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# MILITARY SPECIFICATION

# GOVERNING SYSTEMS, SPEED & LOAD-SENSING

# NAVAL SHIPBOARD USE

This specification is approved for use by the Naval Sea Systems Command, Department of the Navy, and is available for use by all Departments and Agencies of the Department of Defense.

## 1. SCOPE

1.1 Scope. This specification covers the performance and test requirements for speed-governing systems which sense speed and load and permit parallel operation of alternating current generator sets.

1.2 Classification. Speed governing systems are of the following types, as specified (see 6.2):

Type DE - For diesel generator sets.
Type ST - For steam turbine generator sets.
Type GT - For single-shaft gas turbine generator sets.

## 2. APPLICABLE DOCUMENTS

2.1 Government documents.

2.1.1 Specifications, standards, and handbooks. The following specifications, standards, and handbooks form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those listed in the issue of the Department of Defense Index of Specifications and Standards (DODISS) and supplement thereto, cited in the solicitation (see 6.2).

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: Commander, Naval Sea Systems Command, SEA 55Z3, Department of the Navy, Washington, DC 20362-5101 by using the self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

AMSC N/A FSC 6115

SPECIFICATIONS

FEDERAL

PPP-F-320 - Fiberboard: Corrugated and Solid, Sheet Stock (Container Grade) and Cut Shapes.

MILITARY

MIL-R-94 - Resistors, Variable, Composition, General Specification for.
MIL-S-901 - Shock Test, H.I. (High-Impact); Shipboard Machinery, Equipment and Systems, Requirements for.
MIL-E-917 - Electric Power Equipment, Basic Requirements (Naval Shipboard Use).
MIL-I-1361 - Instrument Auxiliaries, Electrical Measuring: Shunts, Resistors, and Transformers.
MIL-E-2036 - Enclosures for Electric and Electronic Equipment.
MIL-P-15024 - Plates, Tags and Bands for Identification of Equipment.
MIL-P-15024/5 - Plates, Identification.
MIL-S-15291 - Switches, Rotary, Snap Action and Detent/Spring Return Action, General Specification for.
MIL-T-16315 - Transformers, Power, Step-Down (Miscellaneous, Naval Shipboard Use).
MIL-E-17555 - Electronic and Electrical Equipment, Accessories, and Provisioned Items (Repair Parts): Packaging of.
MIL-S-18396 - Switches, Meter and Control, Naval Shipboard.
MIL-L-19140 - Lumber and Plywood, Fire-Retardant Treated.
MIL-S-19500 - Semi-conductor Devices, General Specification for.
MIL-R-19523 - Relays, Control.
MIL-C-28748 - Connectors, Electrical, Rectangular, Rack and Panel, Solder Type and Crimp Type Contacts, General Specification for.
MIL-M-38510 - Microcircuits, General Specification for.
MIL-P-55110 - Printed-wiring Boards, General Specification for.
MIL-C-55302 - Connectors, Printed Circuit Subassembly and Accessories.
MIL-C-83723 - Connectors, Electrical, (Circular, Environment Resisting), Receptacles and Plugs, General Specification for.

STANDARDS

MILITARY

MIL-STD-108 - Definitions of and Basic Requirements for Enclosures for Electric and Electronic Equipment.
MIL-STD-167-1 - Mechanical Vibrations of Shipboard Equipment (Type I - Environmental and Type II - Internally Excited).
MIL-STD-178 - Definitions Applicable to Speed-Governing of Electric Generator Sets.

MILITARY (Continued)

MIL-STD-202 - Test Methods for Electronic and Electrical Component Parts.
MIL-STD-275 - Printed Wiring for Electronic Equipment.
MIL-STD-461 - Electromagnetic Emission and Susceptibility Requirements for the Control of Electromagnetic Interference.
MIL-STD-462 - Electromagnetic Interference, Characteristics, Measurement of.
MIL-STD-471 - Maintainability Verification/Demonstration/ Evaluation.
MIL-STD-701 - List of Standard Semiconductor Devices.
MIL-STD-721 - Definitions of Terms for Reliability and Maintainability.
MIL-STD-781 - Reliability Testing for Engineering Development, Qualification, and Production.
MIL-STD-1331 - Parameters to be Controlled for the Specifications of Microcircuits.

HANDBOOKS

MILITARY

MIL-HDBK-217 - Reliability Prediction of Electronic Equipment.

(Unless otherwise indicated, copies of federal and military specifications, standards, and handbooks are available from the Standardization Documents Order Desk, BLDG. 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094.)

2.1.2 Other Government documents, drawings, and publications. The following other Government documents, drawings, and publications form a part of this document to the extent specified herein. Unless otherwise specified, the issues are those cited in the solicitation.

PUBLICATIONS

DEPARTMENT OF LABOR (OSHA)

Code of Federal Regulations (CFR)
29 CFR, Part 1910.1200 - Occupational Safety and Health Standards.

(The Code of Federal Regulations (CFR) and the Federal Register (FR) are for sale on a subscription basis by the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402. When indicated, reprints of certain regulations may be obtained from the Federal agency responsible for issuance thereof.)

NAVAL SEA SYSTEMS COMMAND (NAVSEA)

0967-LP-312-8010 - Electronic Equipment, Shipboard, Maintainability Design Criteria Handbook for Designers of.

(Application for copies should be addressed to the Standardization Documents Order Desk, BLDG. 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094.)

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

3. REQUIREMENTS

3.1 First article. When specified (see 6.2), a sample shall be subjected to first article inspection (see 6.6) in accordance with 4.3.

3.2 Materials. Materials shall be in accordance with MIL-E-917.

3.2.1 Recovered materials. Unless otherwise specified herein, all equipment, material, and articles incorporated in the products covered by this specification shall be new and may be fabricated using materials produced from recovered materials to the maximum extent practicable without jeopardizing the intended use. The term "recovered materials" means materials which have been collected or recovered from solid waste and reprocessed to become a source of raw materials, as opposed to virgin raw materials. None of the above shall be interpreted to mean that the use of used or rebuilt products is allowed under this specification unless otherwise specifically specified.

3.2.2 Nonstructural parts. Nonstructural parts such as terminal boxes, housing, ducts, and similar parts shall be fabricated from aluminum alloy, where feasible.

3.2.3 Prohibited materials. Regardless of any other requirements, materials and parts containing radioactive material, mercury, cadmium, asbestos, or other materials giving off toxic fumes under operating or casualty conditions, shall not be used.

3.3 Construction.

3.3.1 General. Unless otherwise specified herein, the governing system shall be in accordance with MIL-E-917 (see 6.3).

3.3.2 Reliability and maintainability.

3.3.2.1 Definitions. Unless otherwise specified herein, definitions of terms for reliability and maintainability shall be in accordance with MIL-STD-721.

