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MILITARY SPECIFICATION

GENERATOR SET, GAS TURBINE ENGINE,

750 KW, 50/60 HERTZ, PRIME, UTILITY

This limited coordination military specification has been prepared by the USA Mobility Equipment Research and Development Command, Fort Belvoir, Virginia 22060, based upon currently available technical information, but it has not been approved for promulgation as a coordinated revision of Military Specification MIL-G-28670. It is subject to modification. However, pending its promulgation as a coordinated military specification, it may be used in procurement.

1. SCOPE

1.1 Scope. This specification covers an enclosed, gas turbine-engine-driven, prime, (Type II) utility (Class 2) generator set, rated for 750 kilowatts (kW) at 60 Hertz (Hz), 625 kW at 50 Hz, 0.8 power factor (pf), lagging, and reconnectable for the following voltage connections:

(a) For 60 Hz operation:

(1) 2400/4160 volts, 3 phase, 4 wire, wye (2400 volts, line-to-neutral, 4160 volts, line-to-line).
(2) 2400 volts, 3 phase, 3 wire, delta (2400 volts, line-to-line).

(b) For 50 Hz operation:

(1) 2200/3800 volts, 3 phase, 4 wire, wye (2200 volts, line-to-neutral, 3800 volts, line-to-line).
(2) 2200 volts, 3 phase, 3 wire, delta (2200 volts, line-to-line).

2. APPLICABLE DOCUMENTS

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

SPECIFICATIONS

FEDERAL

O-E-910	- Extinguisher, Fire, Carbon Dioxide (Hand and Wheeled Types).
O-E-915	- Extinguisher, Fire, Dry-Chemical (Hand-Portable).
W-B-131	- Battery, Storage: Vehicular, Ignition, Lighting and Starting.
W-C-375	- Circuit Breaker, Molded Case; Branch-Circuit and Service.
W-C-596	- Connector, Plug, Electrical; Connector, Receptacle, Electrical.
W-P-115	- Panel, Power Distribution.
QQ-S-571	- Solder; Tin Alloy; Lead-Tin Alloy; and Lead Alloy.
VV-F-800	- Fuel Oil, Diesel.
PPP-T-60	- Tape: Packaging, Waterproof.

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MIL-S-61	- Shunts, Instrument, External, 50 Millivolt (Lightweight Type).
MIL-T-152	- Treatment, Moisture- And Fungus-Resistant, Of Communications, Electronic, and Associated Electrical Equipment.
MIL-V-173	- Varnish, Moisture-and-Fungus-Resistant (For Treatment of Communications, Electronic, and Associated Equipment).
MIL-S-207	- Sulfuric Acid, Electrolyte: Packaging, Packing, and Marking for Shipment and Storage of.
MIL-J-641/6	- Jacks, Telephone, Type JJ-034.
MIL-T-704	- Treatment and Painting of Materiel.

MIL-E-917	- Electric Power Equipment, Basic Requirements (Naval Shipboard Use).
MIL-I-3505	- Insulation Sheet and Tape; Electrical, Coil and Slot, High Temperature.
MIL-L-3661/8	- Housings Indicator-Light, Style LH76.
MIL-L-3661/14	- Lenses, Indicator-Light Dripproof, Style LC14.
MIL-L-3661/21	- Lenses, Indicator-Light, Dripproof, Style LC21.
MIL-L-3661/38	- Housings, Indicator-Light, Style LH80.
MIL-M-3971/2	- Meters, Time Totalizing, Non-Hermetically Sealed, Electrical: Type II, 120V, 60 CPS and 120V, 400 CPS, Grades A and B, 2-1/2 Inch and 3-1/2 Inch, 3 Hole Flange.
MIL-C-5015	- Connectors, Electric, AN Type, General Specification for.
MIL-W-5088	- Wiring, Aircraft, Selection and Installation Of.
MIL-F-5591	- Fasteners; Panel.
MIL-E-5607	- Engine, Gas Turbine, Preparation for Storage and Shipment of, Process For.
MIL-T-5624	- Turbine Fuel, Aviation, Grades JP-4 and JP-5.
MIL-R-5757	- Relay, Electrical (For Electronic and Communication-Type Equipment), General Specification for.
MIL-R-6106	- Relays, Electric, General Specification for.
MIL-C-6458	- Chain Assembly, Single Leg, Aircraft Tiedown.
MIL-L-7808	- Lubricating Oil, Aircraft Turbine Engine, Synthetic Base.
MIL-A-8421	- Air Transportability Requirements, General Specification for.
MIL-G-10924	- Grease, Automotive and Artillery.
MIL-P-12742	- Primer Coating, Phenolic Water Immersible.
MIL-P-13949	- Plastic Sheet, Laminated, Copper-Clad (For Printed Wiring).
MIL-T-15377	- Temperature Monitor System, Naval Shipboard.

MIL-M-16034/3	- Voltmeters, A.C. Switchboard, 4-1/2 Inch, 250-Degree Scale.
MIL-M-16034/4	- Ammeters, A.C. Switchboard, 4-1/2 Inch, 250-Degree Scale.
MIL-I-16104	- Indicators, Synchronization.
MIL-M-16125	- Meters, Electrical, Frequency.
MIL-F-16884	- Fuel Oil, Diesel, Marine.
MIL-S-18396	- Switches, Meter and Control, Naval Shipboard.
MIL-M-18420	- Meters, Watthours and Auxiliary Apparatus.
MIL-W-19088	- Wattmeters, Switchboard Type, 4-1/2 Inch.
MIL-M-19261	- Meter, Power Factor 4-1/2 Inch, Switchboard Type.
MIL-I-22834	- Insulation, Electrical, Dielectric Barrier, Laminated, Plastic Film and Synthetic Fiber Mat.
MIL-L-23699	- Lubricating Oil, Aircraft Turbine Engines, Synthetic Base.
MIL-G-23827	- Grease, Aircraft and Instrument, Gear and Actuator Screw.
MIL-I-24092	- Insulating Varnish, Electrical, Impregnating.
MIL-T-25959	- Tiedowns, Cargo, Aircraft.
MIL-G-28554	- Generator Sets, Mobile Electric Power; Packaging of.
MIL-P-55110	- Printed Wiring Boards.

STANDARDS

FEDERAL

FED. STD. No. 356	- Commercial Packaging of Supplies and Equipment.
FED. STD. No. 595	- Colors.

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MIL-STD-129	- Marking for Shipment and Storage.
MIL-STD-195	- Marking of Connections for Electric Assemblies.

MIL-STD-199	- Resistors, Selection and Use of.
MIL-STD-209	- Slinging and Tiedown Provisions for Lifting and Tying Down Military Equipment.
MIL-STD-454	- Standard General Requirements For Electronic Equipment.
MIL-STD-461	- Electromagnetic Interference Characteristics Requirements For Equipment.
MIL-STD-705	- Generator Sets, Engine-Driven, Methods of Tests and Instruction.
MIL-STD-781	- Reliability Tests: Exponential Distribution.
MIL-STD-1179	- Lamps, Reflectors and Associated Signaling Equipment for Military Vehicles.
MIL-STD-1472	- Human Engineering Design Criteria for Military Systems, Equipment and Facilities.
MS3102	- Connector, Receptacle, Electric, Box Mounting, Solder Contacts, AN Type.
MS3106	- Connector, Plug Electric, Straight, Solder Contacts, AN Type.
MS21236	- Ring, Cargo Tiedown (10,000 LB), Type III.
MS3[illegible]3	- Hinge, Continuous (Piano), 0.050 Thickness, 0.125 Pin Dia.

DRAWINGS

USAF/SMAMA

54B6236	- Tiedown, Trailer Chassis.

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

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

DEPARTMENT OF TRANSPORTATION (DOT)

Motor Carrier Safety Regulations.

NATIONAL BUREAU OF STANDARDS (NBS)

Handbook H28 - Screw-Thread Standards for Federal Services.

(Application for copies of DOT and NBS should be addressed to the Superintendent of Documents, Government Printing Office, Washington DC 20402.)

AMERICAN NATIONAL STANDARDS INSTITUTE, INC. (ANSI)

B16.5	- Steel Pipe Flanges and Flanged Fittings.
B31.1	- Power Piping.
C37.4	- AC High-Voltage Circuit Breakers Rated on a Total Current Basis.
C37.20	- Switchgear Assemblies, Including Metal-Enclosed Bus.
C37.30	- High Voltage Air Switches, Insulators and Bus Supports.
C50.10	- Synchronous Machines.
C50.12	- Salient Pole Synchronous Generators and Condensers.
C57.13	- Instrument Transformers.
Y32.2	- Graphic Symbols for Electrical and Electronic Diagrams.

(Application for copies should be addressed to the American National Standards Institute, Inc., 1430 Broadway, New York, NY 10018.)

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

A120	- Black and Hot-Dipped Zinc-Coated (Galvanized) Welded and Seamless Steel Pipe for Ordinary Uses.
A181	- Forged or Rolled Steel Pipe Flanges, Forged Fittings, and Valves and Parts for General Service.
A568	- Steel, Carbon and High-Strength, Low-Alloy Hot-Rolled Sheet, Hot-Rolled Strip and Cold-Rolled Sheet, General Requirements.
A569	- Steel, Carbon (0.15 Maximum, Percent), Hot-Rolled Sheet and Strip, Commercial Quality.

(Application for copies should be addressed to the American Society for Testing and Materials, 1916 Race Street, Philadelphia PA 19103.)

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

ICS - Industrial Controls and Systems.
MG1 - Motors and Generators.
SG5 - Power Switchgear Assemblies.
WC3 - Rubber-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy.
WC7 - Cross-Linked-Thermosetting-Polyethylene-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy.

(Application for copies should be addressed to the National Electrical Manufacturers Association, 155 East 44th Street, New York NY 10017.)

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

No. 30 - Flammable and Combustible Liquids Code.
No. 37 - Stationary Combustion Engines and Gas Turbines.
No. 70 - National Electrical Code.

(Application for copies should be addressed to the National Fire Protection Association, 60 Batterymarch Place, Boston MA 02110.)

NATIONAL MOTOR FREIGHT TRAFFIC ASSOCIATION, INC., AGENT

National Motor Freight Classification.

(Application for copies should be addressed to the American Trucking Association, Inc., ATTN: Tariff Order Section, 1616 P Street, N.W. Washington DC 20036.)

SOCIETY OF AUTOMOTIVE ENGINEERS (SAE)

SAE Handbook.

(Application for copies should be addressed to the Society of Automotive Engineers, 400 Commonwealth Drive, Warrendale, PA 15096.)

TIRE & RIM ASSOCIATION, INC. (T&RA)

Yearbook

(Application for copies should be addressed to the Tire & Rim Association Inc., Attn: 3200 West Market Street, Akron OH 44313.)

UNIFORM CLASSIFICATION COMMITTEE, AGENT

Uniform Freight Classification.

(Application for copies should be addressed to the Uniform Classification Committee, ATTN: Tariff Publishing Officer, Room 1106, 222 South Riverside Plaza, Chicago IL 60606.)

Technical society and technical association specifications and standards are generally available for reference form libraries. They are also distributed among technical groups and using Federal agencies.

3. REQUIREMENTS

3.1 Description. The generator set shall consist of an enclosed, dual frequency, gas turbine-engine-driven, prime (Type II), utility Class 2, generator set, rated for 750kW/625kW, 50/60Hz, .8 pf lagging, complete with accessories and auxiliary equipment as specified herein required for normal operation. Generator and auxiliaries shall be rated for 750kW at 2400/4160 volts, 0.8 pf lagging, 60Hz, and 625kW at 2200/3800 V, .8 pf lagging, 50Hz as an individual set and in parallel with other sets of like characteristics and with commercial power. The set shall have provisions for connection to a remote control station to enable starting, stopping, monitoring operation, synchronizing, and complete control from the remote control station. Like components and parts of all generator sets delivered under one contract shall be identical and interchangeable. Each generator set shall consist of one turbine engine connected to the generator via the speed reduction gear, together with switchgear, all necessary components, parts, and equipment that are required for the intended purpose. The generator set shall be factory-assembled-and-alined package type, with all accessories as hereinafter indicated mounted and ready for service prior to shipment. The generator set shall be rated for output in accordance with Figure 1, and shall be reconnectable for the following:

(a) For 60 Hz operation:

(1) 2400/4160 volts, 3 phase, 4 wire, wye (2400 volts, line-to-neutral, 4160 volts, line-to-line).
(2) 2400 volts, 3 phase, 3 wire, delta (2400 volts, line-to-line).

(b) For 50 Hz operation:

(1) 2200/3800 volts, 3 phase, 4 wire, wye (2200 volts, line-to-neutral, 3800 volts, line-to-line).

(2) 2200 volts, 3 phase, 3 wire, delta (2200 volts, line-to-line).

All auxiliaries shall be suitable for operation at both 50Hz and 60Hz. The generator set shall have adequate capacity to deliver the 60Hz rated net output continuously, immediately followed by 110 percent of rated net output for 2 hours during any 24-hour period at sea level (760 mm Hg) and 60° F (15.6° C).

3.1.1 Reliability. The specified Mean-Time-Between-Failure (MTBF) shall be 1,500 hours when tested as specified in 4.6.7.

3.2 First article (preproduction model). The contractor shall furnish two complete assembled sets for examination and testing within the time frame specified (see 6.2) to prove prior to starting production that his production methods and choice of design detail will produce sets that comply with the requirements of this specification. Examination and tests shall be as specified in Section 4 and shall be subject to surveillance and approval by the Government (see 6.4).

3.3 Materials and components. Materials and components not specified shall be selected by the contractor and shall be subject to all provisions of this specification.

3.3.1 Thermal and sound insulating material. The thermal and sound insulating material shall be noncapillary, nonhygroscopic, and free from perceptible odors; resistant to attack by vermin, insects, rodents, and mildew; fire retardant, unaffected by battery electrolyte or petroleum derivatives; capable of maintaining its shape, position and consistency inherently or by suitable retaining methods under conditions of vibration and temperatures specified herein; resistant to or protected from abrasion, if exposed, and shall be replaceable, paintable, and bondable to metal.

3.3.2 Corrosion-resistant metals and treatments.

3.3.2.1 Metals. The following are the only acceptable corrosion-resisting metals (as distinguished from corrosion-resisting treatments).

(a) Corrosion-resisting steel which contains a minimum of 12 percent chromium.
(b) Copper.
(c) Aluminum.

(d) Aluminum alloys which do not contain more than 0.4 percent copper.
(e) Brass.
(f) Bronze.
(g) Beryllium-copper.
(h) Copper-nickel alloys.
(i) Nickel-copper alloys.

3.3.2.2 Corrosion-resisting treatments. The following are the only corrosion-resistant treatments that will be acceptable:

(a) Sheradizing.
(b) Galvanizing.
(c) Electrodepositing with cadmium, chromium, copper, nickel, silver, or zinc.
(d) Aluminizing.
(e) Chromizing.

3.3.3 Hardware. Hardware shall be as follows with the number of different sizes kept to a minimum. All nuts, bolts, and screws shall have standard screw threads in accordance with NBS Handbook H28. A nut located so that it cannot be grasped by the thumb and one finger of one hand, or by a common tool, shall be caged, or some equivalent means shall be used to obviate need for handling of the nut during removal or assembly.

3.3.4 Fasteners.

3.3.4.1 Panel fasteners. Panels, inspection doors, and plates for all components except the engine and engine accessories, which are subject to frequent operation and removal, shall have corrosion-resistant fasteners conforming to MIL-F-5591, Type II, Style 1, class and size as required.

3.3.4.2 Electrical fasteners. Each electrical fastener and other electrical hardware shall be made of corrosion-resistant material or shall be treated to be corrosion-resistant. Fasteners (bolts, screws, studs, or other fasteners) shall not normally carry current; they shall serve merely to hold current-carrying parts (lugs terminals) in firm contact with each other. Where flow of current through a stud cannot be avoided, the stud and all its associated hardware (nuts, locking devices, washers, or other hardware) shall be made of high conductive corrosion-resisting material. Positive means (such as pins, or square shanks) shall be provided to prevent turning of studs in their mountings

when nuts are tightened or loosened; lockwashers which depend on friction or spring action will not be acceptable for this purpose. Unused length of threads or studs (or screws used as studs) shall not exceed half the diameter of the stud.

3.3.4.3 Other fasteners. Each fastener (screw, stud, bolt, pin, or other fastener) shall be equipped with a suitable locking device to prevent loosening due to vibration. Locking shall be locknuts, castellated nuts with cotter pins, lockwashers, lock wire self-locking nuts, or lock plates. No swedging, peening, or staking of parts subject to removal or adjustment will be permitted. Lockwashers other than those on the engine and engine accessories, shall be captive on nuts, machine screws, capscrews, and bolts, when the nominal size is less than 1/4-inch diameter. Fasteners and associated hardware (nuts, locking devices, washers, or other hardware) shall be made of corrosion-resistant material or shall be provided with a corrosion-resistant treatment. Self-locking nuts may be used on removable through bolts in lieu of lockwashers. Sheet metal screws with captive lockwashers will be permitted for limited application in the attachment of items which are seldom removed, such as guards over couplings, fans, or belts.

3.3.5 Pipe, hose, and fittings. Pipe shall conform to ASTM A120, with fittings that conform to ASTM A181. Pressure piping systems shall be in accordance with ANSI B31.1 and B16.5, as applicable. Hose and hose fittings shall be used with piping systems where there is relative motion between parts. The hose and fittings shall be selected and sized for flow rates and the pressures involved. The use of snap rings in conjunction with petroleum products liquid lines where snap ring failure would present a fire hazard is prohibited. Piping which connects liquid systems shall be arranged to avoid any air pockets or undrained traps and shall have provision(s) for venting air after any part, subassembly, or component changeouts are made. All drain piping shall terminate through the side of the base of the set with an installed valve threaded for connection of an external pipe. All external openings shall have captive plugs.

3.3.6 Instrument transformers. Current and potential transformers used for instrumentation and relaying shall be in accordance with ANSI C57.13 and suitable for operation on 50 and 60 Hz. All instrument transformers used in circuits greater than 600 volts shall be 5.0 kilovolt (kv) insulation class; transformers used in circuits at not over 600 volts shall be 1.2 kv insulation class. All instrument transformers shall be within the limits specified for 0.6 accuracy class. Burden rating of all transformers shall be compatible with the application requirements.

3.3.7 Vacuum tubes. The use of vacuum tubes, gas filled tubes, voltage regulator tubes, or any other electron tubes is prohibited.

3.3.8 Terminal lugs. Terminal lugs for conductors rated for not more than 600 volts shall be insulated, ring tongue style, compression or crimp type lugs. Terminal lugs for outgoing power conductors and connections rated for more than 600 volts shall be uninsulated, rectangular tongue, two-bolt style, compression or screw pressure type lugs. Screw pressure type lugs shall require a key wrench for operating the clamping screw. Compression type lugs shall be installed with the proper tools. All terminal lugs shall be of the proper size for both the conductor and the terminal stud or bolt.

3.3.9 Connectors, low voltage. Unless otherwise specified herein, all low voltage connectors (600 volts or less) shall conform to MIL-C-5015. Connector pins may be crimp type in lieu of solder type, provided the connector conforms to MIL-C-5015, in all other respects. Right angle plugs shall be used, when necessary, to avoid making sharp bends in harness leading to the plugs. Plugs and receptacles shall be selected so that the energized member, when the connection is broken, is the female part of the connector. When more than one receptacle is used in the same general location, they shall be of different shell sizes, pin configurations or keyed to prevent inadvertent cross-connection of plugs. All receptacles which are not connected to mating plugs, furnished as part of the electrical harness in the set, shall be equipped with captive dust caps.

3.3.10 Semiconductor devices. All semiconductor devices shall be of the hermetically sealed silicon type. Except for zener diodes and as otherwise specified herein, all semiconductor devices shall have a peak repetitive rating not less than three times the peak repetitive voltage to which they will be subjected in the set; also, they shall have a current rating equal to not less than 150 percent of the maximum rectified current (dc) which they carry when installed in the set, ignoring transients. Diodes or controlled rectifiers used to supply dc power to the alternator main field shall have a peak inverse voltage rating of not less than 10 times nominal alternator field voltage (dc field voltage applying at normal ambient temperature for alternator stabilized at rated output). In addition, all semiconductor devices shall be capable of withstanding, or be protected against, transient voltage and current peaks as may be experienced during all tests, including short circuit (single or 3 phase) at the set terminals, and actuation of the overvoltage protective device through an actual overvoltage condition in the set. The use of circuits which require semiconductor devices with matched or paired characteristics is prohibited.

3.3.11 Shunts. Shunts used for instrumentation purposes shall conform to MIL-S-61.

3.3.12 Capacitors. Capacitors shall be in accordance with MIL-STD-454, Requirement 2. When electrolytic capacitors are used, they shall be the tantalum type.

3.3.13 Toggle switches. Toggle switches shall be mounted in the vertical plane so that in the ON position the handle will be pointing up.

3.3.14 Fungus resistance. Materials used in fabrication of the set shall not support the growth of fungus, except that this requirement need not apply to components within hermetically sealed enclosures. All exposed electrical connections, wires, and tapes shall be treated with varnish conforming to MIL-V-173 and applied according to MIL-T-152.

3.3.15 Resistors and rheostats. Each resistor or rheostat shall conform to MIL-STD-199. Tapped resistors shall be used in preference to the adjustable (slide wire) type. Where adjustable resistors are used and are of the wire wound type, wire shall be of sufficient size to preclude damage through tightening of the adjust device or through corrosion at the contact point. All rheostats and potentiometers shall be of the wire wound type, preferably enclosed.

3.3.16 Hinges and latches. Hinges shall conform to MS35823 and shall be Materi[illegible] C (stainless steel). Hinges or hinge pins shall be peened at the ends, or other means shall be provided to prevent workout of the pins. Latches shall require manual, not spring, action for closing. All parts of the latches having relative motion with each other shall be of corrosion-resisting metal.

3.3.17 Relays. Relays shall conform to MIL-R-5757 or MIL-R-6106, and shall be totally enclosed (provided with cover) or hermetically sealed. Should a particular design circuit not be capable of being adapted to use one of these relays, then specific permission to use relays other than the above must be obtained from the procuring agency.

3.3.18 Soldering. Soldering shall be in accordance with Requirement 5 of MIL-STD-454.

3.3.19 Printed circuit boards. Printed circuit boards shall be fabricated in accordance with MIL-P-55110 using copper clad laminate in accordance with MIL-P-13949, Type GF. The boards shall be electrosolder

plated (0.001 inch minimum thickness) with solder conforming to QQ-S-571, Composition SN60 or SN63. After etching, the boards shall be tin or solder immersed. The finished boards shall be coated with insulating compound, such as Minnesota Mining and Manufacturing Company, Part No. Scotchcast 221, or equal. The coating buildup shall be not less than 0.050 inch. Care shall be exercised to avoid coating connection provisions on the board (pins, sockets, terminal strips, etc.) with the insulating compound.

