MIL-G-83380
21 February 1979
SUPERSEDING
(See Section 6)

MILITARY SPECIFICATION

GENERATOR SETS, GAS TURBINE ENGINE DRIVEN, 30 AND 60 KW, 400 HZ

This specification is approved for use by all Departments and Agencies of the Department of Defense.

1. SCOPE

1.1 Scope. This specification covers the general requirements for turbine-engine-driven (GTED), tactical utility, 30- and 60-KW, 400 Hertz (Hz) generator sets for military applications. The general characteristics of the sets are described in MIL-STD-633.

1.2 Classification. The generator sets shall be rated 0.8 power factor (pf) lagging and connectable for the following output voltages:

a. 3-phase, 4-wire, 120V line-to-neutral and 208V line-to-line (120/208V).

b. 3-phase, 4-wire, 240V line-to-neutral and 416V line to line (240/416V).

1.2.1 Classes, modes and power rating. The generator sets shall be of the following type, class, modes and power rating (see MIL-STD-1332 for nomenclature) as follows (see 6.2):

MEP 403A	MEP 404A
Type I - Tactical	Type I - Tactical
Class 1 - Precise	Class 1 - Precise
Mode II - 400 Hz	Mode II - 400 Hz
Power Rating - 30 Kw (400 Hz)	Power Rating - 60 Kw (400 Hz)

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

W-C-596 Connector, Plug, Electrical; Connector, Receptacle, Electrical

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: ASD/ENESS, Wright-Patterson AFB, OH 45433 by using the self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

QQ-P-416	Plating, Cadmium (Electrodeposited)
VV-F-800	Fuel Oil, Diesel
VV-K-211	Kerosene

MILITARY

MIL-M-14	Molding Plastics and Molded Plastic Parts, Thermosetting
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-P-514	Plate, Identification, Instructions and Marking, Blank
MIL-T-704	Treatment and Painting of Materiel
MIL-E-917	Electric Power Equipment, Basic Requirements for
MIL-D-1000	Drawing, Engineering and Associated List
MIL-I-1361	Instrument Auxiliaries, Electrical Measuring, Shunts, Resistors, and Transformers
MIL-L-2104	Lubricating Oil, Internal-Combustion Engine, Heavy-Duty
MIL-G-3056	Gasoline, Automotive, Combat
MIL-I-3505	Insulation Sheet and Tape, Electrical, Coil and Slot, High Temperature
MIL-C-3702	Cable, Power, Electrical, Ignition, High Tension
MIL-M-3971	Meter, Time Totalizing, Non-Hermetically Sealed, Electrical, General Specification for
MIL-E-4158	Electronic Equipment, Ground, General Requirements for
MIL-C-5015	Connector, Electric, AN Type
MIL-W-5086	Wire, Electric, Hook-up and Interconnecting, Polyvinyl Chloride-Insulated, Copper or Copper Alloy Conductor
MIL-W-5088	Wiring, Aerospace Vehicle
MIL-J-5161	Jet Fuel, Referee
MIL-G-5572	Gasoline, Aviation, Grades 80/87, 100/130, 115/145
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-C-5756	Cable and Wire, Power, Electric, Portable
MIL-R-5757	Relay, Electrical (For Electronic and Communication Type Equipment), General Specification for
MIL-R-6106	Relay, Electric, Aerospace, General Specification for
MIL-S-6721	Steel, Corrosion - and Heat-Resistant (Chemically Stabilized), Plate, Sheet, and Strip
MIL-L-7808	Lubricating Oil, Aircraft Turbine Engine, Synthetic Base
MIL-A-8421	Air Transportability Requirements, General Specification for
MIL-W-8777	Wire, Electrical, Silicone Insulated, Copper, 600 Volt, 200°C
MIL-H-8794	Hose, Rubber, Hydraulic, Fuel and Oil Resistant
MIL-M-10304	Meter, Electrical Indicating, Panel Type, Ruggedized, General Specification for
MIL-B-11188	Battery, Storage, Lead-Acid
MIL-R-11461	Rod, Ground (With Attachments)
MIL-P-12742	Primer Coating, Phenolic, Water Immersible
MIL-P-14105	Paint, Heat-Resisting (For Steel Surfaces)
MIL-P-15037	Plastic Sheet, Laminated, Thermosetting, Glass-Cloth, Melamine-Resin
MIL-W-16878	Wire, Electrical, Insulated, High Temperature
MIL-F-16884	Fuel Oil, Diesel, Marine
MIL-G-21480	Generator System, Single Generator

MIL-I-22834	Insulation, Electrical, Dielectric Barrier, Laminated, Plastic Film and Synthetic Fiber Mat
MIL-I-24092	Insulating Varnish, Electrical, Impregnating
MIL-W-25038	Wire, Electrical, High Temperature and Fire Resistant, Aircraft
MIL-I-25623	Indicator, Electrical Tachometer, Aircraft Turbo Speed, 0-110 Percent RPM, 2-Inch Size, Type MU-1
MIL-W-27076	Workmanship Standards for Ground Electronic and Associated Equipment
MIL-H-27267	Hose, Tetrafluoroethylene, High Temperature, Medium Pressure
MIL-G-28554	Generator Sets, Mobile Electric Power, Packing of
MIL-G-81322	Grease, Aircraft, General Purpose, Wide Temperature Range

STANDARDS

MILITARY

MIL-STD-100	Engineering Drawing Practices
MIL-STD-129	Marking for Shipment and Storage
MIL-STD-130	Identification Marking of US Military Property
MIL-STD-143	Standards and Specifications, Order of Precedence
MIL-STD-170	Moisture Resistance Test Cycle for Ground Signal Equipment
MIL-STD-195	Marking of Connections for Electrical Assemblies
MIL-STD-454	Standard General Requirements for Electronic Equipment
MIL-STD-461	Electromagnetic Interference Characteristics Requirements for Equipment
MIL-STD-462	Electromagnetic Interference Characteristics, Measurement of
MIL-STD-470	Maintainability Program Requirements (For Systems and Equipments)
MIL-STD-471	Maintainability Demonstration
MIL-STD-633	Mobile Electric Power Engine Generator Standard Family Characteristics Data Sheets
MIL-STD-705	Generator Sets, Engine-Driven, Methods of Tests and Instructions
MIL-STD-781	Reliability Tests Exponential Distribution
MIL-STD-785	Reliability Program for Systems and Equipment Development and Production
MIL-STD-882	System Safety Programs for Systems and Associated Subsystems
MIL-STD-889	Dissimilar Metals
MIL-STD-1332	Definition of Tactical, Prime, Precise, and Utility Terminologies
MIL-STD-1474	Noise Limits for Army Material
MS3100	Connector, Receptacle, Electric, Wall Mounting, Solder Contacts, AN Type
MS3102	Connector, Receptacle, Electric, Box Mounting
MS24393	Union, Flared Tube 3-8 Bulkhead and Universal, Precision Type
MS25036	Terminal, Lug, Crimp Style, Copper Insulated, Ring-Tongue, Bell-Mouthed, Type II, Class 1
MS25042	Cover, Electrical Connector, Plug, AN Type
MS25043	Cover, Electrical Connector, Receptacle, AN Type
MS25182	Plug, Electric, Aircraft Storage Battery
MS35000	Battery, Storage, Lead-Acid, Waterproof
MS75058	Connector, Receptacle
MS90413	Tool, Crimp, Hand, for MIL-T-7928 Insulated Terminals

DRAWINGS

AIR FORCE

66C44953	Socket, Wall Mounted
66C44954	Plug, Cable
68D22671	Skid-Base Assembly
68E22601	Frame Assembly, Generator Set
68E23164	Battery, Nickel Cadmium
68E23310	Generator, 30 KW, 400 Hz - 6,000 RPM
68E23311	Generator, 60 KW, 400 Hz - 6,000 RPM
68J22600	Generator Set EMU-29/E
68J22700	Generator Set EMU-30/E
68J22795	Generator Set Configuration Outline

PUBLICATIONS

MILITARY

MIL-HDBK-705 Generator Sets, Electrical, Measurements and Instrumentations

AIR FORCE EXHIBIT

SMNE 66-179 Maintainability Requirements for Generator Sets

(Copies of specifications, standards, drawings, and publications 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.

NATIONAL BUREAU OF STANDARDS

Handbook H28 Screw-Thread Standards for Federal Services

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

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

S1.4	General Purpose Sound Level Meters
S1.6	Preferred Frequencies for Acoustical Measurements
Y14.15	Electrical and Electronics Diagrams
Y32.2	Graphic Symbols for Electrical and Electronic Diagrams
Y32.16	Reference Designations for Electrical and Electronic Parts and Equipment
Z24.10	Octave Band Filter Set for Analysis of Noise and Other Sounds

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

SOCIETY OF AUTOMOTIVE ENGINEERS (SAE)

AMS3205	Synthetic Rubber, Low Temperature Resistant 45-55
J514	Hydraulic Tube Fittings
J726	Air Cleaner Test Code

(Application for copies should be addressed to the Society of Automotive Engineers, Inc., Department 001, 400 Commonwealth Drive, Warrendale, PA 15096.)

AMERICAN WELDING SOCIETY (AWS)

Standard Qualification Procedure

(Application for copies should be addressed to the American Welding Society, 345 East 47th Street, New York, NY 10017.)

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

Boiler and Pressure Vessel Code, Welding Qualifications

(Application for copies should be addressed to the American Society of Mechanical Engineers, United Engineering Center, 345 East 47th Street, New York, NY 10017.)

NATIONAL MOTOR FREIGHT TRAFFIC ASSOCIATION, AGENT

National Motor Freight Classification

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

UNIFORM CLASSIFICATION COMMITTEE, AGENT

Uniform Freight Classification

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

3. REQUIREMENTS

3.1 Description. Individual set requirements shall be specified herein. In the event of any conflict between requirements of drawings and this specification, this specification shall govern. The designs are established in accordance with:

Model	Drawing Index List
MEP 403A	68J22600
MEP 404A	68J22700

3.1.1 Baseline drawings. The drawings forming a part of this specification are product baseline drawings. No deviation from drawing requirement is permissible without prior approval of the contracting officer. Where requirements are within the limits of this specification but more specific and stringent, this is not a conflict within the meaning of 3.1, and the drawing

detail will govern (e.g., specification requires minimum of 1 minute; drawing requires 75 seconds ±10 seconds, acceptance criterion is 75 ±10 seconds). In addition, if dual entries are identical (e.g., ±10 percent), this is to be interpreted as a reiteration, neither a cumulative nor multiplicative tolerance on a tolerance, (e.g., acceptance criterion is ±10 percent and neither ±20 percent nor ±11 percent).

3.1.2 Contractor data. The drawings forming a part of this specification are engineering design drawings. The supplier is responsible for preparing his own shop drawings. Where tolerances prescribed could cumulatively result in incorrect fits, the supplier shall provide tolerances within those prescribed on the drawings to insure correct fit, assembly, and operation of the generator set. Deviation from the prescribed dimensions or tolerances shall have prior approval of the contracting officer. Any data (e.g., shop drawings, layouts, flow sheets, processing procedures, et cetera) prepared by the supplier or obtained from a vendor to support fabrication and manufacture of the production item shall be made available, upon request, for inspection by the contracting officer or his designated representative.

3.2 Preproduction. This specification makes provisions for preproduction testing.

3.2.1 Preproduction model. Unless otherwise specified (see 6.2), two gas turbine generator sets of specified size shall be furnished within the time frame specified in the contract or purchase order to prove, prior to starting production, that the generator sets comply with the requirements specified herein. Examination and tests shall be those specified herein. Any changes or deviations from the preproduction set during preproduction shall be subject to the approval of the contracting officer. Approval of the preproduction model by the activity concerned shall not relieve the supplier of his obligation to furnish generator sets conforming to this specification.

3.2.1.1 Initial production. When specified (see 6.2), the supplier shall furnish to the procuring activity one or more generator sets of each size for testing as specified in 4.4.

3.3 Selection of standards and specifications. Standards and specifications for necessary commodities and services not specified herein shall be selected in accordance with MIL-STD-143.

3.4 Materials, parts, and processes. The requirements for materials, parts, and processes used in construction of the generator set shall be in accordance with MIL-E-4158 and as specified herein. Materials not specified shall be selected by the supplier and shall be subject to all provisions of this specification.

3.4.1 Insulating materials. Thermal and sound insulating materials shall be noncapillary; nonhygroscopic; free from perceptible odors; resistant to attack by insects, rodents, mildew, and fungi; fire retardant; and unaffected materially by battery electrolyte or petroleum derivatives. The materials shall be capable of maintaining their shape, position, and consistency (inherently or by suitable retaining methods) under conditions of vibration and temperatures as specified. Insulating materials shall be resistant to or protected from abrasion, and paintable and bondable to metal. Sound insulation material shall not be painted.

3.4.2 Metal parts. Metals shall be of the corrosion-resistant type or treated to resist corrosion due to fuels, salt fog, or atmospheric conditions likely to be met in storage and normal service.

3.4.2.1 Corrosion-resisting materials. Corrosion-resisting (stainless) steel, copper, anodized commercially pure aluminum and aluminum alloys which do not contain more than 0.4 percent copper, brass, bronze, beryllium-copper, copper-nickel, and nickel-copper alloys will be considered the only satisfactory corrosion-resisting materials for use on the generator set as distinguished from corrosion-resisting treatments.

3.4.2.1.1 Treatments. The only accepted corrosion-resistant treatments are sharadizing; galvanizing; electrodepositing with cadmium, chromium, copper, nickel, or zinc; aluminizing; chromizing; anodizing; chromate corrosion coating; chemically deposited nickel; and phosphate coating.

3.4.2.2 Dissimilar metals. Contact between dissimilar metals as defined in MIL-STD-889 shall be avoided as much as practicable. Contacts between aluminum or magnesium or their alloys and copper or copper bearing alloys are prohibited. Where contacts between dissimilar metals cannot be avoided, the contact joints shall be painted with not less than one coat of phenolic primer in accordance with 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 feasible.

3.4.3 Standard and commercial parts. Where substitution is mandatory, standard and preferred parts shall be selected in accordance with MIL-E-4158. The choice of nonstandard and commercial parts shall be at the discretion of the contractor. A nonstandard parts list shall be submitted to the procuring activity for reference purposes only. Adequacy of the part to perform within its requirements shall be proven during the preproduction testing. Test results to the extent that the system performs its intended function shall prove adequacy of all nonstandard and commercial parts used therein.

3.4.4 Fungus resistance. All electrical equipment (or the electrically insulated components thereof) including wire, cable, and cable bundling material shall be treated in accordance with MIL-T-152, with varnish conforming to MIL-V-173, except where the insulation will not support the growth of fungus or where the component is treated and insulated in accordance with 3.5.10.

3.4.5 Terminal boards, terminal strips, and supports. All terminal boards, terminal strips, and other supports for electrical terminals and studs shall be made of laminated plastic material conforming to MIL-P-15037 or shall be molded of alkyd, melamine, or silicone resin plastic material conforming to MIL-M-14. Maximum practicable creepage and clearance distance shall be maintained between energized terminals and grounded parts, such as frames and enclosures, and between energized terminals at different potential. Where feasible, barriers may be used to increase creepage distances.

3.4.6 Fasteners. Screw threads shall conform to Handbook H28. American National coarse threads shall be used where threads are provided in aluminum, magnesium, or plastic parts and are preferred for all other parts. Bolts, screws, and other fasteners used on rotating parts shall have positive-locking devices or means which do not depend upon spring action or friction for their locking action, such as lock plates, lock wire, snap rings, castellated nuts, and cotter pins. Means shall be provided for locking fasteners on all non-

rotating parts. Swaging, peening, or staking of threads will not be acceptable as a locking device or means for parts subject to adjustment, disassembly, or removal. The number of different sizes and types of bolts, screws, nuts, and washers shall be the minimum practicable. Sheet-metal screws shall not be used, except in the fastening of identification and instruction plates.

3.4.6.1 Quick-disconnect fasteners. Removable panels and doors shall be equipped with simple, substantial, captive, quick-disconnect fasteners.

3.4.6.2 Blind fasteners. Nuts used with screws, bolts, and studs shall be readily accessible for removal during disassembly of the housing or during removal of any major component from the generator set. Where a nut is so located that it cannot be grasped by at least the thumb and one finger of one hand, it shall be caged or some equivalent means used to obviate the need for handling the nut during removal or assembly.

3.4.6.3 Corrosion resistance. All fasteners, such as bolts, screws, and studs, and their associated hardware (washers, lockwashers, pins) shall be made of corrosion-resisting material or shall be treated to be corrosion resistant, except for the following:

a. Fasteners within hermetically sealed components

b. Fasteners within components which operate immersed in or filled with a fluid that will form a protective film

c. Fasteners in parts which are not subject to adjustment, disassembly, or removal for servicing, maintenance, and repair during the life of the component of which they are a part.

3.4.6.4 Assembly in light metals. Assembly of aluminum parts shall be accomplished by fasteners in the following order of preference:

a. By the use of through bolts

b. Steel bushings with tapped holes

c. Studs with threads allowing maximum strength

d. Helical coil inserts

e. Tapped holes in the light metal

f. Sheet metal screws or rivets (information plates only).

3.5 Design and construction. The generator set shall conform to the requirements specified herein. The generator set shall consist of a gas turbine engine driven generator using an alternator with static voltage regulator, self-contained starting system (consisting of a battery, electric starter motor, and battery charging system), automatic speed governing system, controls, instruments, protective devices and control cubicle, all enclosed in a weather-resistant housing. The design and construction of the generator set shall be such that it will withstand the hard usage encountered in military service, such as transportation by fixed wing and rotary wing aircraft, rail, and by truck or trailer over rough terrain.

3.5.1 Conversion capability. When so specified, the size 60-kw generator set shall be designed to permit conversion to continuous-duty 30-kw operation with a fuel consumption not to exceed 68 pounds per hour. The conversion shall be accomplished by changing the turbine nozzle. The design shall be such that conversion can be accomplished with minimum downtime by operating personnel using standard handtools. (See 6.2.)

3.5.2 Reliability. A reliability program shall be conducted in accordance with MIL-STD-785.

3.5.2.1 Mean-time-between-failures (MTBF). The generator set shall have a specified MTBF of not less than 500 hours when operating in any environment required by this specification. (As specified in MIL-STD-781.)

3.5.2.2 Useful life. The generator set shall be designed and constructed to attain at least 15,000 hours of operation with specified performance under the required operating rate and service conditions before the set becomes economically unrepairable.

3.5.2.3 Shelf life. The generator set shall be capable of starting and operating following depreservation after storage over periods of up to 5 years when properly preserved, packaged, and mechanically protected.

3.5.3 Maintainability. Components which require periodic servicing as a matter of routine maintenance shall be readily accessible without removal of structural member of the set. The generator set shall have a mean-time-to-repair (MTTR) of no greater than 0.5 hour and a maximum repair time at the 90th percentile of 1.5 hours. The repair time shall include only time required to repair/replace the failed part and shall not include time spent waiting for a spare part or time required to isolate and check out the generator set. The maintainability program shall be conducted in accordance with MIL-STD-470 and Exhibit SMNE 66-179.