3.3.2.2 Reliability. A reliability measure shall be mean time between failures (MTBF) in accordance with MIL-STD-781 (see 6.3). The MTBF shall be greater than 25,000 hours.

3.3.2.2.1 Equipment failures. Governing systems failure shall be defined as inability of the system to perform and function within the requirements of this specification.

3.3.2.2.2 Failure rate data. Failure rate data used shall be as given in MIL-HDBK-217, within the applicability constraint.

3.3.2.2.3 Stress levels. Stress levels shall be calculated from design data in accordance with MIL-HDBK-217.

3.3.2.3 Maintainability.

3.3.2.3.1 Maintainability measure. The measure of maintainability shall be equipment repair time (ERT) in accordance with MIL-STD-471. The ERT shall be less than 3 hours. No repair shall require more than 10 hours.

3.3.2.3.2 Maintainability design. Maintainability design shall be in accordance with NAVSEA 0967-LP-312-8010 (see 6.3).

3.3.3 Detail requirements.

3.3.3.1 Basic requirements. The governor system shall be designed for two modes of operation: isochronous and droop.

(a) Transfer between the two modes of operation shall be accomplished by the operator using the mode control selector. System shall allow transfer between modes while in operation and without abnormal reaction during transfer.
(b) The mean governed speed shall be adjustable by means of the speed changer during both modes of operation.
(c) The speed regulation changer shall have no effect on steady state speed regulation (or mean governed speed) in the isochronous mode. In the droop mode, it shall be capable of adding positive steady state speed regulation to that obtainable in the isochronous mode.

3.3.3.2 Enclosure and mounting. The governor system components shall be designed for the following mounting:

(a) Governor electrical control equipment - mounted within switchgear enclosure or separately mounted, as specified (see 6.2).
(b) Manual speed changer (rheostat) - back of board mounting, front of board operation.
(c) Motor operated speed changer control switch - back of board mounting, front of board operation.
(d) Mode control switch - back of board mounting, front of board operation.
(e) Normal high-speed stop override switch - back of board mounting, front of board operation.
(f) Normal/overspeed selector switch - back of board mounting, front of board operation.
(g) Manual overspeed potentiometer - back of board mounting, front of board operation.
(h) Unless otherwise specified in the applicable generator set specification, all other adjustments or selectors are behind board mounted and operated.

3.3.3.2.1 Ambient. Switchgear enclosed or separately mounted equipment shall be designed for 50 degrees Celsius (°C) ambient. Equipment shall remain operable at an ambient of 0°C. Equipment shall withstand a non-operating (storage) temperature range of minus 40 to 85°C.

3.3.3.2.2 Enclosures. Enclosures for separately mounted systems (see 3.3.3.2) shall be spraytight protected in accordance with MIL-E-2036. Ready accessibility of electrical connections, test points, and adjustments shall be provided for convenience in installation and maintenance. Enclosures and framework shall be constructed of steel, aluminum, or both. The use of aluminum for weight reduction is considered desirable and shall be used if structurally suitable.

3.3.3.2.3 Cooling. Unless otherwise specified (see 6.2), cooling shall be accomplished by natural convection.

3.3.3.3 Reactors. Reactors shall be in accordance with the materials and methods of manufacture of MIL-E-917 except as follows:

(a) Allowable temperatures and insulation classes shall be as specified in table I.

TABLE I. Maximum permissible temperature (°C) (continuous rated load).

| | Insulation class | | | |
|---|---|---|---|---|
| Name of part 1/ | A | B | F | H |
| Coils: | | | | |
| Windings measured by thermocouples or thermometers | 90 | 110 | 135 | 170 |
| Windings measured by resistance | 100 | 120 | 145 | 190 |
| Cores and mechanical parts adjacent to insulation | 90 | 110 | 135 | 170 |
| | All classes | | | |
| Capacitors - air within 1.27 cm (1/2 inch) of case | | | 85 | |
| Rectifiers | | | 2/ | |
| Rheostats and resistors: | | | | |
| Bare resistor material | | | 425 | |
| Resistor embedding material | | | 350 | |
| Bolted connection and terminal studs: | | | | |
| Not plated | | | 100 | |
| Silver plated | | | 115 | |
| Contact: | | | | |
| Solid | | | 120 | |
| Solid silver faced | | | 130 | |

1/ Where no measurement method is indicated, thermometer or thermocouple method shall be used.

2/ Silicon rectifiers, voltage reference elements, voltage regulator elements, and transistors-permissible temperature rise on these parts is dependent upon operating conditions. Maximum permissible case temperature shall be shown on the equipment drawing.

3.3.3.4 Transformer application. Current, potential, or combination transformers shall be provided for each governor system and no other burden shall be placed on them. Transformers shall be ungrounded. Open delta connections of potential transformers shall not be permitted.

3.3.3.4.1 Potential and combination transformers. Potential or combination transformers shall be in accordance with type SA of MIL-T-16315, and shall conform to the materials and methods of manufacture of MIL-E-917 except as follows:

(a) Allowable temperatures and insulation classes shall be as specified in table I.

3.3.3.4.2 Current transformers. Current transformers used in the real load compensation circuits shall be designed for either generator or switchboard mounting as required by specific application. Current transformers shall be in accordance with class 3 of MIL-I-1361 and shall conform to the materials and methods of manufacture of MIL-E-917 except as follows:

(a) Allowable temperatures and insulation classes shall be as specified in table I.
(b) The current ratio, phase angle error, ratio error, and burden shall be as required for the particular application.

3.3.3.5 Semiconductor devices. Semiconductor devices used in the equipment shall be silicon.

3.3.3.5.1 Microcircuits. Integrated circuits shall be selected from MIL-STD-1331 and shall be in accordance with MIL-M-38510.

3.3.3.5.2 Discreet devices. Semiconductor devices, other than those specified in 3.3.3.5.1, shall be selected from MIL-STD-701 and shall be in accordance with MIL-S-19500. The use of devices not listed in MIL-STD-701 shall require specific approval in accordance with MIL-E-917.

3.3.3.6 Prohibited parts. The governor system shall not employ vibrating contacts, carbon piles, or electron tubes.

3.3.3.7 Operating modes. The governor system shall have the following operating modes:

(a) Isochronous. Steady state speed regulation shall be as specified in 3.4.2. Where parallel operation is required (see 6.2), real load (kilowatts (kW)) differential compensation shall be performed in order to maintain isochronous speed regulation and real load (kW) balance. Performance of kW load sharing system shall be as specified in 3.5.7.1.
(b) Droop (speed-load characteristic). Steady state speed shall be adjusted in the negative direction with increasing kW load by the droop control circuit. Droop mode shall provide stable operation with dissimilar governors, infinite bus (shore power) or another generator set with the same governor system operated in isochronous.