3.4 Environmental, operational, and handling requirements. When equipped with all accessories, the set shall start (see 6.3.1) and operate as follows:

3.4.1 Starting. The set shall start within 2.5 minutes:

(a) At ambinet temperatures from +125° F (+51.7° C) to -25° F (-31.7° C), at msl (29.92 In Hg) (760.0 mmHg) and any possible relative humidity.
(b) With rainfall up to and including 12 inches per hour impinging on the set at angles from the vertical to 45 degrees from the vertical.
(c) With the base of the set in planes from level to 5 degrees from level.
(d) At any altitude from msl (29.92 In Hg) (760.0 mmHg) and a maximum temperature of + 125° F (+51.7° C) to and including 8,000 feet (564.4 mmHg) and a maximum temperature of +95° F (+35.0° C).

3.4.2 Storage temperature and humidity. The set shall not be damaged (see 6.3.2) by storage in temperatures from +155° F (+68.3° C) to -65° F (-53.9° C) at any possible relative humidity within that range.

3.4.3 Operating. After starting, the set shall operate for a total of 20,000 hours, in accordance with provisions as specified herein and under conditions as follows:

(a) Without maintenance, overhaul, or replacement of parts, other than lubrication, routine engine servicing, and periodic adjustments as permitted in the schedule of Table I.
(b) At continuous loads up to and including the output power (kW) as shown in Figure 1, under the conditions specified in 3.4.1 using the altitude correction factor shown in Figure 1.

Table I. Servicing, Adjustment, and Replacement Schedule

Minimum hours of operation	Servicing, adjustment, and replacement permitted
8 (Daily)	Check lubricating oil level; add oil as required without stopping the set.
8 (Daily)	Check pressure drop across lubricating oil filters.
8 (Daily)	Check pressure drop accross low pressure fuel filter.
24	Visually inspect the set for loose connections, leaks in lubricating oil, fuel, exhaust, and compressed air (if used) systems. Check for free action of moving parts, such as governor linkage. Correct as necessary without stopping the set.
500	Gas path washing, as required.
500	Check battery, battery charging system, all terminals and connections. Add distilled water to cells as required.
500	Inspect and lubricate governor and throttle linkage; adjust as required.
(1000 Hours)	Check combustion chamber for excessive carbon formation and burning. Clean as required. Record.
(1000 Hours)	Replace lubricating oil filter elements; lubricate accessories as required.
(1000 Hours)	Check igniter system and fuel nozzles. Clean and adjust, or replace, as required.
(1000 Hours)	Clean or replace fuel filter elements, as required; drain condensate from fuel tank.
(1000 Hours)	Take samples of lubricating oil for analysis. Change oil, when directed, as a result of analysis.
(1000 Hours)	Inspect compressor bleed air valve and clean as necessary.
(1000 Hours)	Clean lube oil cooler fins.
(1000 Hours or 200 Starts)	Check starter brushes.
(1000 Hours)	Inspect compressor air inlet for dirt and foreign object entry.
(1000 Hours)	Check condition of air inlet filters. Blow compressed air (100 psig or less) through exhaust and combustion chamber drain lines.

3.4.4 Rated operating speed(s). The gas turbine engine, through the speed reduction gear, shall drive the generator at a speed of 1,800 revolutions per minute (rpm) for 60 Hz operation, and 1,500 rpm for 50 Hz operation. All rotating components of the set shall operate at speeds up to and including 120 percent of the 60 Hz rated speed for a period of not less than 5 minutes without damage.

3.4.5 Flexural vibrations and critical speeds. The set shall be free from dangerous flexural vibration (see 6.3.3), or dangerous torsional vibrations at critical speeds (see 6.3.4), between 90 and 110 percent of rated speed for both 50 Hz and 60 Hz operation (see 3.4.4).

3.4.6 Rough handling. The set shall withstand, without damage (see 6.3.5), the rough handling which would normally be encountered during transportation (see 6.3.6).

3.4.7 Alinement. The alinement between the engine, speed reducing gear, and alternating current (ac) generator shall not be disturbed or undue stress set up in any of the connected equipment when operating under the conditions specified herein. Alinement shall be maintained by flanges, dowels, keys, thrust plates, or fitted bolts. Attachments for mounting the engine shall be of a type that shall permit movement of the engine due to expansion.

3.4.8 Sound pressure levels. The sound pressure levels (SPLs), to which personnel may be exposed during normal operation of the set, under all conditions specified herein, shall not exceed the values shown for internal SPLs in Table II for the respective locations. Compartments which personnel need not enter during normal operation, but in which the SPLs exceed the values shown, shall have a conspicuous warning sign as follows:

WARNING

NOISE AREA. MAY CAUSE HEARING LOSS.

USE PROPER EAR PROTECTION

The set shall have sound attenuating accessories to reduce the external SPLs, at 100 feet radial distance from the set, to values which do not exceed the values shown for external SPLs in Table II.

Table II. Maximum SPLs in Decibels (db) Reference 0.0002 microbar).

Receiver location	Octave band midfrequency (Hz)							
	63	125	250	500	1000	2000	4000	8000
Internal:								
Operator's position	82	76	72	65	64	64	65	67
Other work areas	98	92	87	80	80	80	80	80
External: (100 ft radial distance)	77	67	59	55	50	47	45	40

3.5 Control and emergency power. The set shall have a control power system rated at 24 volts, dc, nominal. The system shall consist of storage batteries, battery charging system, dc panelboard, and all necessary wiring, fittings, and accessories. All dc control devices shall be suitable for operation at 20-32 volts dc.

3.5.1 Battery disconnect switch. The battery disconnect switch shall allow complete isolation of the batteries from the generator set.

3.5.2 Panelboard, dc. The dc panelboard shall be a 2 wire, circuit breaker panelboard, rated for operation at a nominal 24 volts dc, complete with all wiring, and installed in the control center (see 3.11). The panelboard shall have a branch circuit breaker for each branch circuit. The branch circuit breakers and panelboard mains shall be adequately sized for the connected loads.

3.6 Additional requirements

3.6.1 Safety. Exposed parts which are subject to high operating temperatures, or which are energized electrically and moving parts which are of such nature, or so located, as to be a hazard to operating personnel, shall be insulated, enclosed, or guarded; however, safety measures shall not impair the functioning of these parts. All liquid petroleum systems shall be arranged such that neither liquids nor vapors may escape and create hazardous flammable conditions by aspiration into the gas turbine engine air intake system, or contact surfaces at high temperatures or be aspirated into the ac generator windings. Couplings and shafts shall be furnished with removable guards of sufficiently heavy and rigid design to prevent bodily contact with the couplings or shaft. Guards shall cover rotating parts to within

1/2 inch of adjacent stationary housings. For personnel protection, turbine casings, exhaust ducts, oil pipes, and other hot parts shall be insulated and jacketed to maintain surface temperatures below 165° F or shall be provided with suitable guards or protective enclosures. Jackets and insulation shall be removable for maintenance and shall not be damaged by oil and fuel. Access and walkways, where possible, shall be designed to provide personnel escape in opposite directions and prevent entrapment of personnel in dead ends in case of fire.

3.6.1.1 Emergency shutdown. An engine emergency shutdown externally mounted on the control panel shall be provided. This device, when manually activated, will simultaneously stop the engine and open the circuit breaker. A nameplate, with the wording "EMERGENCY SHUTDOWN" and painted red, shall be mounted adjacent to the shutdown control. The controls shall be guarded or protected in a manner to minimize inadvertent operation without restricting access for necessary operation.

3.6.1.2 Prevention of fire. Components of the set subject to high operating temperatures shall be isolated to preclude the ignition of flammable fluids resulting from failures, such as a leak in fuel or lubricating oil piping systems. Gearcases, lubricating oil sumps, fuel oil tanks, and vent pipes shall be so located that fire will not result from any operating condition, leakage, or failure.

3.6.2 Maintainability. The set shall operate as specified herein with only the maintenance authorized in Table I. All assemblies, installed attachments, wiring, and tubing shall be accessible for servicing, repair, and replacement without removal of other major assemblies and other installed attachments. Covers, safety guards, and plates which must be removed for component adjustment, repair, replacement, or maintenance shall be equipped with quick-disconnect fastenings. Dimensions of hand access openings shall be in accordance with MIL-STD-1472. All fuel, lubricant, and liquid reservoirs shall be piped to drain in accordance with 3.3.5. Each maintenance assembly or disassembly operation shall be accomplished with common tools and special tools. All special tools shall be furnished with the set.

3.6.3 Mean preventive maintenance time. The mean preventive maintenance time to check, fill, adjust, clean, or replace (as appropriate see Table I), the item or system, shall not exceed 1.5 man-hours.

3.6.4 Contact of dissimilar metals. Contact joints between dissimilar metals shall be avoided as much as practicable. Contacts between aluminum or magnesium or their alloys and copper or copper-bearing alloys is prohibited. Where contacts between aluminum, magnesium or their alloys and other metals cannot be avoided, such as at faying surfaces, the contact joints shall be painted with not less than one coat of phenolic primer specified in MIL-P-12742, Type 1, except where electromagnetic interference reduction requirements preclude the use of such primer, and on machined fits where such painting is not practicable.

3.6.5 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 the ends which screw into aluminum or magnesium.
(d) Helical-coil type inserts.
(e) Threads (coarse thread series) in the light-metal alloy, as permitted by the contracting officer.

3.6.6 Welding. Surfaces to be welded shall be free from foreign matter which would be injurious to the weld. Welding procedures shall be in accordance with a nationally recognized welding code that is applicable to the materials being joined. Welds shall be of sufficient size and shape to develop the full design strength of the parts connected by the welds. Welds shall transmit imposed stresses without permanent deformation or failure when subjected to proof or service testing. In addition, the following shall apply:

(a) Spray metalizing of shafts will not be permitted.
(b) The strength of welded joints on rotating parts of the engine or generator shall be not less than 100 percent of strength of the materials being joined.
(c) The strength of welded joints on stationary parts of the engine or generator and on structural components of the set shall be not less than 80 percent of the strength of the materials being joined.
(d) Any rotating part of welded construction shall be stress relieved after welding.

3.6.7 Wiring. Wiring arrangement for low voltage circuits (up to 600 volts) shall conform to best commercial standards for this type of equipment and the NFPA No. 70. The wiring, 600 volts or less, used for connecting all instrumentation, control devices and control panel wiring shall be single stranded conductor copper No. 16 American Wire Gage (AWG) or larger, conforming to NFPA No. 70, Type TBS, TA, or SIS. Wire numbering shall conform to MIL-W-5088, except that length between adjacent groups of numbers shall not exceed 6 inches; the current carried by any conductor shall be not more than the value specified in NFPA No. 70 for bundled wire. Wires energized from the battery bank shall be identified by wire numbering stamped in red color. All control panel and subpanel wiring shall be neatly laced into harnesses through the use of fungus resistant cord, self-locking nylon straps, or wire harness duct. Lacing loops or straps shall be located at each wire break-out at periodic intervals for the entire length of the harness; if cord is used, these intervals shall not exceed 1-1/2 inches; if strap is used, these intervals shall not exceed 3 inches in length. Wires in all harnesses shall be of the proper length so that it will not be necessary to coil excess length. Wire harnesses not installed in wire duct shall be so run and clamped (with insulated clamps) as to protect insulation against contact with sharp corners and edges, pinching, sharp bending and twisting, abrasion caused by vibration or contact with moving parts and exposure to engine fuel oil, lubricating oil, and parts at high temperatures. The clamps shall also serve to prevent transmittal of mechanical stress to internal connections of electrical components. Where a cable or wire is run between parts which move relative to each other (as a result of vibration and operation), sufficient slack shall be left in the harness to allow for movement to take place repeatedly without bending or twisting to the point of damaging the wire in any manner. Wires shall not be spliced at any point throughout the length of their runs. All wiring used to interconnect assemblies shall terminate with connectors (see 3.3.9) at each end or branch. Connectors shall be potted where wires exit or seals shall be used to prevent entrance of water, dust, dirt, or other contaminants. Tubular clamp type terminal block shall be furnished and installed where required. The terminals on electrical components or operating voltage selected shall not have more than two wires attached to any one terminal.

3.6.7.1 Lighting and power circuit wiring. Wiring for lighting, power (auxiliaries and accessories), and receptacles shall conform to the requirements of NFPA No. 70. Wire shall be not smaller than No. 14 AWG copper.

3.6.7.2 Control center wiring. Wiring for the control center (switchgear and turbine control panel) shall conform to ANSI C37.20.

3.6.8 Weight, dimensions, and clearances.

3.6.8.1 Weight. The gross weight of the generator set shall be not more than 36,000 pounds. The generator set with the underbody kit installed shall not exceed 40,000 pounds. The weight shall include the complete generator set, with all equipment, auxiliaries, accessories, tools, spare parts, and portable power cables. The weight of fuel and lubricants, other than as required to protect or preserve the equipment during transit or storage, are not included in the gross weight. The weight distribution of the set shall be such that with the underbody kit installed and the generator set in a level position, the vertical load on the kingpin shall not exceed 17,000 pounds and the load on the running gear assembly measured at the tires shall not exceed 30,000 pounds.

3.6.8.2 Dimensions. Dimensions of the set shall not exceed 99 inches in height, 96 inches in width and 360 inches in length. With the underbody kit installed, the height of the set and kit shall not exceed 150 inches.

3.6.8.3 Clearances. Clearances shall be as specified in Table III. Clearances shall be measured with the underbody kit installed and the generator set in a level position.

Table III. Clearances.

Item	Dimension (inches)
Ground clearance (with running gear and landing gear in the highway transportable position), minimum	9.5
Swing clearance (radius from centerline of the kingpin to any portion of the enclosure or protruding component 6 inches or more below the upper fifth wheel plate), minimum	82.0
Forward swing radius (radius from centerline of the kingpin to the most distant point on the forward end of the enclosure), maximum	60.0
Kingpin centerline to the forward end of the enclosure body	36.0

3.6.9 Enclosure. The enclosure shall contain all equipment specified herein. The enclosure shall have provisions for the storage of tools, spare parts, material removed for transit, lifting slings and power cables (3.13).

3.6.9.1 Chassis (enclosure). The chassis shall have adequate strength to withstand all forces imposed during operation and transit. The chassis shall:

(a) Extend beyond all other parts of the set.
(b) Be suitable for operation of the set when resting on a flat surface.
(c) Have provisions for mounting the underbody kit by means of bolts.
(d) Be suitable for loading on a C-130 cargo type aircraft having an A/A32H-4A dual rail system.
(e) Have rear end bumper protection conforming to DOT Motor Carrier Safety Regulation, Section 393.86.

3.6.9.2 Enclosure body. The enclosure body shall be of the trussed body side type, stressed skin (monocoque) type, or a combination thereof. Interior and exterior panels, structural parts, and other material or components used in the body construction shall meet or exceed in strength and quality the corresponding material regularly furnished by commercial manufacturers of semitrailers. The body panels shall overlap the chassis to preclude the entry of water under operating or transport conditions. The body shall have hinged doors, as required, to provide ready access for repairs or removal and replacement of major components of the set. The interior of the body shall be insulated. The insulation shall be not less than the equivalent of 2 inches of fiberglass batt, compressed to 1-1/2 inch thickness under a perforated aluminum alloy inside skin. Retainers shall be used, if required, to prevent sagging and bulging. The roof shall support a 200-pound man, plus any equipment mounted thereon, without permanent deformation. The roof shall have a nonskid surface.

3.6.9.2.1 Floor. The floor of the enclosure shall be metal, reinforced to support the engine-generator assembly, complete with auxiliaries, accessories, tools, and on-board spare parts, under all conditions specified herein. The floor shall have a nonskid surface. Each compartment of the enclosure shall have provisions to drain liquids, such as spilled fuel or water, to the exterior of the enclosure.

3.6.9.2.2 Partitions. The enclosure body shall have partitions, located as required to accommodate installed equipment, to divide the interior into three compartments, as follows:

(a) Fuel tank and battery compartment.
(b) Turbine engine-generator compartment.
(c) Control center compartment.

The partitions shall have insulation to conform to the SPL limits specified in 3.4.8, but in no case shall the insulation be less than specified for the outside body panels. In addition, the fuel tank-battery compartment shall have a partial height insulated partition and an insulated extended shelf to isolate the fuel tank from the interior of the compartment. The battery compartment shall have a vent to exhaust battery fumes and gases to the exterior of the set.

3.6.9.2.3 Doors. Doors shall have reinforced structural frames of extruded aluminum alloy shapes and shall be covered with aluminum alloy sheet material. Door frames shall be fabricated from extruded aluminum alloy shapes that provide a mating fit with the structural frame of the doors. Insulation in the doors shall be equal to that specified for the body panels or partitions in which they are located. All door hinges, hinge pins, and latches shall be corrosion-resisting metal. The hinge pins shall be peened to prevent them from working out of the hinges. The latches shall secure the doors under all conditions specified herein, including transportation. The enclosure shall have three exterior doors, one double door at the rear, one double door on the curbside of the turbine engine-generator compartment, and one single door on the road side of the turbine engine-generator compartment. The exterior doors shall swing outward and each door shall have not less than four heavy-duty pin strap hinges permitting the doors to fold back against the sides of the enclosure body. Double doors shall be not less than 64 inches wide and 75 inches high. Single doors shall be not less than 32 inches wide and 75 inches high. The exterior rear door shall have a key lock. Other exterior doors shall have locks to enable securing the doors from the inside, or shall have key locks. All doors with key locks shall be keyed alike, and not less than three keys shall be furnished with the set. Each exterior door shall have provision for opening the door from the inside when locked. The partitions shall have doors to provide passage between service the equipment, but not less than one door in each full height

partition. The interior doors shall be not less than 20 inches wide and 66 inches high and shall have continuous (piano) hinges. Where there is a difference in air pressure between compartments, the door shall swing into the higher pressure compartment. Interior doors shall have latches that are operable from either side. Interior doors shall swing through an arc of not less than 90 degrees from the closed to the fully opened position, and each door shall have a lock-open device.

3.6.9.2.4 Louvers and openings. The enclosure shall have louvers as required to provide air supply and circulation to meet the generator and engine manufacturer's specified conditions of operation and environmental control of the generator set with the doors closed. Personnel work areas shall be positively ventilated and shall have not less than two complete air changes per minute. Personnel ventilators shall be energized by station power. Louvers shall be adjustable to enable control of air flow within the enclosure and to enable complete closure during transit and storage to prevent the entrance of rain, dust, and other blown matter. Provisions shall be made to prevent starting when the engine air intake louvers and exhaust openings are closed. Openings for power cables, piping, exhaust ducting, and other required openings shall be weatherproofed to exclude rain, snow, and sand. The openings shall have captive covers and caps to weatherproof and protect the openings during transit and storage.

3.6.9.2.5 Lifting system. The enclosure shall have a lifting system within the body, to aid in maintenance, inspection, removal, and replacement of components of the set. Lifting shall be accomplished by a chain hoist or a ratchet and gear device. The lifting system shall be sized as required, using a safety factor of five. Other means shall be provided, as required, to enable removal and replacement of major components that exceed the practical weight limits of the lifting system. Methods such as provision for fork lifting are acceptable.

3.6.9.2.6 Access ladder provisions. Provision shall be made for attaching an access ladder at each exterior door. The ladders shall be provided with the underbody kit. Provision shall be made for storage of the ladders inside the enclosure during transit. In addition, permanent means shall be provided to enable access to the roof. The roof access provisions shall not protrude beyond the overall limits specified for the enclosure when prepared for transit.

3.6.9.2.7 Interior lighting system. The interior lighting system shall include both the lighting circuits and receptacle circuits. The normal 120-volt ac power supply for the lighting system shall be provided from the 120/208 three phase, station power distribution panel.

3.6.9.2.7.1 Lighting circuits. The lighting circuits shall be complete with fixtures, incandescent type lamps control switches, in each compartment and wiring. Lighting fixtures shall be vapor-proof with guards and shall be a type and installed in a manner to preclude damage in operation, transit, or storage. Lighting fixtures shall be located to provide illumination on equipment, instruments, meters, and controls to enable efficient operation and maintenance, but shall be not less than 20-foot candles.

3.6.9.2.7.2 Receptacle circuits. The receptacle circuits shall be complete with receptacles and wiring. Receptacles shall be provided in each compartment, 18 inches above the floor, in quantities of not less than the following:

(a) Fuel tank and battery compartment: One ac receptacle, located adjacent to the door from the turbine engine-generator compartment.
(b) Turbine engine-generator compartment: Two ac receptacles, one on each side of the enclosure, located in the body panels near the longitudinal midpoint of the compartment.
(c) Control center compartment: One ac receptacle, located in the body panel, adjacent to the exterior door.

In addition, the enclosure shall have one emergency dc receptacle, painted red, and located near the control center. The ac receptacles shall conform to W-C-596, Style D4, and shall be energized from the station power system at 120 volts, ac. The emergency dc receptacle shall conform to W-C-596, Style A1, polarized, and shall be energized from the control power system.

3.6.9.2.8 Operator's desk. The enclosure shall have an operator's desk with a document storage compartment under the desk top. The desk top shall be not less than 24 inches long by 18 inches wide, shall have a 1/2-inch lip across the front, and shall slope 2 inches in 12 inches. The document storage compartment shall be not less than 6 inches deep and the bottom of the storage compartment shall be parallel to the floor of the enclosure. The operator's desk shall be fabricated from aluminum alloy sheet, not less than 0.101-inch

(Brown and Sharpe 10 gage nominal thickness). The operator's desk shall be mounted in the control center compartment, near the control center, attached by bolted construction to the structural members of the enclosure, and with the front edge of the desk 46 inches above the floor of the enclosure.

3.6.9.2.9 Telephone jack. A telephone jack conforming to MIL-J-641/6, Type JJ-034, shall be mounted 30 inches above the enclosure floor, adjacent to the operator's desk. The telephone jack shall be connected by conductors in conduit to a telephone terminal connection on the outside of the enclosure body and the control center (3.11).

3.6.9.2.10 Fire extinguisher. Unless otherwise specified (see 6.2), two portable dry chemical fire extinguishers in accordance with O-E-915, Type I, Class 2, Size 10, shall be furnished with mounting brackets and installed in accessible locations one each in the control center, and engine-generator compartments. The fire extinguisher shall be charged with potassium bicarbonate ($KHCO_3$). When specified (see 6.2), two 15 pound fire extinguishers with bracket in accordance with O-E-910, Type I, Size 15, shall be furnished with each set, in lieu of the dry chemical extinguisher specified above, and mounted in the same locations.

3.6.9.2.11 Brake lines. The brake lines shall be permanently installed. The lines shall terminate at the tractor end with standard connections and shall be provided with captive caps. The termination at the running gear shall be recessed to prevent damage and shall have captive plugs.