3.5.3.1 Maintenance and repair cycles

3.5.3.1.1 Scheduled preventive maintenance. Scheduled preventive maintenance that results in downtime shall be required not more than once every 300 operating hours for nonleaded fuel. When leaded fuel and diesel fuel are used, preventive maintenance shall be required not more than once every 100 operating hours.

3.5.3.1.2 Depot overhaul or maintenance. Depot overhaul or maintenance for major components shall be required not more than once every 6,000 operating hours.

3.5.3.2 Ease of servicing and maintenance. The generator set shall be designed and its components assembled so as to insure ease of servicing and maintenance. All components which require periodic servicing as a matter of normal routine maintenance between major overhauls shall be readily accessible without the removal of any other parts. Such components shall include, but not be limited to, all filters, strainers, gages, drains, fluid filters, batteries, flame tube, igniter, and fuel nozzle.

3.5.3.3 Accessibility of parts. All parts of the generator set shall be readily accessible for operation and servicing by personnel wearing bulky clothing and gloves or mittens. Wiring between major electrical components

shall be through military standard connectors to allow easy disassembly and servicing. Maintenance in the field shall be possible with conventional tools. Replacement and adjustment of components and accessories shall be possible with minimum draining requirements and minimum disturbance to other components. Covers or plates that are to be removed for operation or servicing shall be equipped with simple, substantial, captive quick-disconnect fasteners.

3.5.4 System safety. System design shall be evaluated to identify hazards and prescribe corrective action in accordance with MIL-STD-882. All Category IV hazards shall be eliminated. All Category III hazards shall be eliminated or effectively controlled.

3.5.4.1 Personnel safety. All exposed parts which are subject to extremes of temperature or which are energized electrically and all rotating or reciprocating parts which are of such nature or so located as to become a hazard to operating personnel shall be insulated, fully enclosed, or guarded. Insofar as practicable, the engine exhaust system shall be designed and located to minimize hazard to operating personnel. A threaded, slotted terminal stud (with captive nut) suitable for No. 1/0 AWG solid wire shall be secured in the base in the vicinity of the main output terminals or receptacles and shall be marked GROUND. As far as possible, the design shall also eliminate other features, such as protruding parts, which could cause damage to personnel or to other equipment.

3.5.4.2 Protective device. Each device shall be capable of functioning independently without reference to other protective devices. Protective devices which will shut down the engine and cause opening of electrical circuit breakers shall provide for the following malfunctions:

a. Electrical malfunctions that cause opening main circuit breakers (see 3.14)

b. Failure to reach 96 percent rated speed within 60 seconds

c. Cranking motor overtemperature. Temperatures shall be as specified by component manufacturer.

3.5.4.2.1 Safety devices. In addition to the protective devices specified in 3.5.4.2, the generator set shall be equipped with the following to shut down the engine and simultaneously open the AC output circuit breaker:

a. Overspeed safety device - This device shall operate automatically to cut off engine fuel at any speed between 109 and 111 percent of that corresponding to 400 Hz output from the alternator. The device shall automatically reset and shall operate independently from the engine governing system.

b. Lubricating oil safety device - This device shall operate to stop the generator set if the engine lube oil pressure drops to a value which could result in damage during continuous operation. The low oil pressure limit shall be specified by the component manufacturer.

c. Exhaust temperature safety device - This device shall operate to stop the generator set in the event of an engine exhaust gas temperature exceeding safe operating temperatures. This device shall be designed for a minimum of 1,500 hours of operation.

In addition to shutting off the engine fuel supply, the three safety devices shall operate to open the generator circuit breaker independently of any other protective device.

3.5.5 Transportability. The generator set shall be transportable while in operable condition, but not operating, at any angle from horizontal to 30° from the horizontal in any plane. There shall be no spillage from the generator set or any of its components under these conditions. The generator set shall withstand, without damage, shock and vibration encountered during railway humping.

3.5.5.1 Mobility. The generator set, in the trailer configuration, shall withstand the roadability and railroad humping tests specified in 4.6.2.1.2.1 and 4.6.2.1.2.2.

3.5.5.2 Air transportability. The generator set shall meet the air transportability requirements of MIL-A-8421.

3.5.6 Lifting attachments. A lifting attachment having a retractable lifting eye(s) shall be mounted on the top of the generator set. The arrangement shall be such that the housing will not be damaged and the set will remain within 5° of level when lifted. The attachment shall be of sufficient capacity to carry at least five times the total generator set weight and shall withstand all conditions which might be encountered during lifting, such as rapid lowering and violent braking by a crane. The lifting attachment shall not restrict accessibility for removal of generator set parts, being itself removable (if necessary) through use of bolted construction to meet this requirement. Fork-lift openings shall be provided in the skid base. Each opening shall be not less than 11 inches by 3 inches in size. Openings shall be equally spaced from the center of gravity and shall be an even number of inches from 36 inches to 60 inches between opening center lines. The openings shall be reinforced and the fork-lift tine areas shall be surrounded by reinforcement such that fork-lift tines will not damage the bottom of the set housing during lifting operations.

3.5.7 Fuel hoses. The hoses used in the generator set shall conform to MIL-H-8794 or MIL-H-27267 and shall be reinforced with wire braid.

3.5.8 Drainage. Provisions shall be incorporated for draining liquid which may accumulate at the bottom of the generator set. Drains shall be provided in the bottom of the exhaust box. A drain also shall be provided for the engine combustor plenum and shall exit immediately below the exhaust box. All drains shall have threaded fittings and, except for exhaust box and plenum drains, shall be provided with captive screw-on type plugs or caps. Ball type chain devices are prohibited. Complete drainage of the lubricating oil sumps shall be feasible without leakage into or onto the generator set during the draining operation. (See 3.26.3 and 3.26.3.1.) Drains shall not promote collection of combustible liquids inside set housing either as puddles or film.

3.5.9 Voltage ratings. The generator set voltage ratings shall be 3-phase, 4-wire, 120/208V and 3-phase, 4-wire 240/416V.

3.5.9.1 Voltage reconnection system. Provisions shall be incorporated for reconnecting the alternator armature windings (see 3.12.13). Leads from the alternator armature shall be brought through current transformers in a manner that reconnecting the windings will automatically and completely change the generator set from 120/208 to 240/416V operation, without the necessity for

making additional changes in connections to any individual set component such as the circuit breaker, meters, synchronizing lights, governor electrical circuits, voltage regulator, and exciter. Generator sets shall be shipped connected for 120/208V operation. A diagram shall be attached to the generator set showing alternator high and low voltage connections.

3.5.10 Electrical insulation. All electrical components shall be insulated and protected for continuous open-air operation in a humid, salty atmosphere, with provisions to inhibit failure of insulation due to condensation of moisture. Insulation shall conform to MIL-E-917, class B or H. Class B and H slot and pole insulation shall conform to MIL-I-3505.

3.5.10.1 Coils, windings, and ground insulation. The insulation of all coils and windings shall be class F as defined in MIL-E-917, except temperature limits specified therein are not applicable (see 3.5.11). Varnish applied to the coils and windings shall meet, but not be limited to, the requirements of MIL-I-24092, type M, class 155, and shall be applied by varnish-treating methods and procedures as specified in MIL-E-917. When varnish treatment is used, a minimum of three dips and bakes are required. Sterling U-300-20 or equivalent thermopoxy compound, brush applied or wet-winding method applied may be used in lieu of varnish meeting the requirements of MIL-I-24092, type M, class 155 applied in accordance with MIL-E-917 with a minimum of three dips and bakes providing the finished product is at least equivalent, in all respects, to the equipment produced using the varnish method specified above. Ground insulation for coils or windings shall conform to MIL-I-22834, as deemed necessary. Insulation resistance of all circuits shall be not less than 1 megohm in an ambient temperature of 25°C with the generator set at stabilized rated load operating temperatures.

3.5.10.2 Insulation resistance. With the generator set operating in an ambient temperature of 25°C and after operation at rated load to insure stable temperature, the insulation resistance of all electrical windings shall be not less than 1 megohm to ground.

3.5.10.3 Dielectric strength. Electrical windings shall withstand the following 60-Hz voltages applied for 1 minute between the windings and ground; insulation breakdown as observed visually in the form of arcing between wires or burned or charred insulation shall be cause for rejection.

a. Alternator stator - 1,000V plus two times rated volts, but not less than 1,416V.

b. Alternator rotor and exciter winding (excluding rectifiers, capacitors, etc.) - Ten times exciter ceiling voltage, but not less than 1,500V nor more than 3,500V.

c. Battery charger system (transformer windings) - 1,000V plus two times rated volts, but not less than 1,416V.

d. Cranking system (other than battery-charging system) - 500V.

3.5.11 Temperature rises. The maximum allowable temperature rises in degrees Centigrade for all electrical windings, bearings of rotating electrical components, and mechanical parts (such as cores and poles) in contact with electrical windings shall not exceed the following when the generator set is operated continuously at rated load in ambient temperature of 52°C.

Parts	Class B	Class H
Coils and connections (measured by change in resistance method)	95°C	150°C
Bearings	50°C	100°C
Mechanical parts	Same as insulation with which parts are in contact	

The temperature rise values shall apply for electrical components mounted in place and operating as a part of the complete generator set. They do not necessarily apply for components tested separately, without regard to location, arrangement, and function in the generator set.

3.5.12 Electrical connections. Cables and wires shall be so connected to electrical components as to minimize difficulty in replacement of such components. Connections shall provide the maximum clearance between conductor ends and ground, and shall preclude contact with ground or adjacent apparatus as a result of vibration. Creepage and clearance distances shall be not less than those specified in MIL-E-917. Resin flux shall be used for all soldered connections, and all traces of remaining flux shall be removed after soldering.

3.5.12.1 Terminal lugs. Terminal lugs conforming to MS25036 shall be used on the ends of wire conforming to MIL-W-5086, except where the wire must be crimped or soldered directly to terminals on a part or component. A crimping tool conforming to MS90413 shall be used to fasten lugs to wires. If necessary because of space limitation or other special circumstances, other crimp-type, closed-tongue, shank-insulated lugs of special configuration (such as angled lugs) may be used when approved by the procuring activity.

3.5.12.2 Fasteners (electrical). Locking devices shall be provided for each fastener used in making an electrical connection. The fastener, locking device, and other hardware, such as washers, shall be made of corrosion-resistant material or shall be treated to be corrosion resistant by cadmium plating in accordance with QQ-P-416, type II, to a thickness of not less than 0.0005 inch. Fasteners (bolts, screws, studs) shall not be depended upon to carry current, but shall serve to hold current-carrying parts (lugs, terminals) in firm contact with each other. Where flow of current through a stud or bolt cannot be avoided, the stud or bolt and all its associated hardware such as nuts, locking devices, and washers shall be made of a corrosion-resistant material. Positive means such as pins or square shanks shall be provided for preventing turning of studs in their mountings when nuts are tightened or loosened. Lockwashers which depend upon friction or spring action shall not be used for this purpose. Unused lengths of threads on studs (or screws used as studs) shall not exceed the diameter of the stud or 0.5 inch, whichever is smaller. Any nut used for making electrical connections shall be so engaged over the entire nut thread length that the stud engaged is either flush or protruding from the free side of the nut.

3.5.13 Electrical wiring. Wire installation and identification shall be in accordance with MIL-W-5088. Wire and cables shall be bundled together and clamped to supporting structures with insulated clamps at intervals to insure a neat and orderly cable run. All wires and cables shall be of such length that it will not be necessary to coil excess length about or in the bundles. Cables

and wire bundles shall be run and clamped so as to protect conductor or jacket insulation against contact with sharp corners and edges, pinching, sharp bending and twisting, abrasion because of vibration or contact with moving parts, and exposure to engine fuel, lubricating oil, and parts at high temperatures such as exhaust stacks and heaters. The clamps shall also serve to prevent transmittal of stress from the bundles to terminals and internal connections of electrical components. Where a cable or wire is run between parts which move relative to each other as the result of vibration, for purpose of adjustment or inspection, or as a matter of normal operation, slack shall be left in the bundle to allow the movement to take place repeatedly without bending or twisting to the point of damaging the wire or cable. Cables and wires shall not be spliced at any point throughout the length of their runs, except that connection to leads which are integral with control devices shall not be considered to be a wire splice. Military standard connectors shall be used in making interconnection between major components of the generator set. Open (exposed) connections will not be permitted except for generator output and cranking-circuit power leads, if located in a protected position.

3.5.13.1 Connectors. Unless otherwise specified herein or approved by the procuring activity, all connectors shall conform to MIL-C-5015, class R. Connector pins may be crimp type in lieu of solder type provided the connector conforms to MIL-C-5015 in all other aspects. Right-angle plugs shall be used as necessary to avoid making sharp bends in harnesses leading to plugs. Plugs and receptacles shall be so selected 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 or pin configurations to prevent inadvertent cross connection of plugs. All receptacles which do not connect to mating plugs furnished as part of electrical harnesses in the set shall be equipped with captive dust caps.

3.5.13.2 Wires and cables. Wire and cable shall conform to MIL-W-5086, type II, with current-carrying capacity as specified in MIL-W-5088, except that battery cables shall be as specified herein. Where high-temperature wire is required, it shall be insulated wire conforming to MIL-W-25038, MIL-W-8777, or MIL-W-16878 (type E or type F) with fiberglass cover. All wires which are energized from the battery or battery-charging system shall have a distinctive color or tracer (preferably red) which will contrast with other wiring. All wire and cable shall be stranded, with conductor size not less than 18 AWG, except as follows:

a. Wire used in coils and windings

b. Control wiring located within the enclosure of an electrical component may be smaller than 18 AWG.

3.5.14 Rectifiers and transistors. All rectifiers shall be of the metallic, hermetically sealed, silicon type. Transistors shall be of the metallic, hermetically sealed, silicon or germanium type, silicon being preferred. During testing, each rectifier shall be subjected to the maximum voltage and currents, including transients, found to exist during the conditions of short circuit and application of one-half per unit load impedance specified herein. A peak pulse reading type voltmeter or a memory-type oscilloscope shall be used in determining voltage transients. This test may be waived by the contracting officer if the manufacturer's routine tests include tests at least as severe as those specified herein. The rectifiers shall have a peak inverse voltage rating not less than three times the peak voltage to which they are normally subjected

in service, including transients. The rectifiers shall have a continuous current rating equal to not less than 150 percent of the maximum current which they carry when installed in the generator set, ignoring transients. All transistors and diodes shall be capable of continuous operation at 71°C ambient.

3.5.15 Capacitors and tubes. Electrolytic capacitors shall not be used, except that tantalum capacitors of suitable ratings and characteristics may be employed. Electron tubes shall not be used. All capacitors shall be capable of continuous operation at 71°C.

3.5.16 Switches, pushbuttons, and relays. Insulation for switches, push-buttons, and relays shall be made of material as specified in 3.4.5. All switches, pushbuttons, and relays shall be sealed against entrance of water, dust, and grime; hermetic sealing of relays being preferred. Relays shall be of a type which will withstand severe mechanical shock and vibration as encountered in field use, without damage or false operation. The number of different types of relays shall be kept to a minimum. Relays shall conform to MIL-R-5757 and MIL-R-6106.

3.5.17 Current transformers. Current transformers shall be the window-type, classification GU, with burden to suit load and shall conform to MIL-I-1361, except that nonstandard ratio, as required, may be used. Double primaries shall be used with each transformer to insure balance between each circuit of the alternator armature windings and to avoid necessity for separate reconnection of transformer windings when changing from series to parallel connection of alternator windings.

3.5.18 Shunts. Shunts shall be in accordance with MIL-I-1361. Where a shunt is used in a grounded circuit, it shall be placed in the ground lead.

3.5.19 Parallel operation. The generator set shall operate to meet the quality of power requirements specified herein with two, three, or four other size 30 or size 60 sets in parallel. The sets operated thus in parallel shall be of the same frequency rating built to the requirements of this specification by the same manufacturer. Current transformers shall be provided as necessary for cross-current compensation.

3.5.19.1 Real and reactive load division. For the parallel combinations specified (one to four units) and for the conditions specified below, the individual sets shall share real and reactive load to the extent that the real or reactive load carried by any one set will not differ from its proportionate share (based on the ratio of the rating of a set to the combined ratings of all the sets in parallel) by more than 5 percent of rated kw real load and kvar reactive load which is numerically equal to real load difference for the unit kw rating. This load sharing shall be automatically or manually attained within 30 seconds after the units are put in parallel and automatically maintained thereafter for any steady-state load, once load division has been established within the stated limits. Periodic changing of load division (load swapping) between the parallel units shall be limited to plus and minus 10 percent of the full load rating of one set. The degree of unbalance in load sharing within the stated limits will determine the amount that any one unit in parallel may be continuously overloaded; therefore, the set shall be capable of carrying the extra load imposed by unbalance during parallel operation

continuously under all required ambient conditions in addition to the overload requirements. Means of adjustment shall be provided so that the degree of real load sharing at any given steady-state load can be balanced within 0.20 kw.

a. Under any load condition from 20 to 100 percent of the combined kva ratings of the generators in parallel. This shall apply for any load power factor from 0.8 lagging to unity

b. With the automatic voltage regulators in operation

c. Throughout all normal load variations (20 to 100 percent) during parallel operation, the above limits shall apply to all parallel units irrespective of the load level of on-the-line units at the time additional unit(s) are brought into parallel.

3.5.19.2 Compensation cabling and circuitry. All compensation circuits required to achieve equal division of real and reactive load as specified shall be provided. Cables required to connect the compensation circuitry or the parallel units shall be provided. The compensation circuitry shall not require external loops around the sets in parallel. Hence, the number of cables permissible for completion of the compensation circuits is equal to one less than the number of sets running in parallel at a given time. With this cabling arrangement, it shall be possible to shut down one or more sets in a parallel group of sets without interfering with the load division characteristics of the sets remaining on the line. It shall be possible to physically remove the interior unit from the parallel configuration by bypassing the interior unit to be removed by using the spare cable. (Since one cable is furnished with each set and the paralleling operation requires one less, there will always be one cable available for bypassing.) Similarly, it shall be possible to physically insert an oncoming unit into the parallel group without interfering with the load division characteristics on the on-the-line sets.

3.5.19.3 Cables and connectors. Completion of any loops which may be required shall be effected internally and enclosed in a single compensation cable furnished with each set. One complete cable shall be furnished with each set. Each cable shall be 20 feet long and have connectors conforming to Drawing 66C44954. Each generator set shall be provided with storage space for the load division cable.

3.5.19.3.1 Paralleling receptacles. Three military standard receptacles which will mate with the connectors on the compensation cable specified above shall be provided. They shall conform to MS3102R with captive dust cap conforming to MS25043. On each set, all three receptacles shall be paralleled. The receptacles shall be located on the control panel end of the generator set.

3.5.19.4 Paralleling aid device. The generator set shall be equipped with a paralleling aid device of such design that failure of the device will not allow closure of the circuit breaker. The device shall sense the following functions and provide a signal at the output terminals to initiate the closure of the generator set circuit breaker only when either of the following conditions exist:

a. Condition I

(1) Voltage difference not greater than ±3.5 percent of the average of the three line-to-neutral (120V) rms voltage, both load bus and the oncoming generator.

(2) Frequency difference not greater than ±1 Hz existing between the oncoming generator and the load bus.

