1 Government material identified herein shall be furnished to the Contractor within 60 days of notification from Contractor. This material will be incorporated into each power plant as identified in this SOW. The materials include:

a. MUSE registration number for each generator set.
b. Department of Navy (DON) data plate for each generator set (Contractor shall engrave pertinent data).
c. Four (4) Seabee decals for each power plant.

8.0 GOVERNMENT ACCEPTANCE

8.1 Acceptance. The Government shall not accept any power plant until the outlined requirements are met.

a. All required testing (Section 6.4) have been successfully completed to the Government's satisfaction and witnessed by the Government.
b. All required operation and maintenance manuals and prints have been approved for content by the Government and turned over to the Government.
c. All required training dates have been scheduled.

8.2 Preservation and Packaging. Support parts shall be preserved and packaged in accordance with the Contractor's standard practice.

8.2.1 Tools and Technical Publications. Tools and publications shall be preserved and packaged in accordance with the Contractor's standard practice.

8.2.2 Stowage. Items which are removed for transit, including accessories and special tools shall be placed in the storage facilities provided in the power plant. Cushioning, locking and bracing shall be used to prevent damage during all modes of shipment specified in this SOW.

8.3 Packing. Each complete power plant shall be packed in a manner which will ensure arrival at a destination in the same condition as prior to shipment and be acceptable to the carrier at the lowest rates for this type of equipment. Containers and packaging shall comply with the Uniform Freight Classification or the National Motor Freight Classification Rules.

8.4 Markings. Packages and shipping containers shall be marked in accordance with MIL-STD-129P requirements.

9.0 SPECIAL TOOLS AND TEST EQUIPMENT

9.1 Special Tools. For each unit delivered, the Contractor shall supply a complete set of special tools required for maintenance at no additional cost to the Government. Special tools are those that only the manufacturer provides, for special purposes, or to reach otherwise inaccessible parts. The tools shall be supplied complete with a suitable toolbox.

9.2 Test Equipment. The Contractor shall provide the latest revision of all associated computer software and connection equipment necessary for operation, maintenance and adjustment of each power plant. The Contractor shall provide updates, hardware, firmware and software to connection equipment during the standard warranty period at no additional costs to the Government.

10.0 TRAINING

10.1 The Contractor shall provide Government employees forty (40) hours of comprehensive operating and mechanical/electrical maintenance technical training classes.

a. The training shall consist of inspection, operation, maintenance, and troubleshooting topics specific to the equipment provided under this contract by instructors who are factory certified to teach each particular course of instruction.
b. The training shall take place at the Government facility listed as the delivery site; while onsite the actual training is to be conducted outdoors at the physical location of the power plant and in a classroom provided by the Government.
c. Specific training dates and daily training times shall be coordinated prior to the Governments acceptance of each power plant and mutually agreed upon. Training schedule shall commence within 60 days of acceptance.
d. A training manual and course curriculum shall be provided for Government to review 30 days prior to training commencement. Government review of training manual and curriculum shall be completed and returned to the Contractor within ten days with recommendations and/or approval.
e. The training curriculum shall accommodate no less than 12 students with a maximum of 25 students.

11.0 WARRANTY

11.1 Warranty. The Contractor shall provide warranty for each power plant, and associated equipment, for a period of not less than twelve (12) months to include protective coating warranty for not less than five (5) years from the date of acceptance by the Government against defects in materials, workmanship and below stipulations:

a. The warranty shall be one that is typically provided to the Contractor’s most favored customers and shall be redeemable in the 50 United States.
b. All installed devices and components, including assemblies and subassemblies, shall be included in Contractor’s warranty.
c. The Contractor shall be the single point of contact for the warranty of all products and services furnished.
d. The Contractor shall provide access to repair parts, via normal Government procurement process, for a minimum of twelve (12) months or 4000 hours of operation from date the last power plant is accepted by the Government.
e. The Contractor shall guarantee design of each power plant. If during the duration of this contract, including the warranty period, any power plant cannot be installed in the field due to poor or faulty design the Contractor shall expedite any and all necessary repairs at no cost to the Government.

f. The Contractor shall warranty the exterior coating system of the power plant against paint chipping, peeling, corrosion, and/or fading for a minimum of five (5) years.
g. The warranty shall be comprehensive. No deductibles shall be allowed for travel time, service hours, repair parts cost, etc.

12.0 DELIVERY SCHEDULE AND SHIPPING ADDRESS

12.1 All power plants and associated test equipment, computer software, technical manuals, collateral equipment, spare parts and drawings shall be ready for delivery no more than 365 days from date of award until all power plants are received. Any time frame after the 365 days must be approved by the Contracting Officer. Industry lead times shall be considered. Power plant(s) shall be shipped to the following address:

Naval Base Ventura County
Mobile Utilities Support Equipment Division
Building 1360
Port Hueneme, CA 93043
Attn: Engineering Branch Director, telephone (805) 982-5323

13.0 ADDITIONAL Collateral Equipment, Services and Spare Parts

13.1 Examples of additional collateral equipment, services, and spare parts that may be included in deliverables to the government.

a. Provide load cables to connect power plants to load connection point at deployment sites. Cable will be suitable for wet and dry locations, flame retardant, moisture, heat, and ultra-violet resistant. Cable will be sized to allow operation at 110% overload for 2 hours without any mechanical or electrical degradation to the cable assembly.
b. Training, in addition to minimal training as described in Section 10.0 with emphasis on mechanical, electrical or computer controls. Training on computer controls and electrical systems specific to delivered unit is preferred.
c. Spare parts that have long shelf life and can be stored in any conditions with no degradation to the part.
d. Long Lead time items that have long shelf life and can be stored in any conditions with no degradation to the part.
e. Any additional parts, services or collateral equipment as recommended.