3.6.9.2.12 Exterior lighting system. The enclosure shall have a dual exterior lighting system for highway travel. The lighting system shall be rated for operation on 12 and 24 volt dc power from the towing vehicle. The lighting system shall conform to DOT Motor Carrier Safety Regulations, Sections 393.14, 393.20, 393.22, 393.25 through 393.29, 393.32, and 393.33. The 24 V lighting system shall conform to applicable military standards. Lights and reflectors shall be recessed or shall be guarded for protection from damage during normal operation of the generator set. The lighting system shall have a lighting cable connector receptacle conforming to SAE J560, for the 12 V system and MIL-STD-1179 for the 24 V system, with the receptacle located and the conductors color coded and connected as specified herein. All wiring in the exterior lighting system shall conform to SAE J555.

3.6.9.3 Lifting and tiedown attachments. The enclosure shall be equipped with lifting and tiedown attachments, including slings, conforming to MIL-STD-209, Type II, and as specified herein. The maximum shipping weight, for determining conformance to MIL-STD-209, shall include the weight of the complete generator set, auxiliaries, accessories, spare parts, tools, portable power cables, full tank of fuel, all lubricants, underbody kit, and other items required to provide a ready-for-operation set.

3.6.9.3.1 Lifting provisions. The sets shall be provided with lifting provisions, slings, and spreader bars to enable its being lifted in its normal position. All lifting apparatus shall be tested dynamically to three times the working load and statically four times the working load. The provisions for multiple slings shall be designed so that the attached slings will converge at a point not to exceed 24 feet above the lowest extremity of the load. Lifting provisions shall be positioned in such direction that the lifting strain will be in line with the longitudinal axis (peripheral plane) of the eye of the provision. The supporting members to which pad eyes are attached shall be of sufficient strength to withstand stresses in the amount and direction of pull specified for the pad eye. Where required, suitable reinforcements shall be used to meet the requirements specified herein. Stowage for lifting slings and spreader bars shall be provided, without increasing the dimensions of the set.

3.6.9.3.2 Tiedowns. Attachment points to accommodate tiedown devices shall be provided in accordance with MIL-A-8421. The design requirements of MIL-A-8421 shall apply except that the sets shall be loaded into aircraft with the longitudinal axis of the set parallel to the longitudinal axis of the aircraft.

3.6.9.3.3 Attachment point. Each attachment point shall be designed to accept the hook device of the Type MB-1 and MB-2 tensioning devices specified by MIL-T-25959; shall have an opening large enough to permit both the hook and chain ends of the Type I chain assembly (10,000 pound capacity) specified in MIL-C-6458 to pass through the opening; and shall be large enough to permit the chain end of the Type II chain assembly (25,000 pound capacity) specified in MIL-C-6458 to pass through the opening. Lifting provisions are acceptable attachment points provided they meet the criteria above. Computations of the quantity and strength of the required tiedown points shall be accomplished in accordance with MIL-A-8421 with the following exceptions:

(a) Compute using MB-1 tiedown device (10,000 pounds) specified in MIL-T-25959 only.

(b) Tiedown points on aircraft floor are on 20-inch centers.
(c) Total load on each tiedown point shall not exceed 10,000 pounds.
(d) The loading position shall be parallel to the longitudinal axis of the aircraft.
(e) Lifting provisions may be used as tiedown points, provided all the above specified devices are accommodated.

3.6.9.3.4 Plate nut. When a ring, cargo tiedown (10,000 pounds), Type III as specified in MS21236-2, Detail B is used as an attachment point, it may be threaded to the plate nut, tiedown, trailer chassis as shown on USAF/SMAMA Drawing 54B6236. The plate nuts should be located on the chassis, and provisions should be made to permit the tiedown rings to be threaded to the plate nuts through the web of the chassis, and to hang vertically between the channel or I-beam. The plate nut shall be held in place by two 3/8-inch bolts. The plate nut shall not be welded in place. The location of the plate nut shall allow the tiedown rings to pass both ends of the Type I chain assembly and the chain end of the Type II chain assembly and shall allow the hook ends of the MB-1 and MB-2 tiedown tensioning devices to be attached without interference from any nearby appurtenance.

3.6.9.3.5 Tiedown marking. The enclosure shall be stenciled "TIEDOWN" in red near each of the tiedown attachment points.

3.6.9.4 Maintenance heater. A heater shall be provided to maintain the temperature in all compartments at 60° F when the generator set is not operating. The heaters shall be the forced ventilated type and operated on station power. The heaters in each compartment shall be individually thermostatly controlled. Individual ON-OFF control shall be provided by circuit breakers located on the station power distribution panel. The heaters shall heat the compartments to 60° F in not more than 6 hours.

3.6.9.5 Upper fifth wheel. The upper fifth wheel shall conform to DOT Motor Carrier Safety Regulations, Section 393.70. The upper wheel plate shall be of the one piece reinforced type and shall have sufficient bearing area to cover a 36-inch diameter, full oscillating, lower fifth wheel assembly on a truck tractor. The forward end of the upper fifth wheel plate shall have a turned-up lip for ease of loading and for body protection. The upper fifth wheel plate shall be flush with the enclosure chassis. The kingpins shall be retractable and shall have a 2-inch throat diameter and shall conform to SAE J700. The center of the kingpin shall be not more than 1/4 inch from the longitudinal centerline of the enclosure chassis. The kingpin shall be fabricated of heat-treated alloy steel.

3.6.10 Transportability. The set and the set with the underbody kit installed shall be suitable for highway, rail, water and air transportation. Tiedown for all modes of transportation shall be accomplished by use of the lifting and tiedown attachments (see 3.6.9.3). The shock, impact, vibration, and oscillating loadings generated by the modes of transport shall be considered for the tying down devices as well as for the blocking and bracing provisions. Blocking and bracing devices shall be furnished with the unit and shall be suitable for repeated reuse. Means shall be provided to enable the blocking and bracing devices to be readily installed or removed with the use of common tools and without any disassembly of the generator set or auxiliary equipment. Suitable stowage shall be provided for the blocking and bracing devices. The above factors shall also be considered in the selection, location, mounting, and stability of all components of the generator set.

3.6.10.1 Highway transportation with underbody kit installed. The generator set, with underbody kit installed, when towed by a M123, 10 ton fifth wheel truck-tractor, shall be suitable for unrestricted operation over improved roads (see 6.3.7), at any speed up to a maximum of 55 mph. It shall also be suitable for operation at any speed up to a maximum of 20 mph over unimproved roads (see 6.3.8). The maximum towing speeds shall be stenciled on the forward end of the enclosure in a location that is readily visible to the operator of the towing vehicle. The generator set with the underbody kit installed shall meet the towing requirements of DOT Motor Carrier Safety Regulations, Section 393.70(e).

3.6.10.1.1 Turning ability. The generator set with the underbody kit installed shall be capable of assuming a 90 degrees angle to the coupled towing vehicle without cramping, sideslipping, or damage to the generator set, the underbody kit, or the towing vehicle.

3.6.10.1.2 Tracking. The generator set with the underbody kit installed shall conform to the tracking requirements of DOT Motor Carrier Safety Regulations, Section 393.70.

3.6.10.1.3 Brake performance. The service brakes of the generator set with the underbody kit installed shall comply with the performance requirements specified in DOT Motor Carrier Safety Regulations, Section 393.52.

3.6.10.2 Rail transportation. The set, and the set with the underbody kit installed, shall withstand without damage, the shock vibrational oscillatory, and torsional loading normally experienced

in cross-country rail shipment. The set with the underbody kit installed shall meet the above requirement in both the piggy-back method or resting on the landing gear and tied down to a standard flat car.

3.6.10.3 Water transportation. The set and the set with the underbody kit installed, shall withstand without damage, the shock, rolling, and pitching normally experienced in water transportation, on the deck and in the hold of a cargo vessel. For design purposes, the following conditions are assumed:

(a) Normal roll shall not exceed 15 degrees.
(b) Normal pitch shall not exceed 10 degrees.

3.6.10.4 Air transportation. The set, and the set with the underbody kit installed, shall be suitable for transport on cargo type aircraft, without the use of pallets.

3.7 Underbody components. When specified (see 6.2), an underbody kit shall be furnished, including but not limited to, the following (see Figure 2):

(a) Running gear assembly.
(b) Landing gear assembly.
(c) Leveling jacks.
(d) Access ladders.

The underbody components shall be constructed to withstand the forces imposed by the gross weight of the generator set, (with the fuel tank filled, all lubricants provided, and the set ready for operation), plus all dynamic forces resulting from operation and transportation. The underbody components shall be attachable to the generator set by use of bolts provided as part of the kit. Means shall be provided to assure alinement upon attachment of the underbody components. The underbody kit shall be constructed such that the enclosure in the ground transportation mode can be loaded, by removing the underbody kit, into a C-130 aircraft, and unloaded by installing the underbody kit. The loading and unloading shall be accomplished without the use of ground support equipment. Loading and unloading shall be accomplished by two men within 4 hours for each operation.

3.7.1 Weight and dimensions. The weight of the underbody kit shall not exceed 4000 pounds. The running gear assembly shall not exceed 144 inches in length and 96 inches in width.

3.7.2 Running gear assembly. The running gear assembly shall be an integral, tandem axle assembly for attachment to the structural framework of the enclosure as a unit. The running gear assembly shall have adequate strength of the imposed loads and operating conditions specified herein. The running gear assembly shall have sufficient articulation to support the enclosure with all wheels remaining on the ground under the following conditions:

(a) With each diagonally opposite pair of dual wheels elevated 6 inches above the other wheels.
(b) With the forward pair of dual wheels elevated 8 inches above the rear pair of dual wheels.
(c) With the rear pair of dual wheels elevated 8 inches above the forward pair of dual wheels.

The elevation of the sets of dual wheels shall be measured at the center of the tread on the outer tire.

3.7.2.1 Axles and suspension system. The axles and suspension system shall have a rated capacity of not less than the imposed load measured at the ground. Radius rods shall be rubber bushed and shall have provision for adjustment to enable axle alinement. Clearances shall preclude any interferences between the wheels and tires and any other portion of the enclosure or mounted equipment under any operating conditions specified herein. The suspension system shall maintain the enclosure with full payload in a level position for highway operation. The suspension system shall be a flexible leaf or air-spring suspension system and shall be of the equalizing type, incorporating characteristics which provide freedom from brake hop. The suspension system shall have elastomer bushings or blocks that eliminate the need for lubrication. Cushioning bumper stops shall be provided to prevent axle-to-framing contact at maximum compression.

3.7.2.2 Wheels, rims, and tires. The running gear assembly shall have dual wheels on each axle. Tire and rim sizes shall be the same for all wheels. The rims and tire ratings shall conform to Tire and Rim Association (T&RA) recommendations for the type and size of tires furnished. Unless otherwise specified (see 6.2), tires shall be the tube type with tubes and boots installed with highway tread. Tires shall have a rated capacity of not less than the actual load imposed on each tire, measured on each wheel at the ground, for 55 miles per hour (mph) highway travel. Tires shall be not less than 100 level quality and shall

contain antiozone compounds. Tires shall be not smaller than 10.0 x 20, 12-ply, and rated to support not less than 4,800 pounds per tire at 70 pounds per square inch gage. Recommended tire pressures shall be stenciled on the enclosure above each tire location.

3.7.2.3 Brakes. Brakes shall be the full air, internal expanding type. The brakes shall conform to DOT Motor Carrier Safety Regulations, Sections 393.40 through 393.43, 393.45 through 393.47, and as specified herein. The brake system shall include piping, hose connections; gladhands with cover assembly, dummy couplings equipped with corrosion-resistant security chains, relay emergency valves, air reservoirs, slack adjusters, brake chambers, and all other parts and connections required for a complete airbrake system. Location of air fittings and configuration of air hose couplings shall be in accordance with SAE J702. All components of the brake system shall be installed to provide adequate road clearance while traveling over uneven or rough terrain, including protection from subjects likely to strike and cause damage to the brake system components. No part of the brake system shall extend below the bottom of the wheel rims. The brake lines shall attach to the brake lines on the enclosure and be provided with captive protective caps.

3.7.2.4 Splashguards. The running gear assembly shall have splashguards for each of the rear dual wheels. The splashguards shall conform to SAE J682 and shall be attached to the structural framework of the running gear assembly.

3.7.3 Landing gear. The landing gear assembly shall have two vertical lift, steel-wheeled rotating, individually-adjustable, telescopic-landing legs, operated by a two speed gear with a handcrank. The landing legs shall have a range of adjustment to vary the height of the upper fifth wheel from 47 inches to not less than 53 inches from the ground. The assembly shall have supports for the crank extension shafts and clips for securely holding the crank when not in use. The landing gear shall be of the heavy-duty type and shall withstand, without deformation, the combined static and dynamic forces resulting from both the proportion of the gross payload sustained and the impact during coupling and uncoupling operations. When placed in the travel position, the landing gear assembly shall remain positively locked. With the generator set with the underbody kit installed coupled to a towing tractor and in level position, the clearance under the fully retracted landing gear shall be not less than 11 inches. The landing gear shall be protected to preclude the entry of foreign matter which could impair the function or mechanical efficiency. The landing legs shall be positioned as far apart as practicable to provide stability.

3.7.4 Leveling jacks. Not less than four removable leveling jacks shall be provided. The leveling jacks shall be vertical lift, individually adjustable, telescopic and operated by a two speed gear with a handcrank. The leveling jacks shall have a range of adjustment to vary the height of the generator set to meet the requirements for loading and unloading into a C-130 aircraft. The assemblies shall have clips for securely holding the crank when not in use. The leveling jacks shall be of the heavy-duty type and shall withstand, without deformation, the combined static and dynamic forces resulting from the gross payload and generator set operation when the set is supported on the leveling jacks. Provisions shall be made for storage of the jacks inside the enclosure.

3.7.5 Access ladders. Three ladders shall provide access to the interior of the generator set when the underbody kit is installed. Each ladder shall be not less than 32 inches wide and shall have a platform not less than 12 inches deep at the top. Each ladder shall have not less than three steps between the ground and the top platform. The steps and platform shall have nonskid surfaces. Each ladder shall have a continuous handrail on each side of the steps. The method of attaching the ladder to the enclosure shall insure safe usage by operating and maintenance personnel. The ladders shall be removable (see 6.9.2.6).

3.7.6 Lubrication system. The underbody kit shall have provision for the lubrication of parts normally requiring lubrication. Fittings with pressure release shall be used where high pressure might damage seals or other parts. A lubrication diagram (see 3.15.2.4), showing lubrication points, type of lubricant to be used, and frequency of lubrication shall be mounted in a conspicuous location on the underbody kit.

3.7.7 Lifting and tiedown. The underbody kit assemblies shall have lifting and tiedown provisions as specified in 3.6.9.3.

3.8 Engine-generator subbase. The engine-generator assembly, including the gas turbine engine, speed reduction gear, and generator, shall be mounted on a structural subbase. The subbase shall have structural strength, and be sufficiently rigid, to maintain alinement of the assembly (see 3.4.7). The gas turbine engine, speed reduction gear, generator shall be doweled to the subbase to assure proper realinement for reassembly, following removal of components for repair.

3.9 Gas turbine engine. The gas turbine engine shall develop the shaft power to produce the generator set electrical output specified in 3.1 and Figure 1 for the appropriate output frequency when fully equipped with all accessories, when subjected to engine compressor inlet heating and pressure loss associated with effects of the set enclosure and air cleaner restriction; exhaust system losses associated with installation ducting and exhaust silencing provisions; when operating on the fuels specified in 3.9.1; under the environmental conditions in 3.4 for the minimum operating interval specified in 3.4.3.

3.9.1 Fuels and lubricants. The generator set shall meet all requirements specified herein when operating on diesel fuel conforming to VV-F-800, MIL-F-16884, or turbine fuel conforming to MIL-T-5624, Grade JP-4 or JP-5. The gas turbine engine shall meet all requirements specified herein when using lubricating oil conforming to MIL-L-7808 or MIL-L-23699.

3.9.1.1 Fuel consumption. The generator set shall have fuel consumption rate, under standard operating conditions, and using fuel conforming to VV-F-800, Grade DF-2, with a heat value of 18,440 British thermal units (Btu) per pound, of not more than the following:

Percent rated load	Fuel consumption pounds per kW hour net output
100	0.95
75	1.05
50	1.25

Standard operating conditions are as follows:

(a) At msl (760.0 mmHg).
(b) Ambient air at 60° F (15.5° C).

3.9.1.2 Air pollution control. The turbine generator set shall comply with all Federal regulations governing environment control.

3.9.2 Turbine air supply. The air supply to the turbine shall be drawn from the exterior of the enclosure. The intake opening shall be as high above the ground as practicable. The air supply to the turbine shall

be ducted from the inlet opening, through the air filter system, to the air inlet on the turbine. The turbine air supply system shall consist of an inlet screen, an air filter and silencer unit, and ducting, complete with all auxiliaries, accessories, and wiring necessary to provide an operable system.

3.9.2.1 Turbine inlet screen. The turbine inlet screen shall be 1/4- by 1/4-inch mesh, noncorrosion screen, of sufficient strength for expected operating conditions. Access for cleaning the screen shall be provided.

3.9.2.2 Turbine air filter and silencer unit. The turbine air filter and silencer unit shall be an inertial separator type of cleaner, complete with electric-motor-driven scavenger blower and backflow valve, and an air silencer. Capacity of the air filter and silencer unit shall be adequate to enable operation of the set under all conditions specified herein, with an intake air pressure drop of not more than recommended by engine manufacturer. Efficiency of the air filter unit shall be not less than 95 percent when tested in accordance with SAE J726, with AC coarse test dust. The filter unit shall remove not less than 98 percent of all dust particles 10 micron and larger and not less than 99 percent of all visible water droplets from the incoming air flow. The efficiency of the unit shall not decrease with use, and the unit shall be self-cleaning. Secondary (scavenging) air flow shall be not more than 10 percent of the primary air flow. The air filter inlet shall have a hood or other means to protect the inlet screen from icing. The air filter unit shall have alarm circuits, connected to the annunciator (see 3.11.3.6), to provide alarm on scavenger blower failure, and air flow restriction. Motors shall be suitable for operation on the station power supply. The air filter and silencer unit shall be fabricated of steel or aluminum. No nuts, bolts, or loose hardware shall be used inside air passageways. Materials and finish shall withstand exposure and service under all conditions specified herein, without maintenance or replacement of parts, for not less than 20,000 hours operation.

3.9.3 Lubricating oil system. The lubricating oil system shall utilize lubricating oils conforming to MIL-L-23699 and MIL-L-7808. It may be a single pressure-feed lubricating system for both the turbine and speed reduction gear. The lubricating oil system shall include an engine-driven main lubricating oil pump, oil filter(s), oil cooler, pressure and temperature gages, oil storage tank, and electric-motor-driven pressure prelubrication and post lubrication pump (where required), complete with all auxiliaries, accessories, and piping

necessary to provide a complete operable system. The auxiliary prelubrication and post lubrication oil pump shall have adequate pressure and capacity to bring the unit to a stop without damage to other rotating components should the main lubrication oil pump fail. The system shall be designed to preclude the possibility of metal particles from a single area failure from being distributed to other areas and causing secondary damage. Bearing drains shall be of sufficient capacity to prevent the accumulation of excess oil at the bearings. Drain(s) shall be conveniently located, and shall enable complete drainage of the system and shall be piped outside the housing to an accessible location (see 3.3.5). Piping and valve arrangement shall enable purging of air from the system on initial startup and after maintenance operations.

3.9.3.1 Lubricating oil strainer. Each lubricating oil system shall have a full-flow element type oil strainer. The strainer element(s) shall be the replaceable cleanable and reuseable type. The lubricating oil strainer(s) shall remove not less than 90 percent of all particles of 81 microns and larger.

3.9.3.2 Lubricating oil filter(s). The lubricating oil filter(s) shall be the full-flow, duplex type, sized to meet all requirements of operation specified herein. Pressure gage(s) shall be provided to indicate a pressure drop across the filters. All pump suction lines shall be equipped with filters or strainers as required to exclude particles which could cause damage to the pump.

3.9.3.3 Lubricating oil cooler. Oil coolers shall use air as the cooling medium, and shall be readily accessible for inspection and maintenance. Means shall be provided for automatic oil temperature regulation via an oil cooler thermostatic-controlled bypass. The oil cooler drain shall be readily accessible to personnel.

3.9.3.4 Lubricating oil storage tank. The lubricating oil storage tank shall have capacity for 500 hours continuous operation of the set without adding makeup oil. The lubricating oil tank shall have an access cover sized to enable visual internal inspection and cleanout, an oil level indicating gage with an operating and stopped level indicating mark, and a drain valve. Any equipment attached to the top of the tank shall be mounted by means of pads to ensure that no tapped holes will extend into the tank. The tank shall be sealed against the entrance of dirt and water. All cover openings shall be gasketed. All openings in the top surface shall be raised at least 1 inch. The oil drain shall be piped outside the set housing (see 3.3.5).

The tank shall have an accessible fill opening with captive cap to enable adding oil during operation of the set. A breather system shall vent the lubricating oil system without the escape of liquid oil or the aspiration of oil vapor into the turbine air intake system.

3.9.3.5 Prelubrication and post lubrication pump. When recommended by the engine and gear box manufacturer, the prelubrication and post lubrication pump shall be a dc electric-motor-driven, positive displacement pump to circulate the lubricating oil for the prelubrication and post lubrication of the turbine, including accessories and reduction gear. The arrangement of the piping and valves shall enable control of the oil flow. The electric motor and controls shall be suitable for operation on the dc control and emergency power system.

3.9.4 Turbine exhaust system. The turbine exhaust system shall be complete with an exhaust silencer, if applicable, and the ducting between the exhaust collector on the turbine and the silencer. The exhaust discharge shall be located to minimize the recirculation of the exhaust gases into any air intake openings.

3.9.4.1 Exhaust ducting. The ducting between the exhaust collector on the turbine and the exhaust discharge shall allow for relative expansion and movement between components. There shall be no leaks of exhaust gases within the housing. The ducting shall not produce undue strain on the turbine or exhaust collector.

3.9.4.2 Exhaust silencer (if applicable). The exhaust silencer shall, in conjunction with other provisions to reduce SPLs, enable meeting the SPL requirements specified herein. The exhaust silencer together with exhaust extension, if applicable, shall vent the exhaust gases in a vertical direction above the roof of the set. Cover for the exhaust opening in the roof of the enclosure shall be provided for use under longterm storage and transport conditions.

3.9.5 Starting system. The turbine engine shall have an electric starting system, complete with all auxiliaries, accessories, wiring, and controls necessary to provide an operable system. The electric starting system shall be suitable for operation on power from the dc control power system. The starting system shall be capable of five sucessive starts (see 6.3.1) of the turbine engine within a 30-minute period without recharging the set batteries. The starting

system shall not overheat when motoring the engine for gas path cleaning. The starting system shall be automatically controlled by the start or stop sequence controls (see 3.11.1.3.2 and 3.11.1.3.3).

3.9.5.1 Batteries. Unless otherwise specified (see 6.2), batteries shall be 12-volt lead acid storage batteries, conforming to W-B-131. Batteries shall be furnished, installed, anchored in a battery rack, and so positioned that the electrolyte level may be inspected and water added without removing any battery. The battery shall be complete with interconnecting cables and incoming dc load cables with lugs. The battery rack shall be finish painted with an acid-resisting paint. Unless otherwise specified (see 6.2), batteries shall be shipped charged and dry. When specified (see 6.2), one filling of electrolyte of the required specific gravity shall be furnished for each battery.