(3) Phase displacement not greater than ±15° between the waveform of the oncoming generator and that of the load bus.

b. Condition II

(1) Zero voltage on all three phases of the load bus.

3.5.19.4.1 Paralleling aid switch. A paralleling aid switch shall be mounted on the front panel of the generator set. This switch shall be a two-position switch marked MANUAL/AUTOMATIC, spring-loaded to the manual position. The paralleling aid device shall also signal a green light mounted on the panel of the generator set. The light shall press-to-test and be marked READY TO PARALLEL. (The light shall be lit only when the proper conditions exist for paralleling.) The paralleling aid device shall be such that the sensing points do not vary more than ±25 percent throughout the operating temperature ranges. The device shall be so designed that the output signal, when the proper conditions exist, allows the generator set circuit breaker to be energized (closed) from the breaker control specified in 3.14, otherwise the circuit breaker will be inhibited from closing. The design shall be such that failure of components will not allow closing of the circuit breaker.

3.5.20 Remote control. The generator set shall be so equipped that it can be controlled and monitored from a remote station. A connector conforming to MS3102R-22-14S with captive protective cap conforming to MS25043 shall be mounted on the front of the generator set. The design shall be such that the generator set can be connected to a station located up to 100 feet from the set, and through this receptacle it shall be possible to perform the following functions:

a. Start and stop (the set shall automatically come up to rated speed and voltage when started)

b. Voltage adjustment

c. Frequency adjustment

d. Open and close the circuit breaker

e. Output voltage indication (120V, single-phase)

f. Remote voltage sensing.

3.5.20.1 Selector switches. A local remote selector switch shall be used in changing the generator set controls from local to remote (and vice versa) and shall be mounted on the instrument panel. A separate selector switch shall be used in changing the voltage regulator from local to remote voltage sensing and

vice versa and shall be mounted on the instrument panel. The two selector switches shall be provided with suitable locking devices. The controls for the remote station need not be provided as part of the generator set.

3.5.20.2 Automatic starting system. An automatic starting system shall be provided as an integral part of the generator set. With one generator set operating and supplying power and an adjacent set properly interconnected and set for standby (engine control switch in RUN position and standby switch in ON position) any failure or malfunction, except overcurrent, shall initiate automatic startup of the standby generator set. After automatically starting, the standby set shall come up to rated speed and voltage, close the main breaker (if main circuit breaker switch is in CLOSED position), and accept full load. When the generator breaker opens as a result of overcurrent conditions, the standby set shall not start up. When the interconnected set standby switch is set to the OFF position, the unit shall be isolated from the operating unit and shall not start up automatically if the operating unit fails.

3.5.20.3 Automatic start activation control cable and receptacles. Each generator set shall include one direct-current power cable assembly for automatic starting interconnection with another generator set. The cable assembly shall be 20 feet long, two-conductor flexible cable and connectors conforming to Drawing 66C44954 (on each end) with Kellems grip and dust cover, or equal. A connector conforming to MS3102R-22-8S with captive protective cap conforming to MS25043 shall be mounted on the front of the generator set. The receptacle shall be marked AUTOMATIC START. Storage provisions shall be made within the generator set for the automatic start cable.

3.5.21 Welders. Before assigning any welder to manual welding work covered by this specification, the supplier shall provide the contracting officer with certification that the welders have passed qualification tests as prescribed by either the Standard Qualification Procedure of the American Welding Society or Welding Qualifications of the ASME Boiler and Pressure Vessel Code.

3.5.22 Technical publications. Technical publications shall be furnished as specified (see 6.3).

3.6 Performance

3.6.1 Maximum power. The generator set shall be capable of operating in excess of rated power for 5 minutes. The generator set shall be loaded at unity power factor to the maximum power limit as determined by the following limiting conditions:

a. The exhaust temperature is within -4°C of the exhaust temperature safety device trip point. The trip point temperature limit shall be as specified by the component manufacturer.

b. The 5-minute 125 percent overload rating of the alternator is reached (see 3.5.19.1 and 3.12.13).

c. The maximum fuel stop setting on the generator is reached.

3.6.2 Environmental conditions. The generator set shall satisfactorily withstand the following environmental conditions without degradation in performance, permanent deformation, and mechanical or electrical damage when stored, operated and transported:

a. Storage and operation time under conditions of 2 inches of glazed ice and winds up to 50 mph

b. Storage and operation in rainfall of 12 inches per hour at 45° from the vertical, and up to an equal amount of precipitation per hour of windblown snow

c. Storage and operation in an atmosphere of 95 percent relative humidity

d. Storage and operation during and after exposure to a salt atmosphere which could cause corrosion or salt deposits

e. Storage and operation under conditions of blowing sand and dust

f. Exposure to altitudes up to and including 50,000 feet above sea level

g. Operation at altitudes up to and including 8,000 feet at an ambient temperature of 35°C with power output derated to 95 percent of rated

h. Storage and operation when exposed to fungi for extended periods. All electrical equipment shall be protected in accordance with 3.4.4

i. Storage and operation in sunshine for a period of 10 years with normal preventive maintenance

j. Storage in ambient temperatures from +74°C (for periods of 4 hours daily) to -62°C (for periods of 3 days at a time)

k. Operation at any ambient temperature from -54°C to +52°C at sea level

l. Operation with the base of the generator set inclined at any angle up to 15° from the horizontal in both fore-aft and side-to-side positions.

3.6.2.1 Environmental limits. The generator set shall be capable of operating continuously in accordance with the requirements of this specification at any load within its rating under the following conditions after exposure to any nonoperating conditions specified herein:

a. Elevation of 8,000 feet at an ambient temperature of 35°C

b. At any ambient temperature from +51.7°C to -53.9°C at sea level

c. Combinations of high temperature and high humidity conditions as encountered in tropical regions.

3.6.3 Cold starting. At any temperature down to -31.7°C, the generator set shall start, come up to rated speed, and accept full load within 60 seconds after cranking is initiated without the use of external heat. The generator set winterization system specified in 3.10.2.1 shall be used to permit starting between -31.7°C and -53.9°C.

3.6.4 All-weather operation. The generator set shall withstand operation in open air under all weather conditions for extended periods of time.

3.6.5 Critical speeds. The generator set shall be free of injurious flexural vibrations and dangerous torsional critical speeds (see 6.4.1) between 20 percent below and 20 percent above the operating speed.

3.6.6 Operational endurance. The generator set shall be capable of delivering rated output for 6,000 hours under the conditions specified herein without replacement of parts other than those required for normal servicing of the set and unscheduled maintenance as permitted in 3.5.2.1.

3.6.6.1 Time between overhaul (TBO). The generator set shall have a TBO of not less than 5,000 hours.

3.6.6.1.1 Servicing and adjustment schedule. A servicing and adjustment schedule of operations permitted between TBO shall be provided (see 6.2). This schedule shall be prepared in conjunction with and approved by the engine manufacturer. The schedule shall be verified during the endurance run (see 4.6.2.1). The schedule for production sets shall be approved by the procuring activity.

3.6.7 Mechanical shock and vibration. The generator set shall withstand shock as may be encountered in lifting and handling with a crane or other handling equipment. Cantilever mounting of parts shall be avoided insofar as practicable. This applies in particular to electrical parts such as resistors, capacitors, rectifier stacks, filters, and brackets.

3.7 Engine. The gas turbine engine shall operate the generator continuously at rated output under all conditions specified herein. The gas turbine engine shall be of the simple, open-cycle, coupled-turbine type. The engine shall consist of a compressor assembly, a combustion chamber assembly, a turbine assembly, an output shaft and accessory drive system, and all necessary operating accessories and controls, all assembled and arranged as a single unit.

3.7.1 Engine ease of maintenance. The construction arrangement of the engine shall be such as to facilitate maintenance under conditions of military field operation where only common handtools may be available and where personnel may be hampered by exposure to environmental conditions as specified herein. The location and arrangement of high-mortality parts and parts or controls frequently requiring cleaning, adjustment, repair, or replacement shall be such as to minimize removal or necessity for readjustment of other parts or controls or drainage of liquid systems.

3.7.2 Engine parts interchangeability. All parts having the same part number shall be directly and completely interchangeable with each other with respect to installation and performance. Matched parts or selective fits shall be used only where absolutely required. Changes in part numbers shall be governed by the drawing requirements of MIL-D-1000.

3.7.3 Engine overspeed. The engine shall be capable of operating continuously at 105 percent of normal rated speed (see 6.4.2) and for 110 percent of normal rated speed for 5 minutes without damage or reduction in life.

3.7.4 Engine vibration. The engine shall be free of destructive vibration at all engine speeds and power, including steady-state and transient conditions, throughout the complete operating range of the engine.

3.7.5 Engine mounting provisions. Mounting provisions shall safely accommodate engine thermal expansion and shall be of sufficient strength to support the engine under the conditions specified herein.

3.7.6 Compressor assembly. A centrifugal-type compressor rotor shall be used. A 0.25-inch mesh, screened, air inlet plenum shall enclose the compressor inlet.

3.7.7 Combustion chamber assembly. A single annular-type combustor shall be provided and shall contain one igniter. The combustor shall be so designed that replacement or removal of the combustion liner for inspection can be accomplished by one man without special tools in not more than 15 minutes. The life of the combustor liner shall be 1,500 hours minimum.

3.7.8 Turbine. A single radial inflow turbine rotor shall be used with an appropriate nozzle ring and shroud. The turbine nozzle(s) shall permit operation of the generator set at the rated power output and fuel consumption specified in 3.7.10.2.

3.7.9 Output and accessory drive system. The engine shall be provided with an output drive suitable for driving the alternator and exciter at the speed specified. Power shall be transmitted to the output shaft through speed reduction gearing. An easily accessible accessory drive system shall be provided and shall include provisions for driving fuel and oil pumps, a governor, a speed sensing unit, and any other accessories required for this application.

3.7.10 Engine fuel system. The fuel system shall include a fuel filter, high-pressure fuel pump, fuel flow regulating provisions integral with the engine control system, and necessary piping and fittings. All components of the fuel system shall operate satisfactorily with the fuels specified in 3.7.10.1 and under the specified ambient conditions. A field-adjustable acceleration schedule and maximum/minimum fuel stop shall be provided on the engine fuel control.

3.7.10.1 Fuels. The engine shall operate on all of the fuels listed below, but must meet specification requirements on JP-4 turbine fuel. Appropriate grades of these fuels shall be used for low ambient temperature operation.

a. JP-4 and JP-5 turbine fuels conforming to MIL-T-5624

b. Aviation gasoline conforming to MIL-G-5572

c. Jet fuel conforming to MIL-J-5161

d. Diesel fuel conforming to VV-F-800 and MIL-F-16884

e. Kerosene conforming to VV-K-211.

3.7.10.2 Fuel consumption. The maximum fuel consumption (using grade JP-4 turbine fuel conforming to MIL-T-5624), at rated load, sea level, and 15°C ambient temperature shall not exceed 2.2 pounds per kilowatt hour for the MEP 403A and 1.9 pounds per kilowatt hour for the MEP 404A.

3.7.10.3 High-pressure fuel pump. The high-pressure fuel pump shall be of the positive displacement gear type, and shall be capable of providing fuel to the fuel nozzle(s) at the required pressure. The pump shall incorporate means to prevent buildup of excessive pressures in the pump or fuel system.

3.7.10.4 Fuel filters. One or more fuel filters shall be provided as necessary for protection against fuel contaminants. The filter(s) shall be provided with replaceable filter element(s) and shall be of sufficient capacity to permit a minimum of 200 hours continuous operation without replacement. (See 3.26.9.)

3.7.10.5 Fuel lines and fittings. Fuel lines shall be of fire-resistant material and so installed that they will not be subject to chafing from vibration or be under strain due to sharp radii or other causes. Clips, braces, or brackets shall be used to securely fasten all fuel lines to the engine. All fuel lines and fuel fittings shall be made of corrosion-resistant material. Aluminum or plastic tubing shall not be used for fuel lines, except that polyvinylidine chloride type plastics may be used in the short flexible fuel lines if required to isolate vibration. Where practicable, fuel lines shall be terminated with SAE flared or inverted flared fittings.

3.7.11 Lubrication system. The lubrication system shall include an engine-driven, positive displacement pressure pump, oil filter, oil storage reservoir, and the necessary relief valves and internal oil lines. Lubrication from an external source shall not be required. The engine shall operate for periods of not less than 100 hours between oil changes. Lubrication shall be provided to all moving parts of the engine using lubricating oil conforming to MIL-L-2104, or MIL-L-7808. These oils shall be used in the engine within their appropriate operating ambient temperature ranges. The lubricating system, such as seals, gaskets, bearing and pump clearances, shall be such that the specified lubricating oils are satisfactorily supplied to the major wearing parts and retained within the system without leakage within the specified temperature range. The temperature of the oil in the oil reservoir shall not exceed 121°C when the engine is operating continuously as part of the generator set at any load up to and including rated load and at any of the operating conditions specified herein. A manual shutoff valve shall be incorporated in an accessible place in the lines between the engine and the lube oil drain fittings on the left side of the generator set.

3.7.11.1 Oil pumps. Positive displacement, engine-driven oil pumps shall be provided for oil pressurization and scavenging. The pumps shall maintain correct oil pressures and complete scavenging of the engine.

3.7.11.2 Oil filter. A full-flow oil filter with replaceable element shall be provided. The filter shall be of sufficient capacity to permit a minimum of 300 hours continuous operation on the specified lubricating oils without replacement. The filter shall be capable of filtering particles down to 10 microns in size. The filter shall be so located that filter elements can be easily replaced.

3.7.11.3 Oil storage reservoir. An oil reservoir shall be provided for oil storage and shall be a part of the engine. The reservoir shall supply engine lubricating requirements, with adequate reserve, and shall function correctly when the engine is in the normal horizontal position or inclined as specified in 3.6.2. Provision shall be made for inspection and cleaning of the tank. An oil reservoir filler shall be provided so that the tank cannot be overfilled when the engine is inclined from the normal horizontal position. Special funnels for filling the oil reservoir shall not be required. A chain-secured filler cap shall be provided and marked to indicate oil reservoir storage capacity. The oil reservoir shall have an air vent and shall incorporate provisions for the separation of entrained oil from the air being vented. An

oil drain not less than 0.75 inch in diameter shall be provided to permit easy and complete drainage of the oil reservoir. A bayonet gage shall be provided and installed in an accessible location whereas the level can be observed to prevent oil leakage while the engine is operating or nonoperating.

3.7.11.4 Oil consumption. Engine oil consumption shall not exceed 0.02 pound per hour.

3.7.12 Engine electrical system. The engine electrical system shall include a cranking motor, ignition system, electrical controls as required to perform the functions specified in this specification, and the necessary interconnecting electrical wiring and connections. The electrical system shall operate from a 24-V, dc storage battery power source.

3.7.12.1 Ignition system. The ignition system shall include an ignition unit, ignition cable, and igniter plug(s). Ignition shall be required during the starting cycle only; combustion shall be self-sustaining during normal operation. High tension ignition cable shall conform to MIL-C-3702.

3.7.13 Engine control system. The engine controls shall be matched to the generator set controls to provide an automatic control system including automatic starting, governing, and safety devices.

3.7.13.1 Acceleration control. An acceleration control shall be provided to automatically limit turbine inlet temperatures to safe values during engine starting cycle. Temperatures shall be as specified by the component manufacturer.

3.7.14 Air intake system. An air cleaner shall be provided for engine intake air (see 3.17). The housing shall be so designed that air enters only through the air cleaner so that the air cleaner can be removed and replaced from outside the housing. The air cleaner shall be the inertial separator type. The air cleaner shall be designed to meet the following requirements:

a. On fine grade test dust, as defined by SAE J726, have a minimum efficiency of 80 percent.

b. Be automatically and continuously self-cleaning. Air cleaner restriction shall not cause a reduction in rated power under any environmental condition specified herein

c. Be protected from adverse environmental conditions and physical damage.

3.8 Fuel system (generator set). The fuel system shall consist of an external fuel connection, a fuel filter, detachable control tank (day tank), boost pump, and a fuel level control system. Fuel shall be drawn from an external source by the generator set boost pump into the generator set fuel system. The generator set shall operate throughout its operating range using the applicable fuel specified in 3.7.10.1 under all specified environmental conditions.

3.8.1 Fuel system components. Fuel lines shall be corrosion-resistant material or rubber hose. Fuel line fittings shall be corrosion resistant. Arrangement of piping, valves, filters, and connections shall be designed to avoid introduction of air into system and to avoid restriction of fuel flow.

Dips or loops in fuel lines shall be avoided. The external hose connection shall be a fitting in accordance with MS24393-5 bulkhead or other suitable style fitting (1/2-20 SAE J514 thread).

3.8.1.1 Fuel boost pump. The fuel boost pump shall be resistant to corrosion by water. The engine control system shall be arranged to shut down the fuel boost pump simultaneously with engine shutdown. The fuel boost pump shall be mounted between the fuel inlet fitting and the control tank. The mounting bracket shall permit easy removal of the pump. The pump shall maintain the correct level in the control tank when the external fuel tank is located 12 feet below the generator set and displaced from the generator set by 25 feet in a horizontal direction. This requirement shall apply for any of the specified fuels under any of the specified ambient conditions, within limitations imposed by vaporization pressure of the fuels.

3.8.1.2 Fuel control tank. A detachable fuel control tank (day tank) shall be provided within the generator set housing. The tank shall be air-vented and shall be equipped with a drain valve mounted on the outside of the set to completely drain the tank at a point external to the set. The tank shall incorporate any necessary baffling. The fuel outlet of the tank shall be located high enough to permit entrapment of water and contaminants in the bottom of the tank. The drain connection shall be located to preclude entrance of contaminants into the fuel line. The tank, and necessary baffling, shall be of stainless-steel construction of sufficient rigidity to eliminate excessive vibration and handling damage. The control tank capacity shall be sufficient for 4 minutes operation (see 3.8.2).

3.8.2 Fuel system operation. Boost pump outlet flow shall be delivered to the inlet port of the control tank (day tank). If the control tank is not full, the float-vent valve shall vent air as the tank is being filled. The engine can be running during filling because the boost pump flow will exceed maximum engine requirements. When the tank has been filled, buoyant force shall close the float-vent valve and prevent leakage overboard. Pressure in the control tank shall rise to the boost pump relief valve setting of 10 psig and remain at this level as long as the fuel supply is not interrupted. Excess boost pump flow shall be recirculated through the boost pump relief valve. If the fuel supply to the generator set is interrupted, the engine pump shall continue to draw fuel from the control tank and the float-vent valve shall open as the tank fuel level is reduced, thereby preventing vacuum locking the engine pump inlet. After 3 minutes at maximum engine flow without external fuel supply, the control tank fuel level shall be low enough to actuate the float switch and initiate an engine shutdown. After shutdown, the fuel remaining in the control tank shall be sufficient for 1 minute of operation at rated load on restart.

3.9 Exhaust system. The engine exhaust shall be directed out the end of the generator set in a vertical direction. The exhaust system shall be fabricated of stainless steel conforming to MIL-S-6721, type TI.321 or Cb Ta 347 and shall be insulated. The exhaust system shall be so attached to the housing that it can be easily removed with conventional tools. The opening shall be covered with a corrosion-resistant metal screen.