3.3.3.8 Operators controls.

3.3.3.8.1 Mode control selector. When governor system is mounted either in the switchboard or local control panel and the mode control selector is contained either in the switchboard or local control panel with no remote control, the mode control selector may be a switch in accordance with MIL-S-15291. The switch shall be for switchboard mounting and shall be rated in accordance with the table for class designation in MIL-S-15291. The mode control selector switch shall have positions designated "Isochronous" and "Droop". When the governor system is to have a remote mode control selector, actual mode selection shall be accomplished at the governor control assembly by a relay in accordance with MIL-R-19523. Isochronous mode shall be selected when relay coil is de-energized. The relay coil shall be controlled by a mode selector switch in accordance with MIL-S-15291 and as discussed above.

3.3.3.8.2 Speed changer. A speed changer shall be provided for adjustment of the mean governed speed during isochronous and droop operation. The speed changer can be either manually controlled or motor operated, as specified in 3.3.3.8.2.1 and 3.3.3.8.2.2. Both speed changer types shall provide continuous adjustment over the range specified in 3.4.4. Both speed changer types shall have provisions for selectable operation above the normal maximum speed for overspeed trip testing as specified in 3.4.4.

3.3.3.8.2.1 Manual speed changer. The manual speed changer shall be used only in applications where the governor assembly is located in either the control panel or switchboard and has no provisions for remote operation. The manual speed changer shall consist of a panel mounted three-turn potentiometer for normal speed control, a panel mounted ten-turn potentiometer for overspeed trip testing, a normal/overspeed selector switch, and the speed limit potentiometers required to obtain the speed ranges specified in 3.4.4. Panel mounted potentiometers shall be provided with the appropriate knob/dial assembly and meet the applicable requirements of MIL-S-901, MIL-STD-167-1, and MIL-STD-202. The panel mounted normal/overspeed selector switch shall be in accordance with MIL-S-15291. The behind panel mounted low speed, high speed and overspeed limit potentiometers as specified in 3.4.4 shall be single-turn, screwdriver-adjust, locking-bushing potentiometers in accordance with MIL-R-94. Potentiometer shall increase associated parameter with clockwise rotation and have a plate indication parameter and increase and decrease directions.

3.3.3.8.2.2 Motor operated speed changer. The motor operated speed changer shall be used where remote operation is required at one or more stations. The motor operated speed changer shall be operated by a three-position (Decrease/Neutral/Increase), spring return to neutral switch in accordance with MIL-S-18396. Speed increase shall be with clockwise rotation of the switch. The motor operated speed changer shall be provided with limit potentiometers and/or cams as required in order to obtain speed ranges specified in 3.4.4. The motor operated speed changer shall have provisions for a selectable overspeed for overspeed trip testing as specified in 3.4.4. The motor operated speed changer shall have provisions for return to a speed as specified (see 6.2) when the generator set is secured. The motor operated speed changer shall have normal and overspeed control at the local operating panel for use in routine tests. Motor operated speed changer control switches shall be interlocked in order to prevent speed control activation when generator set is not operating.

3.3.3.8.3 Speed regulation changer. The speed regulation changer will be referred to as the droop control. An electronic droop control circuit, which electrically senses generator kW load shall be provided as part of the governor electrical control equipment. The droop control shall influence the system only in droop mode. The droop control circuit shall function to decrease generator set speed with increasing load as specified in 3.4.5. The droop control shall be a single-turn, screwdriver-adjust, locking-bushing potentiometer in accordance with MIL-R-94, unless otherwise specified (see 6.2). The droop control potentiometer shall be mounted on the governor control assembly and be provided with a dial indicating decrease and increase directions. Clockwise rotation of the droop control shall provide increased speed droop.

3.3.3.8.4 Direction of rotation. Unless otherwise specified, turning each control device clockwise shall increase the parameter and turning the control counter-clockwise shall decrease the parameter.

3.3.3.9 Control functions. The following control functions will be included in speed and load sensing speed governing systems depending on specific application.

3.3.3.9.1 Normal speed controller. The normal speed controller will function to regulate prime mover speed during all normal operating conditions. The normal speed controller will sense prime mover or generator speed electronically and provide an output signal to the fuel/energy medium control positioner. During parallel operation, the normal speed controller will be acted upon by the load balance control for proper kW load sharing. During startup or under abnormal conditions, the normal speed controller will be acted upon by the additional control functions required for the specific application.

3.3.3.9.2 Standby speed controller. If a standby (back-up) speed controller is specified (see 6.2), it shall be a mechanical, hydraulic (ball-head) device. The standby speed controller shall provide speed control during the start cycle, low-speed operation, and speed control when the normal speed control is inoperative (see 3.4.7 and 3.5.8).

3.3.3.9.3 Load balance controller. Unless otherwise specified, all governor systems will be equipped with a kW load balance controller. The kW load balance controller will sense real (kW) generator load and provide for automatic load sharing in isochronous mode. The load balance controller will provide a speed droop signal proportional to real (kW) load during droop mode operation. The load balance controller shall be provided with means for adjusting in both isochronous and droop mode. If specified, the load balance controller may also contain a load pulse function for improved transient response.

3.3.3.9.4 Fuel/energy medium controller. The fuel/energy medium controller is defined as the actual mechanism for regulating fuel or steam flow. For diesel and steam turbine applications, the fuel/energy medium controller will not be supplied as part of the governor system unless otherwise specified for the specific application. For gas turbine applications, unless otherwise specified, the fuel control valve will be provided as part of the governor system.

3.3.3.9.5 Turbine inlet temperature (TIT) controller. Gas turbine generator set governor systems shall provide for electronic TIT control, unless otherwise specified.

3.3.3.9.6 Fuel scheduling controller. Gas turbine generator set governor systems shall provide for electronic fuel scheduling, unless otherwise specified.

3.3.3.9.7 Load limit controller. If specified, an adjustable load limit controller shall be provided. This controller will function to automatically limit the generator set output to a preset value.

3.3.3.9.8 Acceleration controller. Diesel generator set governor systems shall provide for automatic acceleration control during startup, as specified (see 6.2). The acceleration controller shall be provided with an automatic defeat, which functions to allow maximum acceleration rate during emergency startup. The defeat shall not function during normal startup.

3.3.3.10 Allowable temperatures. Governor systems shall be designed so that the individual component temperatures do not exceed those shown in table I.

3.3.3.11 Insulation resistance. The insulation resistance, when corrected as specified in 4.6.13, shall be not less than 10 megohms.

3.3.3.12 Dielectric strength. Governor controller sets shall withstand a dielectric test voltage of twice rated voltage plus 1000 volts, but not less than 1,500 volts. The test voltage shall be applied for 1 minute as specified in 4.6.14.