3.9.5.2 Battery current drain.

(a) When the set is not operating, but with station power supplied from an external source, no current drain shall be imposed on the batteries except as follows:

(1) Lights on the control panel with associated switch(es) in the ON position.
(2) Indicator lights which require manual reset or cutout.

(b) When the set is not operating and without auxiliary ac power from an external source, the current drain on the battery bank, in addition to that permitted in (a) above shall be limited to the emergency lighting with the associated switch(es) in the ON position.

(c) When the set is stopped by other than normal shut-down, current drain for a maximum of 30 seconds will be permitted to return the set to the normal "OFF" configuration.

3.9.5.3 Battery charging system. The battery charging system shall consist of a heavy-duty, industrial type, wall-mounted battery charger, in a ventilated dripproof enclosure, complete with all accessories and wiring, installed and ready for operation. The battery charging system shall maintain the charge in the batteries under all operating conditions specified herein. The battery charging system shall operate at rated load in ambient temperatures up to 130° F (54.4° C). The

battery charging system shall operate on the station power supply. The battery charger shall produce a modified constant potential curve, which varies from 2.0 volts per cell at full load to 2.33 volts per cell on unloaded fully charged lead acid cells. The charger shall maintain this curve when subjected to ± 10 percent incoming voltage variation. The output current of the charger shall automatically adjust from 0.25 to 15.0 amperes, dependent upon the percent of charge in the bank of cells. The battery charger shall include, but is not necessarily limited to the following.

(a) Automatic overload and short circuit protection (current limiting).
(b) Automatic surge suppressors.
(c) Automatic dc voltage regulation.
(d) Internally adjustable current limit and voltage cutout controls.
(e) Fusing on both ac input and dc output.
(f) Hermetically sealed silicon diode full-wave rectifiers.
(g) All control devices of silicon type.
(h) Protection from accidental shorting at terminals.
(i) Protection from reverse connection to the batteries.
(j) A dc output voltmeter, 0-30 volts dc.
(k) A dc output ammeter, 0-30 amperes dc.

3.9.5.4 Timer. Unless otherwise specified (see 6.2), a timer with 0-24 hour adjustable range shall be furnished and installed to enable periodic equalizing charges. When the timer is manually started, the charger output shall be automatically adjusted to 2.33 volts times number of cells. When the timer shuts off the equalizing charge, the charger output shall automatically return to normal float charge voltage.

3.9.6 Fuel system. The fuel system shall include a fuel transfer pump, fuel strainer(s), filters, main fuel pump, boost fuel pump, and a fuel tank. The fuel system shall be complete with piping, valves, fittings, gages, and auxiliaries necessary to assure fuel supply at the required pressure to the turbine engine under all conditions specified herein. Drainage shall be provided to prevent the accummulation of fuel in any collection points in the turbine engine assembly. Provisions shall be included to insure drainage of unburned fuel, such as could collect during an aborted start attempt, before further start attempts are made possible. Contaminated fuel shall not be permitted to re-enter the fuel system.

3.9.6.1 Fuel tank. A baffled fuel tank shall be permanently located within the fuel tank and battery compartment. The fuel tank shall be fabricated in accordance with NFPA No. 30, except as modified herein, shall have a 500 gallon capacity, and shall be provided with means for connection to an auxiliary fuel supply (see 3.9.6.3). The fuel tank shall be equipped with fuel level switches to automatically control the motor driven fuel transfer pump (see 3.9.6.2). In addition, the tank shall be covered with a fire protective barrier of nonhygroscopic, thermal, insulating material to provide not less than 1 hour fire resistant rating in accordance with NFPA No. 37. A 1-1/2 inch drain with shutoff valve, vent, 3 inch filler neck and captive cap shall be provided. The fuel filler shall be positioned to prevent spillage of fuel into the set during filling. Capacity of the tank shall be indicated on a metal plate attached adjacent to the filler neck. The filler opening and venting system shall be constructed to permit filling the tank when the set is inclined in planes from level to 5 degrees from level. The fuel tank shall be provided with a sight glass with gage cock and a fuel level indicating system with an indicator to be located on the turbine control panel (see 3.11.1). The fuel drain and drain valve shall be located for emptying all the fuel and sediment in the tank without requiring the removal of the tank from the set. The fuel outlet shall be so located that the last (bottom) half inch of fuel cannot be introduced to the engine when the set is level.

3.9.6.2 Fuel transfer pump. The fuel transfer pump shall be a positive displacement, rotary pump, directly connected to an electric motor, through a flexible coupling, and mounted on a common base. The discharge of the fuel transfer pump shall be connected to the fuel tank. The inlet (suction side) of the fuel transfer pump shall be piped to a fitting on the exterior of the housing. This fitting shall have American National taper pipe thread (NPT), to mate with the fittings on the auxiliary fuel hose. The motor shall be dripproof, with Class B insulation, and shall conform to NEMA MG1. The motor controller shall be a magnetic, across-the-line, nonreversing, single speed, controller conforming to NEMA ICS Type I enclosure. The motor controller shall have a HAND-OFF-AUTO selector switch. When the selector switch is in the AUTO position, the operation shall be controlled by the float level switch in the fuel tank. The motor and control shall be suitable for operation on the station power supply. The fuel transfer pump shall pump not less than 15 gallons per minute of all fuels specified in 3.9.1, against a total head of 20 pounds per square

inch (psi), with the fuel 10 feet below ground level. The pump assembly shall have a bypass relief valve. The fuel transfer piping system shall have a solenoid operated, positive acting, shutoff valve in parallel with the transfer pump to prevent fuel flow into the fuel tank, even though the external fuel supply is pressurized. The fuel transfer pump shall be located as follows:

(a) To permit visual inspection, while the set is in operation.
(b) So that a leak in the fuel inlet or outlet lines will not allow fuel to enter turbine compressor intake.

3.9.6.3 Auxiliary fuel hose. The auxiliary fuel hose assembly shall consist of two lengths of hose, each 25 feet in length (50-feet total), complete with fittings, couplings, and protective caps. Hose shall be not less than 3/4-inch inside diameter, oil resisting, and having flexibility and other characteristics suitable for use with the generator set under all conditions specified herein. Each end of each length of hose shall have a suitable reusable fitting with female, NPT pipe thread. Replaceable threaded couplings and one swivel shall be provided on the ends of each hose. Couplings shall have protective caps to prevent entry of dirt. Caps shall be captive with the couplings. Storage shall be provided in the set for the auxiliary fuel hose.

3.9.6.4 Fuel strainer and filters. The fuel filter system shall provide not less than three stages of filtration, consisting of a fuel strainer(s), low pressure fuel filter, and a high pressure fuel filter. The fuel strainer shall have a cleanable and reuseable type element and shall remove not less than 90 percent of all particles of 75 microns and larger. The low pressure fuel filter shall be the duplex type and shall be arranged to enable the replacement or cleaning of the filter elements with the set in operation. The low pressure fuel filter shall remove not less than 90 percent of all particles 5 microns and larger. The high pressure fuel filter shall have replaceable or cleanable and reuseable type filter elements. The high pressure filter shall remove not less than 90 percent of all particles of 10 microns and larger. Both the low pressure filter and the high pressure filter shall have differential pressure indicators to indicate the pressure drop across the filters. Coalescing filters shall be provided when recommended by the engine manufacturer for use with the fuels and in the environments specified; all pump suction lines shall be equipped with filters or strainers as required to exclude particles which could damage the pump.

3.9.7 Engine speed (frequency) governing system. The set shall have a speed (frequency) governing system that is electric-hydraulic for controlling the set speed either independently, in parallel with like sets, or with commercial power. The governing system shall have controls for adjusting the speed (frequency) and speed droop (frequency regulation) while the set is in operation. The system components shall include a Woodward Governor Company hydraulic actuator, Model EG-B type, and control box, Model 2301, or equal. The Governing system shall be reverse acting (the engine speed shall go to the backup governor setting on loss of electric signal). A motor-actuated mechanism shall be included with the speed governing system to enable adjustment of speed from the control center. The set shall perform within the requirements specified herein without intermediate adjustment. The interconnecting wiring of the system shall be 16 AWG, or larger, shielded, twisted pairs, with the shield electrically grounded to the chassis at one point only as follows:

(a) Magnetic pickup to control box, shield grounded at control box.
(b) Control box to actuator, shield grounded at control box.
(c) Control box to paralleling receptacle (see 3.11.2.3.5), shield grounded at the "C" pin of the receptacle.

3.9.7.1 Governor installation. Linkages between the governor actuator and the engine fuel injection system fuel rack shall be made of corrosion-resistant material, and shall utilize rod end bearings, which do not require periodic lubrication between moving parts.

3.9.7.2 Governor system performance. When initially adjusted for 0 to 5 percent droop, the governing system shall provide set performance, as specified herein, (see 3.9.7.6) without adjustments other than permitted (see Table I).

3.9.7.3 Frequency regulation. The turbine engine speed governing system shall have provision for manual adjustment of the frequency regulation (see 6.3.9) at, or near, the speed governing system while the set is in operation. The frequency regulation (droop) shall be adjustable between 0 and 5 percent, inclusive. The frequency regulation for zero droop shall not exceed one-fourth of 1 percent of rated frequency for every load change including rated load.

3.9.7.4 Frequency drift. With the set operating at constant load and voltage, a change in the ambient temperature of 60° F (33.3° C) in an 8-hour period shall not cause the frequency to change by more than 1 percent, set temperature stabilization being accomplished at both the initial and final ambient temperature conditions.

3.9.7.5 Frequency adjustment range. With the set operating at any constant load up to and including rated load, the frequency shall be adjustable between 96 percent and 104 percent, inclusive, of rated frequency. When the set is operating at no load, the frequency shall be adjustable between 90 percent and 106 percent, inclusive, of rated frequency. The speed adjustment mechanism shall not enable increasing the speed to a value which, when supplemented by the transient overshoot, will actuate the overspeed protection device (see 3.9.8.1).

3.9.7.6 Governing system performance.

3.9.7.6.1 Short-term frequency stability (30 seconds). At every constant load from no load to rated load, the speed governing system shall maintain frequency within a bandwidth equal to 0.5 percent of rated frequency. The governing system shall not permit repetitive periodic frequency variation even though within the allowable 0.5 percent band.

3.9.7.6.2 Long-term frequency stability (4 hours). At constant ambient temperature, constant barometric pressure, constant voltage, and any constant load from no load to rated load, the speed governing system shall maintain frequency within a bandwidth equal to 1.0 percent of rated frequency within a 4-hour operating period.

3.9.7.6.3 Frequency transient performance. With the speed control system set for 0 to 5 percent droop, and following a sudden increase or decrease in load up to and including rated load, the speed governing system shall reestablish stable engine operating conditions within 4 seconds. The maximum transient frequency change above the new steady state frequency (overshoot) shall be not more than 4 percent of rated frequency. The maximum transient frequency change below the new steady state frequency (undershoot) shall be not more than 4 percent of rated frequency.

3.9.8 Engine safety and protective devices. The set shall have engine safety and protective devices of the automatic reset type for

overspeed, low lubricating oil pressure, high lubricating oil temperature, high turbine temperature, low fuel level, start failure and excessive vibrations. The respective devices, when activated, shall immediately stop the engine, simultaneously trip the generator power circuit breaker, and provide an indication on the annunciator alarm system. All electrical devices shall be fail safe.

3.9.8.1 Overspeed. The overspeed device shall trip at engine manufacturer's recommended trip speed, but shall not be more than 115 percent of the rated 60 Hz operating speed. The overspeed device shall not be actuated from the exciter voltage, generator output voltage, fuel-metering system or from any linkage under the control of the speed-regulating governor.

3.9.8.2 Low lubricating oil pressure. The low lubricating oil pressure protective device shall be activated when the lubricating oil pressure decreases to a value, as recommended by the engine manufacturer, at which continued operation may result in damage to the engine or components.

3.9.8.3 High lubricating oil temperature. The high lubricating oil temperature protective device shall be activated when the temperature of the lubricating oil increases to a value, as recommended by the engine manufacturer, at which continued operation may result in damage to the engine or components.

3.9.8.4 High turbine temperature. The high turbine temperature device shall be activated when the temperature of the turbine gas or the turbine case (as applicable) increases to a preset value, as recommended by the turbine engine manufacturer, at which continued operation may result in damage to the engine or components.

3.9.8.5 Low fuel level. The low fuel level protective device shall be a two-step device. When the fuel in the tank reaches a level at which sufficient fuel remains only for 1 hour operation of the set at rated load, a warning light and signal on the annunciator alarm system shall be activated. If the fuel in the tank reaches a level at which sufficient fuel remains for only 15 minutes operation of the set at rated load, the device shall initiate shutdown of the set.

3.9.8.6 Start failure. The ignition failure protective device shall be activated on ignition failure or turbine flameout. Indication on the annunciator alarm system shall be the start failure.

3.9.8.7 Excessive vibration. The excessive vibration protective device shall be activated when the vibration increases to a value, as recommended by the engine manufacturer, at which continued operation may result in damage to the engine or components.

3.9.9 Gas path cleaning. The turbine engine shall have gas path cleaning systems to enable cleaning of the compressor by water washing, kerosene-water-detergent washing, and abrasive cleaning. The cleaning systems shall include all equipment and accessories, except the cleaning agents, required for the cleaning processes. Storage shall be provided in the set housing for all cleaning system equipment that is not installed in a fixed mounting. The water washing, cleaning system shall be an integral, automatic water washing system consisting of a reduced-speed control system, a water wash manifold, a control switch, and a water storage tank, complete with all accessories, piping, and wiring required to provide an operable system. The water storage tank shall have storage capacity for not less than two water washing and rinsing cycles, but not less than 20 gallons. Washing and other cleaning provisions shall be incorporated in the unit to enable salt deposits, oily substances, and other deposits to be removed from the engine during operation. Power output after cleaning shall be not less than normal rating at the same turbine inlet temperature, except for long-term performance degradation attributable to normal wear. It shall not be necessary to replace lubricating oil, to plug any air passages, or to remove any components, such as fuel or lubricating oil lines, accessories, or inlet bell mouth during cleaning. All necessary components shall be furnished to conduct two successive cleanings.

3.9.10 Speed reduction gear. The speed reduction gear shall be an enclosed assembly to reduce the turbine engine output shaft speed to the generator speed for 60 Hz operation. The speed reduction gear shall be a heavy-duty unit for long-term continuous operation at 110 percent of the rated net output of the set. The speed reduction gear shall withstand sudden changes in load from no load to rated load and shall not be damaged by the torque resulting from a short circuit at the output terminals of the set. The speed reduction gear shall be approved by the turbine engine manufacturer for the specific application. Failure of an accessory, or its immediate drive mechanism, shall not endanger the main engine rotating parts. When specified (see 6.2), speed reduction gear components shall be furnished with the set to enable reducing the turbine engine output shaft speed to the generator speed for 50 Hz operation. Provision shall be provided for storing either the 50 Hz or 60 Hz reduction gear within the enclosure.

3.10 Generator. The generator shall be a synchronous, rotating field, brushesless, air cooled, self-ventilated, ac generator conforming to ANSI C50.10, ANSI C50.12, and NEMA MG1. The generator shall have a dripproof enclosure with the cooling air discharge ducted to the exterior of the housing. The cooling air discharge shall be located to minimize the recirculation of the discharged air into any air intake opening. The generator shall be rated for continuous operation at rated load, immediately followed by 10 percent overload for 2 hours in any 24-hour period. The generator shall have amortisseur windings. The generator speed shall be 1,800 rpm for 60 Hz operation and 1,500 rpm for 50 Hz operation. The generator shall have strip heaters, suitable for operation on the station power system, to prevent condensation under all conditions specified herein. In addition, the following calculations and data shall be furnished to the contracting officer:

(a) Open-circuit saturation curve.
(b) Short-circuit saturation curve.
(c) Zero-power-factor saturation curve.
(d) Rated-load saturation curve.

3.10.1 Windings and leads. The insulation system of the generator and exciter shall be Class B or F. The generator shall have a six lead stator winding with all six leads brought out. Generator windings and leads shall be copper. The generator windings shall have not less than six imbedded temperature detectors, equally spaced in the windings, to enable selective indication of winding temperature, and to detect hot spots. The windings shall be braced to withstand the stresses of both phase-to-phase and phase-to-neutral faults. The generator leads shall be not smaller than No. 1/0 AWG.

3.10.1.1 Coil, winding, and ground insulation. The insulation of all coils and windings shall be Class B or F as defined in MIL-E-917, with temperature limits as specified in 3.10.1.2. Varnish applied to the coils and windings shall conform to MIL-I-24092, Type M, Class 155, and shall be applied by varnish-treating methods and procedures specified in MIL-E-917. A minimum of three dips and bakes are required. Ground insulation for coils or windings shall conform to MIL-I-3505 and MIL-I-22834, as applicable. Insulation resistance of all circuits shall be not less than 1 megohm in an ambient temperature of 77° F (25° C) with the set at stabilized rated load operating temperatures.

3.10.1.2 Temperature rises. Allowable temperature rises of coils, windings, and mechanical parts, when the generator and auxiliary items are installed in the set, shall not exceed the following:

	Class B Insulated Component	Class F Insulated Component
Coils, windings, and connections measured by thermometer	75C° (135F°)	85C° (153F°)
Measured by rise in resistance	90C° (162F°)	100C° (180F°)
Generator bearings	50C° (90F°)	50C° (90F°)
Poles, cores, and other mechanical parts in contact with insulation.	Same as for the insulation with which the parts are in contact.	

3.10.1.3 High potential. Electric windings shall withstand the following 60 Hz voltages applied for 1 minute:

(a) Generator armature - 9320 volts between phase windings and 5800 volts between phase windings and ground.
(b) Generator field and exciter windings - 10 times ceiling voltage, but not less than 1,500 or more than 3,500 volts. (Applied between windings and ground.)
(c) Windings energized by the 28 volt dc control, cranking and battery-charging systems - 500 volts. (Applied between windings and ground.)
(d) All others - Twice rated voltage plus 1000 volts. (Applied between windings and ground and between windings where applicable.)

3.10.1.4 Generator, system neutral grounding. All ac electrical components of the set shall be isolated from ground, except as otherwise specified herein. The neutral output terminal (L_0) shall be connected to the ground stud by an insulated conductor of No. 1/0 AWG or larger using fastening methods separate from the output cable connection of the applicable terminals. The neutral connecting conductor shall be readily disconnectable from ground. The dc components utilizing chassis or case grounding shall not be used unless otherwise specified herein. No less than two designated grounding points on the outside, lower quarter, of the enclosure shall be furnished. The grounding points shall be permanent, reusable, and of the appropriate size for use with earth grounding rods. The location of the points shall be within 5 feet of the

front and rear, respectively, on opposite sides of the enclosure. The grounding points shall be electrically common with the neutral output terminal (L_0) using an insulated conductor of No. 1/0 AWG or larger. The grounding point shall be permanently identified as specified in 3.15.2.7.

3.10.2 Generator construction. The generator frame shall maintain alinement of all parts which it supports. An eye bolt shall be provided to facilitate mounting and removal of the generator.

3.10.2.1 Generator rotor. The rotor shall be in electrical and mechanical balance at all speeds up to 2500 rpm and shall withstand operation at 2500 rpm. Permissible balance methods are drilling out material, adding rivets, adding corrosion-resisting weights securely locked, adding lead or babbitt metal carried in a receiver to preclude breaking loose, and adding corrosion-resisting metal welded in place or dovetailed and anchored in balance grooves. The rotor shall be equipped with effective amortisseur damper windings to insure that the generators will operate satisfactorily in parallel; damper windings between poles shall be interconnected. Generator rotor and fan shall be separately balanced. The fan shall be cast and directly fastened to the flywheel. The rotating rectifiers shall be accessible without disassembly of the generator. If the rotor shaft is of welded construction, it shall be stress relieved before machining.

3.10.2.2 Generator bearings. A removable double-seal type bearing shall be used and shall be packed with grease conforming to MIL-G-23827. The bearing shall be removable without removing the engine or generator from the set. The inner race of the bearing shall be installed so that there is no relative movement between the inner race and the generator shaft under operating conditions, rough handling or shipment.

3.10.3 Generator coupling. The generator shall be directly driven from the turbine reduction gear through a flexible steel coupling. The flexible coupling shall compensate for misalinement between the reduction gear and generator shafts without causing injurious stresses on the connected equipment and shall allow movement of the shafts caused by expansion or contraction as well as angular displacements. The coupling shall be sized to allow for rated phase load current plus the overload and short circuit requirements (see 3.10.7). Positive locking of coupling bolts and fan bolts with lockwire, lock plates, or castellated nuts with cotter pins shall be used.

3.10.4 Excitation system. The generator excitation system shall consist of the rotating brushless exciter with rectifier assembly, voltage regulator, voltage adjustment control, accessories, and wiring required to provide excitation and control to the generator output voltage under all operating conditions specified herein. The excitation system shall have capacity to: (a) provide for the specified set performance; (b) permit the set output voltage to trip the overvoltage protective device at no load, hot field, rated frequency conditions, at 125° F (51.7° C) under fault conditions; (c) support the minimum short circuit current, and (d) provide sufficient current to initiate operation of current sensitive protective devices.

3.10.4.1 Exciter. The exciter shall be integral with the generator and shall be cooled by the air supplied from the generator cooling fan. The exciter shall be of the synchronous, rotating armature, rotating rectifier type. The exciter field shall be electrically isolated from the rest of the generator. The rotating rectifier assembly shall be mounted in a manner to provide ready access for inspection and replacement of the rectifier diodes.

3.10.4.2 Voltage regulator. The voltage regulator shall be solid state and shall automatically control the generator field current through action on the exciter. The reference voltage shall be 3 phase averaged and shall be obtained from the potential transformers in the switchgear. The voltage regulator shall enable manual adjustment of the set output voltage, while the set is operating, by the voltage adjustment control on the generator control panel. The voltage regulator shall permit parallel operation of sets with or without voltage droop. Cross-connection of voltage regulators of sets will be permitted to enable operation in parallel without voltage droop, provided that cross-connection requires no more than two wires (see 3.10.8). The voltage regulator shall enable parallel operation (see 3.10.8) by the droop method with commercial power by adjustment of the reactive load compensation control mounted behind the generator control panel. Automatic field flashing shall be provided using power from the dc control and emergency power system. Where field flashing is required, means shall be provided to limit the flashing current to a safe value.

3.10.4.3 Exciter field current. The exciter field current of production generators shall not differ by more than 10 percent from the field current required by the preproduction generators under the same conditions.

3.10.4.4 Winding resistance. The generator, exciter, and voltage regulator winding resistances of production sets shall not differ by more than 10 percent from the resistance of the corresponding winding of the preproduction generators. All resistance values shall be corrected to winding temperature of 25° C (77° F).