3.10 Cranking system. The generator set shall be equipped with a negative-ground, 24-V, electrical cranking system consisting of a cranking motor with an engaging and release mechanism, storage batteries, battery charging system,

switches, relays, connectors, and wiring needed for compliance with the requirements specified herein. The installation of the cranking system shall prevent accidental shorting of batteries during service or maintenance.

3.10.1 Cranking motor. The motor shall have sufficient capacity for repeatedly cranking the engine at a speed high enough to start within the range of temperature specified herein. Positive engagement of the motor pinion with the engine gears shall take place before the motor is energized, and means shall be provided to prevent re-engagement and restarting of the motor while the engine is in motion. The drive mechanism shall release automatically upon starting the engine. The cranking motor system shall be so designed that if the turbine fails to start, the cranking motor will shut off and remain off until the start/run/off toggle switch is turned to the OFF position. The cranking motor shall be re-energized by placing the start/run/off switch to the START position. The cranking motor shall be provided with a motor-mounted thermal protective device which will prevent damage to the cranking motor windings. This device shall be self-resetting when the cranking motor returns to safe operating temperature as specified by the component manufacturer. The motor shall be a two-terminal type; mounting and mounting bolts shall not be depended upon to carry current.

3.10.2 Storage batteries. When specified (see 6.2), lead acid batteries shall conform to MIL-B-11188, type BB-249/U, MS35000, and shall be furnished dry and charged. Electrolyte of the correct quantity and specific gravity shall be supplied in separate containers. Lead acid batteries shall be carried in the set in a container as specified herein. When specified, nickel-cadmium batteries shall conform to Drawing 68E23164 and shall be furnished with connectors conforming to MS25182.

3.10.2.1 Battery winterization. (Nickel-cadmium battery option.) A winterization system for nickel-cadmium batteries shall be provided and installed in the battery compartment. The winterization system shall provide an electrical circuit to permit direct shorting of the battery at temperatures below -32°C and shall include a circuit breaker, located above the battery box on the inside wall of the structure, that can be manually energized or de-energized. The circuit breaker shall be provided with a protective device to prevent shorting the battery at temperatures above -29°C. The trip point for the circuit breaker shall be designed to provide maximum battery activation without depleting the battery capacity beyond that necessary to successfully start the engine after completion of the shorting procedure. The set shall be capable of starting and achieving rated performance within 10 minutes after initiation of the battery shorting procedure at any ambient temperature from -29°C to -54°C.

3.10.2.2 Battery heaters. Provisions shall be incorporated to maintain the batteries in such condition that the generator set starting sequence may be initiated immediately at all ambient temperatures from -53.9°C to +51.7°C when nickel-cadmium batteries are specified. The electrolyte temperature of the batteries shall be automatically maintained at a temperature of -16°C to +4°C for all ambient temperatures from -54°C to -10°C. Blanket-type heaters designed for 115V may be used. Provisions shall be incorporated to obtain electric power from an external source when the generator set is in a standby condition. Use of heaters may be eliminated if connecting two generator set batteries in parallel will provide immediate starting on either set at all ambient temperatures specified herein.

3.10.3 Battery cables. Battery cables shall conform to MIL-C-5756. The positive battery cable shall be provided with a red sleeve for quick identification.

3.10.4 Battery charging receptacle. A two-pole receptacle shall be mounted in a mechanically protected and accessible place on the front of the generator set and shall serve as a means whereby the batteries may be charged in place or the set may be started from an external source. The receptacle shall conform to MS75058. The receptacle shall be mounted with keyway at the top and shall be equipped with a dummy plug or dust cover on a captive chain to provide protection when the receptacle is not in use.

3.10.5 Battery charging system. A 3-phase charging system shall serve to keep the batteries fully charged so that they can deliver 100 percent of their rated ampere hour output. The system shall be a solid-state type charger consisting of a transformer, full wave rectifier, and controls energized from the alternator. Means shall be provided to prevent discharge of the batteries through the rectifier or any other part of the system when the generator set is not operating. Means also shall be provided so that the rate of charge is independent of the output voltage of the alternator within the range of voltage adjustment specified for the alternator. A current-regulating device shall be provided to prevent damage to the charger or batteries. Means shall be provided to prevent damage to the charging system if polarity of the batteries should accidentally be reversed. When set is operating the batteries and charging system shall be isolated from the 24V dc bus.

3.10.5.1 The battery charger shall be so designed that either nickel-cadmium or lead acid batteries can be charged in accordance with the above requirements. This requirement shall be effected without the use of special tools. Any interchange of parts shall be subject to the approval of the procuring activity. Parts not in use shall be captive to prevent loss and provisions shall be incorporated for their proper stowage to prevent damage. The battery shall be fully charged from discharge condition in 8 to 12 hours.

3.10.6 Battery container. The battery container shall be single-walled and fabricated from corrosion-resistant material with provisions for gas venting. The material also shall be resistant to battery electrolyte. The battery-container cover shall fit over the top of the container and shall have quick-opening latches and accessible handles suitable for manipulation with mittened hands. The container shall be so constructed that at all times there is at least 1 inch clearance between battery terminals (or cable terminals) and any uninsulated part of the container or components fastened to the container when the cover is in place or when the cover is being removed. With the cover removed, sufficient clearance shall be available to permit connection and disconnection of the battery cables, using a standard wrench, and removal and reinstallation of batteries from the container without danger of shorting the battery. Heat supply to the battery container shall be automatically controlled to prevent thermal damage to battery cases and to prevent battery electrolyte temperatures from exceeding 40°C when nickel-cadmium batteries are provided.

3.10.6.1 Holddown provisions. The batteries shall be so secured in their container that they cannot shift or move under the influences of vibration, transportation, or handling of the generator set. Interior holddown bolts shall not be used for this purpose. Acid-resistant, non-conductive blocks and brackets or other means which will prevent transfer of heat to and the

softening or charring of the battery cases shall be used. The holddown provisions shall be so designed that either nickel-cadmium or lead-acid batteries can be secured in the container.

3.10.6.2 Drains. Drains within the battery container shall direct water/electrolyte away from all apparatus, and shall discharge fluids through a main drain of 0.3125 inch diameter (minimum) terminating external to the generator set.

3.11 Governing system. The generator set shall be equipped with a governing system that incorporates a 3-phase electrical load sensing feature and is capable of both isochronous and droop operation. All mechanical linkages between various governor components and between the governor and the engine shall be made of corrosion-resistant material.

3.11.1 Electric control features. The governor shall incorporate electric control features such that the generator set frequency may be adjusted, at any load from no load to rated load, between 388 and 412 Hz from a control device on the control cubicle or from the remote station. Accidental open-circuiting or short-circuiting of any electrical components or of any electrical circuits associated therewith, including the frequency adjusting device, shall not cause the engine speed to rise to the point where the overspeed safety device will operate. It shall not be possible, by means of the frequency adjusting device, to bring the engine speed to the point where the overfrequency protective device will operate.

3.11.2 Frequency regulation. The governing system shall be equipped with adjustable frequency regulation (droop control) on the control panel and shall be adjustable to maintain frequency regulation from 0 to 3 percent. At the 0 percent setting (isochronous) regulation, the governor shall return to a steady value within bandwith of .5 percent of rated frequency for every load change.

3.11.3 Frequency variations at constant load. At any constant load between no load and rated load, the governing system shall maintain the generator set frequency constant within .25 percent bandwidth. There shall be no sustained periodic frequency oscillations, even if the oscillations are within the allowable ±1 Hz variation at constant load; this requirement applied under all conditions including those which exist after settling takes place following load changes as specified in 3.11.4.

3.11.4 Frequency transient performance. Following any sudden load change from no load to any load up to and including rated kw or vice versa, the generator set frequency shall reach its final value within 1 second. It shall stabilize at this value with no more than one overshoot or one undershoot outside the ±1 Hz tolerance for constant load conditions. There shall be no sustained periodic oscillations even though within the allowable ±0.25 percent frequency variation band for constant load. With sudden application or removal of any load up to and including rated kw from the generator set, the frequency shall at no time depart from rated value by more than 1.5 percent of rated value.

3.11.5 Frequency drift. The governing system shall not permit the generator set frequency to change more than ±1 Hz for an ambient temperature change of 33.3°C, within the specified temperature range, at any constant load condition from no load to rated load. The governing system shall not permit the

frequency to change more than 4 Hz during warmup and stabilization for any load condition from no load to rated load for any environmental condition specified herein.

3.11.6 Long term stability 4 hours. At constant ambient temperature constant barometric pressure, constant voltage and any load from no load to rated load the set shall maintain frequency within a bandwidth equal to .25 percent of rated frequency in a 4-hour operating period.

3.12 Alternator. Unless otherwise specified herein, the alternator shall conform to MIL-G-21480 and Drawing 68E23310 for the MEP-403A and Drawing 68E23311 for the MEP-404A. The alternator shall be of the self-ventilated type, having ventilating openings covered with 0.5-inch mesh wire screen. The exhaust air shall be ducted through the firewall partition into the combustor compartment. The cooling air exhaust shroud shall be removable without disturbing the fuel system components.

3.12.1 Frame. The alternator frame shall maintain correct alignment of all parts which it supports. Tapped holds for eyebolts or equivalent means shall be provided in the frame to facilitate mounting and removing the alternator. Insulated abrasion-resistant sleeves or bushings secured to the frame shall be provided for passage of leads out of the alternator. The alternator stator windings shall terminate at terminals mounted on the frame and provided with suitable covers. Direction of rotation shall be shown by an arrow on the frame.

3.12.2 Bearings. The alternator and exciter shall utilize double-seal (sealed-for-life) ball bearings, packed with grease conforming to MIL-G-81322. If the alternator bearings operate at temperatures higher than that allowed in MIL-G-81322, a special high-temperature grease subject to approval by the contracting officer shall be used.

3.12.3 Rotors (alternator and exciter). Rotors shall be in electrical and mechanical balance at all speeds up to 125 percent of rated speed. Balancing of rotors shall utilize one of the following methods:

a. Drilling out of material

b. Rivets

c. Lead or babbitt metal carried in a receiver in a manner to preclude their breaking loose or shifting

d. Steel weights welded in place or dovetailed and anchored in balance grooves.

3.12.3.1 Field poles shall be integral with the spider or yoke or secured thereto by dovetails or tap-bolts. Rotor coils shall be braced against loosening due to centrifugal force or vibration. Field coils of like polarity shall be interchangeable, except for coils wound in place on poles which are integral with the spider or yoke. The alternator and exciter shall withstand an overspeed of 125 percent of rated speed for 5 minutes without damage to any part.

3.12.4 Waveform. With the alternator operating at rated voltage and frequency under control of its exciter and voltage regulator, and at any balanced unity

power factor or 0.80 power factor (lagging) load between no load and rated load, the following requirements shall apply to line-to-neutral and line-to-line voltage waveforms. This requirement is based on use of linear (nonsaturating) reactors to obtain the lagging power factor load component.

a. The deviation factor shall not exceed 5 percent

b. The fifth harmonic shall not exceed 1.5 percent of the fundamental; the seventh harmonic shall not exceed three-fourths of 1 percent; no other single harmonic shall exceed one-half of 1 percent of the fundamental

c. Total harmonic content (square root of the sum of the squared values of all the harmonics) shall not exceed 1.73 percent

d. There shall be no discontinuities, spikes, or notches in the waveform when viewed on an oscillograph having a minimum display area of 6 by 10 cm dc to 15 mc (or higher) bandwidth, and 23 n sec (or less) rise time.

3.12.5 Transient reactance. The rated voltage transient reactance shall not exceed 20 percent.

3.12.6 Negative sequence reactance and impedance. The negative sequence reactance and impedance shall not exceed 19 percent of the 120/208 test voltage.

3.12.7 Phase balance. With the generator set operating at no load, rated voltage and frequency, the maximum difference in the three line-to-neutral voltages (measured at the generator set terminals) shall not exceed 1 percent of rated line-to-neutral voltage. When the alternator is connected for 240/416V operation, the difference in voltage of the windings of any one phase shall not exceed 1V at no load.

3.12.8 Effect of unbalanced load. With the generator set operated at no-load, rated voltage and frequency, application of a single-phase, line-to-line, unity power factor load equal to 25 percent of rated current shall not cause the three steady state line-to-line voltages to differ from each other by more than 5 percent of rated voltage.

3.12.9 Voltage operating range. The generator set shall operate as specified herein at rated kilowatts, frequency, and power factor at any voltage between 95 and 110 percent of rated voltage.

3.12.10 Exciter field current. With the generator set operating at rated load current (at either 1.0 or 0.80 power factor, lagging) at rated frequency and voltage, the exciter field current shall not differ by more than 10 percent from the field current required by the preproduction model generator set under the same load and environmental conditions.

3.12.11 Short circuit requirements. When under control of its exciter and voltage regulator, the alternator shall withstand, without injury, application of any 2-second short circuit (3-phase, single-phase, L-L, and single L-N) at its terminals during operation at rated kilowatts, power factor, frequency, and 5 percent overvoltage. Also, for application of a symmetrical 3-phase short circuit, the steady-state short circuit current shall be not less than 300 percent of rated current. The current limiting feature of the alternator shall not be used to meet the above requirements. The generator and voltage

regulator shall be capable of providing a single-phase to neutral or 3-phase fault of at least three per unit current for 5 seconds without damage. The voltage regulator shall include a current-limiting feature employing current transformers which shall limit steady-state fault current to a five-per-unit maximum.

3.12.12 Armature windings. The alternator armature shall be wound with two circuits per phase, at least 10 armature leads being brought out of the machine and terminating at a terminal block on the frame. Leads or terminals shall be marked in accordance with MIL-STD-195.

3.12.15 Efficiency. The overall alternator-exciter efficiency shall not be less than 89 ±0.25 percent for rated output at rated voltage and frequency at 0.8 power factor lagging.

3.12.16 Slip rings. The alternator for the preproduction model generator set may be equipped with slip rings to permit accomplishment of tests requiring separate excitation and measurement of alternator field current. If used, the slip rings shall be easily removed for normal connection of exciter and alternator rotor windings after completion of testing.

3.12.15 Overload. The alternator shall be capable of delivering 125 percent of rated load at 0.8 pf lagging plus load sharing allowance for 5 minutes (see 3.5.19.1).

3.12.16 Out-of-phase paralleling. The alternator, exciter, and regulator shall not be damaged while attempting to parallel two machines with voltages out-of-phase up to and including 180°, with the permissive paralleling relay inoperative.

3.13 Exciter and voltage regulator for alternator. Unless otherwise specified herein, the voltage regulator shall be solid state design conforming to MIL-G-21480. The voltage regulator shall utilize modular, plug-in board type construction in an enclosure with a removable panel equipped with quick-disconnect fasteners for easy access. Component identification on the printed circuit plug-in-boards shall be in accordance with ANSI Y32.16. The design of the voltage regulator shall also be such that circuit adjustment of the regulator will not be required to meet the specification requirements when the plug-in-boards are being replaced by like boards. All circuit and component adjustment procedures necessary for specification compliance shall be subject to the approval of the procuring activity. The generator and voltage regulator shall be capable of providing 3-phase fault current limiting features as specified in 3.12.12. The exciter shall be of the rotating type not requiring the use of brushes. Electronic tubes shall not be used. The exciter and voltage regulator shall be capable of operating satisfactorily and controlling the alternator voltage as specified herein, throughout the range of voltages specified in 3.12.9. Exciter buildup shall be automatic and shall not require the use of manual flashing circuits. Forced cooling of the regulator and exciter (by locating them in the flow of alternator or generator set intake air) will be permitted. Separate fans or blowers shall not be used for forced cooling.

3.13.1 Exciter ceiling voltage. The exciter ceiling voltage and speed of response shall be adequate to meet the voltage dip requirements specified herein for the one-half per unit impedance low power factor loads and to supply excitation required during the specified short circuit conditions.

3.13.2 Voltage regulator. Voltage sensing shall be a 3-phase type. The regulator shall be equipped with compensating provisions as necessary to minimize drift in the regulated voltage due to warmup of alternator field, exciter, and regulator or changes in ambient temperatures. Drift in line-to-line voltage shall not exceed 2V (for 120/208V connection) as the machine stabilizes from cold conditions under rated-load, or for a change in ambient temperature of 15°C. The voltage regulator shall incorporate reactive biasing circuitry to permit interconnection of voltage regulator between sets for parallel operation. This mode of operation shall permit parallel operation without voltage droop. The regulator shall also have provisions for operation in a voltage droop mode where a voltage droop is introduced for paralleling of generator sets without connecting cables. The amount of droop introduced shall be adjustable from 0 to 4 percent of rated voltage for zero power factor (lagging) currents equal to 60 percent of rated current. This adjustment shall be located on the control panel. The voltage regulators shall be furnished with the circuitry connected in the reactive biasing mode. The regulator sensing circuits shall allow remote voltage sensing through the remote control receptacle specified in 3.5.20.

3.13.3 Voltage regulation. With the generator set initially adjusted at rated frequency and for any voltage within the specified range of adjustment, the average rms terminal voltage shall remain within a band of plus or minus three-fourths of 1 percent of the average no-load and rated-load rms voltages as the load is changed in increments from no-load to rated-load, and vice versa, ignoring the voltage variations permitted in 3.13.4. This requirement shall also apply for steady-state conditions when any load between no-load and rated-load is suddenly applied or removed in one step. The regulator shall meet the above requirements for each voltage connection of alternator stator windings, with the reactive droop compensation inactive, and at any power factor from unity to 0.80 lagging.

3.13.4 Voltage variations at constant load. At any constant load between no load and rated load, the generator set output voltage shall not deviate more than one-half of 1 percent from its average rms value. There shall be no sustained periodic voltage oscillations, even though within the allowable one-half percent short term stability (30 seconds) and long term stability (4 hours); this requirement shall apply under all conditions, including those which exist after settling takes place following load changes as specified in 3.13.5b.

3.13.5 Transient voltage regulation. Performance of the generator set under transient conditions shall be as follows (reactive droop compensation of the voltage regulator being operative):

a. With the generator set initially operating at 400 Hz and rated voltage, sudden application of a balance 0.5 per unit load (power factor of 0.4 lagging, or less) static load impedance shall not cause the rms terminal voltage to drop to less than 70 percent of initial voltage measured by an oscillograph. The voltage shall reach 95 percent of initial value within 0.15 second and shall stabilize at or above this voltage (95 percent of initial) with not more than one overshoot and one undershoot of the final stabilized value. The alternator, regulator, and exciter shall be so designed that the above specified voltage dip will not be exceeded when an induction motor of the above specified impedance is used in place of the static load and that no reactions will be set up to prevent full acceleration of the motor.

b. With the generator set initially operating at rated frequency and voltage, application or removal of any balanced load up to and including rated load in one step shall not cause the rms terminal voltage (as measured by an oscillograph) to change by more than 15 percent of its initial value. The voltage shall reach its final value within 0.10 second and shall stabilize at this value with not more than one overshoot and one undershoot outside the allowable voltage variation band for constant load conditions.

3.13.6 Range of voltage adjustment. By means of a manual rheostat on the control cubicle, it shall be possible to adjust the regulated line-to-line voltage at any value between 95 and 110 percent of rated voltage at any load up to and including rated load, at any ambient temperature within the specified temperature range, and at any frequency between 388 to 412 Hz. Voltage adjustment shall be accomplished through the remote control receptacle specified in 3.5.20.