3.3.3.13 Shock. The governor system and all switchboard mounted components shall be designed and tested to withstand the high impact shock test in accordance with MIL-S-901 (see 4.6.15).

3.3.3.14 Electromagnetic emission and susceptibility. The governor system and all switchboard or engine mounted components shall be designed and tested to meet the applicable EMI requirements of MIL-STD-461 (see 4.6.20).

3.3.3.15 Vibration. The governor system and all switchboard mounted components shall be designed and tested to withstand externally excited vibration, type I, in accordance with MIL-STD-167-1 (see 4.6.16).

3.3.3.16 Life. Wherever the expected life of parts is predictable and can be controlled through design or application, the parts shall be designed or applied so that an equipment life of 40,000 hours of operation can be expected.

3.3.3.17 Speed sensing. The speed sensing circuit shall not be affected by disturbance in the voltage of the generator. Speed sensing shall not be lost when generator output voltage is reduced to zero.

3.3.3.18 Load sensor isolation. The load sensors must be isolated by transformers from the generator stator output terminals.

3.3.3.19 Assembly. To facilitate troubleshooting and repair, the equipment shall be packaged, insofar as practicable, into functional assemblies. Such assemblies, except those which are plug-in assemblies, shall be wired to associated assemblies with screw terminal connections for ease of replacement.

3.3.3.20 Printed circuit board assemblies. Unless otherwise specified herein, printed circuit board assemblies shall be in accordance with MIL-STD-275.

(a) A conformal coating may be provided at the contractor's option, provided that it is easily removable by means of a soldering iron without damage to the printer circuit board.
(b) Printed circuit board assemblies shall be plug-in, and each shall include keying provisions so that it shall not be possible to plug in any assembly in an incorrect mounting location.
(c) Guides or tracks shall be provided to direct each printed circuit board assembly into its mounting location. Each printed circuit board assembly shall be restrained in its mounting location by captive hardware. No special tools shall be required to remove or install an assembly.
(d) An extender board shall be provided to assist in troubleshooting the printed circuit board assembly. The extender board shall extend each circuit at the terminals of the printed circuit board assembly. Each circuit shall be readily accessible on the extender board without removing any other assembly.

3.3.3.20.1 Printed circuit boards. Printed circuit boards shall be in accordance with MIL-P-55110.

3.3.3.21 Multipin connectors. Multipin connectors shall be in accordance with MIL-C-28748, MIL-C-55302, or MIL-C-83723, series 3. Connectors shall be selected so that the connector crimp or solder cups are of sufficient size to permit termination of the required wire size without cutting or otherwise deforming the wire to fit the crimp or cups.

3.4 Performance requirements.

3.4.1 Steady state governing speedband. The governing system shall regulate the mean governed speed of the primer mover within a steady state governing speedband of 0.25 percent of rated speed for any load between 0 and 100 percent (see 4.6.7).

3.4.2 Steady state speed regulation.

3.4.2.1 Isochronous mode. With the real differential compensation inoperative, the steady state regulation of the governing system shall be between 0 and positive 1.0 percent (see 4.6.2).

3.4.2.2 Droop mode.

(a) With the speed regulation changer set at 0 percent, the steady state speed regulation of the governing system shall be the same as obtained in the isochronous mode.

(b) With the speed regulation changer set anywhere within the range specified in 3.4.5, the steady state speed regulation of the governing system shall be as specified in 3.4.2.2(a), plus the setting of the speed regulation changer.

3.4.3 Steady state incremental speed regulation. At all values of load from no load to full load, the steady state incremental speed regulation of the governing system shall be positive to ensure stability. Steady state incremental speed regulation in the droop mode shall be the same as in the isochronous mode, plus the setting of the speed regulation changer (see 4.6.6).

3.4.3.1 Type DE and GT systems. Steady state incremental speed regulation shall be less than positive 1.0 percent in the isochronous mode.

3.4.3.2 Type ST systems. Steady state incremental speed regulation shall be less than positive 3.0 percent in the isochronous mode.

3.4.4 Speed changer, range and sensitivity. In the isochronous mode, with the real differential compensation inoperative, the speed changer shall have a maximum continuous adjustable range of 90 to 116 percent of rated speed for type DE. For type ST, the speed changer shall have a maximum continuous adjustable range of 90 to 113 percent of rated speed. Normal speed range stops shall be set for 95 to 105 percent of rated speed. Type DE shall have a high speed stop override to allow adjustment to 116 percent rated speed. Type ST shall have a high speed stop override to allow adjustment to 113 percent rated speed (see 4.6.5.1).

3.4.5 Speed regulation changer, range and sensitivity. In the droop mode, the speed regulation changer shall be capable of increasing steady state speed regulation (and incremental speed regulation) in the positive direction. The operating range of the speed regulation changer shall be continuously adjustable from 0 to 5.0 percent. The speed regulation changer shall decrease set speed linearly as load is increased to ensure paralleled generator stability and load sharing (see 4.6.5.2).

3.4.6 Transient response. For types DE and GT, the maximum permissible overspeed or underspeed upon application or removal of 100 percent rated kW load shall be 3.0 percent of rated speed. For type ST, the maximum permissible overspeed or underspeed upon application of 100 percent rated kW load shall be 3.0 percent of rated speed. For type ST, the maximum permissible overspeed or underspeed upon removal of 80 percent (100 to 20 percent) rated kW load shall be 3.0 percent of rated speed. Based on a prescribed speed band of 1.0 percent of rated speed (plus or minus 0.5 percent), the recovery time for all types shall not exceed 1.5 seconds in either the isochronous or droop modes (see 4.6.3).

3.4.7 Standby speed controller performance requirements.

3.4.7.1 Speed adjustment range.

3.4.7.1.1 Speed adjustment range (type DE). Means shall be provided for continuous adjustment of type DE from 33 percent to 116 percent of rated speed. Normal high speed stop shall be set at 103.3 percent rated speed. The maximum

high speed stop shall be set at 116 percent rated speed. Means for transferring from normal high speed to maximum high speed without adjustment of stops shall be provided.

3.4.7.1.2 Speed adjustment range (type GT). Unless otherwise specified, the speed adjustment range for type GT shall be continuous from 95 to 110 percent rated speed. Normal high speed stop shall be set at 105 percent rated speed.

3.4.7.1.3 Speed adjustment range (type ST). Unless otherwise specified, the speed adjustment range for type ST shall be continuous from 95 to 113 percent rated speed. Normal high speed stop shall be set at 105 percent rated speed. Means for overriding the normal high speed stop in order to allow continuous adjustment up to 113 percent rated speed shall be provided.

3.4.7.2 Speed regulation changer. Means for providing up to 5 percent rated speed droop at full rated kW load shall be provided. Unless otherwise specified, speed regulation changer shall be set to 0 percent.