3.10.5 Generator performance. The generator, together with the excitation system, shall provide performance as specified herein. The generator shall have an inherent limit of 150 percent of rated voltage for any condition of load and field at rated frequency and any ambient condition specified herein.

3.10.5.1 Voltage waveform. The deviation factor for the line-to-line and line-to-neutral voltage, for each voltage connection, shall be not more than 5 percent, nor shall any single voltage harmonic be more than 2 percent, under the following output conditions of the generator, when under automatic control of the excitation system:

(a) No load.
(b) At any load up to and including rated kW and at any pf between unity and 0.8 lagging.

In addition, when the waveform is viewed on a high speed oscilloscope (single channel Tektronix Model 555, or equal) there shall be no evident discontinuities, spikes, and notches in the waveform when oscilloscope gain is set such that peak-to-peak excursion of the voltage wave covers approximately the full vertical dimension of the viewing screen.

3.10.5.2 Voltage unbalance. With the generator under control of the excitation system, and operating at no load with rated voltage and frequency, the maximum difference in the three line-to-neutral voltages shall be not more than 1 percent of the rated line-to-neutral voltage. The voltage unbalance between phases shall not exceed 5 percent of rated voltage under the following simultaneous load conditions:

(a) The generator connected for 3 phase output.
(b) A single phase, unity pf load connected line-to-line, with no other load on the set.
(c) The load current shall be 25 percent of the rated full load current of the set.

3.10.5.3 Voltage regulation. The voltage regulation (see 6.3.9) of the generator set shall be not more than 2 percent.

3.10.5.3.1 Voltage-short term stability (30 seconds). At every constant load from no load to rated load, the voltage at the set terminals shall remain within a bandwidth equal to 1 percent of rated voltage.

3.10.5.3.2 Voltage-long term stability (4 hours). At constant ambient temperature, constant barometric pressure, constant frequency, and any constant load from no load to rated load, the voltage shall remain within a bandwidth of 2 percent of rated voltage.

3.10.5.3.3 Voltage drift. With the set operating at constant load and frequency, a change of 60° F (33.3° C) from ambient temperature in an 8-hour period shall not cause the voltage to change by more than 1 percent, set temperature stabilization being accomplished at both the initial and final ambient temperature conditions.

3.10.5.3.4 Voltage-transient performance. With the reactive load compensation of the voltage regulator inoperative, and with the engine speed control system set for 0 to 5 percent regulation, performance of the set under transient conditions as measured by an oscillograph, shall be as follows:

(a) With the set initially operating at rated frequency and rated voltage, and following any sudden change in load from no load to full load, the instantaneous root mean square voltage shall not drop to less than 80 percent of rated voltage and shall reach stable conditions within 3 seconds. No overshoot or undershoot of the final voltage may exceed the initial voltage transient in amplitude.
(b) The above requirements shall also apply when load is suddenly changed from full load to no load, except that the initial voltage transient shall involve a voltage rise not to exceed 130 percent of rated voltage.

3.10.6 Voltage operating range. The output voltage of the set shall be adjustable to any value within the following line-to-line voltage operating range:

(a) With the operating voltage selector (see 3.11.3.4) in the 2400 volt connection position:
(1) At 60 Hz: Between 2160 and 2640 volts.
(2) At 50 Hz: Between 1980 and 2420 volts.

(b) With the operating voltage selector (see 3.11.3.4) in the 2400/4160 volt connection position:

(1) At 60 Hz: Between 3750 and 4575 volts.
(2) At 50 Hz: Between 3420 and 4180 volts.

The set shall operate as specified herein at any load between no load and rated load throughout the voltage operating range.

3.10.7 Short circuit. The generator and excitation system operating as a unit shall withstand, without injury, 10-second single phase line-to-line, single phase line-to-neutral, and symmetrical 3 phase short circuits at the output terminals, when operating at rated load. The sustained 3 phase short circuit current shall be not less than 300 percent of rated output current.

3.10.8 Parallel operation. The set shall be capable of parallel operation at zero speed droop with not more than 2 percent voltage droop, and at 3 percent speed droop with not more than 3 percent voltage droop. The governor parallel control and reactive load compensation control shall remain in the same position during both conditions.

3.10.8.1 Parallel operation with zero speed droop. With their governor and voltage regulator paralleling circuits properly interconnected, any six like sets operated in parallel shall divide load in accordance with the following, as system load at rated power factor is varied between 0 and 100 percent (and vice versa) of the combined rating of the connected sets:

(a) Real power division. The difference between the average individual kW output shall at no time be more than 10 percent of the kW rating of one set.
(b) Power exchange. At any constant system load, power exchange between the sets shall not exceed 10 percent of the rating of one set. Power exchange is the difference between the maximum and minimum power output of one set, for constant system load conditions, as determined from oscillographic measurements.
(c) The reactive power division. The difference between the average reactive kilovolt-amperes (kvar) supplied shall at no time be greater than 10 percent of the reactive kvar rating of one set.

For the above requirement, the initial system load, both kW and kvar, shall be equally divided between the sets. Thereafter, no adjustment shall be made to the governors, voltage regulators, or other components of the set as the system load is varied.

3.10.8.2 Parallel operation with speed droop. With the generator set controls in the droop configuration, any six like sets operated in parallel shall divide load in accordance with 3.10.8.1 as system load at rated power factor is varied between) .nd 100 percent (and vice versa) of the combined rating of the connected sets.

3.11 Control center. The generator set shall be controlled from a single control center. The control center shall contain all equipment and controls required to enable one operator to start, adjust, and operate the set, monitor all critical parameters of the set, and stop the set without leaving the operating station. The control center shall include, but be not limited to, the following: Turbine control panel, generator control panel, annunciator alarm system, the switchgear, the remote control receptacle, and remote station power receptacle. The construction, assembly, and test of the control center shall conform to ANSI C37.20 and NEMA SG5.

3.11.1 Turbine control panel. The turbine control panel shall be a formed, vertically-hinged panel on the control center, and shall contain controls, instruments, and switches necessary to start, operate, monitor pe. rmance, and stop the turbine engine. The panel shall have a positive, manual latch to secure the panel in the closed position and a lock-open device which will permit the panel to swing through an arc of not less than 105 degrees, but not to a point at which damage may occur.

3.11.1.1 Start system instrumentation. The start attempt counter shall be a four digit, panel mounted, nonresetting type counter. Additonal start system instrumentation shall be provided as necessary to permit proper operation, monitoring, and troubleshooting of the starting system.

3.11.1.2 Turbine instruments and meters. Instruments and meters, mounted on the turbine control panel and connected for the required function, shall include, but be not limited to, the items specified in the following paragraphs. The instruments shall have an accuracy of 2 percent, shall be not less than 3-1/2 inch dial size, and shall be of the back-connected, flush-mounted type. Instrument cases shall be metal, with an integral mounting flange. The dials shall be white with black graduations and markings. Indicating pointers shall be dull black and of unembellished design. The dial cover shall be clear glass, free from blemishes, and secured to exclude the entry of dust and permit removal.

3.11.1.2.1 Turbine speed indicator. The turbine speed indicator shall be calibrated to indicate percent of rated speed.

3.11.1.2.2 Turbine temperature indicator(s). The turbine temperature indicator(s) shall indicate the temperature of the turbine at a critical temperature point or the temperature of the turbine exhaust gas or both, as recommended by the engine manufacturer.

3.11.1.2.3 Fuel level gage. The fuel level gage shall be calibrated in gallons to show the amount of fuel in the tank.

3.11.1.2.4 Engine hour meter. The engine hour meter shall be a nonreset, repeating, time totalizing meter conforming to MIL-M-3971/2, Type II, Grade A, Dash Number 3. The meter shall indicate total engine operating hours up to 9,999.9, then repeat.

3.11.1.2.5 Lubricating oil pressure indicator. The lubricating oil pressure indicator shall indicate the pressure of the lubricating oil supply to the engine. The indicator shall have an operating range as recommended by the engine manufacturer and shall be calibrated to read directly in psi.

3.11.1.2.6 Lubricating oil temperature indicator. The lubricating oil temperature indicator shall indicate the temperature of the oil leaving the engine. The indicator shall have an operating range as recommended by the engine manufacturer and shall be calibrated to read directly in ° F.

3.11.1.2.7 Vibration indicator(s). The vibration indicator(s) shall indicate vibration levels at locations recommended by the engine manufacturer to enable vibration to be monitored to ensure satisfactory service in the intended usage and minimum cost of maintenance. A stamped nonferrous plate near the indicator(s) shall state the levels of vibration on each recommended detector corresponding to:

(a) Normal operation.
(b) Remedial action required at next scheduled inspection (e.g., compressor cleaning).
(c) Further operation detrimental - shutdown as soon as possible.
(d) Further operation dangerous - shut down immediately.

3.11.1.3 Turbine controls. Control devices, mounted on the turbine control panel and connected for the required function shall include, but be not limited to, the items specified in the following paragraphs. The control devices shall conform to NEMA ICS.

3.11.1.3.1 Control power switch. The control power switch shall be a two position (ON-OFF), maintaining contact switch to control the power supply to the turbine control panel.

3.11.1.3.2 Start device. The start device shall be a momentary contact, spring return toggle switch or pushbutton that, when actuated, initiates the automatic start sequence.

3.11.1.3.3 Stop device. The stop device shall be a momentary contact, spring return toggle switch or pushbutton that, when actuated, de-energizes the start control relays to cause turbine shutdown and simultaneously trips the main circuit breaker.

3.11.1.3.4 Local-remote switch. The local-remote switch shall be a two position (local-remote), maintaining contact switch to transfer control of the generator set to the remote control station.

3.11.1.3.5 Speed (frequency) control. The turbine engine speed (frequency) control shall be a three position (DECREASE-OFF-INCREASE) control switch with spring return to the OFF position, conforming to MIL-S-[illegible]396. The control switch shall be rated for 500 volts ac and shall have the number of poles (stages) required for control of the operating motor on the engine speed governing system (see 3.9.7.2). The control switch shall have an escutcheon plate that is marked to show clockwise motion to increase the speed (frequency) of the set and counterclockwise motion to decrease the speed (frequency) of the set.

3.11.1.3.6 Fuel transfer pump switch. The fuel transfer pump switch shall be a three position (HAND-OFF-AUTO) switch to control the power supply to the fuel transfer pump (see 3.9.6.2).

3.11.1.3.7 Frequency selector switch. A frequency selector switch with a locking device to prevent accidental actuation shall be provided and interconnected with the governor circuitry such that selection of the operating frequency can be made. The switch positions shall be identified as "60 Hz" and "50 Hz".

3.11.1.4 Indicating lights (turbine). Indicating lights mounted on the turbine control panel and connected for the required function, shall include, but be not limited to, the items specified in the following paragraphs. The lampholder and housing assembly for each indicating light shall conform to MIL-L-3661/38, Style LH 80, Type Designation LH 80/1. The lens assembly for each light shall conform to MIL-L-3661/21, Style LC 21, Type Designation as specified herein. Each indicating light shall have a lamp Industry Designation 6S6DC, of the voltage rating required for the respective control circuit.

3.11.1.4.1 Ready-to-load indication. The ready-to-load indicating, light shall be energized when the turbine has reached operating speed, is operating properly, and ready to accept load. The lens assembly shall be Type Designation LC21GN3, with a nondiffusing green lens.

3.11.1.4.2 Fuel transfer pump pilot light. The fuel transfer pilot light shall be energized when the fuel transfer pump is operating (see 3.9.6.2). The lens assembly shall be Type Designation LC21YN3, with a nondiffusing yellow lens.

3.11.2 Generator control panel. The generator control panel shall be a formed, vertically-hinged, dead front panel in the control center. The control panel shall contain controls, instruments, meters, and protective devices required for the control and operation of the generator. The control panel shall have a positive, manual latch to secure the panel in the closed position and a lock-open device which will permit the panel to swing through an arc of not less than 105 degrees, but not to a point at which damage may occur.

3.11.2.1 Instruments and meters. Instruments and meters, mounted on the generator control panel and connected for the required function shall include, but be not limited to, the items specified in the following paragraphs.

3.11.2.1.1 Ammeter. The ammeter shall be a switchboard type instrument conforming to MIL-M-16034/4, Type Designation MR49W300AMAAH. The ammeter shall be connected to indicate line current. The ammeter shall be transformer rated for 5 amperes and shall have a 0-300 ampere scale.

3.11.2.1.2 Generator-bus voltmeter. The generator-bus voltmeter shall be a switchboard type instrument conforming to MIL-M-16034/3, Type Designation MR49WSPECAMKVH. The voltmeter shall be connected to indicate line-to-line voltage on the generator side or load side of the circuit breaker, depending on the position of the selector switch (see 3.11.2.2.3). The voltmeter shall be transformer rated for 150 volts and shall have a 0-5.25 kv scale.

3.11.2.1.3 Frequency meter. The frequency meter shall be a switchboard, dial and pointer indicating type conforming to MIL-M-16125, except it shall be suitable for operation at 48 to 65 Hz. The frequency meter Type Designation shall be MR49W50/60SPECH. The scale divisions shall be 0.2 Hz and the scale shall have a blue mark at 50 Hz and a red mark at 60 Hz. The region between 53 and 57 Hz shall contrast, by color shading or some other manner, with the rest of the scale or shall be unmarked. The needle shall rest on the left-hand edge of the scale when the instrument is de-energized.

3.11.2.1.4 Kilowattmeter. The kilowattmeter shall be a switchboard type instrument conforming to MIL-W-19088, Type Designation MR492W001ACGWH, except the instrument shall indicate the power output of either 3 phase, 4 wire, or 3 phase, 3 wire circuits. The instrument shall be transformer rated for 5 amperes, 120 volts, shall operate on 50/60 Hz, and shall have a 0-1000 kW scale.

3.11.2.1.5 Kilovarmeter. The kilovarmeter shall be a switchboard type instrument conforming to MIL-W-19088, Type Designation MR492W500ACKWH, except that the instrument shall have a phase-shifting transformer and shall indicate the kvar of either 3 phase, 4 wire, or 3 phase, 3 wire circuits. The instrument shall be transformer rated for 5 amperes, 120 volts, shall operate on 50/60 Hz, and shall have a 0-500 kvar scale.

3.11.2.1.6 Power factor meter. The power factor meter (pf) shall be a switchboard type instrument conforming to MIL-M-19261 and complete with all external accessories, except potential and current transformers. The instrument shall be rated for 5 amperes, 120 volts, single phase, ac, and operate on 50/60 Hz. The instrument shall have a white dial with black pointer and markings and the scale calibrated to read zero lag to zero lead from left to right.

3.11.2.1.7 Synchroscope. The synchroscope shall be a switchboard type instrument conforming to MIL-I-16104, Type II, except it shall operate on 50/60 Hz. The instrument shall be transformer rated, 120 volts, single phase, ac.

3.11.2.1.8 Watt-hour meter. The watt-hour meter shall be a switchboard type meter conforming to MIL-M-18420, Type II, Class 3, Style B. The instrument shall be transformer rated for 5 amperes, 120 volts, and suitable for operation on 50/60 Hz.

3.11.2.1.9 Generator temperature indicator. The temperature indicator shall conform to MIL-T-15377. The instrument shall be rated for 120 volts ac and operate on 50/60 Hz. The instrument shall be calibrated to read directly for 20° C to 140° C minimum, shall be compatible with the temperature detectors imbedded in the generator windings, and shall indicate the temperature. The temperature indicator shall have a white dial with black pointer and markings.

3.11.2.2 Generator controls. Control devices, mounted on the generator control panel and connected for the required function, shall include, but be not limited to, the items specified in the following paragraphs.

3.11.2.2.1 Circuit breaker control. The circuit breaker control shall be a three position (TRIP-NORMAL-CLOSE) control switch, with spring return to NORMAL position, conforming to MIL-S-18396. The control switch shall be rated for 500 volts ac and shall have the number of poles (stages) required for the control of the circuit breaker in the specific application. The control switch shall have an escutcheon plate with a window and red and green flag indicator to show the last operation of the control and shall be marked CIRCUIT BREAKER. The escutcheon plate shall be marked to show clockwise motion to close the circuit breaker, and counterclockwise motion to trip the circuit breaker. A pull-to-lock feature shall be provided to trip the circuit breaker and de-energize the position indicating lights.

3.11.2.2.2 Ammeter selector switch. The ammeter selector switch shall be a four position, nonspring return meter switch, rated for 500 volts ac, conforming to MIL-S-18396. The switch shall enable selective connection of the ammeter to indicate the current in each of the 3 phases of the generator output, plus an OFF position. The switch shall have a round, knurled operating handle with a pointer,

and an escutcheon plate marked to show the switch position and the word AMMETER. The OFF position shall be with the pointer in the vertical up position. The other three positions, clockwise from the OFF position at 90 degrees, 180 degrees, and 270 degrees, respectively, shall be marked PHASE 1, PHASE 2, and PHASE 3. Switch contacts shall be so arranged that the current transformer secondaries are never open-circuited by the operation of the ammeter selector switch.

3.11.2.2.3 Generator-bus voltmeter selector switch. The generator-bus voltmeter selector switch shall be a seven position, nonspring return meter switch, rated for 500 volts ac, conforming to MIL-S-18396. The switch shall enable selective connection of the voltmeter to indicate phase-to-phase voltage of the generator and bus, plus on OFF position. The voltmeter switch shall have a round, knurled operating handle with a pointer and an escutcheon plate marked to show the switch position and the words GENERATOR-BUS VOLTMETER. The vertical up position shall be marked OFF. The other six positions, clockwise from the OFF position (± 1 degrees) at 50 degrees, 100 degrees, 150 degrees, 200 degrees, 250 degrees, and 300 degrees, shall be marked "GEN 1-2", "BUS 1-2", "GEN 2-3", "BUS 2-3", "GEN 3-1, and "BUS 3-1", respectively.
"

3.11.2.2.4 Synchronizing switch. The synchronizing switch shall be a two position, nonspring return control switch, rated for 500 volts ac, conforming to MIL-S-18396. The synchronizing switch, when in the ON position, shall energize the synchroscope and synchronizing lights. The switch shall have a round, knurled operating handle with a pointer and an escutcheon plate marked to show the switch position. The synchronizing switch shall be electrically interlocked with the parallel switch, the synchronizing check relay, and the closing circuit of the circuit breaker so that, with the parallel switch in the PARALLEL position, the synchronizing switch must be in the ON position and the synchronizing check relay must verify that the generator is synchronized with the bus before the circuit breaker can be closed.

3.11.2.2.5 Generator temperature indicator selector switch. The temperature indicator selector switch shall be a rotary, cam operated switch rated for not less than 240 volts ac and having a contact rating designation of A300 in accordance with NEMA ICS. The switch shall have not less than six positions to enable selection by phases of the individual imbedded detector to be monitored by the temperature indicator. The switch shall have a round, knurled knob with a pointer and an escutcheon plate marked to show the switch position and the words GENERATOR TEMPERATURE.

3.11.2.2.6 Manual voltage control. The manual voltage control shall be a manually operated variable resistor to enable manual adjustment of the set output voltage. The control shall have an escutcheon plate marked by an arrow and the word INCREASE to indicate clockwise rotation to increase the set voltage, and an arrow and the word DECREASE to indicate counterclockwise rotation to decrease the set output voltage.

3.11.2.2.7 Parallel switch. The parallel switch shall be a two position, maintained contact switch rated for not less than 240 volts ac, and having a contact rating designation of A300 in accordance with NEMA ICS. The two switch positions shall be marked PARALLEL and SINGLE SET, respectively. With the switch in the PARALLEL position, the reactive load compensation control shall be fully operative and the synchronizing switch, the synchronizing check relay, and the closing circuit of the circuit breaker shall be electrically interlocked (see 3.11.2.2.4). With the switch in the SINGLE SET position, the reactive load compensation control shall be inoperative and the interlock between the synchronizing switch, the synchronizing check relay, and the closing circuit of the circuit breaker shall be bypassed.

3.11.2.2.8 Phase sequence indicator. The phase sequence indicator shall consist of two indicating lights, a three position (GEN-OFF-BUS), selector switch and a single pole, momentary contact, normally open pushbutton, together with the necessary auxiliary devices and circuitry to provide a selective indication of the phase sequence of the generator output and the bus, when connected to an outside source of power. The indicating lights shall be mounted side-by-side in a horizontal configuration and each indicating light shall consist of the following:

(a) A lampholder and housing assembly conforming to MIL-L-3661/8, Style LH76, Type Designation LH76/2.
(b) A lens assembly conforming to MIL-L-3661/14, Style LC14, Type Designation LC14CD3, with a colorless diffusing lens.
(c) A neon lamp, Industry Designation NE51H, 100-125 volts.

The selector switch and pushbutton shall be mounted in close proximity to the indicating lights, and shall be rated for not less than 240 volts ac with a contact rating designation of A300 in accordance with NEMA ICS. The circuitry of the phase sequence indicator shall be such that, with the selector switch in either the GENERATOR or BUS position, the indicating light on the left will be energized when the

phase sequence is 1, 2, 3 (or A, B, C) and the indicating light on the right will be energized when the phase sequence is 3, 2, 1 (or C, B, A). With the selector switch in the OFF position, the phase sequence indicator system shall be de-energized. The pushbutton shall be connected in the circuitry to provide a test switch, so that depressing the pushbutton will simultaneously energize both indicating lights with the selector switch in either position. The selector switch shall have a pointer type operating knob and an escutcheon plate that is clearly marked to indicate GEN (generator), OFF, and BUS positions. The pushbuttons shall be marked "test".

3.11.2.3 Other controls. The following controls shall be mounted on the inside of the control center with the control features accessible externally, unless otherwise specified herein.

3.11.2.3.1 Reactive load compensation control. The reactive load compensation control shall be a manually operated variable resistor to enable adjustment of the reactive droop of the voltage regulation system, and thereby control the division of kvar between sets operating in parallel. The reactive load compensation control shall be mounted on the inside face of the generator control panel, or on a subpanel immediately behind the generator control panel. The reactive load compensation control shall have a round knob with a pointer and an escutcheon plate that is clearly marked to indicate the clockwise rotation of the knob which causes the set to increase its share of total reactive kva.

3.11.2.3.2 Governor paralleling control. The governor paralleling control shall be manually operated potentiometer to permit intitial matching of the governor paralleling circuits for sets operating in parallel. The control shall have a slotted shaft with locking devices. Counterclockwise rotation of the control shall cause increase in the signal appearing at the paralleling receptacle (see 3.11.2.3.5) and an escutcheon plate shall be provided to show this information.

3.11.2.3.3 Frequency droop switch. A frequency droop switch with a locking device to prevent accidental actuation shall be provided and interconnected with the governor circuitry such that the set will operate isochronous or droop operation. The switch position shall be identified as "ISOCHRONOUS" and "DROOP".

3.11.2.3.4 Maintenance lockout switch. A maintenance lockout switch shall be provided to prevent energizing of all circuits except for circuits energized by external power. The switch positions shall be identified as "OPERATION" and "MAINTENANCE". The switch shall have provisions for pad-locking.