3.14 Alternator circuit breaker. A latch-in-type circuit breaker rated not less than 250 amperes shall be mounted within the generator set. It shall be an electrically operated, remotely controlled, 3-pole, 3-phase breaker and its controls shall consist of a switch for opening and closing the breaker, a red light for indicating closing of main contacts, and a green light when the contacts are open. The lights will be marked CLOSED and OPEN. The contacts associated with all three poles shall operate together. It shall not be possible for any of these contacts to be closed while others are open. Auxiliary contacts as required shall be included as part of the circuit breaker. The circuit breaker shall be so connected that it will open automatically when the engine control switch is in the OFF position and shall be independent from the underfrequency or other protective device. The minimum fault current capacity of the circuit breaker shall be 5,000 amperes per phase. Any malfunction which causes shutdown of the turbine shall also cause the circuit breaker to open.

3.14.1 Generator fault current protection. Fault current protective features shall be provided. When the current in any one phase exceeds three per unit of generator set rated current, the breaker main contacts shall open in 2 seconds. This device shall have an inverse time current characteristic which shall provide sufficient time delay in the tripping of the generator breaker so that a fault on any feeder located external to the set, will always trip the feeder breaker and clear the fault without tripping the generator breaker. The feeder breakers shall not have any intentional time delay in their fault current sensing device.

3.14.2 Undervoltage protection. Undervoltage protective features shall be provided. Undervoltage sensing devices may be external to the circuit breaker and shall be of the 3-phase type. The circuit breaker shall be time-delayed before opening in such a manner that the undervoltage sensing is compatible with the inverse time characteristic of 3.14.1. The voltage protection system shall operate in the range of 60 to 80V.

3.14.3 Overvoltage protection. Overvoltage protective features shall be provided. A 3-phase overvoltage sensing device shall be provided to trip the circuit breaker if the alternator output voltage rises above 130 percent of rated voltage and remains at this value for more than 180 milliseconds. It shall not cause the breaker to trip for values of voltage at or below 127 percent of rated voltage. The device shall be connected in parallel with the

voltage regulator sensing circuits. In addition to tripping the circuit breaker, action of the overvoltage sensing device shall cause loss of alternator excitation.

3.14.4 Underfrequency protection. Underfrequency protective features shall be provided. A frequency or speed sensing device shall be provided to cause the circuit breaker to trip when the generator set frequency drops to 370 ±5 Hz. It also shall prevent closure of the circuit breaker if the frequency is less than 365 Hz.

3.14.5 Reverse power protection. A reverse power relay shall be provided to open the generator circuit breaker upon detection of reverse power flow. The relay shall have sufficient sensitivity so that a flow of power in reverse direction of 10 to 25 percent of rated load power will cause it to operate with a time delay of 3 to 10 seconds.

3.14.6 Fault indication. Weatherproof, press-to-test blackout-type fault breaker control lights (red) shall be so mounted on the hinged panel of the control cubicle that the operator can easily distinguish between the fault lights and the circuit breaker control lights. The fault indicator lights shall be marked with the malfunction they indicate. The control circuits for the fault lights shall be so designed that the first malfunction which occurs will cause the appropriate indicator to light and inhibit all others from lighting as the generator set shuts down. The light shall remain on, and the alternator circuit breaker cannot be closed until the master switch has been moved to the OFF position except for cranking motor over temperature shutdown. The following malfunctions shall be indicated on the control cubicle:

a. Overcurrent

b. Undervoltage

c. Overvoltage

d. Underfrequency

e. Reverse current

f. Overspeed

g. Low lube oil pressure

h. Exhaust temperature

i. Low fuel

j. 96 percent speed (failure to reach 96 percent of rated speed within 60 seconds)

k. Starter hot (cranking motor overtemperature).

3.15 Receptacles and output terminals. The generator set shall be provided with receptacles and output terminals as follows: All receptacles shall be provided with chained covers or caps, and all terminals shall be located in a protected place convenient to the operator.

3.15.1 Phase rotation. Phase rotation shall be L_1, L_2, L_3, and 1, 2, 3 at the generator set output terminals and receptacles. The terminals shall be arranged in line, reading from left to right or from top to bottom in the sequence 1, 2, and 3.

3.15.2 Receptacles, alternator output. Three receptacles conforming to Drawing 66C44953 (except crimp contacts may be used in lieu of solder) and covers conforming to MS25042-32C shall be provided in the center of the left side (when looking at control panel) of the generator set and recessed in the base of the set. A receptacle conforming to MS3100R36-5S and a cover conforming to MS25043-36C shall be located beneath the control panel and recessed at the front of the generator set.

3.15.3 Output terminals. Four alternating-current output terminals with supports as specified in 3.4.5 shall be provided in a convenient place at the alternator end of the set. Access to terminals shall be accomplished through a hinged door with terminal L_0 being the neutral and grounded to the generator set frame or base. L_1, L_2, and L_3, shall connect through the circuit breaker to generator leads T_1, T_2, and T_3, respectively. The terminals shall be arranged in line in the sequence L_1, L_2, L_3, and L_0, when reading left to right or from top to bottom. Terminal studs shall be of the slotted type conforming to Drawing 68J22795. Clamping of cable ends shall be accomplished by a captive hexagon nut assembly threaded on the stud or by split-bar-type wire locking receivers with hexagon nuts. Terminals shall be rigidly mounted; studs shall not twist or turn in their mountings when the hexagon nuts are tightened. Each terminal shall be adjustable to accommodate a range of conductors up to and including two number 0 AWG. When specified (see 6.2), a 12-point plastic lead terminal wrench shall be provided (see 3.17.3.4).

3.15.4 Convenience receptacle. A duplex receptacle conforming to W-C-596, style D shall be provided and arranged for 120-V output by connecting it between neutral and alternator terminal T_9 through a suitable 15-ampere circuit breaker. The receptacle grounding terminal shall be connected to the generator set housing or base. The receptacle shall be provided with a captive weatherproof cover to prevent entrance of rain when the cover is in place.

3.15.5 Grounding. All alternating-current electrical components of the generator set shall be isolated from ground, except as otherwise specified herein. The neutral output terminal (L_0) shall be connected to the ground stud (see 3.5.4.1) by an insulated conductor No. 1/0 AWG or larger using fastening methods other than the split stud features of the applicable studs or terminals. The connecting wire shall be readily disconnectable from the neutral terminal (L_0). The loose end shall be retained when not in use. Neutral connection of wye-connected current transformer secondaries may be connected to circuits leading to output terminal L_0. Unless otherwise specified herein, direct current components utilizing chassis or case grounding shall not be used. When specified (see 6.2), two ground rods (six sections), type II, style 2, conforming to MIL-R-11461 shall be provided for each set. Provisions shall be made for storing the rods on the generator set so that the dimensions specified in 3.22 are not exceeded. Rods shall be stored in a manner to preclude damage from vibration, shock, and impact normally encountered in operation and transportation.

3.16 Control cubicle. A metal control cubicle shall be mounted at the generator set. The cubicle shall be sealed against the entrance of rain, snow

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and dust. The entire control cubicle shall be equipped with military standard connectors (plugs and sockets) to allow quick removal and replacement of the cubicle. Terminal strips shall not be used.

3.16.1 Ventilation. Ventilation of the control cubicle shall be provided to prevent buildup of artificially high ambient temperature within the cubicle. This may be accomplished by natural convection or through action of the alternator fan in drawing air through the cubicle.

3.16.2 Panel lights. At least two 24-V dc panel blackout type lights shall be mounted on the control cubicle or on the structure immediately above the cubicle in such a manner as to illuminate all controls and instruments. The panel lights shall be shielded. Lamps for all lights shall be removable from the control cubicle without the use of tools or other aids.

3.16.3 Instruments and control devices. Except as otherwise specified herein, instruments and control devices shall be flush-mounted on the front of the control cubicle. Gaskets shall be provided under each instrument or control to prevent the entrance of rain into the cubicle. In addition, all instruments and controls shall be sealed against the entrance of rain and dust.

3.16.3.1 Vibration influence. Instruments shall be mounted to operate satisfactorily and be clearly readable when under the influence of any vibration which is transmitted to the control cubicle from rotating parts of the unit. There shall be no increase in instrument errors (over those permitted as specified herein) when the instruments are mounted on the generator set and the set is operating.

3.16.3.2 Arrangement and grouping of controls and instruments. Controls and instruments shall be arranged for maximum simplicity of operation. The controls shall be easy to manipulate by personnel wearing arctic mittens. All controls shall be so arranged that one man can start and operate the generator set under all environmental conditions. Controls and instruments shall be arranged in related groups as follows:

a. Engine instrument and control group

b. Alternator electrical group. Within each group, instruments shall be of the same size and shape. The cubicle shall be so designed that each group of controls and instruments can be removed as a unit without disturbing the other groups, except the alternator and winterization groups may be located on the same panel.

3.16.3.2.1 Engine instrument and control group. Access for maintenance shall be provided through a hinged panel at the front of the control cubicle. The hinge shall be horizontal and located at the bottom of the panel. Stops (not chains or ropes) shall be provided to prevent the panel from swinging through more than 90°. The following instruments and controls shall be provided on the hinged panel:

3.16.3.2.1.1 Exhaust temperature gage. The exhaust temperature gage shall be marked from -18°C (0°F) to 816°C (1,500°F) in 55°C (100°C) increments. Overtemperature zones shall be marked in red.

3.16.3.2.1.2 Speed indicating system. The speed indicating system shall consist of an indicator conforming to MIL-I-25623 mounted on the control

cubicle as part of the engine instrument and control group, and a tachometer generator compatible with the indicator and mounted on the gas turbine engine. Solid-state components shall be used.

3.16.3.2.1.3 Elapsed time meter. The elapsed time meter shall conform to MIL-M-3971, type I, and shall indicate operating time for the generator set. The meter shall be suitable for use at voltages up to and including 30V.

3.16.3.2.1.4 Battery-charging indicator. A 2.5-inch direct-current ammeter with shunt (if required) shall be provided to indicate charge or discharge of the battery. Except as otherwise specified herein, the indicator shall conform to MIL-M-10304. The dial of the indicator shall have a white background and black markings. The scale shall be 10-0-20 amperes, with the portion to the left (10-0) of zero being red and marked DISCHARGE. The portion to the right (0-20) shall be green and marked CHARGE. Non-fading colors shall be used in coloring the scale.

3.16.3.2.1.5 Engine control switch. A three-position engine control switch marked START, RUN, and OFF, with spring return to the center position (from START position only), shall be provided to control the generator set as follows:

a. Lower position - the lower position of the switch shall be marked OFF and shall be employed to stop the generator set. When the switch is in the off position, all generator set circuits, except those required to open the circuit breaker, which are fed from the battery shall be de-energized

b. Center position - the switch shall be in the center position for operation of the generator set after the switch has been placed momentarily in the start position. The run position in combination with the standby switch in the on position shall put the set in standby. In addition, the run position in combination with the off position of the standby switch shall run the boost pump

c. Upper position - the upper position shall be marked START. After the switch is momentarily actuated to the upper position, the generator set shall crank, come up to rated speed and voltage, and reach a ready-to-load start automatically without additional action on the part of the operator.

3.16.3.2.1.6 Standby switch. The standby switch shall be a two-position (ON-OFF) switch. In the on position, the switch will automatically start the standby set upon a command from the other set. (See 3.5.20.1.) A separate pole shall be incorporated on the standby switch to accommodate circuitry to run the fuel boost pump when the standby switch is moved to the off position and the master switch is moved to the run position.

3.16.3.2.1.7 Master switch. A two-position toggle circuit breaker labeled MASTER SWITCH, OFF-ON shall be connected in the direct current supply ahead of the engine control switch to protect all circuits energized from the battery, except those associated with the winterization and battery charging systems.

3.16.3.2.2 Alternator electrical group. Access for maintenance shall be provided through a hinged panel at the front of the control cubicle. The hinge shall be horizontal and located at the bottom of the panel. Stops (not chains or ropes) shall be provided to prevent the panel from swinging through more than 90°. Except as otherwise specified herein, instruments shall conform to

MIL-M-10304 for 3.5-inch, style 36 instruments with zero adjusters, color scheme W. All controls or instruments associated with a particular function (e.g., the voltmeter and the voltage regulator adjusting rheostat) shall be grouped together. Instruments and controls shall be supplied as follows:

3.16.3.2.2.1 Voltmeter. The voltmeter shall have a single 250° 0-500-V scale with red markings at the 120-, 208-, 240-, and 416-V points. Each scale division shall represent not more than 5V, and needle deflection shall be directly proportional to voltage over the entire scale (within the initial accuracy of the instrument). A d'Arsonval-type instrument with integral rectifiers will be acceptable, provided the combination meets the ac voltmeter requirements, including temperature errors, of MIL-M-10304, as modified herein. Initial accuracy (error) of the instrument shall be not more than 2.5 percent of full scale, except that within the ranges of 15 to 125 and 200 to 250V the error shall not exceed 5 and 10V, respectively. The voltmeter shall withstand application of 3,000V dc suddenly applied between the case and the two terminals connected together. This dc voltage shall be applied with both positive and negative polarity with respect to the case.

3.16.3.2.2.2 Ammeters. Three ammeters shall be provided to read each phase current. The ammeters shall conform to MIL-M-10304 and shall be calibrated to indicate percent of rated current. Full scale shall be 150 percent, and the part above the 100 percent point shall be colored red. Initial accuracy (error) of the instrument shall be not more than 2.5 percent of full scale.

3.16.3.2.2.3 Kilowatt meter. The kilowatt meter shall be capable of measuring and indicating the power output of both a 3-phase, 3-wire and a 3-phase, 4-wire distribution system to an accuracy of 3 percent of full scale value from alternator no load to rated full load current under the following conditions:

a. Balance load at any power factor from unity to 0.50 lagging

b. Unbalanced load, where the 3-phase voltages, currents, and power factors differ

c. With the output of any one phase equal to zero.

The temperature error at an ambient of 50°C shall not exceed 1.5 percent and that at -55°C shall not exceed 4 percent of full scale value. The meter shall conform to the requirements of MIL-M-10304 as specified for 3.5-inch size, except a kilowatt scale shall be used. Full scale shall be approximately 125 percent of rated load with a red mark at rated load. The instrument may utilize static circuit elements which convert ac voltage and current input signals to a dc signal then being indicated on a d'Arsonval-type instrument. All converter circuit elements shall be static, potted, packaged together, and mounted within the control cubicle; only the indicator portion of the instrument shall be mounted on the hinged panel. Operation of the meter and its converter, if used, shall not be adversely affected by any of the following conditions:

a. Twice rated voltage at zero current for 5 seconds

b. Twice rated current at normal voltage continuously

c. Five times rated current at normal voltage for 5 seconds.

3.16.3.2.2.4 Frequency meter. The frequency meter shall consist of a converter and an indicator. The scale shall be calibrated in Hertz over the range of 388 to 412 Hz with not less than 48 scale divisions; the scale shall have a red mark at the 400-Hz point. When the instrument is de-energized, the needle shall rest at the 388-Hz mark on the left end of the scale. Alternating current voltage applied to the converter shall be transformed to a dc voltage (or current) which is proportional to the frequency of the ac voltage and which is registered on the d'Arsonval-type indicator. The converter shall be made up entirely of static (not moving) components, except that electronic tubes and electrolytic capacitors shall not be used, and shall be potted or hermetically sealed. The converter and indicator acting as a combination shall have characteristics as follows:

a. Basic accuracy - error at any point on the scale shall not exceed 1 Hz for 120V sine wave input at room ambient

b. Temperature error - temperature error shall not exceed 2 Hz at any ambient temperature from -54° to +52°C

c. Operating voltage - the instrument shall operate over the range of 105 to 135V, an increase in basic error proportional to the difference in voltage from 120V being allowed, but not to exceed 1 Hz

d. Harmonic effects - no single harmonic of any frequency of a magnitude equal to 10 percent of the fundamental shall cause an error of more than 1 Hz, regardless of the phase relation of the harmonic with respect to the fundamental

e. Shock and vibration - the instrument shall meet the shock and vibration test specified in MIL-M-10304, with error due to shock and vibration effects not exceeding 1 Hz

f. Drift - there shall be not more than 0.5 Hz change in indication over a period of 8 hours from the time the instrument is first energized, frequency voltage, temperature, and harmonic content of the input voltage being constant.

The frequency meter shall not be damaged or the accuracy permanently impaired by application of the following voltages:

1. 240V at 400 Hz for 10 seconds
2. 150V at 400 Hz continuously
3. 120V at 150 Hz continuously
4. 120V at 500 Hz continuously.

At 120V and any frequency between 150 and 388 Hz, the frequency meter shall read off scale to the left; at 120V and any frequency between 412 and 500 Hz, the meter shall read off scale to the right. The converter may be mounted within the control cubicle rather than on the hinged panel with the indicator.

3.16.3.2.2.5 Voltmeter transfer switch. A voltmeter transfer switch shall be provided and connected to allow measurement of the voltage in each phase, the three line-to-neutral voltages, and three line-to-line voltages. Indication for various positions of the switch shall be as follows:

Switch position	Voltage
1	$L_1 - L_N$
2	$L_2 - L_N$
3	$L_3 - L_N$
4	$L_1 - L_2$
5	$L_2 - L_3$
6	$L_3 - L_1$

3.16.3.2.2.6 Panel light switch. An on-off switch for panel lights shall be provided.

3.16.3.2.2.7 Voltage regulator adjusting rheostat. A rheostat shall be provided to permit adjustment of the regulated voltage within the specified range. The rheostat shall have a slotted shaft for screwdriver-type adjustment and shall be equipped with a locking device. Direction of rotation to increase voltage shall be clockwise; an escutcheon shall be provided to show this information.

3.16.3.2.2.8 Frequency adjusting means. A rheostat shall be provided on the instrument panel for adjusting the frequency within the specified band. The rheostat shall have a slotted shaft for screwdriver-type adjustment and shall be equipped with a locking device. Direction of rotation to increase frequency shall be clockwise. An escutcheon shall be provided to show direction of manipulation of the control to increase frequency.

3.16.3.2.2.9 Circuit breaker closure indicator. An indicating light blackout type, with a yellow window shall be provided to indicate when the ac output circuit breaker is in the closed position; green when the breaker is open. The lights shall be provided with blackout and press-to-test features.

3.16.3.2.2.10 Voltage regulator cross-current compensating control. This control (see 3.13.2) shall consist of a rheostat with slotted shaft and locking nut, for adjustment with screwdriver. Clockwise rotation of the shaft shall decrease the voltage droop due to cross-current compensating; an escutcheon shall be provided to show this information.

3.16.3.2.2.11 Unit-parallel switch. The unit-parallel switch shall be a two-position switch which, when in the PARALLEL position, will activate the synchronizing light circuits, governor speed droop circuits (if electric), and voltage regulator cross-current compensating circuits. In the UNIT position, the switch shall inactivate these circuits. In changing from one position to another, current transformer secondary windings shall not be open-circuited.