3.4.7.3 Transient response.

3.4.7.3.1 Speed transient response. The standby speed control shall be designed so that an instantaneous transfer from electric governor control to standby governor control at any load will not result in the generator set tripping on overspeed.

3.4.7.3.2 Load transient response. Unless otherwise specified, the standby speed control shall meet the following load transient requirements:

(a) Maximum permissible overspeed or underspeed upon application of 100 percent rated kW load shall be 7.0 percent of rated speed.
(b) Maximum permissible overspeed or underspeed upon removal of 100 percent rated kW load for types DE and GT shall be 7.0 percent of rated speed.
(c) Maximum permissible overspeed or underspeed upon removal of 80 percent rated kW load (100 to 20 percent) for type ST shall be 7.0 percent of rated speed.
(d) Maximum permissible recovery time to plus or minus 0.5 percent rated speed following application or removal of load step is 5.0 seconds.

3.5 System requirements.

3.5.1 General. In the isochronous mode, the governing system shall tend to reduce to zero any error in speed which may occur under any operating condition.

3.5.2 Load sensor. The system shall include a load sensor which shall measure the real load, or a quantity proportional to the real load, of the generator set. Its operation with the other components of the governing systems shall be such that real load is divided between paralleled generators within 5.0 percent of rated load for all types of governing systems.

3.5.3 Speed sensor. The system shall include a speed sensor which shall measure the speed, or a quantity proportional to the speed, of the generator set. Its operation with the other components of the governing system shall be such as to correct for any deviation in speed from the value for which the speed changer is set.

3.5.4 Damping. The system shall be damped such that the maximum departure of speed outside of the prescribed speedband, during any half-cycle of transient oscillation resulting from load application or removal, is less that one-third of the similar departure during the previous half-cycle. This only applies to those half-cycles which occur after the initial half-cycle of transient oscillation.

3.5.5 Stability. The governing system shall be stable which includes the electric governor and standby ball head back-up governor, if installed. The governor system offeror shall mathematically verify generator set stability under all modes of expected operation with normal and standby speed controls. Generator set stability shall be verified during testing under the following conditions:

(a) All values of load not exceeding generator set rated overload capacity with power factors from 0.4 lagging to 0.8 leading during single unit or parallel operation in isochronous or droop mode using electric governor control. This shall include all combinations with one generator set in droop mode paralleled to one or more generator sets in isochronous mode.
(b) All values of load not exceeding generator set rated overload capacity with power factors from 0.4 lagging to 0.8 leading during single unit operation under standby governor control or with one generator set under standby governor isochronous control paralleled with one or more generator sets operating under electric governor control in droop mode.
(c) All values of load not exceeding generator set rated overload capacity with power factors from 0.4 lagging to 0.8 leading during operation with one or more generator sets in electric governor droop mode paralleled with shore (utility) power.
(d) All values of generator voltage from 75 to 130 percent of rated.
(e) All values of speed from 90 to 113 percent of rated speed for types ST and GT while operating under either governor or standby governor control.
(f) All values of speed from 90 to 116 percent of rated speed for type DE under electric governor control.
(g) All values of speed from 33 to 116 percent of rated speed for type DE under standby governor control.

3.5.6 Overspeed protection. In the event of the failure of any electronic part, the loss of governor actuator voltage, or the loss of the generator output voltage, the system shall prevent the generator set from reaching the following speeds:

(a) Type DE - 115 percent of rated speed.
(b) Type ST - 112 percent of rated speed.
(c) Type GT - 125 percent of rated speed.

3.5.7 Parallel operation.

(a) The governing system shall meet the requirements of 3.5.7.1 and 3.5.7.2 in the droop mode. A suitable drooping characteristic shall be provided by the speed regulation change (see 3.3.3.8.3 and 3.4.5).
(b) Where isochronous parallel operation is specified (see 6.2), real differential compensation shall be utilized to meet the requirements of 3.5.7.1 and 3.5.7.2 in the isochronous mode (see 3.3.3.9.3).

3.5.7.1 Load division. The kW load of any generator (expressed as a percentage of its kW rating) shall not differ from the total kW load of all paralleled generators (expressed as a percentage of the total kW rating of all paralleled generators) by more than 5.0 percent as load is varied over the range of 0 to 100 percent of total rated load, at any power factor from 0.4 lagging to 0.8 leading.

The speed controls shall not be adjusted during load changes in order to effect required load balance. Load balance shall be completely automatic. The time required for the load division to become stable shall not exceed 5.0 seconds.

3.5.7.2 Current pulsation. The maximum allowable current pulsation at any load from no load to rated load, and at any power factor from 0.4 lagging to 0.8 leading, shall be 2.0 percent of rated current.

3.5.8 Type GT additional system requirements.

3.5.8.1 Turbine inlet temperature (TIT) controller. In addition to the normal speed/load controller channel, the type GT system shall also have a TIT controller channel (see 6.2).

3.5.8.2 Fuel scheduling controller. Type GT shall provide for electronic fuel scheduling during start up (see 6.2).

3.5.8.3 Standby speed controller. Type GT shall have a standby speed controller (see 6.2).

3.5.9 Type DE additional system requirements.

3.5.9.1 Acceleration controller. Type DE shall have an acceleration controller as specified in 3.3.3.9.8 (see 6.2).

3.5.9.2 Standby speed controller. Type DE shall have a standby speed controller (see 6.2).

3.5.10 Standby speed controller operation.

3.5.10.1 Standby speed controller operation type ST. Standby speed controller for type ST is not required except as follows (see 6.2):

(a) Required in specific generator set specification.
(b) Required in order to meet another requirement of this specification.

3.5.10.2 Standby speed controller operation types DE and GT. The standby speed controller shall function to limit/control speed during startup, as required by the specific system (see 6.2). The standby speed controller shall function to prevent overspeeding if the normal speed controller fails in the "full fuel" direction. The standby speed controller shall provide emergency use speed control as specified in 3.4.7, if the normal speed controller is nonfunctional.

3.6 Short-circuit of generator. With the generator set delivering rated load under normal operating conditions, the governing system shall not permit the generator set to stall or overspeed when a single or three-phase short circuit is suddenly applied to the generator output terminals. The specified performance requirements of the governing system shall automatically be resumed upon restoration of normal operating conditions.

3.7 Identification plates. The identification plates shall be attached to the part of the equipment, which will not ordinarily be renewed during its normal service life. These plates shall be located in a readily accessible position, where they can be read at all times without danger to personnel. Identification plates shall be either type A, B, or C in accordance with MIL-P-15024 and MIL-P-15024/5. All engraved, stamped, or direct etched markings shall be filled with black paint, enamel, or lacquer. The information marked on the plates shall include the following items:

(a) Manufacturer's name, identification symbols, serial number, contract or order number, and date of manufacture.
(b) Salient design characteristics: for example; type, frequency, voltage, and capacity.
(c) Space for inspector's official stamp.
(d) National stock number, if available.