3.11.2.3.5 Paralleling receptacles. Each set shall have six paralleling receptacles; three receptacles, permanently labeled "reactive load compensation"; and three receptacles permanently labeled "governor paralleling circuit". Like receptacles shall be mounted on the exterior of the enclosure and electrically connected in parallel.

3.11.2.3.5.1 Reactive load compensation receptacles. The three reactive load compensition receptacles shall conform to MS3102R12S-3S and shall be used for interconnection of the voltage regulators. Two of the receptacles shall have captive dust caps permanently attached. The third receptacle shall be provided with a permanently attached MS3106R12S-3P captive shorting plug which, when installed, shall short Pins A and B. The receptacles shall be mounted on the exterior of the enclosure.

3.11.2.3.5.2 Governor paralleling circuit receptacles. The three governor paralleling circuit receptacles shall conform to MS3102R10SL-3S, and shall be used for interconnection of the governors. Pins A and B shall be used for governor interconnection, with Pin A being positive. Pin C shall be electrically grounded to the chassis. The receptacles shall be mounted on the exterior of the enclosure.

3.11.2.3.6 Indicating lights (generator). Indicating lights, mounted on the generator control panel and connected for the required function shall include, but be not limited to, the items specified in the following paragraphs. The lampholder and housing assembly for each indicating light shall conform to MIL-L-3661/38, Style LH89, Type Designation LH80/1. The lens assembly for each light shall conform to MIL-L-3661/21, Style LC21, Type Designation as specified herein. Each light shall have a lamp, Industry Designation 6S6DC, of the voltage rating required for the respective control circuit.

3.11.2.3.7 Circuit breaker position indicators. The circuit breaker position indicators shall consist of two indicating lights, one red and one green color lens. The indicating lights shall be mounted side-by-side in horizontal configuration directly above the circuit breaker control switch. The indicating lights shall be connected in the control circuit so that the green light will be energized when the circuit breaker is in the OPEN position. The lens assembly of the green indicating light shall be Type Designation LC21GN3, with a green nondiffusing lens. The lens assembly of the red indicating light shall be Type Designation LC21RN3, with a red nondiffusing lens.

3.11.2.3.8 Synchronizing lights. The synchronizing lights shall consist of two indicating lights, with colorless, nondiffusing lens, mounted side-by-side in horizontal configuration directly above the synchronizing switch. The synchronizing lights shall be connected to supplement the synchroscope when paralleling with another generator or with an energized bus. The lights shall be out (dark) when the generator is in parallel with the other set or the bus. The lens assembly of each synchronizing light shall be Type Designation LC21CN3. Means shall be provided to insure that the voltage applied to the lamps does not exceed the lamp rating, regardless of the connection of the generator windings, either wye or delta.

3.11.2.4 Clocks. The generator control panel shall have two synchronous clocks energized by station power and mounted on the upper portion of the control panel. The clocks shall be of the same design, except that one shall operate at 60 Hz, and the other shall operate at 50 Hz. A double throw toggle switch shall enable selection of the clock to match the operating frequency of the set. The clocks shall have a white dial, not less than 8 inches in diameter, with black numerals and hands. The clocks shall be 12 hour with hour, minute, and sweep second hands, and a red flag to indicate interruption of power.

3.11.3 Switchgear. The generator output shall feed through and be controlled by the switchgear assembly. The switchgear shall contain all equipment and controls required for operation and protection of the generator set as specified herein, including but not limited to the following: Generator power circuit breaker, disconnecting switch, lightning arrestors, surge capacitors, voltage selector panel, voltage regulator, instruments, meters, relays, instrument transformers, station power transformer, 120/208 volt ac station power panelboard,

24 volt dc control and emergency power panelboard, meter switches, control switches, selector switches, indicating lights, and annunciator panel with alarm. All components of the switchgear shall be suitable for operation of the generator set on 50/60 Hz at the local and remote station. The construction, assembly and tests of the switchgear shall conform to ANSI C37.20 and NEMA SG-5. The switchgear shall have electric strip heaters, connected to the 120/208 volt ac station power system and controlled from the station power panelboard, of sufficient capacity to prevent condensation within the switchgear under all conditions specified in 3.4 and without damage to any part of the set.

3.11.3.1 Circuit breaker. The circuit breaker shall be a 3 pole, oilless, drawout type, stored energy, dc controlled, ac circuit breaker. The circuit breaker shall be rated for not less than 1200 amperes, 4.16 kv, and shall conform to ANSI C37.4. The circuit breaker shall have an interrupting capacity of not less than 250 megavolt amperes. The operating mechanism shall be trip-free, and shall have provision for manual operation. The circuit breaker shall be connected in the generator output circuit, ahead of the disconnecting switch. When paralleling the generator with other like power sources, the closing circuit of the circuit breaker shall be electrically interlocked with the parallel switch, the synchronizing switch, and the synchronizing check relay so that the parallel switch must be in the PARALLEL position, the synchronizing switch must be in the ON position, and the synchronizing check relay must verify that the generator is synchronized (proper voltage, frequency, and phase sequence) with the bus (load side of the circuit breaker) before the circuit breaker can be closed. The circuit breaker shall be key interlocked with the disconnecting switch so that the circuit breaker must be in the OPEN position before the disconnecting switch can be opened, and so that the disconnecting switch must be closed before the circuit breaker can be closed. The circuit breaker shall be key interlocked with the operating voltage selector compartment so that the circuit breaker must be locked in the OPEN position to release the key for access to the operating voltage selector.

3.11.3.2 Disconnecting switch. The disconnecting switch shall be a 3 pole, single throw, manual, group operated disconnecting switch rated for not less than 600 amperes, 4.8 kv, conforming to ANSI C37.30. The disconnecting switch shall be installed so as to isolate

the power circuit of the generator set from the outgoing load terminals. The disconnecting switch shall be interlocked with the circuit breaker (see 3.11.3.1) so that the circuit breaker must be in the OPEN position before the disconnecting switch can be opened and so that the disconnecting switch must be closed before the circuit breaker can be closed.

3.11.3.3 Output terminals. Terminals shall be provided to connect the distribution cables (see 3.13) to the switchgear bus. They shall be conspicuously marked and identified in accordance with MIL-STD-195. Terminals shall be rigidly mounted; studs shall not twist or turn in their mountings. Terminal L_1, L_2, and L_3 shall correspond to phase rotation of A, B, and C respectively.

3.11.3.4 Operating voltage selector. The switchgear shall have an operating voltage selector. The operating voltage selector shall be a link-type, manual reconnection panel to enable readily reconnecting the generator output leads from the 2400 volts, 3 phase, 3 wire connection to the 2400/4160 volts, 3 phase, 4 wire connection (and vice versa). All instrumentation and correlated generator set auxiliaries shall be interlocked with the operating voltage selector to assure proper operation of the set under all conditions specified herein. The operating voltage selector shall be in a control center compartment with a hinged access door. The access door shall be key interlocked with the circuit breaker so that the circuit breaker must be locked in the OPEN position to release the key for access to the operating voltage selector compartment; and so that the operating voltage selector compartment must be closed and locked to release the key to unlock the circuit breaker.

3.11.3.5 Generator protective devices. Generator protective devices, installed, connected, and adjusted for the required function shall include, but shall not be limited to, the items specified in the following paragraphs. Operation of a protective device shall trip the generator circuit breaker, sound the alarm, and indicate the respective operation on the annunciator alarm system.

3.11.3.5.1 Overvoltage. The overvoltage protective device(s) shall be a three phase inverse-time-overvoltage type relay(s) that will operate when the voltage between any two phases has risen to and remained at or above a preset value. The relay(s) shall have provisions to enable selecting the overvoltage value and time delay. The overvoltage protective device(s) shall be transformer rated for 120 volts. The overvoltage protective device(s) shall be Westinghouse Electric Corporation Type CV-6, General Electric Company Type IAV51, or equal.

3.11.3.5.2 Undervoltage. The undervoltage protective device(s) shall be a three phase, inverse time-undervoltage type relay(s) that will operate when the voltage between any two phases drops to and remains at or below a preset value. The relay(s) shall have provisions to enable selecting the undervoltage value and the time delay. The undervoltage protective device(s) shall be transformer rated for 120 volts. The undervoltage protective device(s) shall be Westinghouse Electric Corporation Type CV-2, General Electric Company Type IAV54, or equal.

3.11.3.5.3 Overcurrent. The overcurrent protective device(s) shall be a three phase time-overcurrent type relay(s) with very inverse time characteristics that will operate when the current in any phase has risen to and remained at or above a preset value. The relay(s) shall have provision to enable selecting the overcurrent value and the time delay. For any overcurrent and time setting, the time shall be inversely proportional to the current through the relay(s). Each overcurrent protective device shall have an instantaneous unit to provide operation without time delay, or extremely high current flow. The overcurrent protective device(s) shall be transformer rated for 5 amperes. The overcurrent protective device(s) shall be Westinghouse Electric Corporation Type CO-9, General Electric Company LAC53, or equal.

3.11.3.5.4 Synchronizing check relay. The synchronizing check relay shall sense the voltage, frequency, and phase sequence between the generator and the bus (load side of the circuit breaker) during paralleling operations. The synchronizing check relay shall be electrically interlocked with the parallel switch, the synchronizing switch, and the closing circuit of the circuit breaker so that, with the parallel switch in the PARALLEL position and the synchronizing switch in the ON position, the synchronizing check relay shall verify that the generator is synchronized (proper voltage), frequency, and phase sequence with the bus before the circuit breaker can be closed. The synchronizing check relay shall be transformer rated for 120 volts at 100 percent load and synchronizing voltage.

3.11.3.5.5 Reverse power. The reverse power protective device shall be a time delay, power directional relay that will operate when the 3 phase power flowing into the generator (motoring power) reaches and remains at or above a preset value. The relay shall enable selecting the pickup power to initiate operation and to enable adjustment of the time from pickup to closing of the relay contact(s). For any pickup power and time setting, the time from pickup to closing of the relay contact(s) shall be inversely proportional to the magnitude of the power flow sensed by the relay. The pickup power and time setting shall be as recommended by the generator manufacturer. The reverse power protective device shall be transformer rated for 120 volts 5 amperes at 100 percent load and synchronizing voltage. The reverse power protective device shall be Westinghouse Electric Corporation Type CW, General Electric Company Type ICW, or equal.

3.11.3.6 Annunciator alarm system. The annunciator alarm system shall consist of audible and visual signals to attract the attention of the operator and indicate the occurance of abnormal conditions in the set. The visual alarm shall consist of a backlighted annunciator panel with a window for each function specified herein. The annunciator alarm system shall have three pushbuttons, mounted in a convenient location and marked: ALARM SILENCE, TEST, and RESET, respectively. When a monitoring or protective device operates, the annunciator alarm system shall indicate the condition by sounding the audible alarm and by a flashing light behind the respective window(s) of the annunciator panel. Operation of the ALARM SILENCE pushbutton shall silence the audible alarm and cause the light(s) to stop flashing, but remain lighted. After the cause of alarm has been corrected, operation of the RESET pushbutton shall extinguish the light(s) and reset the system. Operation of the TEST pushbutton shall sound the audible alarm and light all windows of the annunciator panel as long as the pushbutton is held in the depressed position. The operations to be indicated on the annunciator alarm system shall include, but is not limited to, the following:

(a) Turbine: High turbine temperature(s), high lubricating oil temperature, low lubricating oil pressure, overspeed trip, excessive vibration, start failure, low fuel level alarm (1 hour), low fuel level shutdown, airflow restriction, and scavenger blower.
(b) Generator: Overvoltage, undervoltage, overcurrent, and reverse power.

3.11.3.7 Station power. The station power system shall be balanced, 3 phase, 4 wire, 120/208 volts 50/60 Hz, ac rating, and shall have capacity to supply all the generator set auxiliaries, equipment, lighting and maintenance heaters, plus not less than 10 kva additional load. The station power system shall consist of a transformer, power distribution panel, protective devices, wiring and other items required to provide the complete system. Provision shall be made to enable a selection of the source of station power from the generator set, an external source of power at generator voltage, or an external source of power at utilization voltage (120/208 volts).

3.11.3.7.1 Transformer. The transformer to supply station power from a source of power at generator voltage shall be a dry-type three phase transformer rated 2400/4160 wye, volts to 120/208 wye, volts, and of sufficient rated capacity to meet the station power requirements.

The transformer shall operate at either 50 Hz or 60 Hz and at the operating voltages specified in 3.11.3.7. The high voltage windings of the transformer shall be connected through fused disconnects to the bus in such manner that the transformer may be energized from either the generator or an external source of power at generator voltage. In addition, the high voltage windings shall be connected through the operating voltage selector (see 3.11.3.4) such that the transformer connections will be compatible with the selected operating voltage of the generator set. The low voltage windings of the transformer, connected for 120/208 wye, volts, shall be connected through a circuit breaker to the station power distribution panel. The circuit breaker shall be a 3 pole molded case circuit breaker rated for not less than 480 volts, ac, and conforming to W-C-375, Class 3b, and shall be mechanically interlocked with the circuit breaker on the external source of power at utilization voltage (see 3.11.3.7.2).

3.11.3.7.2 External source of station power. Provision shall be made to enable the supply of power to the station power distribution panel from an external source of power at utilization voltage (120/208 wye, volts). The equipment shall consist of a connector assembly in a weather resistant enclosure, conductors in conduit from the connector to a circuit breaker in the switchgear, the circuit breaker and conductors from the circuit breaker to the station power distribution panel. The connector shall be a 4 pole, male in a weather resistant enclosure having a spring-loaded closure door and shall be Crouse-Hinds type ARE, or equal, rated for not less than 60 amperes, 600 volts, ac. The circuit breaker shall be a 3 pole molded case circuit breaker rated for not less than 480 volts, ac, and conforming to W-C-375, Class 3b, and shall be mechanically interlocked with the circuit breaker on the station power supply from the transformer (see 3.11.3.7.1) such that when one breaker is closed, the other breaker can not be closed.

3.11.3.7.3 Station power distribution panel. The station power distribution panel shall be located in the control center compartment and shall be a 3 phase, 4 wire, circuit breaker panelboard conforming to W-P-115, Type I, Class 2, and rated for 120/208 wye, volts. The distribution panel shall have mains rated for not less than 100 amperes and shall have branch circuit breakers of the proper rating and number of poles to supply power to all generator set auxiliaries plus not less than one spare 3 pole, 30 ampere and two spare single pole, 20 ampere branch circuit breakers.

3.11.4 Provision for remote control. Each generator set shall have provisions for connecting to a remote station located up to 100 feet from the set. All wiring from the turbine control panel (see 3.11.1) and switchgear (see 3.11.3), to provide for remote control, shall be terminated on terminal blocks, mounted in an enclosure adjacent to the switchgear. The terminal block enclosure shall be fabricated of sheet steel conforming to ASTM A568, not less than 0.059 inch (revised Mfg. Std. Gage No. 16) thickness and shall have a removable bolted steel cover. Each terminal on the terminal blocks shall be identified by permanent markings keyed to a wiring diagram to identify the respective function.

3.12 Other requirements.

3.12.1 Compressor discharge gage. A compressor discharge gage shall be furnished and installed, as recommended by engine manufacturer.

3.12.2 Fuel boost pump discharge gage. A fuel boost pump discharge gage shall be furnished and installed, as recommended by engine manufacturer.

3.12.3 Insulating matting. The floor in all areas near high voltage electrical equipment shall be covered with insulating matting of not less than 5 kv dielectric strength.

3.13 Power cables. Power and interconnecting cables, as specified herein, shall be furnished, and provision shall be made for storage of the cable within the set. Cables for external station power supply shall be heavy-duty extra flexible portable cables, rated for operation at 5 kv, and conforming to NEMA WC7. All cables shall be suitable for direct burial or laying on the earth surface. All portable power cables shall be rated for conductor operating temperature of not less than 75° C and shall be sized to carry the full rated load under all conditions specified herein without exceeding the allowable ampacities, as recommended by the cable manufacturer for application.

3.13.1 Outgoing power cable. The outgoing power (load) cable shall consist of four 150-foot lengths of single conductor, portable power cable, rated for operation at 5 kv. Each end of each conductor shall have a bolted type terminal lug (see 3.3.8). The cables shall be ducted from the output terminals in the control center to one of the

housing. A strain grip shall be installed on each cable to enable transmitting mechanical strain on the cable directly to the enclosure. The strain grips shall be split type, double weave grips.

3.13.2 Station power cable. The station power cable, to provide station power from an external source, shall consist of one 75-foot length of four conductor, portable power cable, rated for operation at not less than 600 volts and 60 Hz. The cable may be either triplexed single conductor cable, or a multiconductor cable. One end of the four conductor cable shall have a dead front type connector plug to mate with the receptacle specified in 3.11.3.7.2. The other end of each conductor shall have a tinned, 1-1/2 inch long, pigtail. A strain grip shall be installed on the cable near the connector plug to enable transmitting mechanical strain on the cable directly to the enclosure. The strain grip shall be a split type, double weave grips.

3.13.3 Paralleling cables. Two paralleling cables for interconnecting sets are required:

(a) Reactive load compensation cable (see 3.13.3.1).
(b) Governor paralleling circuit cable (see 3.13.3.2).

3.13.3.1 Reactive load compensation cable. The reactive load compensation cable shall consist of a 100 foot length of 2 conductor, portable power cable not smaller than 16 AWG and rated for operation at 600 volts. Each end of the cable shall terminate with a connector which will interface with the reactive load compensation receptacles specified in 3.11.2.3.5.1

3.13.3.2 Governor paralleling circuit cable. The governor paralleling circuit cable shall consist of a 100 foot length of shielded, twisted pair, 2 conductor, portable power cable not smaller than 16 AWG and rated for operation at 600 volts. Each end of the cable shall terminate with a connector which will interface with the governor paralleling circuit receptacles specified in 3.11.2.3.5.2. The shield of the cable shall be attached to Pin "O" of the connector on one end only.

3.14 Electromagnetic interference. Unless otherwise specified (see 6.2), the electromagnetic interference emission and susceptibility characteristics of the set shall conform to MIL-STD-461A, Class V, even through the set kilovolt-ampere (kva) is greater than 60 kva.

3.15 Identification, marking, and information. The sets shall be identified and marked and have information and instruction plates as specified herein. Plates shall be copper-base alloy or anodized aluminum not less than 0.030-inch thick and permanently affixed to the set with rivets or bolts and photoetched.

3.15.1 Set identification plate. A plate containing the following information shall be mounted near the forward end of the set enclosure: National stock number, technical manual number, serial number, manufacturer's name and date of manufacture, contract number, length, width, height, cube, dry weight, turbine engine manufacturer and model number, and generator manufacturer and model number. Also, all applicable ratings of the generator set (voltage, kW, frequency, pf) shall be shown on the plate. In addition, the plate shall have a place for the Government inspector's stamp and date of inspection.

3.15.2 Information plates, instruction plates, and markings. Plates specified below shall be supplied and installed.

3.15.2.1 Operating instructions. Operating instructions shall be mounted adjacent to the switchgear. The operating instructions shall be complete and brief; shall describe procedures for starting, operating, and stopping at ambient temperatures from 125° F (51.7° C) to -25° F (31.6° C); shall describe procedures for paralleling; shall state types and quantities of oil, grease, and fuel to be used for each operating temperature range; shall state information on grounding the set frame with a warning that this should be done to avoid shock hazard.

3.15.2.2 Schematic and wiring diagrams. A schematic wiring diagram shall be mounted near the switchgear. The schematic diagram shall show the complete operation and functional sequence of the circuit for analysis and maintenance of the set. The wiring diagram shall show the physical location of all wiring interconnections in the same relationship in which they are installed. Identification marking of instruments, control devices, and connections shall be shown in both diagrams and shall coincide with markings on all items being identified. Electrical symbols shall be in accordance with ANSI Y32.2. When additional electrical symbols are used for items not in ANSI Y32.2, the meaning of the symbols shall be defined by a note on the diagrams.

3.15.2.3 Fuel system diagram. A diagram, mounted near the control center, shall show the fuel system. The diagram shall include identification of valves and proper positions for operation under all conditions specified herein.

3.15.2.4 Lubricating oil system diagram. A diagram, mounted near the control center, shall show the lubricating oil system. The diagram shall include identification of all components of the system and position of valves for operation under all conditions specified herein.

3.15.2.5 Connection changeover instructions. A plate, mounted near the operating voltage selector, shall show the connections and outline the procedures for reconnecting the generator output leads for the required voltage connection (see 3.11.3.4).

3.15.2.6 Battery connection plate. A plate, mounted adjacent to the batteries, shall have a schematic diagram showing the battery cable connections. The plate shall include instructions for removing, installing, and servicing batteries.

3.15.2.7 Grounding stud plate. A plate at the grounding stud shall be marked GROUND.

3.15.2.8 Caution plates. All high voltage terminals, switchgear, and switchboard shall be prominently marked with DANGER - HIGH VOLTAGE plates in accordance with NFPA No. 70. A plate adjacent to the battery charger shall indicate a warning for insuring proper ventilation of batteries when charging, and a sign to indicate NO SMOKING in the battery compartment.

3.15.2.9 Instrument and control identification. Each instrument and control device shall be identified by nameplate. Terminals and conductors shall be properly marked in accordance with MIL-STD-195. Identification tags or markings shall be made in a manner and of a material that will not become illegible through daily use and maintenance of the generator set. Each conductor shall have, and the connection diagram shall show, identical designation at both ends of the wire.

3.15.2.10 Lifting and tiedown attachments diagram. A plate, mounted in a conspicuous location on the enclosure, shall have a diagram showing the lifting attachments, slings, spreader bars, and tiedown attachments

for the enclosure. The diagram shall have a silhouette of the enclosure showing the following:

(a) The center of gravity of the generator set with underbody components installed and removed with no fuel or lubricants, other than as required to protect or preserve the equipment during transit or storage.
(b) The center of gravity of the generator set with the underbody components installed and removed with a full tank of fuel, all lubricants, and other items required, to provide a ready-for-operation generator set.
(c) The arrangement of the lifting slings with spreader bars, and the lifting capacity of each attachment.
(d) The location and load capability of each tiedown device. The identification of the tiedown devices shall clearly indicate that the devices are intended for tiedown of the generator set and generator set with the underbody kit installed on the transportation carrier during shipment.

3.15.2.11 Receptacle plates. A plate at the receptacles shall be marked "120 VOLTS AC" or "24 DC", as applicable (see 3.6.9.2.7.2).

3.15.2.12 Identification plates for optional equipment (see 3.7.2, 3.7.3, 3.7.4, 3.7.5, 3.17.1. Each assembly shall be provided with an identification plate showing nomenclature, contract No., manufacturer's name, date of manufacture, serial No., dimensions and weight. The plate(s) shall also have a place for the Government inspection stamp and date.

3.15.2.13 Schematic and wiring diagram for remote control station. Remote control station shall be provided with a schematic and wiring diagram as specified in 3.15.2.2.