3.16.3.2.2.12 Synchronizing lights. Two synchronizing lights, blackout type, covered with clear lenses shall be provided and so connected that they are dark when the generator set is ready to parallel with a bus supply. Means shall be provided to insure that voltage applied to the lights is within their operating range, regardless of the connection of the alternator windings (i.e., series or parallel).

3.16.3.2.2.13 Governor frequency droop adjustment. If speed (frequency) droop is introduced into the governor by electrical means, a rheostat for adjustment of the droop shall be provided on the control panel and shall have a slotted shaft and locking nut for adjustment with a screwdriver. Clockwise rotation of the shaft shall decrease the frequency droop; an escutcheon shall be provided to show this information.

3.16.3.2.2.14 Protection bypass switch. A two-position device contact maintaining switch shall be provided and connected to prevent shutdown of the engine and opening of the circuit breaker under the action of any safety or protective device, except overspeed, when specified and short circuit, when the set is operated under battle conditions. The switch shall be labeled PROTECTION BYPASS and shall be marked ON in the bypass position and OFF for the normal position. A hinged red cover shall be provided which can be quickly raised to provide access to the switch and which returns the switch to the off position when lowered.

3.16.3.2.2.15 Remote sensing switch. A two-position switch shall be provided and connected into the voltage regulator sensing circuit to facilitate switching the voltage regulator to either local or remote sensing as specified in 3.5.20.

3.16.3.2.2.16 Circuit breaker closure. A toggle switch shall be provided to permit opening and closing the ac output circuit breaker.

3.16.3.2.2.17 Remote control selector switch. A local-remote selector switch that will not shut down the turbine when transferring control from local to remote, or remote to local, shall be provided as required in 3.5.20.

3.17 Housing. The housing shall be constructed of aluminum not less than 0.063 inch thick for the sides and ends, not less than 0.125 inch for the top, and not less than 0.050 inch for the bottom skin. The housing shall fully enclose the sides, top, ends, and bottom of the generator set, except for an opening for the air intake and exhaust. The top of the housing shall serve as a working platform for a maximum of three men whose combined weight is not less than 500 pounds. The housing wall shall be lined with a layer of sound-attenuating material, and means shall be provided for maintaining the material in place. The housing shall exclude entry of wind-driven snow, rain, or dust when doors and covers are closed. Drip channels or equivalent means shall be used as necessary to prevent the entry of rain or melted snow. Provisions shall be made for entry of a sufficient quantity of cooling air to the alternator and other electric parts when the generator set is operating. Means shall be provided to prevent dead air spaces within the housing. The housing shall withstand the acceleration, railroad humping, and shock tests specified herein. Box sections, if used, shall not permit entrapment of moisture.

3.17.1 Firewall. The housing shall be provided with a partition to separate the engine turbine and combustor sections from the rest of the generator set and thereby minimize heating of air intake through radiation and recirculation of hot air from the engine. This partition may serve as a mounting surface for minor generator set components, as practicable.

3.17.2 Covers and doors. The housing shall be sectionalized and equipped with fitted covers and hinged doors, reinforced as necessary with stiffeners, to provide complete access to and, if necessary, replacement of components of the generator set without removal of the complete housing. All hinges shall be of the continuous (piano) type, shall be made of stainless steel, and shall have positive means to prevent the pins from working out. The air intake opening shall be provided with a louvered, removable cover. The side access to the day tank shall be a removable panel. Hinged doors shall be provided over the control cubicle. Flush latches or fasteners of a type which can be operated by personnel wearing arctic mittens shall be provided to hold the doors and covers tightly closed. A screwdriver may be used as an aid, when wearing mittens to operate the fasteners in cold weather.

3.17.2.1 Housing seals. A silicone rubber type seal conforming to AMS 3205, or tear resistant silicone rubber seals shall be used on openings such as doors, covers, and panels at all points where a seal is necessary to exclude rain or blowing snow. The seals shall be so riveted to supporting parts that the rivets will not pull through if the seal is subjected to tension. The seals shall remain flexible and resist cracking over the range of ambient operating temperatures specified herein. The seals shall be removable and replaceable and held in place without adhesive.

3.17.3 Stowage space

3.17.3.1 Spare fuses. Stowage space shall be provided on the inner front wall of the generator set to stow spare fuses provided with the set.

3.17.3.2 Spare turbine nozzle. When specified, a bracket shall be provided in an accessible position within the size 60 generator set for stowing a spare turbine nozzle.

3.17.3.3 Document compartment. A readily accessible, metal compartment shall be provided within the housing for storing instruction books, logs, and other documents. The inside dimensions shall be not less than 12 inches by 10 inches by 2 inches.

3.17.3.4 Terminal wrench. When wrench is required, a bracket shall be provided in an accessible position for stowage. Wrench shall be held captive.

3.18 Skid base and frame assemblies. The skid base assembly shall be in accordance with Drawing 68D22671, and the frame assembly shall be in accordance with Drawing 68E22601.

3.19 Audio noise. The average noise level of the generator set shall not exceed the values specified in MIL-STD-1474, table II, Category D. Noise level measurements shall be taken at head level (5 feet 8 inches) on a circle of 25-foot radius centered on the geometric center of the set. Readings shall also be taken at the operator's position (at head level) by slowly moving the measuring microphone in a 2-foot-diameter circle centered on the most probable position for an operator and the same limits shall apply. Readings shall be taken with the generator set operating at rated speed, no-load, and rated-load.

3.20 Electromagnetic interference. The generator set shall conform to the electromagnetic interference emission and susceptibility characteristics of MIL-STD-461, Class V.

3.21 Interchangeability

3.21.1 Part numbering of interchangeable parts. All parts having the same manufacturer's part number shall be functionally and dimensionally interchangeable. The item identification and part number requirements of MIL-STD-100 shall govern the manufacturer's part numbers and changes thereto.

3.21.2 Interchangeability and replaceability. The interchangeability and replaceability of like assemblies, subassemblies, and replaceable parts in the generator set shall be in accordance with MIL-STD-454, requirement 7.

3.22 Dimensions. The overall dimensions of the generator set shall not exceed 60 inches length, 36 inches width, and 30 inches in height.

3.23 Weight. The dry weight of the generator set shall not exceed 850 pounds for the MEP-403A and 900 pounds for the MEP-404A.

3.24 Finishes and protective treatments

3.24.1 Treatment and painting. Except as otherwise specified herein, the generator set shall be treated and painted in accordance with MIL-T-704, type A. Color of finish coat shall be specified (see 6.2). Treatment and painting of components interior to the generator set may be in accordance with the manufacturer's standard practice, if such practice is compatible with the environmental and other performance requirements specified herein, except that interior parts such as panels, brackets, angles, and channels of the housing shall be treated in the same manner as external surfaces. Stainless steel parts need not be painted, except the exhaust box shall be painted with heat resisting paint conforming to MIL-P-14105. The following items shall not be painted: Electrical terminals and connections, governor linkages, instruction plates, nameplates, switches, sound insulating materials, and all other parts the operation of which would be adversely affected by paint. Set components or items, such as grease fittings and bayonet gages, requiring routine servicing shall be marked by red paint.

3.25 Operational markings and nameplates. The following instructions and nameplates shall be provided on the generator set proper.

3.25.1 Nameplate. A nameplate shall be permanently attached to the housing. The nameplate shall conform to MIL-P-514, type I, style 2, composition A, class 2, 0.030 inch thick.

3.25.2 Instruction plates. Instruction plates describing any special or important starting, operating, or servicing procedures and any applicable warnings or cautions shall be permanently attached to the generator set. The operating instructions shall be mounted inside the control panel cover. Legend and background shall be in contrasting colors. The plates shall be made of corrosion-resistant metal, with the legend engraved or etched thereon; or the plates may be made of plastic material with the legend permanently etched, engraved, or otherwise inscribed thereon. When aluminum plates are used they shall be a minimum of 0.030 inch thick. Instruction plates shall include, but not be limited to, the following:

3.25.2.1 Fuel system diagram. A schematic diagram shall be supplied showing the entire fuel system.

3.25.2.2 Schematic and wiring diagrams. A plate, or plates, containing a schematic diagram and a connection (wiring) diagram shall be mounted on the set. The schematic diagram shall show the complete operational and functional sequence of the circuit for analysis and maintenance of the electrical system. The connection diagram shall show the physical location of all wiring interconnections in the same relationship as when they were installed. Identification markings of instruments, control devices, and connections shall coincide with markings on all items being identified.

3.25.2.3 Preoperating instructions (size 60). Preoperating instructions shall be brief but complete and shall include required changes to engine, fuel control, and exhaust gas temperature protective circuit settings for 60/30 kw conversion of the size 60 generator set.

3.25.2.4 Operating instructions. Operating instructions shall be brief but complete and shall include instructions for starting and operating (both at normal and very low ambient temperatures); use of winterization equipment; various ambient temperatures; and instructions on grounding of the generator set frame with a warning that this should be done to avoid shock hazard.

3.25.2.5 Winterization equipment diagram. A schematic diagram including a winterization system shall be supplied, when specified. The schematic diagram will include the identity and function of the various controls.

3.26 Identification of product. Nameplates, permanently and legibly marked for identification in accordance with MIL-STD-130, shall be attached to individual assemblies. All high-voltage danger areas shall be clearly marked for caution. Identification of components, receptacles, drains, fittings, wiring, instruments, control devices, and terminals shall be marked as follows:

3.26.1 Components. Each part of component shall be permanently marked with the manufacturer's name and part or type number.

3.26.2 Receptacles. Each receptacle shall be marked with an identifying number which will correspond to a number for that receptacle on the generator set schematic wiring diagram.

3.26.3 Drains and fittings. All drains, fuel inlet fittings, heater exhaust caps, and the bleed air fitting shall be plainly marked as to function. This requirement shall not apply to the exhaust box drain since its function is easily recognized.

3.26.3.1 All drains shall be identified by engraving, stamping, or etching on plastic plates securely fastened to supporting structure in the vicinity of the drains.

3.26.4 Wiring. The insulation on each wire shall be stamped with an identifying number at intervals of approximately 4 inches for the complete length of the wire, except for battery leads and identification, PLUS or MINUS, shall also be stamped in the cable connector and shall be in accordance with MIL-W-5088.

3.26.5 Instruments. Each instrument shall be identified by legible printing on the face or dial.

3.26.6 Generator set conversion (size 60). Means shall be provided to identify size 60 generator sets and gas turbine engines that have been converted from 60 to 30 kw operation and vice versa.

3.26.7 Control devices. Each control device shall be identified by engraving, stamping, or etching on a plastic or corrosion-resistant-metal plate which is securely fastened to the supporting structure in the vicinity of the device. Each device shall be marked ON, OFF, INCREASE, DECREASE, as applicable to indicate required manipulation to obtain a particular desired effect. Adhesives shall not be used to fasten the plates to the supporting structure unless used in conjunction with screws or some other positive fastener.

3.26.8 Terminals. All terminals shall be identified by a number stamped, etched, or engraved in the terminal or in supporting material adjacent to the terminal.

3.26.9 Marking of fuel filters. The inlet and outlet connections of fuel filters shall be plainly marked.

3.27 Workmanship. The generator set, including all parts and assemblies, shall be constructed and finished in accordance with MIL-W-27076. The generator set shall be free from defects such as incomplete welds, rust, cracks, misaligned or burred boltholes, and other defects that could impair the operation or serviceability of the generator set. Requirement 9 of MIL-STD-454 shall apply to electronic equipment and workmanship standards.

3.27.1 Welding. The surfaces of parts to be welded shall be free from rust, scale, paint, grease, and other foreign matter. Welds shall transmit stress without permanent deformation or failure when the generator set is tested as specified herein.

3.27.2 Machine work. Tolerances and gages for metal fits shall conform to the limitations specified herein and on the applicable drawings. Unless prior approval is obtained from the contracting officer, all tapped holes shall be countersunk before tapping.

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 and repeat 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 supplier is responsible for insuring that components and materials used are manufactured, examined, and tested in accordance with reference specifications and standards and as specified herein.

4.1.2 Inspection failure. Should the Government elect to perform or repeat any inspection or test in this specification, failure of a set to meet any requirements specified herein shall be cause for refusal by the Government to accept production sets in accordance with provisions of 4.4.1.

4.1.3 Detection of defects. The Government reserves the right to reject the set for non-compliance with any requirement of this specification even though not performing an inspection directly related to the specific requirement.

4.2 Classification of inspection. Inspection shall be classified as follows:

a. First article (preproduction) inspection (see 4.3)

b. Initial production (see 4.4)

c. Individual sets quality conformance inspection (see 4.5)

d. Sample inspection (see 4.5.4)

e. Inspection comparison (see 4.6.3).

4.3 First article (preproduction) inspection. The first article (preproduction) set shall be examined without dissembly for conformance to the drawings. Evidence that the set does not conform to the drawings shall be cause for rejection.

4.3.1 Tests. After successful completion of examination as specified in 4.3, conduct the applicable tests as listed in 4.6.2 through 4.6.2.2 and tests marked X as specified in table I, column 3. Failure of any test shall be cause for rejection.

4.4 Initial production inspection. When specified (see 3.2.1.1), one or more initial production set(s) will be selected at random by the procuring activity from the sets being produced from production tooling and will be subjected to tests specified in 4.6.2 through 4.6.2.2 and table I column 3 to determine conformance to the requirements of this specification. The inspection will be performed by the procuring activity at a site selected by the procuring activity. Acceptance of an initial production set shall not exclude the remaining sets from the quality conformance inspection and acceptance provisions specified herein.

4.4.1 Inspection failure. Failure of an initial production set to meet any requirement specified herein during and as a result of the examination and tests specified in 4.4, shall be cause for rejection of the initial production set(s) and shall be cause for refusal by the procuring activity to continue acceptance of sets until evidence has been provided by the supplier that corrective action has been taken to eliminate the deficiencies. Correction of such deficiencies shall be accomplished by the supplier at no cost to the Government on sets previously accepted and produced under the contract. Any deficiencies found as a result of the initial production testing will be considered prima facie evidence that all sets accepted prior to the completion of initial production testing are similarly deficient unless evidence to the contrary is furnished by the supplier and such evidence is acceptable to the contracting officer.

TABLE I. Test schedule.

Individual 1	First Article Preproduction 2	IPT 3	Sample 4	Test No. 5	Test 6	Requirement Paragraph 7	Test Method MIL-STD-705 8	Test Conditions or Comments 9
X	X	-	X	A-1	Winding resistance measurements	3.12.10	401.1	Measure the resistance of all main alternator on Test A1 windings.
X	X	-	-	A-2	Heat run	3.5.11	680.1	At 120/208 or 240/416V also at 126/218 or 252/436V.
X	X	-	X	A-3	Insulation resistance measurements	3.5.10.2	301.1	Disconnect capacitors and rectifiers from circuits to be tested.
-	X	-	-	A-4	Open circuit saturation curve	3.12.11	410.1	Use separate alternator field excitation for preproduction tests.
-	X	-	-	A-5	Rated load and zero pf saturation curve	3.12.11	413.1	Use separate alternator field excitation and perform at 1.0 pf 0.8 pf (lagging) and zero pf (lagging) for preproduction sets.
-	X	-	-	A-6	Negative sequence reactance and impedance	3.12.6	422.1	Use separate alternator field excitation for preproduction sets.
-	X	-	X	A-7	Voltage waveform	3.12.4 4.6.2.1.11	601.1 601.4	Perform at no load, rated load (1.0 pf) lagging) for L-L and L-N voltage. View wave shape on oscilloscope having specified characteristics and observe for discontinuities, notches, or spikes.
X	X	X	X	A-8	Phase balance	3.12.7	508.1	Use separate alternator field excitation; measure voltage of all six armature windings as well as the three L-N voltages.

TABLE I. Test schedule. - Continued

Individual 1	First Article Preproduction 2	IPT 3	Sample 4	Test No. 5	Test 6	Requirement Paragraph 7	Test Method MIL-STD-705 8	Test Conditions or Comments 9
-	X	X	-	A-9	Voltage unbalance with unbalance load	3.12.8	620.2	Apply a single-phase L-L unity pf load of 25 percent rated current (no other load on generator). Repeat for each L-L connection.
-	X	-	-	A-10	Synchronous impedance	3.12.6	411.1	Use separate alternator field excitation for preproduction sets.
-	X	-	X	A-11	Short circuit	3.5.14 3.12.11	625.1	Measure steady-state short circuit current; record alternator and exciter field currents on oscillograms; repeat test for L-L, L-N, and 3-phase short circuits (see Note 16).
-	X	-	-	A-12	Exciter nominal ceiling voltages	3.13.1	-	Obtain data from test A-2, A-12, and A-13.
X	X	-	-	A-13	High potential	3.5.10.3	302.1	Disconnect capacitors and rectifiers from circuits to be tested, if necessary.
-	X	-	-	A-14	Rotor overspeed	3.12.3	505.3	At 125 percent rated speed for 5 minutes.
-	X	-	X	A-15	Measurement of exciter field current	3.12.11	-	At rated ac output amps for 0.80 lagging pf and 1.0 pf.
-	X	-	-	A-16	Out-of-phase paralleling	3.12.17	-	Use circuit breaker or fuses for protection of alternator windings repeat test at least 10 times (see Note 16).
X	X	X	X	See Note 2 B-1	Start and stop	3.6.3	503.1	Start and stop; record acceleration and rolldown times.

TABLE I. Test schedule. - Continued

Individual 1	First Article Preproduction 2	IPT 3	Sample 4	Test No. 5	Test 6	Requirement Paragraph 7	Test Method MIL-STD-705 8	Test Conditions or Comments 9
-	X	-	-	B-2	Remote operation	3.5.20	-	Perform all specified control functions from a remote station through the remote control receptacle.
-	X	-	-	B-3	Remote sensing	3.5.20	-	Operate with voltage regulator sensing circuits connected at the load. Place sensing selector switch on remote; check for ability to adjust voltage open and close circuit breaker - output voltage should remain at normal value.
X	X	-	-	B-3A	Automatic start control	3.5.20.2	-	Demonstrate and record complete sequence.
X	X	X	X	B-4	Instrument check	3.16.1.2.2	513.1	For 240/416 and 120/208V connection.
X	X	-	X	B-5	Engine	3.7.3	505.1	At a speed of 110 percent normal rated speed for 5 minutes.
X	X	-	X	B-6	Insulation resistance	3.5.10.2	301.1	Repeat test A-3 on alternator and exciter stators only (see Note 13).
X	X	-	X	B-7	High Potential	3.5.10.3	302.1	Repeat test A-15 on alternator and exciter stators only (see Note 13).
X	X	-	X	B-8	Safety devices: Overspeed Low lube oil Exhaust over temperature	3.5.4.2 505.2 515.1	-	Record operating points At unity pf, load generator set until safety device operates; exercise care to avoid damaging alternator.