3.8 Workmanship.

3.8.1 General. Workmanship shall be in accordance with the requirements herein applicable to soldering, marking of parts and assemblies, wiring, welding and brazing, plating, riveting, finishes, machine operations, screw assemblies, and freedom of parts from burrs, sharp edges, or any other damage or defect that could make the part (or equipment) unsatisfactory for the purpose intended.

3.8.2 Threaded parts or devices. Screws, nuts, and bolts shall show no evidence of cross threading, mutilation, or detrimental or hazardous burrs.

3.8.2.1 Tightness. Screw-type fasteners shall be tight. The word tight means the screw shall be firmly secured, and that there shall be no relative movement possible between the attached parts.

3.8.3 Wiring. Insulated wire shall be formed into cables or ducted, wherever practicable. Wires and cables shall be positioned or protected to avoid contact with rough or irregular surfaces and sharp edges.

## 4. QUALITY ASSURANCE PROVISIONS

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

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

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

(a) First article inspection (see 4.3).
(b) Quality conformance inspection (see 4.4).

4.3 First article inspection. First article inspection shall be made on the first governor equipment of a given design and size. First article inspection shall be required after any change in design, or use with a new generator set design, which affects the performance characteristics. First article inspection shall be as shown in table II and shall be conducted essentially in the order listed.

TABLE II. First article inspection and quality-conformance inspection.

| Examination and test | Requirement | Reference | First article inspection | Quality conformance inspection |
|---|---|---|---|---|
| Visual examination | 3.8 | 4.5 | X | X |
| Creepage and clearance | 3.3.1 | 4.6.1 | X | --- |
| Steady state speed regulation | 3.4.2 | 4.6.2 | X 1/ | X 2/ |
| Transient response | 3.4.6 | 4.6.3 | X 1/ | --- |
| Generator short-circuit | 3.6 | 4.6.4 | X 1/ | --- |
| Adjustments | 3.4.4, 3.4.5 | 4.6.5 | X 1/ | X 2/ |
| Speed load characteristic | 3.4.1 | 4.6.7 | X 1/ | X 2/ |
| Steady state incremental speed regulation | 3.4.3 | 4.6.6 | X 1/ | |
| Starting | --- | 4.6.8 | X 1/ | --- |
| Loss of excitation to governor system | 3.5.6 | 4.6.9 | X 1/ | --- |
| Loss of generator excitation | 3.5.6 | 4.6.10 | X 1/ | --- |
| Heating | 3.3.3.10 | 4.6.11 | X 1/ | --- |
| Enclosure test | 3.3.3.2.2 | 4.6.12 | X | --- |
| Insulation resistance | 3.3.3.11 | 4.6.13 | X | X |
| Dielectric strength test | 3.3.3.12 | 4.6.14 | X | X |
| Shock test | 3.3.3.13 | 4.6.15 | X | --- |
| Vibration test | 3.3.3.15 | 4.6.16 | X | --- |
| Parallel operation | 3.5.7 | 4.6.17 | X 1/ | --- |
| Maintainability demonstration | 3.3.2.3 | 4.6.18 | X | --- |
| Electric performance test | --- | 4.6.19 | X | --- |
| Electromagnetic emission and susceptibility | 3.3.3.14 | 4.6.20 | X | --- |

1/ These tests shall be conducted with the primer mover, generator, and regulator-exciter for which the governing system is intended.
2/ These tests may be conducted with the primer mover, generator, and regulator-exciter for which the governing system is intended, or simulated operation may be used (see 4.6.19).

4.4 Quality conformance inspection. Quality conformance inspection shall be conducted on every governor equipment offered for delivery as specified in table II.

4.5 Visual examination. A careful examination shall be made of the materials and workmanship to ascertain that they are of the quality specified herein. The principle features of the design such as terminal connections, case construction, mounting, nonstructural parts, assembly, and identification plate data shall be checked for compliance with this specification.

4.6 Test procedures.

4.6.1 Creepage and clearance distances. Creepage and clearance distance shall be demonstrated by actual measurement to be in accordance with MIL-E-917.

4.6.2 Steady state speed regulation. Steady state speed regulation tests shall be conducted as follows:

(a) The regulator-exciter shall be in the automatic mode for this test. The reactive current compensation shall be inoperative or set to zero. The governor shall be in the isochronous mode.
(b) The generator set shall be operated at 100 percent of rated load, at rated power factor, voltage, and speed, until temperatures have stabilized.
(c) The regulator-exciter and governor shall be adjustable to obtain rated values of terminal voltage and speed. No further adjustments shall be made. The instrument readings shall be taken at this time.
(d) Load shall be reduced to no load in one step. After voltage and speed have stabilized, all instrument readings shall be taken. 100 percent of rated load shall then be applied in one step. After voltage and speed have stabilized, all instrument readings shall again be taken.
(e) Step (d) shall be repeated two additional times.
(f) The minimum information for each set of readings taken during the test shall be the three-phase root mean squared (rms) voltages and line currents, frequency, kW output, power factor, and speed.
(g) The following formula shall be used to determine compliance with 3.4.2:

$$\text{Average steady state speed regulation} = \frac{X_{ANL} - X_{AFL}}{X_{AFL}} \times 100$$

Where: $X_{ANL}$ = Average measured speed at no load.
$X_{AFL}$ = Average measured speed at full load.

4.6.3 Transient response.

4.6.3.1 Electric governor transient response. The electric governor transient response test shall be as follows:

(a) The regulator-exciter shall be in the automatic mode for this test. The reactive current compensation circuit shall be inoperative or set to zero. The governor shall be in the isochronous mode.
(b) The generator set shall be operated at 100 percent of rated load, at rated power factor, voltage, and speed, until temperatures have stabilized. All load shall then be removed from the generator set.
(c) The regulator-exciter and governor shall be adjusted to obtain rated values of terminal voltage and speed. No further adjustments shall be made. The instrument readings shall be taken at this time.

(d) A 100 percent rated kW load shall be applied in one step. After voltage and speed have stabilized, all instrument readings shall be recorded. The load shall then be reduced to no load in one step (for type ST, reduce to 20 percent load). After voltage and speed have stabilized, all instrument readings shall be taken.
(e) Step (d) shall be repeated two additional times.
(f) The test shall be repeated using loads of 75, 50, and 25 percent of rated kW load.
(g) The test shall be repeated for all loads (100, 75, 50, and 25 percent of rated kW load) with the governor in the droop mode and the speed regulation changer set at 3.3 percent.
(h) The minimum information for each set of readings taken during the test shall be the three-phase RMS voltages and line currents, frequency, kW output, and frequency deviation. A recording instrument of suitable accuracy and response shall be used to provide a permanent trace of speed versus time during the tests. The information obtained shall be used to determine compliance with 3.4.6.