3.15.2.14 Lubrication diagram plate for underbody kit. The underbody kit shall be provided with a lubrication diagram plate (see 3.7.6).

3.16 Cleaning, treatment, and painting. Unless otherwise specified (see 6.2), surfaces normally painted shall be cleaned, treated, and painted as specified herein. When specified (see 6.2), the unit shall be cleaned, treated, and painted in accordance with MIL-T-704, Type A. In either case, color of the finish coat shall be as specified (see 6.2). Color numbers specified shall conform to FED. STD. No. 595.

3.16.1 Cleaning. Metal surfaces to be painted shall be cleaned to insure that they are free from all oil, grease, welding slag and spatter, all mill scale, products of corrosion, dirt, and other foreign substances.

3.16.2 Treatment. As soon as practicable after cleaning, and before any evidence of rust or other contamination can result, metal surfaces shall be treated with a primer pretreatment coating to increase the adhesion of the coating system.

3.16.3 Painting. Painting shall consist of at least one coat of rust-inhibiting primer and one coat of finish enamel. The rust-inhibiting primer shall be applied to a clean, dry surface as soon as practicable after cleaning and treating. Painting shall be with manufacturer's current materials according to manufacturer's current processes except that the total dry film thickness shall be not less than 2.5 mils. The paint shall be free from runs, sags, orange peel, or other defects.

3.17 Remote control. When specified (see 6.2), each generator set shall be furnished with a separate remote control station (see 3.17.1) and remote control cable (see 3.17.2). When used, the remote control station and cable will allow remote start and stop, monitor, control of the set in unit operation, and paralleling with like sets from a remote location up to 100 feet away.

3.17.1 Remote control station. The remote control station shall be 58.75 $\pm$ 0.50 inches high, 34.75 $\pm$ 0.50 inches wide, and 23.50 $\pm$ 0.50 inches deep, with a terminal board indentation in the rear. The terminal board shall be a duplication of the terminal board on the set (see 3.11.4) and be mounted in the terminal board indentation located at the rear of the cabinet (Item 21, Figure 3). The rear indentation shall be centered on the vertical centerline, shall be four sided, with a back and bottom open, and the bottom shall share a common base with the remote control station. The indentation shall be 36 $\pm$ 0.50 inches high, 24 $\pm$ 0.50 inches wide, and 6 $\pm$ 0.50 inches deep. The remote control station shall have a hinged front panel with hinge located vertical on the left side and thumb nut fasteners at the side, top and bottom as necessary to secure the panel closed. Means shall be provided to permit swing-out and lock-open of the panel to not less than 105 degrees, but not to a point that damage occurs. Devices mounted on the control panel shall be divided and labeled into local-remote control, electrical control, and annunciator.

Each individual device on the control panel shall have a permanent identifying nameplate attached. A two position switch shall be installed and labeled "local-remote" (see 3.11.1.3.4). In the local position, the generator set shall be controlled by " on set" devices and the remote control will be inactive. In the "remote" position, control of the generator set shall be from the remote control station only. A permanently attached plate, located at the top center of the panel, shall identify the associated generator set (750 KW, GTED) (see Item 1, Figure 3).

3.17.1.1 Annunciator. The annunciator is a duplication of the set annunciator alarm system, with its associated devices (see 3.11.3.6) (Item 2, Figure 3).

3.17.1.2 Electrical control: The controls shall be identical to like controls used on the generator set.

(a) Ammeter (Item 3, Figure 3).
(b) Ammeter Selector Switch (Item 4, Figure 3).
(c) Generator/Bus Voltmeter (Item 5, Figure 3).
(d) Generator/Bus Selector Switch (Item 6, Figure 3).
(e) Synchroscope (Item 7, Figure 3).
(f) Synchronizing Switch (Item 8, Figure 3).
(g) Synchronizing Lights (Item 9, Figure 3).
(h) Voltage Adjustment Control (Item 10, Figure 3).
(i) Phase Sequence Indicator (Item 11, Figure 3).
(j) Parallel Switch (Item 12, Figure 2).
(k) Speed (Frequency) Control (Item 13, Figure 3).
(l) Frequency Meter (Item 14, Figure 3).
(m) KW Meter (Item 15, Figure 3).
(n) KVAR Meter (Item 16, Figure 3).
(o) PF Meter (Item 17, Figure 3).
(p) Circuit Breaker Control (with position lights) (Item 18 Figure 3).
(q) Start/Stop Button (Item 19, Figure 3).
(r) Telephone Jack (Item 20, Figure 3).

3.17.2 Remote control cable. The remote control cable shall allow 4 feet on both ends for connection to the appropriate terminal boards when the generator set and remote control station are separated up to 100 feet. The cable shall be for underground as well as above ground use. The cable shall include telephone lines in addition to the necessary lines for remote operation.

3.18 Delivery lubrication service. Unless otherwise preserved for packaging (see 5.1), all components shall be lubricated. Grease lubrication, including lubrication of sealed bearings, shall be with military greases conforming to MIL-G-10924 or MIL-G-23827, as applicable. The sets shall

be serviced with winter grades of military oils designated for use in the temperature range of 0° F (-17.8° C) to 32° F (0° C). Each component shall be tagged in a conspicuous place to indicate the temperature range and grades of oils and greases used.

3.19 Workmanship. Workmanship shall be in accordance with Requirement of MIL-STD-454.

4. QUALITY ASSURANCE PROVISIONS

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

4.1.1 Component and material inspection. The contractor is responsible for insuring that components and materials used are manufactured, examined and tested in accordance with referenced specifications and standards.

4.2 Classification of inspections. The inspection requirements specified herein are classified as follows:

(a) Preproduction inspection (see 4.3).
(b) Quality conformance inspection (see 4.4).
(c) Inspection of packaging (see 4.7).

4.3 Preproduction inspection.

4.3.1 Examination. The preproduction sets shall be examined as specified in 4.5. Presence of one or more defects shall be cause for rejection.

4.3.2 Tests. The preproduction generators-generator sets shall be subjected to the tests marked "X" in Columns 1 and 2 of Table V, as applicable. The tests under Column 2 may be conducted in any order, except that endurance-reliability shall be conducted last. The minimum acceptable maximum power for each set shall be established in accordance with MIL-STD-705, Method 640.2c, from the average of the initial and the average of the final maximum power values found for the preproduction sets. Failure of any test shall be cause for rejection.

4.4 Quality conformance inspection.

4.4.1 Examination. Each set shall be examined as specified in 4.5. Presence of one or more defects shall be cause for rejection.

4.4.2 Tests. Each set shall be subjected to the tests marked "X" in Column 3 of Table V. The tests shall be conducted in the order listed. Failure of any test shall be cause for rejection.

4.5 Examination. The sets shall be examined as specified herein for the following defects:

TABLE IV. DEFECTS

CRITICAL:

1. Safety

MAJOR

101. Generator power input requirement not as specified.
102. Weight and dimensions not as specified.
103. Electromagnetic interference reduction (quality conformance inspection only) not as specified.
104. Fungus and moisture resistance not as specified.
105. Thermal and sound insulation not as specified.
106. Capacitors not as specified.
107. Toggle switches not as specified.
108. Limit switches not as specified.
109. Relays not as specified.
110. Terminal boards and supports not as specified.
111. Hoses and fittings not as specified.
112. Hinges and latches not as specified.
113. Vibration proofing not as specified.
114. Dripproof construction not as specified.
115. Skid base not as specified.
116. Engine and generator mounting not as specified.
117. Housing not as specified.
118. Doors, covers, and access panels not as specified.
119. Opening for cooling air not as specified.
120. Operation of all shutter assemblies not as specified.
121. Opening for generator ventilation not as specified.

122. Cable openings not as specified.
123. Weather stripping seals not as specified.
124. Fire extinguisher mounting not as specified.
125. Fuel system not as specified.
126. Fuel tank not as specified.
127. Governing system not as specified.
128. Manual engine control not as specified.
129. Exhaust system not as specified.
130. Cranking system not as specified.
131. Storage batteries not as specified.
132. Battery rack not as specified.
133. Battery cables not as specified.
134. Battery charging system not as specified.
135. Protective devices not as specified.
136. Lubricating system not as specified.
137. Generator not as specified.
138. Generator leads not as specified.
139. Voltage reconnection system not as specified.
140. Generator drive not as specified.
141. Generator frame not as specified.
142. Generator rotor not as specified.
143. Generator bearings not as specified.
144. Rectifiers not as specified.
145. Excitation system not as specified.
146. Load terminals not as specified.
147. MS connectors not as specified.
148. Convenience receptacles not as specified.
149. Annunciator alarm system not as specified.
150. All fuses not as specified.
151. Control panel and associated devices not as specified.
152. Lifting attachment not as specified.
153. Identification and instructions not as specified.
154. Workmanship not as specified.

MINOR

201. Engine information on make, model, and qualification test reference number of the engine not as specified.
202. Weight and dimensions not as specified.
203. Standard hardware not as specified.
204. Threads not as specified.
205. Corrosion-resisting metals and treatment not as specified.
206. Blind hardware not as specified.

207. Contact of dissimilar metals not as specified.
208. Assembly of light-metal not as specified.
209. Treatment and painting not as specified.
210. Toolbox not as specified.

4.6 Tests. All tests shall be conducted with the generator set connected for 2400/4160 volts, 60 Hz operation, unless otherwise specified in Table V. The sets shall use lubricants specified in 3.9.1. Each turbine engine shall be subjected to green run testing following manufacturing and assembly. Except as otherwise specified herein, tests shall be conducted using fuel conforming to VV-F-800, Grade DF-2, and having a heat value of 18,440 Btu per pound. Test data shall be corrected to conditions of msl (760.0 mmHg) and 59° F (15.0° C). Test instruments shall be of the laboratory type and shall have been calibrated within 30 days of the start of testing and at 6-month periods thereafter. Instruments used in calibration should have at least five times the accuracy of the instrument being calibrated. Calibrated reference instruments of lesser accuracy than standard and which are not used for any other purpose may be used for the required periodic check of test instruments. Instruments shall be calibrated at the frequencies at which they are going to be used. Direct-reading instruments shall have at least 0.5 percent accuracy and shall be connected to indicate in the most accurate portion of their range. On dc instruments, the readings shall not be made on the lower one-third of the scale. On ac instruments, the readings shall not be made on the lower one-third of the scale. When the test methods call for the use of recording-type meters, the Texas Instrument Company Model PDRHXFHXVA-A16-XT shall be used. Oscillograph galvanometer frequency response shall be not 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 stating the warm-up period of the set and record continuously for the duration of the test. The recording meter shall be operated at a minimum speed of 6 inches per hour during the portions of the test where steady state loading conditions exist, and shall be operated at a minimum speed of 6 inches per minute at least 30 seconds before during, and after a load change. Nonconformance to the applicable requirement paragraph shown in Column 5 of Table V shall constitute failure of these tests. The Government reserves the right to reject the equipment for not meeting any requirement herein, even though not performing a test directly related to the specific requirement.

Table V. Test Schedule

Preproduction		Quality Conformance	Test	Test Method of MIL-STD-705 or test paragraph
Generator	Generator Set	Production Generator Set		
1	2	3	4	5
-	X	-	Torsiographing	504.2
-	X	-	Railroad impact test	740.5b (see notes 5 & 6)
X	-	X	Insulation resistance	301.1 (see Note 1)
X	-	X	High potential	(302.1 (see Note 1)
X	-	X	Winding resistance	401.1 (measure stator and field windings)
-	X	X	Phase balance (voltage)	508.1 (to be measured at load terminals)
X	-	-	Overspeed (Generator	505.3 (at 120 percent rated speed for 15 minutes) speed for 15
-	X	X	Start and Stop	503.1
-	X	X	Overspeed (set)	505.1 (at 120 percent rated speed for 5 minutes) (see Note 1)
-	X	X	Overspeed protective device	505.2
-	X	X	Phase sequence (rotation)	507.1
X	-	-	Open circuit saturation curve	410.1 (at both 50 and 60 Hz)
X	-	-	Synchronous impedance curve (short circuit saturation curve)	411.1 (at both 50 and 60 Hz)
X	-	-	Zero P.F. saturation curve	412.1 (at both 50 and 60 Hz)

Table V. Test Schedule Cont'd

1	2	3	4	5
X	-	-	Rated load saturation curve	413.1 (at both 50 and 60 Hz)
X	-	-	Short circuit (mechanical strength)	625.1 (see Note 7)
-	X	X	Regular range	511.1 (at both 50 and 60 Hz)
-	X	X	Frequency adjustment range	511.2 (at both 50 and 60 Hz)
-	X	-	Voltage unbalance with unbalanced load	620.2
-	X	-	Voltage and frequency drift	See 3.10.5.2 and 3.9.7.4
-	X	-	Fuel consumption	670.1 (see Note 8)
-	X	X	Low oil pressure protective device	515.1 (see Note 3)
-	X	X	Low fuel protective device	515.5 (see Note 3)
-	X	X	Overtemperature protective device	515.2 (see Note 3)
-	-	-	High oil temperature protective device	4.6.4 (see Note 3)
-	X	X	Fuel tank	4.6.1
-	X	X	Circuit breaker (short circuit)	512.1 (see Note 3)use oscillograph for preproduction sets only for production sets L_1-L_0, L_2-L_0 and L_3-L_0 shorts only.
-	X	X	Circuit breaker (overload trip)	512.2 (see Note 3)
-	X	X	Circuit breaker (undervoltage and overvoltage trip)	512.3 (see Note 3)
-	X	X	Reverse power relay	516.2 (see Note 3)

Table V. Test Schedule Cont'd

1	2	3	4	5
-	X	X	Frequency and voltage regulation, stability and transient response (short-term)	608.1 perform at 0 and 5% regulation at both 50 and 60 Hz
-	X	X	Frequency and voltage stability (long-term)	608.2 perform at 0 and 5% regulation at both 50 and 60 Hz.
-	X	-	Altitude operation	720.1 (at 8000 ft, 95° F) (see Note 11)
-	X	-	Remote operation	4.6.6
-	X	-	Voltage dip and rise for rated load	619.2
-	X	-	High temperature at 125° F (51.7° C)	710.1 also 619.2 (take temperature rise measurements on rotor and stator windings under the following conditions: 50 Hz, 1980 volt, delta 50 Hz, 4180 volt, wye 60 Hz, 2160 volt, delta 60 Hz, 4575 volt, wye also perform method 619.2 at 125° F)
-	X	X	Annunciator alarm system	4.6.2
-	X	X	Parallel operation	630.1 at both 50 and 60 Hz see 4.6.5
-	X	X	Electromagnetic interference	MIL-STD-461 (at all rated voltage connections)
-	X	-	Rain test	711.3
-	X	-	Road test	4.6.3 (see Note 9)
-	X	-	Sound level tests	661.2 (see Notes 4 and 5)
-	X	-	Humidity test	711.1c (see Note 9)
-	X	-	Generator power input	415.1b
X	-	-	Direct-axis transient reactance	425.1a

Table V. Test Schedule Cont'd

1	2	3	4	5
-	X	-	Negative sequence reactance	422.1a
-	X	-	Inclined operation	660.1c (5 degrees only)
-	X	-	Starting and operation	702.1b (at -25° F) -31.7° C)
-	X	-	Lifting and towing	740.4b
-	X	-	Tiedown	4.6.8 (see Note 5)
-	X	X	Instrument check	513.1c (for all voltage connections)
-	X	X	Voltage waveform	601.1c and 601.4a (at all rated voltage and frequency connections (see Note 2)
-	X	X	Maximum power	640.1
-	X	-	Air transportability	4.6.9
-	X	-	Maintenance heater	4.6.10
-	X	X	Start failure protective device	4.6.11 (see Note 3)
-	X	X	Airflow alarm	4.6.12 (see Note 3)
-	X	X	Scavenger blower failure alarm	4.6.13 (see Note 3)
-	X	-	Railroad hump (for remote control station)	740.5 (see Note 10)
-	X	-	High temperature (for remote control system)	4.6.15 at 125° F (51.7° C)
-	X	-	Low temperature (for remote control system)	4.6.16 at -25° F (-31.7° C)
-	X	-	Humidity test (for remote control system)	4.6.17
-	X	X	Endurance/reliability	4.6.7

NOTES:

1. Insulation resistance and high potential tests may be made after assembly of the generator to the engine but before final assembly of the complete set.

2. Also, view waveform with oscilloscope. For individual tests, only Method 601.4 need be used.
3. Also record the value at which the annunciator alarm sounds.
4. Exterior readings for sound level tests are to be taken at not less than six positions, one at each end and two at each side of the set. The interior readings for sound level tests are to be taken at not less than three positions located 2 feet from the front of the control center and not less than four positions in other work areas that are representative of required operator positions when the set is operating. Readings shall be taken at full rated load and at no load with the set operating at rated voltage and frequency. The microphone height shall be 5 feet 8 inches and the ambient background noise level shall be not less than 6 db below the specified noise level criteria being tested. Measurement shall be made on the C scale.
5. Also perform this test on the generator set with the underbody kit installed.
6. The set shall be hump tested twice at 5 mph; one set shall be mounted with the engine end forward and the other set shall be mounted with the generator end forward. The set shall be secured to the railroad car using the lifting and tiedown provisions. The set shall be humped with all fluids at the operating level and with not less than 300 gallons of fuel in the fuel tank.
7. Short circuit test shall be conducted for all possible line to line, line to neutral and three phase shorts. Maintain the short circuit for 10 seconds. Use the generator and excitation system.
8. Tests shall also be conducted at rated voltage, frequency and power factor at 3/4 and 1/2 rated load.
9. Perform with underbody kit installed.
10. The remote control station shall be humped at 5 mph. The test may be performed simultaneously with the set tests. Test shall be performed with equipment mounted in the normal position with the long dimension in the direction of motion. The test shall be repeated with the equipment rotated 90 degrees. Test items shall be packed and packaged Level C in accordance with MIL-G-28554.
11. The generator sets may be transported to the required altitude on a mountain for the altitude test. Conduct the test in accordance with Test Method 720.1c of MIL-STD-705.

4.6.1 Fuel tank test. The fuel tank shall be subjected to a hydrostatic pressure of 5 psi. Any leaks and any evidence of other defects shall constitute failure of this test.

4.6.2 Annunciator alarm system test. Test the annunciator alarm system for correct operation and indication of all malfunctions. Nonconformance to 3.11.3.6 shall constitute failure of this test.

4.6.3 Road. The road test shall be conducted with the underbody kit installed on the generator set and with the generator set connected to a suitable tractor. The set shall be in an operable condition with not less than 300 gallons of fuel in the set fuel tank. The combination shall be driven for four cycles of the following:

Road Condition	(miles)	(MPH)
Improved road	250	up to 50
Unimproved road	250	up to 20
Hilly cross country	125	up to 20
Belgian block	15	up to 20

During the road test, the turning ability, tracking ability, and brake performance shall be observed to verify conformance to the requirements. After the test, the complete generator set shall be examined for evidence of damage, misalinement, binding, or other malfunction. Nonconformance to 3.4.6 shall constitute failure of this test.

4.6.4 High oil temperature test protective device. The test shall be conducted using a simulated oil temperature similar to the simulated procedure for low oil pressure. Nonconformance to 3.9.8.3 shall constitute failure of this test.

4.6.5 Parallel operation. Each set shall be tested in parallel with the preproduction set(s). This test shall determine proper operation of all parallel operation controls and devices including the reverse power safety devices. It shall also check for proper load division and kilovolt amperes division at no load, half load, and full load. Set instrumentation may be utilized. Nonconformance to 3.10.8 shall constitute failure of this test.

4.6.6 Remote control and operation. The remote control and operation test shall be conducted with the set and remote control station interconnected by use of a 100 foot cable. By remote operation, determine compliance of: Engine start and stop; voltage and frequency adjustment; synchronizing and paralleling application and removal of load; provision to monitor set and bus frequency and voltages; real and reactive power; annunciator system; and parallel operation. Perform Test Method 513.1 of MIL-STD-705. Nonconformance to 3.17 shall constitute failure of this test.

4.6.7 Reliability-Endurance. Using the MTBF specified in 3.1.1, the sets shall be tested as specified herein, with "accept" and "reject" criteria in accordance with MIL-STD-781, Test Plan V. Continue testing until either an "accept" or "reject" decision is reached. When an "accept" decision is reached, continue testing until 2500 hours have been accumulated. Failures are defined in 6.3.15.

4.6.7.1 Test procedure. The test shall be conducted in accordance with Test Method 690.1c of MIL-STD-705, running 300 hours on fuel conforming to MIL-T-5624, Grade JP-5, 300 hours on fuel conforming to MIL-T-5624, Grade JP-4 and 1900 hours on fuel conforming to VV-F-800, Grade DF-2 with the sulfur content controlled between 0.55 and 0.65 percent. Cyclic loading during the test shall be as follows:

Percent of rated load at rated pf	Hours
75	25
100	30
110	2
50	20
75	15
25	8

Repeat above schedule 24 times (total of 25 cycles). The sets may be shut down at 500-hour intervals for normal servicing. Requirements for tear down will be limited to visual inspection of turbine blading, exhaust gas guide vanes, combustion chambers, fuel nozzles, ignition plugs, and reduction gears. During the test, servicing, adjustments and replacement shall be as specified in Table I.

4.6.7.2 Failure criteria. Nonconformance to 3.1.1 shall constitute failure of this test.

4.6.8 Tiedown. In lieu of the test, an analytical proof and tiedown diagram may be substituted to show that the equipment will comply with the requirements as specified herein; the contractor shall submit the proof to the contracting officer. Disapproval of the report shall constitute failure of this test.

4.6.9 Air transportability. The generator set with the underbody kit installed shall be towed to a C-130 aircraft using a military tractor. The set shall be loaded on the C-130 without the use of ground support equipment. Time shall be recorded from when the generator set is positioned at the rear of the aircraft until the set is loaded and ready for tiedonw. The set shall then be unloaded from the aircraft without the use of ground support equipment. Time shall be recorded from when the set is in position for tiedown until the underbody kit is installed and the set is in the highway transportability mode. Nonconformance to 3.7 shall constitute failure of this test.

4.6.10 Maintenance heater. With the set in the nonoperating configuration, the generator set shall be stored in an ambient temperature of -25° F for a minimum of 24 hours. The maintenance heaters shall be energized by closing the circuit breaker in the distribution panel. The test shall be conducted until the temperature in each compartment has stabilized or the thermostats have caused all heaters to cycle twice. Temperature shall be measured at locations 3 feet above the floor at four random locations within each compartment. The temperature of each compartment shall be the average of the four readings. Time for the test shall be measured from when the heaters are energized until a stabilized temperature is reached. Nonconformance to 3.6.9.4 shall constitute failure of this test.

4.6.11 Start failure protective device. Attempt to start the set with fuel shut off to the engine. Nonconformance to 3.9.8.6 shall constitute failure of this test.

4.6.12 Air flow alarm. Restrict the air flow through the intake air filter. Nonconformance to 3.11.3.6 and 3.9.2.2 shall constitute failure of this test.