TABLE I. Test schedule. - Continued

Individual 1	First Article Preproduction 2	IPT 3	Sample 4	Test No. 5	Test 6	Requirement Paragraph 7	Test Method MIL-STD-705 8	Test Conditions or Comments 9
-	X	-	-	B-9	Inclined operation	3.6.2	660.1	Operate for 15 minutes at each of four positions (side-side and fore-aft) at 15° inclination.
-	X	-	-	B-10	Inclination	3.5.5	-	Incline unit to 30° in each of four positions (side-side and fore-aft); note any leakage.
-	X	-	X	B-11	Harmonic Analysis	3.12.4	601.4	Repeat applicable part of test A-8.
X	-	X	-	B-12	Range of voltage Adjustment	3.12.9 3.13.6	511.1	Record lowest obtainable voltage at no load and highest obtainable at rated load current at rated power factor.
X	X	X	-	B-13	Range of frequency adjustment	3.11.1	511.2	At no load; adjust for minimum and maximum frequencies note action, if any of under- and over-frequency protective devices; demonstrate that opening and short circuit of governor electric circuits do not result in overspeed.
-	X	-	X	B-14	Controls - direction or rotation	3.16.3.2.2.7, 3.16.3.2.2.8, 3.16.3.2.2.10, 3.16.3.2.2.13	-	See Note 7.
-	X	-	X	B-15	Cross-current compensation and frequency droop	3.13.2 3.11.2	-	See Note 6.
-	X	-	X	B-16	Transient voltage regulation	3.13.5	619.1	Repeat test A-12.
-	X	-	X	B-17	Voltage and speed droop	3.13.2, 3.11.3 3.11.2	610.1	Check for compliance with requirements, with unit-parallel switch in unit position 25 percent load steps may be used.

TABLE I. Test schedule. - Continued

Individual 1	First Article Preproduction 2	IPT 3	Sample 4	Test No. 5	Test 6	Requirement Paragraph 7	Test Method MIL-STD-705 8	Test Conditions or Comments 9
X	X	X	X	B-18	Voltage and speed stability and transient response	3.13.3, 3.13.4, 3.13.5(b), 3.11.1, 3.11.2, 3.11.3, 3.11.4	608.1 608.2	See Note 5. Set shall be tested at 0 and 3 percent
X	X	X	-	B-19	Frequency and voltage drift	3.11.5, 3.13.2	-	See Note 17.
X	X	X	-	B-20	Phase rotation	3.15.1	507.1	Check output terminals and receptacles for both voltage connections.
X	X	X	-	B-21	Phase balance	3.12.7	508.1	Repeat test A-9, except do not use separate excitation. Measure three L-L and three L-N voltages only.
-	X	X	-	B-22	Voltage unbalance with unbalanced load.	3.12.8	620.2	Repeat test A-10.
-	X	X	-	B-23	Electromagnetic interference	3.20	-	See 4.6.2.1.1.
-	X	X	-	B-24	Fuel consumption	3.7.10.2	670.1	At 100, 75, 50, 25 and 0 percent of rated load; measure exciter field current at rated load.
X	X	X	-	B-25	Protective devices Undervoltage Short circuit Overvoltage Underfrequency Reverse power	3.14, 3.14.2, 3.14.1, 3.14.3, 3.14.4 3.14	- 512.3 512.1 512.3 506.1 516.2	See Note 12 See Note 8 See Note 10 See Note 8
X	X	X	-	B-25A	Protection bypass	3.16.3.2.2.14	-	Test for each applicable bypass
X	X	X	X	B-26	Synchronizing lights	3.16.3.2.2.12	-	See Note 11
X	X	X	-	B-27	Parallel operation	3.5.19	630.1	Parallel with an identical generator set (see Note 14).
X	X	X	-	B-27A	Paralleling aid device	3.5.19.4	-	Demonstrate operation (see 4.6.2.1.6)
X	X	X	-	B-27B	Parallel operation	3.5.19	630.1	Parallel 2 each 60-kw sets with 2 each 30-kw sets.

TABLE I. Test schedule. - Continued

Individual 1	First Article Preproduction 2	IPT 3	Sample 4	Test No. 5	Test 6	Requirement Paragraph 7	Test Method MIL-STD-705 8	Test Conditions or Comments 9
-	X	-	-	B-28	Battery charger	3.10.5	-	See Note 9.
X	X	_	_	B-29	Audio noise	3.19 4.6.2.1.12	-	At no load and rated load (see 4.6.2.1.3).
X	X	X	X	B-30	Maximum power	3.6.1, 3.6.2.1	640.4, 640.2	Use corrected values for maximum power demonstration operation (see 4.6.2.1.10)
X	X	-	-	B-31	Center of gravity, weight, and dimensions	3.18, 3.22 3.23	-	Determine center-of-gravity in all three planes.
X	X	_	_	B-31A	Lifting	3.5.6	740.4A	
-	X	-	-	B-32	Roadability	3.5.5.1	-	See 4.6.2.1.2.1.
-	X	-	-	B-33	Railroad humping	3.5.5.1	740.5	See 4.6.2.1.2.2.
-	X	-	-	B-33A	Humidity cycle	3.6.2		See 4.6.2.1.4.
-	X	-	-	B-34	Reliability/ Endurance	3.6.6 3.5.2 4.6.2.1.8	690.1 (Table I for gasoline engines) weather (see Note 18).	1,000 hour duration. Generator set outdoors and exposed to weather (see Note 18)
-	X	-	-	B-35	High temperature test	3.6.2, 3.5.11	710.1	Repeat tests A-2, B-12, B-13, B-18.
-	X	-	-	B-36	Altitude operation	3.6.2, 3.5.11	720.1	Repeat tests A-2, B-12, B-13, B-18.
X	X	-	-	B-37	Automatic start	3.5.20.2	-	See 4.6.2.1.5.
-	X	-	-	B-38	Filter	3.7.14	SAE	Check during test B-34.
-	X	-	-	B-39 See Note 19	Voltage dip and rise (rated load)	3.13.5b	619.2	
X	-	-	-	C-1	Start, operate, and stop (local) and remote)	3.6.3 3.5.20	503.1	Start and stop from local position and through remote control receptacle. Also check function of all remote control features.
X	=	=	=	C-1A	Automatic start	3.5.20.2	-	4.6.2.1.5
X	_	_	-	C-2	Instrument check	3.16.3.2.1	513.1	At 416/240V and at 208/120V; at rated load only

TABLE I. Test schedule. - Continued

Individual 1	First Article Preproduction 2	IPT 3	Sample 4	Test No. 5	Test 6	Requirement Paragraph 7	Test Method MIL-STD-705 8	Test Conditions or Comments 9
X	-	-	-	C-3	Insulation resistance	3.5.10.2	301.1	Same as test B-6
X	-	-	-	C-4	High potential	3.5.10.3	302.1	Same as test B-7
X	-	-	-	C-5	Safety devices	3.5.4.2	-	Same as test B-8
X	-	-	-	C-6	Phase rotation	3.15.1	507.1	Same as test B-20
X	-	-	-	C-7	Phase balance	3.12.7	508.1	Same as test B-21
X	-	-	-	C-8	Range of voltage adjustment	3.12.9	511.1	Same as test B-12
X	-	-	-	C-9	Range of frequency adjustment	3.11	511.2	At no load only
X	-	-	-	C-10	Controls-direction of rotation	3.16.3.2.3 7, 3.16.3.2.2.8, 3.16.3.2.2.10, 3.16.3.2.2.13	-	Same as test B-14
X	-	-	-	C-11	Cross-current compensation and frequency droop	3.13.2, 3.11.4	-	Same as test B-15
X	-	-	-	C-12	Voltage and speed regulation	3.11.1, 3.22.3	614.1	
X	-	-	-	C-13	Voltage and speed stability and transient response	3.13.2, 3.13.4, 3.13.5(b), 3.11.1,	608.1	Same as test B-18 except a pen-type oscillograph may be used for recording voltage (chart speed 12 inches per minute or greater.)
X	-	-	-	C-14	Synchronizing lights	3.16.3.2.2.12	-	Same as test B-26
X	-	-	-	C-14A	Paralleling aid	3.5.19.4	-	4.6.2.1.6
X	-	-	-	C-15	Rated load run	-	-	See Note 23
X	-	-	-	C-16	Winterization equipment	3.10.2.1, 3.10.2.2	-	Check operation of winterization heater and safety devices
X	-	-	-	C-17	Maximum power		640.4 640.2	Repeat test B-30
X	-	-	-	C-18	Protective devices undervoltage trip	3.14, 3.14.2	512.3	Demonstrate trip of ac circuit breaker through action of under-voltage protective device; use any convenient method.

TABLE I. Test schedule. - Continued

Individual 1	First Article Preproduction 2	IPT 3	Sample 4	Test No. 5	Test 6	Requirement Paragraph 7	Test Method MIL-STD-705 8	Test Conditions or Comments 9
X	-	-	-	C-18	Short circuit	3.14.1	512.1	Same as test B-25(b) except current and trip time need not be measured. Check trip on all L-L, L-N, and 3-phase short circuits.
X	-	-	-	C-18	Overvoltage device	3.14.3	512.3	Demonstrate trip of ac circuit breaker and operation of overvoltage indicator through action of the overload protective device; use any convenient method.
X	-	-	-	C-18	Underfrequency trip	3.14.4	514.1	Demonstrate trip of ac circuit breaker through action of underfrequency protective device use any convenient method.
X	-	-	-	C-19	Battery charger	3.10.5	-	Observe battery charging ammeter for indication of proper operation during other "C" series tests.
X	-	-	-	C-19 See Note 20	Parallel Operation	3.5.19	630.1	630.1c and 3.5.19 at all rated frequencies.
X	-	-	-	D-1	Winding resistance	3.12.10	401.1	Same as test A-1
X	-	-	-	D-2	Insulation	3.5.10.2	301.1	Same as test A-3
X	-	-	-	D-3	High potential	3.5.10.3	302.1	Same as test A-15
X	-	-	-	D-4	Measurement of exciter field current	3.12.11	-	Same as test A-17
X	-	-	-	D-5	Short circuit test	3.12.12	625.1	Single and 3-phase shorts; 5 percent overvoltage; use fixed exciter excitation.
X	-	-	-	D-6	Phase balance	3.12.7	508.1	Same as test A-9, except separate excitation of alternator field

TABLE I. Test schedule. - Continued

Individual 1	First Article Preproduction 2	IPT 3	Sample 4	Test No. 5	Test 6	Requirement Paragraph 7	Test Method MIL-STD-705 8	Test Conditions or Comments 9
X	-	-	-	D-7	Phase rotation	3.15.1	507.1	Should be T_1, T_2, T_3 for rotation of alternator as driven by engine.
X	-	-	-	D-8 See Note 21	Overspeed	3.12.3	505.3	Same as test A-16
X	-	-	-	E-1	Engine	3.7	-	Data to include complete specific fuel consumption, fuel flow, and exhaust temperature at 0, 25, 50, 75, and 100 percent of engine maximum power at 8,000 and 6,000 rpm on the output shaft for the size 30 and size 60 generator set, respectively. All data shall be correct to sea level, 15°C.
X	-	-	-	E-2	Run-in-test	-	-	Operate engine continuously for 30 minutes at 75 percent of maximum power. Observe for malfunctions.
X	-	-	-	E-3 See Note 22	Overspeed	3.7.3	-	Operate engine for 5 minutes at 10 percent above rated speed.
X	-	-	-	F-1	Battery charger Routine	3.10.5	-	Perform test of Note 9 of B series tests
X	-	-	-	F-1	Special (reverse polarity)	3.10.5	-	Connect charger to a battery with polarity reversed There shall be no damage, except that fuses (if used) may blow (see Note 6).

sections in the same relationship as when they were inspected. Identification

TABLE I. Test schedule. - Continued

Individual 1	First Article Preproduction 2	IPT 3	Sample 4	Test No. 5	Test 6	Requirement Paragraph 7	Test Method MIL-STD-705 8	Test Conditions or Comments 9
X	-	-	-	F-2	Safety and protective (sensing) devices	-	-	Determine operating points (pick-up and drop-out) for each device and compare with requirements therefor
					Engine low lube oil pressure	3.5.4.2(b)	-	
					Engine over-temperature	3.5.4.2(c)	-	
					Engine overspeed	3.5.4.2(a)	-	
					Overvoltage	3.14.3	-	
					Undervoltage	3.14.2	-	
					Underfrequency	3.14.1	-	
					Short circuit	3.14.1	-	
X	-	-	-	F-3	Fuel boost	3.8.1.1	-	Demonstrate ability lift fuel (at maximum flow and output pressure required for the engine) through a vertical distance 12 feet.

TABLE I. Test schedule. - Continued

Notes:

1. Test numbers preceded by the letter "A" are tests on the alternator, exciter, and regulator and may be made at the alternator manufacturer's plant.
2. Test numbers preceded by the letter "B" are set tests and are to be made on the completely assembled generator set, except where otherwise specified.
3. Except where otherwise specified, tests shall be conducted with the alternator under control of its voltage regulator; except where a specific voltage connection is specified, either of the two output voltages (120/208 or 240/416) may be used for the tests.
4. Tests A-1, A-2, and A-3 apply to exciter and voltage regulator as well as the alternator. Test A-15 also applies to the exciter.
5. Use high-speed recording instruments capable of accurately recording frequency and voltage transients as specified in MIL-HDBK-705. A magnetic oscillograph shall be used for recording voltage; the galvanometer shall have a flat response from dc to 2,200 Hz (tolerance: -200 Hz) with a sensitivity which will give at least a 3-inch peak-to-peak amplitude for rated volts (120V, L-N). Oscillograph chart speed shall be between 4 and 6 inches per second and recorder chart speed shall be approximately 12 inches per minute.
6. With unit-parallel switch in parallel position, apply rated kw load at unity and 0.80 power factor, in turn. Unity pf load should cause no appreciable change in output voltage; 0.80 pf load should cause a drop of 4 percent; both should cause a drop in frequency of 3 percent. (4 percent voltage droop equals 60 percent of rated current at zero power factor.)
7. With the unit-parallel switch in the parallel position and at no-load or rated-load (as applicable), vary voltage adjusting rheostat, cross-current compensating control, frequency adjusting means, and frequency droop control (if electric) to determine that clockwise rotation of each control causes change in the direction specified. This test may be combined with other tests herein.
8. Energize device from an autotransformer; use separate excitation for exciter, or other means to obtain required voltage; use oscillograph to record voltage and time for operation of device.
9. Check ability to vary charging current (and voltage) with the voltage adjusting device; check action of current limiter to limit charging current to battery capacity (use discharged battery and adjust for highest possible output voltage); check for effect of alternator output voltage changes or charging current; observe charging ammeter during other tests required herein and note any evidence of nonconformance to requirements.
10. Deactivate low voltage protective device; use oscillograph to record short-circuit current and tripping time for 3-phase, single-phase line-to-line (L_1 - L_2), and single-phase line-to-neutral (L_1 - L_0) short circuits.

TABLE I. Test schedule. - Continued

11. Test at 120/208 and 240/416V; with unit-parallel position, with breaker open and with load connected to set output terminals, determine that lights are on. Test may be combined with others herein.
12. Test method of MIL-STD-705 not entirely applicable. Modify as instructed by notes 8 and 10, as applicable.
13. This test may be made after the generator is coupled to the engine but before it is assembled into the generator set. High potential test shall be performed at 75 percent of specified values (see 3.5.10.3).
14. An 8-hour test shall be run using reactive biasing mode of voltage regulator. Use a magnetic-type oscillograph for recording power exchange between generator sets. The converter, if used with the oscillograph, shall have a response of not less than 100 Hz. Use the oscillograph only at the beginning and end of the test. The test shall be run with generator set connected at 120/208V.
15. Oscillograph speed shall be at least 30 inches per second. Use steady-state amplitude of oscillograph trace and rms voltage reading which result after load change to calibrate trace during transient conditions. Compare transient value of voltage thus obtained with rms value of voltage before the load change, to calculate compliance with requirements. Initial and final rms voltages shall be determined by indicating instruments for use in this calculation.
16. Oscillograph may be used in measuring ac output current. Measure voltage transient appearing on field rectifiers with memory-type oscilloscope or peak-pulse-reading-type voltmeter. The test is to be made with a cold machine, before appreciable warmup of fields has taken place.
17. Perform test at no-load and rated-load. Start machine and apply load (when applicable) as soon as it is up to full speed. Begin recording voltage and frequency immediately after unit is up to speed or circuit breaker is closed (as applicable). Continue recording until voltage and frequency drift has stopped. If oscillograph is used, recording need not be continuous; samples should be taken at the beginning of the test, at 2-minute intervals for the first 10 minutes of the test, and at 5-minute intervals thereafter.
18. The generator set shall be subjected to the following endurance tests:

a. Ten periods of 100 hours each in accordance with MIL-STD-705 Method 690.1 using the cycling load schedule of table I Method 690.1.

b. Two 100-hour test periods shall be run using grade JP-4 fuel conforming to MIL-T-5624.

c. One 100-hour test period shall be run using fuel conforming to VV-F-800.

d. One 100-hour test period shall be run using grade 100/130 or 115/145 fuel conforming to MIL-G-5572.

TABLE I. Test schedule. - Continued

e. Two 100-hour test periods shall be run using combat gasoline conforming to MIL-G-3056.

f. Two 100-hour test periods shall be run using kerosene conforming to VV-K-211.

g. Only the maintenance specified in 3.6.6 shall be performed during the 1,000-hour endurance run. At least 800 hours of this test shall be accomplished with the generator set outdoors and exposed to the weather.

19. The exhaust temperature is within -4°C of the operating temperature of the overtemperature device as specified in the applicable detail specification.

20. The 5-minute overload rating of the alternator is reached.

21. The maximum fuel stop setting of the engine is reached.

22. Test numbers preceded by the letter F are component tests and are to be conducted on miscellaneous components prior to shipment by their manufacturers. They are to be accomplished on each component, except as otherwise specified.

23. Operate generator set at rated Kw, voltage, frequency, and pf for a period not less than 2 hours. Measure and record exciter field current and voltage; calculate exciter temperature, ambient temperature and barometric pressure. Observe unit for any malfunction and evidence of noncompliance with specification.

24. This test is to be accomplished for only one battery charging system. The charging systems so tested shall form part of the preproduction test model generator set.

4.5 Quality conformance inspection

4.5.1 Individual set inspection

4.5.1.1 Examination. The generator set shall be examined without dissembly for conformance to the drawings. Evidence that the set does not conform to the drawing shall be cause for rejection (see 3.1).

4.5.2 Tests. The generator set shall be tested as specified in 4.5.3. Failure of any test shall be cause for rejection.

4.5.3 Quality conformance. Except where otherwise specified herein, each generator set and components thereof supplied under the contract or order shall be subjected to the test specified in table I, column 1. It is preferred that tests shall be conducted in the order listed. Lubricant conforming to MIL-L-7808 shall be used in the engine lube oil reservoir during the entire test period. Nonconformance to any requirement referenced in table II shall constitute failure of the test.

4.5.4 Sample inspection. Sampling shall be in accordance with MIL-STD-105 after all sets comprising a lot have passed the inspection specified in 4.5.1.1. Unless otherwise specified (see 6.2), lot sizes shall consist of not more than 50 sets except that the first lot shall contain not less than 25 sets. The inspection level shall S-3 and the AQL shall be 6.5 percent defective. No adjustment or substitution of components shall be made on the sets selected for sample inspection.

4.5.4.1 Tests. Sets selected in accordance with 4.5.4 shall be subjected to the tests marked X under table I, column 4 in the order listed.