14.0 APPENDIX

14.1 <u>Definitions</u>.

Production Power Plant – the first power plant built on which discrepancies in the design are revealed through construction,

inspection and contract required testing of the power plant. Upon satisfactory resolution of the discrepancies and the power plant has been accepted, the production power plant shall be used as a model to which all other power plants are to be built and a paralleling test unit for the other power plants.

Production Inspection – an inspection to verify all the requirements of Section 3 of the SOW have been complied with.

First Production Power Plant – the first power plant built upon production power plant acceptance and commencement of production.

Internal Parasitic Load – the power (electrical and mechanical) demanded for proper operation of equipment and/or components installed in the power plant.

No Load – no power demanded from the power plant at its output terminals.

Rated Overload – the maximum intermittent power demanded by the power plant at its output terminals.

Rated Load – the maximum continuous power demanded from the power plant at its output terminals.

Rated Output – the continuous rated power supplied by the power plant at its output terminals while simultaneously supplying internal power requirements (parasitic load) necessary for normal power plant operation.

Standard Commercial Industrial Product – a product available as a stock item and is not specifically custom designed or constructed.

Synchronize – coincidence of voltage, frequency and phase between two or more generators or between a generator and a bus.

Validation – successful accomplishment of Contractor developed installation, operation, maintenance, shipment preparation and test procedures.

14.2 Abbreviations.

AC – alternating current
AWG – American Wire Gauge
bhp – brake horsepower
BTU – British Thermal Unit
CT – current transformer
COP – Continuous Power
DC – direct current
DFT – dry film thickness
Hz – hertz
ID – inside diameter

kV – kilovolt
kVA – kilovolt-ampere
kVAR – kilovolt-ampere reactive
kW – kilowatt
kWh – kilowatt-hour
LTP - Limited-time Running Power
msl – mean sea level
MVA – Megavolt-ampere
NPT – National Pipe Thread
NTR – Navy Technical Representative
OEM – Original Equipment Manufacturer
Pf – power factor
PMG – Permanent Magnet Generator
PRP – Prime Power
PT – potential transformer
rpm – revolutions per minute
RTD – Resistance Temperature Device

14.3 Diesel Engine Operational Experience. The model of diesel engine which the Contractor plans to furnish must have performed successfully in stationary electric generation service at three installations independent of the Contractor's facilities. Successful performance for each engine is defined as the following occurring within a consecutive 3-year period.

a. Operating for a minimum of 8,000 hours using DF-2 fuel at 60 Hz. Operating for at least 2,000 hours of the required 8,000 hours equal to or in excess of the required power plant rated capability under this solicitation. (1400 kW COP)
b. Driving a generator which has produced 6,000 kilowatt-hours (kWh) of electricity for each kW of generator nameplate capability.
c. Operating with no major component replacement such as engine blowers or turbochargers; engine cylinder assemblies including cylinder heads, valves, cylinder liners, pistons, piston rings, connecting rods and connecting rod bearings; main bearings and crankshaft; lubricating oil, fuel and water pumps; internal drive gears and governor components.
d. Operating with no major repairs such as repairing a pump, a cracked engine block or a cracked exhaust manifold.

The engines at the three installations shall be identical series to the engine which the Contractor plans to furnish. Engine model is considered to be a given series or class of identical bore, stroke, rated speed, method of aspiration and configuration.

Upon request by the Contracting Officer, the Contractor shall provide evidence of successful performance of the model of diesel engine by submitting the following information for each of the three installations.

a. Owner and location

b. Date of initial operation
c. Total number of operating hours and number of kW hours produced per kW of generator rated capability
d. Horsepower rating, kW rating and rated speed
e. Brake mean effective pressure rating
f. Design characteristics, such as bore and stroke dimensions, number of cylinders and configuration
g. Design characteristics of generator rotor, stator and exciter system insulation materials

STATEMENT OF WORK (SOW)
MOBILE UTILITIES SUPPORT EQUIPMENT (MUSE)
1400kW POWER PLANT REQUIREMENTS

Table I - Power Plant Testing

Generator Only	Power Plant	Production Units	Test Method (MIL-STD_705C) or Test Section	Requirements Sections
-	x	-	Temperature rise (generator in power plant) 680.1 (See Note 1)	3.7.11.1
x	x	x	Insulation resistance 301.1 (See note 2)	Note 2
x	-	x	High potential 302.1 (See note 3)	Note 3
-	x	x	Phase sequence 507.1	NEMA MG1
-	x	-	Frequency and voltage regulation, stability (short term), and transient response 608.1	3.7.6.1, 3.7.11
-	x	x	Frequency and voltage stability (long term) 608.2	3.7.6.1, 3.7.11
-	x	x	Instrument check 513.1	Pass/Fail
-	x	x	Frequency adjustment range 511.2	
-	x	x	Cooling system, hydrostatic test 6.4.7	6.4.4
-	x	x	Overspeed protection device 505.2	Pass/Fail
-	x	x	Low oil pressure protection device 515.1	Pass/Fail
-	x	x	High coolant temperature protection device 515.2	Pass/Fail
-	x	x	Alarm/shutdown system test, visual and audio (all alarms) 6.4.8	3.11.3.1.3, 3.11.3.1.4
-	x	x	Diesel engine exhaust emissions 6.4.9	Data only
-	x	x	Noise level survey 6.4.10	3.6.3, 3.7.5.2
-	x	x	Paint adhesion test 3.12.3	3.13.3
-	x	x	Parallel operation 630.1 (See note 4)	3.7.13
-	x	-	Endurance test 690.1	Note 5
-	-	x	Performance run 6.4.13	6.4.8