4.6.13 Scavenger blower failure alarm. Simulate a scavenger blower failure. Nonconformance to 3.11.3.6 and 3.9.2.2 shall constitute failure of this test.

4.6.14 Remote control system.

4.6.14.1 High temperature. The remote control and remote control cable shall be used to start, load, and stop the set after the control and cable have been at 125° F for at least 24 hours. The start, load, and stop sequence shall be repeated 10 times. Load on the set shall be rated load. Load shall be maintained for at least 15 minutes, for the first nine cycles and for the last cycle the load shall be maintained for 2 hours. Nonconformance to 3.17 shall constitute failure of this test.

4.6.14.2 Low temperature. Conduct the test specified in 4.6.14.1 at -25° F (-31.7° C). Nonconformance to 3.17 shall constitute failure of this test.

4.6.14.3 Humidity. The remote control system shall be subjected to the five 48-hour humidity cycles specified in Method 711.1 of MIL-STD-705. Within an hour after removal from the test chamber the remote control system shall be used to start, load and stop a generator set. Nonconformance to 3.17 shall constitute failure of this test.

4.7 Inspection of packaging. The preservation, packing and marking of the generator set, remote control and underbody kit shall be inspected to determine compliance with the inspection and quality assurance provisions of the documents referenced in Section 5.

5. PACKAGING

5.1 Preservation. The degree of preservation shall be Level A, or Commercial, as specified (see 6.2).

5.1.1 Level A. The generator set remote control and underbody kit shall be preserved in accordance with Level A of MIL-G-28554 and the following.

5.1.1.1 Gas turbine engine. Unless otherwise specified (see 6.2), the gas turbine engine shall be preserved in accordance with MIL-E-5607, except the oil shall not be drained.

5.1.1.2 Dry charged batteries, battery cables, and electrolyte. The dry charged batteries shall be placed and secured in the battery compartment. The filler openings of the batteries shall be moisture sealed in a manner that the battery cannot be activated without destroying the seals. The battery cables shall be disconnected and secured to the battery box or compartment with tape conforming to PPP-T-60, Type IV. Electrolyte shall be contained in Type IV units and overpacked in wood containers in accordance with Level A of MIL-S-207. The packed electrolyte shall be stowed and secured inside the generator set in a manner to permit separate removal.

5.1.2 Level Commercial. The generator set, remote control, and underbody kit shall be preserved in accordance with FED. STD. No. 356.

5.2 Packing. The degree of packing shall be Level A, B, or Commercial, as specified (see 6.2.1).

5.2.1 Level A. The generator set, remote control, and underbody kit shall be packed in accordance with Level A of MIL-G-28554.

5.2.2 Level B. The generator set, remote control, and underbody kit shall be packed in accordance with Level B of MIL-G-28554.

5.2.3 Level Commercial. The generator set, remote control, and underbody kit shall be packed in a manner which will insure arrival at destination in satisfactory condition and which will be acceptable to the carrier at lowest rates. Packing shall comply with Uniform Freight Classification rules or National Motor Freight Classification rules.

5.3 Marking.

5.3.1 Military packaging. Marking shall be in accordance with MIL-STD-129.

5.3.2 Commercial packaging. Marking shall be in accordance with FED. STD. No. 356.

6. NOTES

6.1 Intended use. The generator sets are intended to supply electrical power for multipurpose military application.

6.2 Ordering data. Procurement documents should specify the following:

(a) Title, number, and date of this specification.
(b) Time frame required for submission of preproduction model (see 3.2).
(c) When other than the two dry chemical fire extinguishers are required (see 3.6.9.2.10).
(d) When two carbon dioxide fire extinguishers are required in lieu of the dry chemical fire extinguishers (see 3.6.9.2.10).
(e) When underbody kit is required (see 3.7).
(f) When tires shall be other than as specified (see 3.7.2.2).
(g) When batteries are to be shipped other than charged and dry (see 3.9.5.1).
(h) When electrolyte is to be furnished (see 3.9.5.1).
(i) When batteries shall be other than as specified (see 3.9.5.1).
(j) When a timer is not required (see 3.9.5.4).
(k) When speed reduction gear components are required (see 3.9.10).
(l) When electromagnetic interference shall be other than as specified (see 3.14).
(m) When cleaning, treatment, and painting, shall be other than as specified (see 3.16).
(n) When cleaning, treatment, and painting shall conform to MIL-T-704 (see 3.16).
(o) Color of the finish coat of paint required (see 3.16).
(p) When a remote control is required (see 3.17).
(q) Degree of preservation and packing required (see 5.1 and 5.2).
(r) When preservation and packing of the gas turbine engine shall be other than as specified (see 5.1.1.1 and 5.2).

6.3 Difinitions.

6.3.1 Start. A set is considered to have started when it is operating at rated voltage and speed without the further use of the starting system or starting aids.

6.3.2 Temperature and humidity damage. Temperature and humidity damage is defined as corrosion, breakage, deformation, reduction of insulation resistance below 50,000 ohms, or conditions causing malfunction of any component or part.

6.3.3 Dangerous flexural vibration. Dangerous flexural vibration is defined as vibration which occurs at a speed at which maximum stress in the shaft from flexural vibration exceeds 9,000 psi.

6.3.4 Dangerous torsional critical speed. Dangerous torsional critical speed is defined as the speed at which maximum vibrating stress in the shaft from torsional vibration exceeds 5,000 psi.

6.3.5 Rough handling damage. Rough handling damage is defined as deformation, loosening, breakage, change of fit of any component or part, or any condition resulting in malfunctioning of the set.

6.3.6 Transportation. Transportation is defined as the moving of the set from one location to another by rail, highway, air, or water, including the loading and unloading operations required for the relocation.

6.3.6.1 Rail transportation. Rail transportation shall include shocks and stresses from impact at speeds up to and including 5 mph under test conditions specified in MIL-STD-705, Method 740.5.

6.3.6.2 Highway transportation. Highway transportation, utilizing commercial truck-tractors, shall include speeds up to and including 60 mph over improved roads, and at speeds up to and including 20 mph over unimproved roads.

6.3.6.3 Air transportation. Air transportation shall include the shocks and stresses of take-off, in-flight operation, and landing of cargo type aircraft.

6.3.6.4 Water transportation. Water transportation shall include transport by ship or barge, operating over any type of waterway.

6.3.7 Improved road. An improved road is a smooth, hard surfaced road, such as a concrete or asphalt paved highway.

6.3.8 Unimproved road. An unimproved road is an unpaved, unstabilized road with an undulating surface having occasional chuckholes and exposed rocks.

6.3.9 Frequency and voltage regulation. Frequency and voltage regulation are defined as the difference between the no load value and the rated value divided by the rated load value and expressed as a percent of the rated load value.

6.3.10 Dripproof enclosure. A dripproof enclosure is an enclosure so constructed that falling drops of liquid or solid particles striking the enclosure at angles from 0 degrees to 15 degrees from the vertical cannot enter the enclosure either directly or by striking and running along a horizontal or inwardly inclined surface.

6.3.11 Stable set operating conditions voltage and frequency. Stable set operating conditions are defined as the conditions specified for steady state performance.

6.3.12 Overshoot and undershoot. Reference MIL-STD-705, Figure 608.1-VII for definitions of overshoot and undershoot.

6.3.13 Meter accuracy. Accuracy is a number which defines the limit of error expressed as percentage of full scale value. Error is the difference between the indication and the true value of the quantity measured. It is the quantity which, when algebraically subtracted from the indication, gives the true value. A positive error denotes that the indication of the meter is greater than the true value.

6.3.14 Fail-safe. A circuit arrangement so that an opening anywhere such as a broken wire or the operation of a circuit protection device, will interrupt the circuit output; or if a mechanical malfunction, will return the device to a condition to restrict the damage to the failed part(s).

6.3.15 Failure. A failure is defined as the inability of an item to perform within specified limits. The contracting officer will identify all failures and will classify them into the following categories.

6.3.15.1 Nonrelevant failure. A nonrelevant failure is one which is caused by any of the following:

(1) Failure of test instrumentation or monitoring equipment that is external to equipment under test.
(2) Damage resulting from accident or mishandling.
(3) Failures due to procedural errors by the technicians or operators.
(4) Secondary failures as defined by MIL-STD-781B.
(5) A failure (or shortcoming) that does not affect the intended purpose of the set (furnish electrical power within specified limits, or control the set as intended herein).
(6) Failures resulting from operating items beyond requirements, for example, if belts are run to failure to determine mean life, failures after 1000 hours are not considered set failures.
(7) Failures which may be corrected by normal operator functions, such as readjustment of voltage.

6.3.15.2 Relevant failure. All failures shall be considered relevant unless they are classified to be nonrelevant.

6.3.16 Altitude. Altitude is the elevation in feet above mean sea level (msl); the equivalent barometric pressure in millimeters of mercury (mmHg), shown in parenthesis following the altitude (i.e.: 8000 feet (564.4 mmHg)), is based on a barometric pressure of 29.92 inches (760 mm) of mercury under assumed standard msl conditions of 59° F (15° C) and air mass density of 0.001225 grams per cubic centimeter.

6.4 Any changes or deviations in production sets from the approved preproduction model during production will be subject to the approval of the contracting officer. Approval of the preproduction model will not relieve the contractor of his obligation to furnish sets conforming to this specification.

6.5 Data requirements. The contracting officer should include requirements for such data as technical publications, instructional materials, illustrated parts lists and contractor's maintenance and operation manual to be furnished with each engine-generator set.

6.6 Provisioning. The contracting officer should include provisioning requirements for repair parts and maintenance tools as necessary including any special tools, and instructions on shipment of engine-generator sets under all modes.

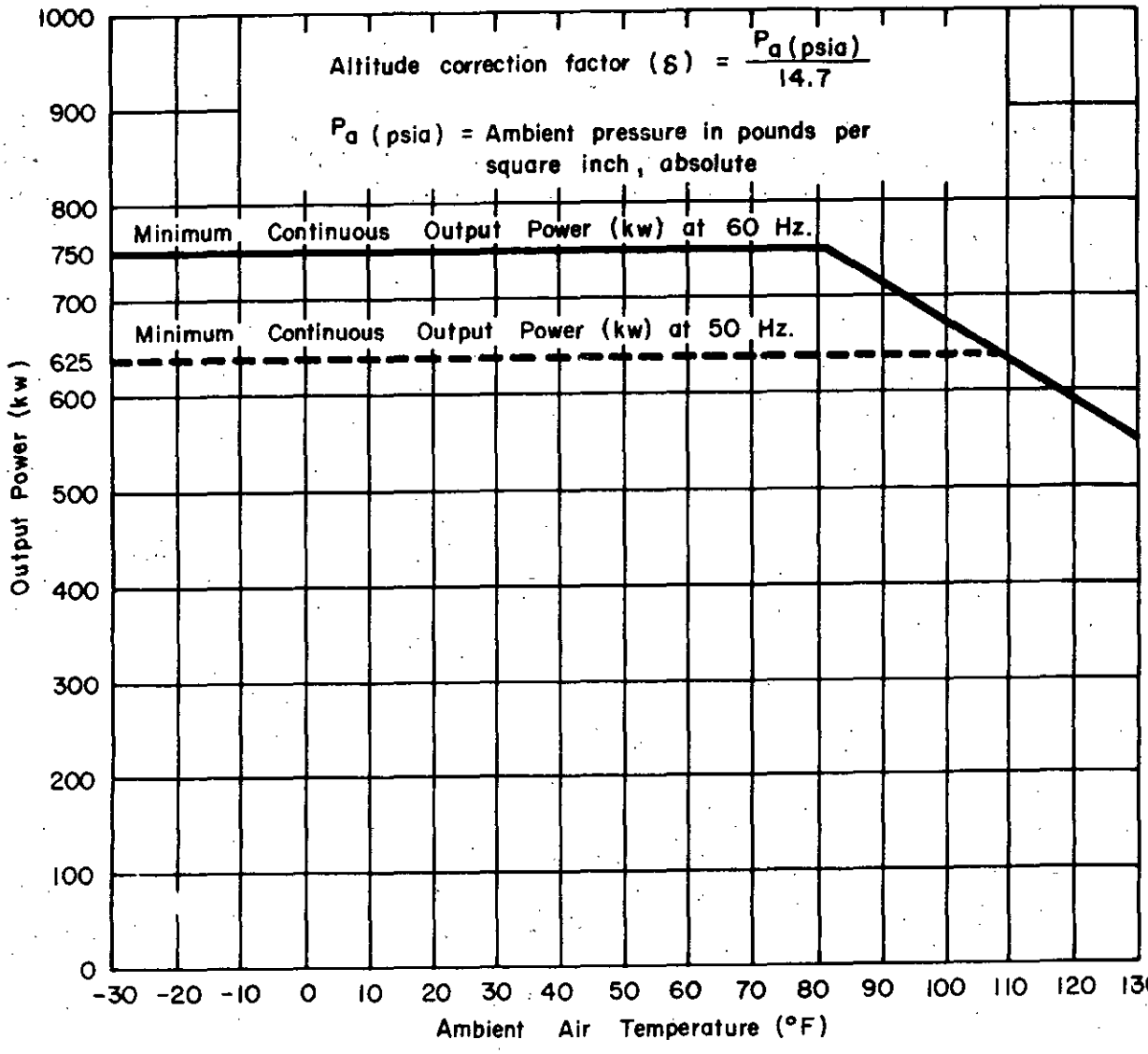
6.7 Preproduction report. The contracting officer should include inspection reports and inspection records of the generator set to include:

(a) Malfunction, evidence of damage, failure, or adjustment, other than adjustments permitted in this specification and the applicable test methods, which occurs 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.

Custodian:
Army - ME

Preparing activity:
Army - ME

Project 6115-A353



Condition shown: Mean sea level (msl) (760.0 mm Hg). (14.7 PSIA).

FIGURE 1. Output power (kw) versus ambient air temperature (°F).

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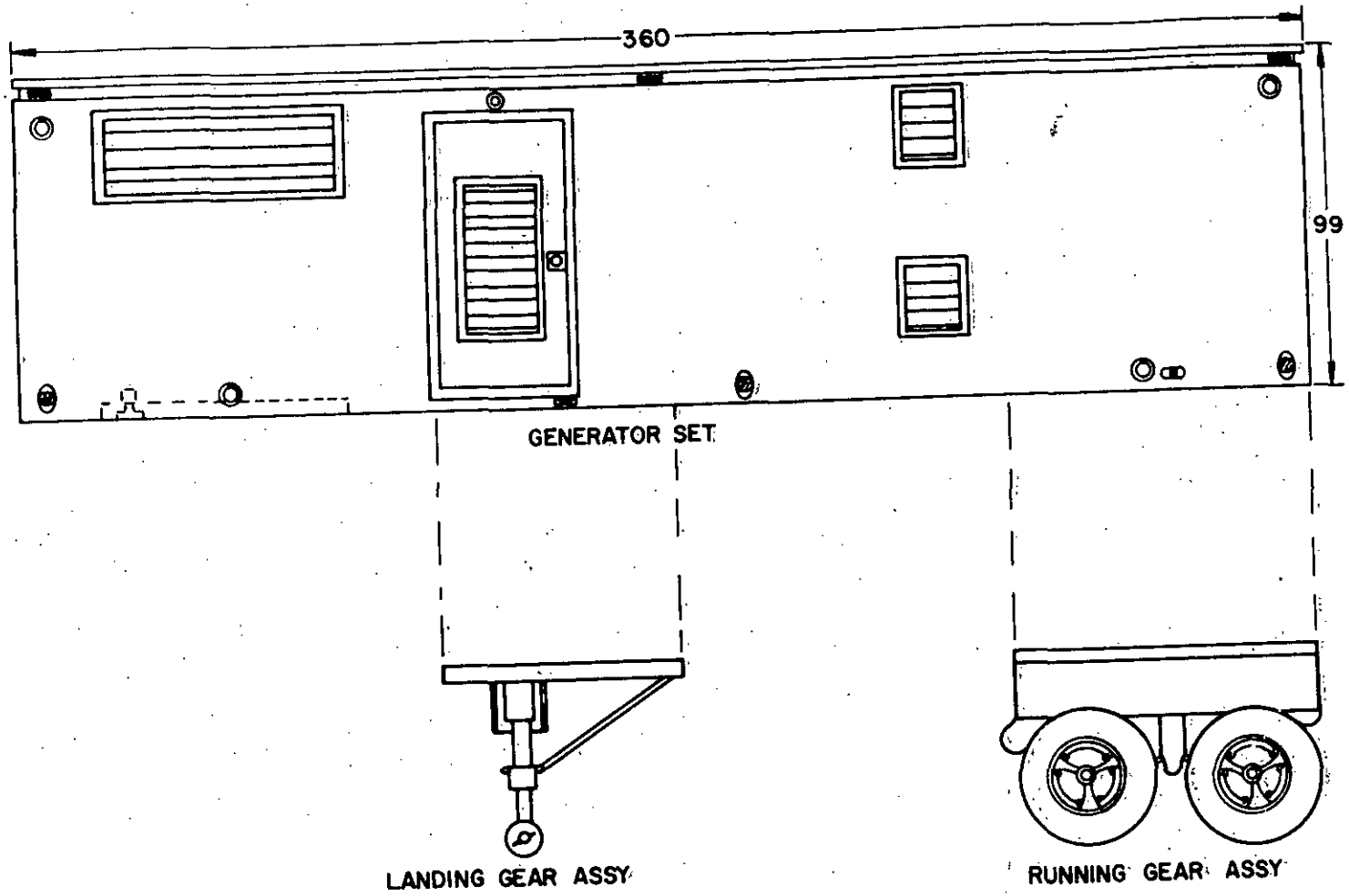
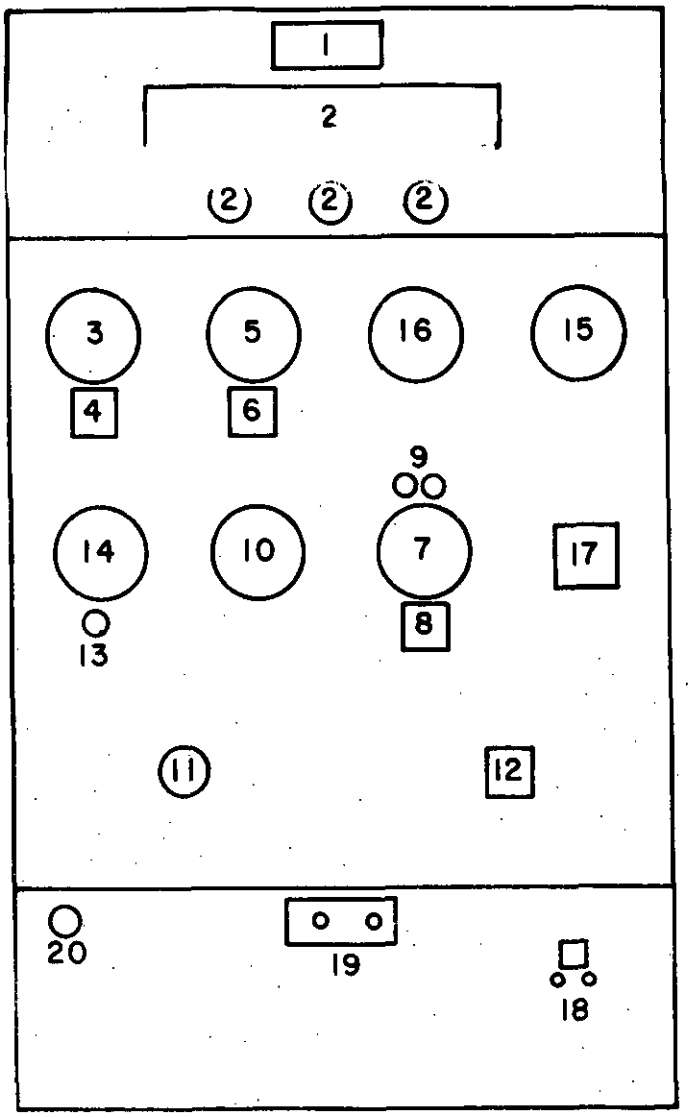


NOTES:

1. ALL DIMENSIONS ARE IN INCHES
2. WIDTH 96
3. TOTAL WT ≈ 40,000LBS
4. INTERIOR HEIGHT 89

FIGURE 2. Concept layout.

X-3187



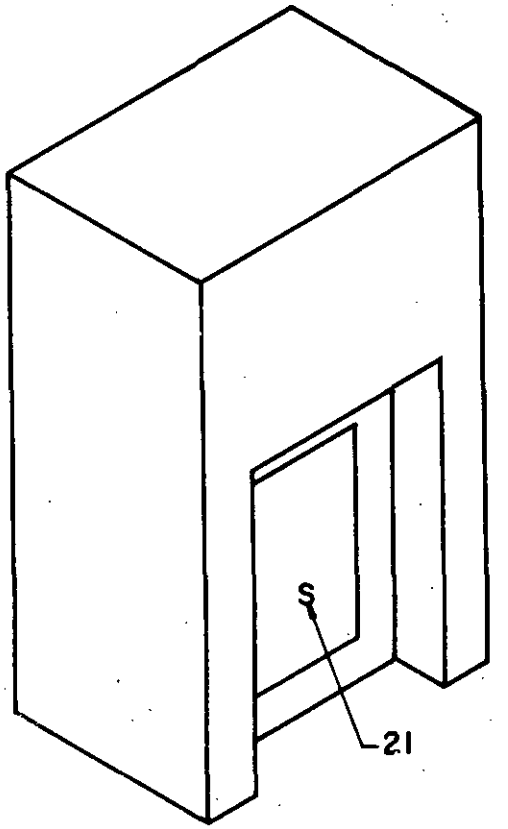


FIGURE 3. Remote control station.

X-3188

STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

OMB Approval
No. 22-R255

INSTRUCTIONS: The purpose of this form is to solicit beneficial comments which will help achieve procurement of suitable products at reasonable cost and minimum delay, or will otherwise enhance use of the document. DoD contractors, government activities, or manufacturers/ vendors who are prospective suppliers of the product are invited to submit comments to the government. Fold on lines on reverse side, staple in corner, and send to preparing activity. Comments submitted on this form do not constitute or imply authorization to waive any portion of the referenced document(s) or to amend contractual requirements. Attach any pertinent data which may be of use in improving this document. If there are additional papers, attach to form and place both in an envelope addressed to preparing activity.

DOCUMENT IDENTIFIER AND TITLE: MIL-G-0028670A(ME) Generator Set, Gas Turbine Engine, 750 KW, 50/60 Hertz, Prime, Utility

NAME OF ORGANIZATION AND ADDRESS

CONTRACT NUMBER

MATERIAL PROCURED UNDER A

☐ DIRECT GOVERNMENT CONTRACT ☐ SUBCONTRACT

1. HAS ANY PART OF THE DOCUMENT CREATED PROBLEMS OR REQUIRED INTERPRETATION IN PROCUREMENT USE?
   A. GIVE PARAGRAPH NUMBER AND WORDING.

   B. RECOMMENDATIONS FOR CORRECTING THE DEFICIENCIES

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