4.6.3.2 Standby speed control transient response. The standby speed control transient response test shall be run as follows:

(a) The regulator-exciter shall be in the automatic mode for this test. The reactive current compensation circuit shall be inoperative or set to zero. The governor shall be in the isochronous mode.
(b) The generator set shall be operated at 100 percent of rated load, at rated power factor, voltage, and speed, until temperatures have stabilized. The load shall then be removed from the generator set.
(c) The regulator-exciter and governor shall be adjusted to obtain rated values of terminal voltage and speed. No further adjustments shall be made. The instrument readings shall be taken at this time.
(d) A 100 percent rated kW load shall be applied in one step. After voltage and speed have stabilized, all instrument readings shall be recorded. The load shall then be reduced to no load in one step (for type ST, reduce to 20 percent load). After voltage and speed have stabilized, all instrument readings shall be taken.
(e) Step (d) shall be repeated two additional times.
(f) With no load on the generator set, instantaneously transfer speed control from electric governor at rated speed to standby speed control which is set for normal high speed, and verify that generator set does not trip on overspeed.
(g) The minimum information for each set of readings taken during the test shall be the three-phase RMS voltages and line currents, frequency, kW output, and frequency deviation. A recording instrument of suitable accuracy and response shall be used to provide a permanent trace of speed versus time during the tests. The information thus obtained shall be used to determine compliance with 3.4.7.3.

4.6.4 Generator short-circuit.

(a) With the generator set delivering rated load under normal operating conditions, a three-phase short-circuit shall be suddenly applied to the generator output terminals. Speed deviation from rated speed, line voltage, and current readings shall be taken. Any stalling or indication of a dangerous disturbance shall be noted in the test record. The duration of the test shall be determined by the following formula:

$$t = \frac{180}{I^2}$$

Where: t = Time in seconds.
I = Sustained short-circuit line current in per-unit.

(b) The test shall be repeated using a single-phase short-circuit. On governing systems where the load sensor does not measure the voltage and current of all three phases of the generator set, the test shall be repeated for all three possible combinations of single-phase short-circuits.

4.6.5 Adjustments. Tests shall be conducted to determine the range and effect of the governing system adjustments and manual controls.

4.6.5.1 Speed changer. The range of control of the speed changer and the effect on the governing system characteristics of representative adjustments throughout the range specified in 3.4.4 shall be determined by operating the generator set at both maximum and minimum speeds, and at representative intermediate speeds, under steady state operating conditions. The system shall exhibit stable operation throughout the range specified in 3.4.4.

(a) The normal speed range test shall be performed at full load and unity power factor. The governing system shall be in the droop mode with the speed regulation changer set at 0 percent. Voltage shall be varied on a volts per hertz basis to prevent overfluxing of magnetic components of the generator set.

(b) Speed shall be continuously adjusted from 95 to 105 percent rated speed. Instrument readings shall be taken at each 0.5 Hz of adjustment. Instrument readings shall be the three-phase RMS voltages and line currents, frequency, power factor, and kW output.

(c) The overspeed adjustment range for types DE and ST shall be demonstrated at no load. Ball head backup governor, if applicable, and overspeed adjustment range shall also be demonstrated. Generator set speed shall be monitored with two independent tachometers throughout the test. Disengage normal high-speed stop as applicable for the specific system and slowly increase speed up to maximum allowable overspeed for specific generator set.

4.6.5.2 Speed regulation changer. The range and sensitivity of the speed regulation changer shall be tested to determine compliance with 3.4.5. As part of the test, the steady state speed regulation of the governing system shall be tested with the speed regulation changer set at 0 percent to determine compliance with 3.4.5.

(a) The test shall be performed with the regulator-exciter in the automatic mode, and the reactive current compensation circuit set to zero or inoperative. The governing system shall be in the droop mode.

(b) The generator set shall be operated at no load and at rated full load for speed regulation changer settings of 0.0 to 5.0 percent, in increments not to exceed 0.5 percent. Instrument readings shall be taken after the system has stabilized at each setting of the speed regulation changer.

(1) Steady state speed regulation (in percent) = $\frac{X_{nl} - X_{fl}}{X_{fl}} \times 100.$

(2) Normal steady state speed regulation in droop mode - 3.3 percent.

(3) Example: SSSR = $\frac{52-60}{60} \times 100 = 3.3$ percent.

(c) The minimum information for each set of readings shall be the three-phase RMS voltages and line currents, frequency, kW output, power factor, speed, and speed regulation changer setting.

4.6.5.3 Other adjusting devices. Tests shall be conducted as necessary to determine the range and effect of any adjusting device other than the speed changer and speed regulation changer.

4.6.6 Steady state incremental speed regulation.

(a) The regulator-exciter shall be in the automatic mode for this test. The reactive current compensation circuit shall be inoperative or set to zero. The governor shall be in the isochronous mode.

(b) The generator set shall be operated from no load, to rated load, to no load in 5.0 percent steps. Voltage shall be adjusted to rated at each load, if necessary. Instrument readings shall be taken after the system has stabilized at each load point. The minimum readings to be taken are the three-phase voltages and line currents, frequency, kW output, and speed at each load point. For type ST systems, valve lifts shall also be determined.

(c) Steady state incremental speed regulation at each load point shall be calculated as specified in MIL-STD-178. The system shall be as specified in 3.4.3 and either 3.4.3.1 (type DE and GT) or 3.4.3.2 (type ST).

(d) The test shall be repeated in the droop mode with the speed regulation changer set at 3.3 and 5.0 percent to determine compliance with 3.4.3 and either 3.4.3.1 or 3.4.3.2.

4.6.7 Speed-load characteristics. Speed-load tests shall be conducted as required by the generator set specification.

4.6.8 Starting (types DE and GT). With the generator set cold, the time elapsing between pressing the starting pushbutton and full kW load at rated conditions, including rated speed being delivered by the generator set, shall be determined. The speed, line voltage, and load current readings shall be taken during this interval. This test shall be repeated with the generating set starting warm.

4.6.9 Loss of excitation to governing system. With the generator set delivering load under normal conditions of operation, the electrical excitation to the governing system shall be suddenly removed. Speed deviation from rated speed, line voltage and current readings shall be taken and any overspeeding or other dangerous performance noted.

4.6.10 Loss of generator excitation. With the generator set delivering rated load under normal conditions of operation, the generator excitation shall be suddenly removed. Speed deviation from rated speed, line voltage and current readings shall be taken and any indication of dangerous performance noted.