4.6 Inspection comparison. The Government may select generator sets at any time during the contract production period and subject these generator sets to the examination specified in 4.6.1 and the tests specified in 4.6.2 through 4.6.2.2 to determine conformation to the requirements of this specification. The inspection will be performed by the Government at a site selected by the Government, on units selected at random from those which have been accepted by the Government and will not include the previously inspected preproduction model and initial production generator sets. In addition to any test specified as part of the inspection comparison, the Government reserves the right to conduct any and all other tests contained in this specification as part of the inspection comparison. The failure of such additional tests shall have the same effect as failure of those tests specified as preproduction, initial production or production.

4.6.1 Weight and dimensions. Dry weight or overall dimensions not in accordance with 3.22 and 3.23 shall be considered a defect.

4.6.2 Tests

4.6.2.1 Preproduction and initial production. The preproduction models and initial production set(s) shall be subjected to the tests specified in table I to determine compliance with this specification (see 3.2 and 3.2.1.1). In dependent type tests (i.e., parallel operation, etc.) requiring two or more sets, one set shall be either an approved preproduction set or an approved initial production set as applicable. This set is designated herein as No. 1 generator set. Tests shall be conducted in the order listed.

The preproduction models shall be retained at the manufacturer's plant for use of Government inspectors during performance of the contract. Grade JP-4 turbine fuel conforming to MIL-T-5624 or jet fuels shall be used during all tests, except that gasoline shall be used during the altitude operation and high temperature tests. Nonconformance to any requirement reference in table I shall constitute failure of the test.

4.6.2.1.1 Electromagnetic interference test. The generator set shall be tested for electromagnetic interference in accordance with MIL-STD-462 to determine compliance with 3.20 herein.

4.6.2.1.2 Transportability tests. The following tests shall be accomplished at a Government installation under the supplier's direction at his expense. The supplier shall notify the contracting officer sufficiently in advance of the date for these tests to permit him to make timely arrangement for use of the necessary Government facilities.

4.6.2.1.2.1 Roadability test. The generator set shall be mounted on a pallet with mobilizers or an M200 trailer and subjected to four cycles of a road endurance test, each cycle consisting of the following:

Course	Distance (Miles)	Maximum speed (MPH)
Paved highway	100	50
Level cross-country	125	20
Hilly cross-country	100	20
Gravel roads	150	20
Belgian block	25	20

4.6.2.1.2.2 Railroad humping test. A railroad humping test shall be performed in accordance with MIL-STD-705, Method 740.5, except the specified accelerometer placement need not apply. The set shall be oriented lengthwise to the direction of travel.

4.6.2.1.3 Noise level test. Noise level measurements shall be made around the generator set as follows (ambient temperature and wind conditions shall be recorded during the tests):

a. Measurements shall be made at 12 points, at 30° increments on a circle of 25-foot radius, centered on the geometric center of the set and at the operator's position, at head level in a 2-foot diameter circle about the operator's head position

b. Measurements shall be made in a level, unobstructed field

c. Vertical elevation of the measuring instrument shall be 5 feet 8 inches above ground level

d. The equipment used for the measurement of sound-pressure level shall conform to ANSI S1.4 and Z24.10, except the octave band analyzer shall employ the preferred frequencies specified in ANSI S1.6. The flat frequency response of the sound-level meter shall be used in making all measurements

e. During acoustical measurements, the ambient background noise levels shall be at least 10 dB below the octave band sound pressure levels produced by the generator set

f. At no point shall the average noise level in any frequency band exceed the values specified in 3.19

g. Readings shall be taken during rated-load and no-load operations.

4.6.2.1.4 Humidity cycle test. The generator set shall be subjected to five consecutive humidity cycles as specified in MIL-STD-170. The generator set shall then be removed from the test chamber and examined for corrosion or other damage resulting from the test. Within 1 hour after removal from the test chamber, surface condensation and excess water shall be removed from the generator set or its components by air blast or dry cloth and the insulation resistance of each electrical circuit measured in accordance with MIL-STD-705, Method 301.1, except the set shall not be operated prior to insulation resistance measurements tests. Any resistance reading below 50,000 Ohms shall be cause for rejection of the set or component. At the end of this test, the generator set shall be operated at various loads for at least 2 hours, and the stability and transient response test, Method 608.1, shall be repeated at rated power factor only. Any evidence of damage, maloperation, or nonconformance to the performance specified herein shall be cause for rejection.

4.6.2.1.5 Automatic starting control functional tests. The following functional testing shall be accomplished to demonstrate the operational suitability of the automatic starting controls. Two generator sets (No. 1 and No. 2) shall be interconnected using the automatic start control cable as specified. No. 1 set shall be started and stabilized at half-load and designated as primary power. No. 2 interconnected set shall be placed in the standby mode and shall be so designated. The No. 1 set shall have a simulated malfunction of overspeed, overvoltage, and undervoltage individually applied. The No. 1 set then shall shutdown, and the No. 2 set shall start up and assume the load. A simulated malfunction of overcurrent shall cause the No. 1 set to shut down; however, the No. 2 set shall not start up.

4.6.2.1.6 Paralleling aid device test. With the No. 1 generator set (see 4.6.2.1) operating and delivering rated load to the feeder bus at rated voltage (120/208) and rated frequency (400 Hz) and with the No. 2 generator set operating and ready to be paralleled, with the paralleling aid switch in the on position, the breaker control switch in the off position, and with the unit-parallel switch of both generators in the parallel position, the paralleling aid device shall be tested as follows. (Measured voltages shall be the average of the three phases. A means of measuring the phase angle at the instant of parallel operation initiation, as approved by the procuring activity, shall be provided, such as a memory type oscilloscope with a dual-trace display.) In the following tests, paralleling is defined as meeting requirements of this specification without failures to either generator set:

4.6.2.1.6.1 Phase angle test. The voltage of generator No. 2 shall be adjusted to within ±0.5 percent of the bus, then the frequency of generator No. 2 slowly adjusted to within ±1 Hz of the bus. The ready-to-parallel indicating lamp shall not light until the phase angle between the generator and bus is between 10° and 15°, then the ready-to-parallel lamp shall light. The

511.1 | Same as test M-1 | | | | | 2.0 | Range of voltage | 3.12.2 |

breaker control switch shall be changed to the close position and when the ready-to-parallel indicating lamp lights, the generator breaker shall close, paralleling the two generators.

4.6.2.1.6.2 Voltage below normal test. With the frequency of generator No. 2 adjusted to within 1 Hz of the bus and the voltage adjusted to 10 percent below the bus, the voltage of generator No. 2 shall be slowly raised to between 4 and 5 percent below the voltage of the bus. The ready-to-parallel lamp shall not light. The voltage shall be raised to between 2 and 3 percent below the voltage of the bus. The ready-to-parallel indicating lamp shall light. The breaker control switch shall be changed to the close position, and when the ready-to-parallel indicating lamp lights, the generator breaker shall close, paralleling the two generators.

4.6.2.1.6.3 Voltage above normal test. With the conditions the same as in 4.6.2.1.6.2, except with the voltage of the generator No. 2 set at 10 percent above the voltage of the bus, the test specified in 4.6.2.1.6.2 shall be repeated, except the voltage of generator No. 2 shall be slowly lowered to the voltage of the bus. The same conditions shall result.

4.6.2.1.6.4 Frequency below normal test. With the voltage of generator No. 2 adjusted to within ±0.5 percent of the bus, and with the frequency adjusted to 12 Hz below the bus, the frequency of generator No. 2 shall be slowly raised to between 1.5 and 2 Hz below the bus. The ready-to-parallel indicating lamp shall not light. The frequency shall be raised to between 1/2 and 1 Hz below the bus. The ready-to-parallel indicating lamp shall light. The breaker control switch shall be changed to the closed position and when the ready-to-parallel indicating lamp lights, the generator breaker shall close, paralleling the two generators.

4.6.2.1.6.5 Frequency above normal test. With the conditions the same as in 4.6.2.1.6.4, except with the frequency of generator No. 2 adjusted to 12 Hz above the bus, the test specified in 4.6.2.1.6.4 shall be repeated, except the frequency of generator No. 2 shall be slowly lowered to the frequency of the bus. The same conditions shall result.

4.6.2.1.6.6 Single phase or no voltage on feeder bus test. With the voltage of generator No. 2 adjusted to within ±1.0 percent of the bus, with the frequency adjusted to within ±1 Hz of the bus, and with one phase of the 3-phase voltage sensing connections between the paralleling aid device and the feeder bus disconnected, perform the following: When the phase angle between generator No. 2 and the bus is between 10^{o} and 15^{o}, the ready-to-parallel indicating lamp shall not light. The breaker control switch shall be changed to the close position. Generator No. 2 circuit breaker shall not close. Generator No. 1 circuit breaker shall be opened. Generator No. 2 circuit breaker shall close energizing the feeder bus.

4.6.2.1.7 Shock test. The generator set shall be lifted 18 inches from the ground and allowed to fall freely with the skids impacting onto a hard concrete surface. This test shall be performed once. Upon completion of this drop test, a rotational drop test shall be performed. The generator set shall have one edge placed on a nominal 4-inch-high member. The opposite edge of the skid base shall be raised 18 inches and allowed to fall freely onto a hard concrete surface. This impact test shall be performed on each bottom edge of the skid base. In each drop test, the 4-inch-high member shall be placed under the skids, and the 18-inch measurement shall be taken from the bottom of the skids.

Immediately upon completion of the rotational drop test, perform Method 608.1 at rated load only. Thermal stabilization is not required and set instrumentation may be used in lieu of indicating instruments specified in MIL-HDBK-705 (voltage and frequency recording required).

4.6.2.1.8 Reliability endurance test. Failure data from the reliability endurance test shall be analyzed in accordance with the accept/reject criteria of Test Plan IV, MIL-STD-781. A reject decision shall be cause for rejection of the first article. Where the number of samples (see 3.2.1) is less than four, in the event of a continue test decision at the end of the 1,500 hour test period, the continue test decision shall constitute satisfactory demonstration of the reliability requirement. Where a reject decision is reached, the data analysis for the new or resubmitted first article shall commence with zero time, zero failures. In no event other than an accept decision based on zero failures, will less than two multiples of the specified MTBF be considered as sufficient total test time for an accept decision. Two or more failures of the same part in the same mode shall be cause for rejection.

4.6.2.1.9 Maintainability tests. The MTTR requirements shall be verified in accordance with MIL-STD-471, Method 1b, consumer risk of 10 percent (Ø=1.28).

4.6.2.1.9.1 Preventive maintenance. The scheduled preventive maintenance requirements shall be verified during the reliability test by performing the maintenance schedules. Any degradation, interruption, or downtime because of the need for additional preventive maintenance shall be considered a relevant failure (see 6.4.3 through 6.4.3.2).

4.6.2.1.10 Maximum power test. The following test shall be conducted to verify that the generator set has a power capability in excess of rated power to the extent specified in 3.6.1:

a. The generator set shall be started and operated at rated speed, voltage, load, and power factor until the unit is stabilized

b. At unity power factor, load shall be applied to the generator set to the maximum power level and held for 5 minutes. The maximum power level shall be determined by any one of the following limiting conditions:

1. The exhaust temperature is within -4°C of the operating temperature of the overtemperature device as specified in the applicable detail specification.

2. The 5-minute overload rating of the alternator is reached.

3. The maximum fuel stop setting of the engine is reached.

CAUTION: Do not exceed the 5-minute overload rating of the alternator. Overload on the alternator shall not exceed the following:

AMBIENT TEMPERATURE AT SEA LEVEL	OVERLOAD RATING	
	60-kw set	30-kw set
-54°C	120 kva	60 kva
25°C	116 kva	58 kva
49°C	112 kva	56 kva

c. The unit shall be operated at no load for 15 minutes to allow the generator set temperatures to return to normal before shutdown or before repeated overload tests.

4.6.2.1.11 Waveform. When demonstrating compliance with 3.12.4d, the waveform shall be viewed on a oscilloscope having a minimum display area of 6 by 10 cm, minimum bandwidth of dc to 15 MHz and maximum rise time of 23n sec.

4.6.2.1.12 Audio noise test. Instruments used in the audio noise test shall conform to MIL-STD-1474. Measurements shall be made on the c (flat response) network. Sound pressure levels shall be made at eight locations 25 feet from the geometric center of the set. The eight locations shall be established by rays through the center of each side and through each corner. In addition, measurements shall be made on the ray through the control panel end of the set at the point displayed 24 inches from the control panel operator's position. Microphone height shall be 5 feet 8 inches on the 25-foot radius and 39 inches for the operator's position.

4.6.2.2 Optional tests. The tests in table II are optional. They may be required to be performed by the contractor as specified (see 6.2).

TABLE II. Optional tests.

Test No.	Test	Requirement Paragraph	Test Method MIL-STD-705	Test Conditions or Comments
G-1	Torsional vibration	3.6.5	504.2	
G-2	Shock	3.5.5.2		See 4.6.2.1.7
G-3	Acceleration Loading	3.5.5.2		See MIL-A-8421
G-4	Starting & Operating (Extreme cold)	3.6.2 3.10.6	701.1 702.1	At -54°C
G-5	Starting & Operating (Moderate cold)	3.6.2 3.10.6 3.6.3	701.2	At -32°C
G-6	Rain	3.6.2	711.3A	
G-7	Maintainability	4.6.2.1.9		

Note 1: Test numbers preceded by letter G are optional and may be performed by the Government unless otherwise specified (see 4.6.2.3).

4.7 Inspection of the preservation, packaging, packing, and marking for shipment and storage. The inspection of the preservation, packaging, packing, and marking for shipment and storage shall be in accordance with the requirements of Section 5.

5. PACKAGING

5.1 Preservation-packaging. Preservation-packaging shall be level A or C, as specified (see 6.2).

5.1.1 Level A. The complete generator set shall be preserved and packaged in accordance with level A of MIL-G-28554, except, unless otherwise specified (see 6.2), the gas turbine engine shall be preserved and packaged in accordance with MIL-E-5607.

5.1.2 Level C. The complete generator set and supplemental equipment shall be preserved and packaged in a manner that will ensure adequate protection against deterioration and damage during shipment.

5.2 Packing. Packing shall be level A, B, or C as specified (see 6.2).

5.2.1 Level A. The complete generator set shall be packed in accordance with level A of MIL-G-28554.

5.2.2 Level B. The complete generator set shall be packed in accordance with level B of MIL-G-28554.

5.2.3 Level C. The complete generator set shall be packed in a manner that will ensure arrival at destination in satisfactory condition and that will be acceptable to the carrier at the lowest rates. Packing shall comply with Uniform Freight Classification rules or National Motor Freight Classification rules.

5.3 Shipment marking. The generator set, interior packages, and shipping containers shall be marked in accordance with MIL-STD-129.

6. NOTES

6.1 Intended use. The generator sets covered by this specification are intended for military field use where small size and lightweight are highly important characteristics. It is intended for multipurpose usage to cover a wide variety of applications.

6.2 Ordering data. Procurement documents should specify the following:

a. Title, number, and date of this specification.

b. Size of generator set required (see 1.2.1)

c. Quantity of generator sets to be furnished if other than as specified in 3.2.1.

d. Whether initial production testing is required (see 3.2.1.1).

e. Quantity of generator sets to be furnished for initial production testing, when applicable (see 3.2.1.1).

f. Whether 60 Kw - 30 Kw conversion is required (see 3.5.1).

g. Repair parts and maintenance tools required (see 3.5.3.4).

h. Servicing and adjustment schedule of operations permitted between TBO (see 3.6.6.1.1).

i. Whether nickel-cadmium or lead acid batteries are required (see 3.10.2).

j. Whether grounding rods are to be provided (see 3.15.5).

k. Color of finish coat (see 3.24.1).

l. Conditions for testing production models and initial production sets (see 4.6.2.1).

m. Whether any optional tests are to be contractor performed (see 4.6.2.3).

n. Levels of preservation-packaging; and packing required (see 5.1 and 5.2)

o. If level A preservation-packaging is to be other than as specified in 5.1.1.

p. Whether additional remote functions are required (see 3.5.20).

q. Whether short circuit requires by-passing under battle conditions (see 3.16.3.2.2.14).

r. Whether spare turbine nozzle bracket is required (see 3.17.3.2).

6.3 Data. Data generated by this document are not deliverable unless specified on the Contract Data Requirements List (DD Form 1423) referencing the appropriate data item description in the military departments' Authorized Data List (ADL). The data produced by this specification is as follows:

a. A nonstandard parts list (see 3.4.3)

b. A fuel system diagram (see 3.25.2.1)

c. A wiring diagram (see 3.25.2.2)

d. Preoperating instructions (see 3.25.2.3)

e. Operating instructions (see 3.25.2.4)

f. Winterization equipment diagram (see 3.25.2.5)

6.4 Definitions. For the purpose of this specification, the following definitions will apply:

6.4.1 Dangerous torsional critical speed. A dangerous torsional critical speed is defined as a speed at which the maximum vibrating stress induced in the shaft from torsional vibration exceeds 5,000 psi.

6.4.2 Normal rated speed. Normal rated speed is defined as the engine speed corresponding to 400 Hz output for the alternator.

6.4.3 Failure classification. Failures are classified as either relevant or non-relevant. Only relevant failures shall be used to compute MTBF and MTTR.

6.4.3.1 Relevant failure. A relevant failure is the inability of the item to perform any one of its intended and specified functions within the specified limits. All failures are considered relevant until classified as non-relevant by one of the following provisions per agreement of the procuring activity:

a. A secondary or dependent failure that is caused by the failure of associated items. For every secondary failure classified as non-relevant, a primary or independent failure shall be identified. Only one secondary non-relevant failure of the same part (same drawing number or other unique identifier) shall be allowed during the test. The second and later failures of the same part shall be counted as relevant and corrective action shall be taken to reduce the failure rate of such parts to acceptable low levels. Secondary failures as defined in MIL-STD-781B

b. A test-operator or test-facility-induced failure may be classified as non-relevant if it can be substantiated that the equipment was subjected to operation or stress conditions beyond specified limits

c. Changes to the item to correct a deficiency that caused a failure shall not classify such a failure as not relevant until the change has been demonstrated as a fully effective correction to the satisfaction of the procuring activity

d. Preventive maintenance, servicing, and adjustments may be counted as non-relevant if such actions are specified as normal maintenance in the existing or planned technical manuals to be supplied for use with the equipment

e. Damage resulting from accident or mishandling shall not be relevant

f. Complete data shall be taken and retained of the analysis, tests, and other actions taken to fully justify each classification of a failure as non-relevant.

6.4.3.2 Recurring failures. Apparent recurring failure events resulting from the same cause shall be chargeable only once as a relevant failure provided the cause was unknown at the time of the failures. Once the cause is known and fix is completed and the same failure occurs again, it will be counted as a relevant failure. It must be positively shown that the failures were truly due to the same cause before they may be classed as recurring events.

6.4.4 Damage. Damage shall be defined as puncture, denting or scraping through paint on the bottom of set housing.

6.5 Supersession data. For follow-on procurements, this specification and the applicable detail specification supersede Solar Division of International Harvester Company CEI Specifications CP-ES1275A and CP-ES1276A developed under contract No. F04606-68-D-0643.

Custodians:
Air Force - 11
Army - ME
Navy - YD

Reviewers:
Air Force - 99
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