4.6.11 Heating. Heating tests shall be made on the governor equipment under operating conditions. Measurement methods, method 1 (thermometer) and method 2 (resistance) shall be as specified in MIL-E-917.

4.6.12 Enclosure test. The enclosure test shall be in accordance with MIL-STD-108 to determine if the enclosure is drip-proof.

4.6.13 Insulation resistance. The insulation resistance test shall be conducted before the dielectric test. Prior to the application of the test voltage, all circuits shall be thoroughly discharged. The test voltage shall be applied between all electrically isolated circuits and between each circuit and frame (or chassis). Circuit diagrams shall be carefully studied prior to conducting this test to ascertain that circuits, which may be isolated by transformers, are not inadvertently neglected. When testing between the circuits and frame (or chassis), all circuits may be tied together so that only one test voltage need be applied, providing that the insulation resistance when tested in this manner meets the minimum value specified in 3.3.3.11. Insulation resistance measurements shall be corrected to 25°C. Corrections shall be made on the basis of insulation resistance doubling for each 15°C decrease in temperature. The relative humidity at the time of the test shall be measured.

4.6.14 Dielectric strength test. The dielectric strength test (see 3.3.3.12) shall be conducted on the completely assembled unit and not on an individual part. The test voltage shall be applied both between circuits and between each circuit and frame (or chassis). The frequency of the test voltage shall be not less than 60 cycles and shall be approximately a true sine wave.

4.6.15 Shock test. The shock test shall be conducted in accordance with grade A, class I of MIL-S-901 and as follows:

(a) General. The governor system or components thereof shall be energized during the shock test. The equipment may be tested when operating with its intended generator or under simulated loading. All equipment or parts shall be mounted on the shock machine in a manner simulating the actual installation on board ship. The weight designation of the shock test shall be as required by the combined weight of the equipment or components thereof being tested. The output of the equipment shall be determined before and after the test to determine compliance with 4.6.15(b).

(b) Criteria for compliance with the shock tests. The governor system shall be considered to comply with the shock tests unless any of the following failures are experienced. Any of the following failures shall be considered as cause for rejection of the equipment:

(1) Breakage of any parts, including mounting bolts. Cracking or signs of cracking in parts vital to operation shall be considered breakage.
(2) Appreciable distortion or dislocation of any parts such as mounting feet, coils, or conducting terminals.
(3) A value of insulation resistance (corrected to 25°C) less than that permitted by 3.3.3.11.
(4) Failure to withstand a dielectric test voltage equal to 65 percent of that specified in 3.3.3.12.
(5) Failure to meet the steady state speed regulation requirements (see 3.4.2).
(6) Shift in value of regulated speed of more than 2 percent.

(c) Shock tests shall be performed at the contractor's plant, commercial laboratory, or Government laboratory which is suitably equipped to perform these tests. When shock tests are conducted at other than the contractor's plant, copies of all master drawings shall accompany the equipment.

(d) Correction and disposal of shock-tested equipment.

(1) Equipment, which has been subjected to the high impact shock test and has failed to perform any of the principal functions specified herein, shall not be acceptable, either in whole or any of the parts, until it has been modified and successfully passed the HI shock test, or until the design modifications have been approved by the contracting activity.
(2) Equipment, which has been subjected to the high impact shock test and has successfully performed all the principal functions specified herein, will be acceptable provided the following post-shock tests are satisfactorily met:

a. Dielectric.
b. Insulation resistance.
c. Steady state speed regulation. The steady state speed regulation test may be conducted with the test generator set or by use of simulated loading conditions. When simulated means are used, and input-output form of test

shall be conducted on the equipment prior to and again after the shock test, to demonstrate that the electrical operating characteristics of equipment meet the speed regulation requirements of 3.4.2. To the extent possible, the equipment should be energized and operated at its rated values.

4.6.16 Vibration test. The governor equipment shall be tested in accordance with MIL-STD-167-1 to demonstrate that the equipment meets the requirements of 3.3.3.15. The method of energizing and loading during the test and information obtained before, during, and after the test, shall conform to 4.6.15. Criteria for compliance shall be as specified in 4.6.15(b).

4.6.17 Parallel operation. Two generators sets shall be operated in parallel to determine compliance with 3.5.7. The test procedure shall be as follows:

(a) The regulator-exciter of each generator set shall be in the automatic mode with the reactive current compensation circuit in operation. The governing system of each generator set shall be in the droop mode.

(b) The generator sets shall be operated in parallel at various loads up to the combined rated load of both generator sets. Adjustments shall be made, as necessary, to achieve proper real and reactive load division between the two generator sets. Load on the generator sets shall be reduced to 20 percent of the combined rating, and any final adjustments shall be made. The setting of the speed regulation changer of each generator shall be determined. No further adjustments shall be permitted.

(c) Load on the parallel generator sets shall be increased from 20 percent to 100 percent of the combined ratings in four, approximately equal, steps. If the generator sets have an overload rating, load shall be further increased to that rating in one step. The power factor of the load shall be corrected to the rated power factor at each step of increasing load. The instrument readings shall be taken at the beginning of the test and at each load step.

(d) The minimum readings to be taken for each generator at each load step, shall be the three-phase RMS voltages and line currents, frequency, kW output, power factor, speed, and the time required for load division to become stable.

(e) At each steady state load condition, all instruments shall be observed for evidence of periodic pulsations such as those occurring at a frequency of three hertz. The maximum and minimum values of generator line currents shall be determined during these pulsations. The percentage of pulsation for each generator shall be in compliance with 3.5.7.2 and shall be calculated as follows:

$$P = \frac{I_{max} - I_{min}}{I_{rated}} \times 100$$

Where: $P_I$ is the percent of pulsation.
$I_{max}$ is the maximum current value.
$I_{min}$ is the minimum current value.
$I_{rated}$ is the rated current value.

(f) At each load step where periodic pulsations occur, the load shall be applied and removed three times while observing for evidence of speed hunting and load surges. The instrument readings shall be taken after each load change.

(g) Total load on the parallel generators shall be changed in steps as specified in table III. The instrument readings shall be taken after each load change.

TABLE III. Total load change.

| Step number | Approximate power factor (percent) | Percent of combined kW load rating of load generators | | |
|---|---|---|---|---|
| | | Initial load | Applied load | Removed load |
| 1 | 100 | 0 | 50 | --- |
| 2 | 100 | 50 | --- | 50 |
| 3 | 100 | 0 | 100 | --- |
| 4 | 100 | 100 | --- | 100 |
| 5 | 80 lagging | 0 | 50 | --- |
| 6 | 80 lagging | 50 | --- | 50 |
| 7 | 80 lagging | 0 | 100 | --- |
| 8 | 80 lagging | 100 | --- | 100 |
| 9 | 40 lagging | 0 | 50 | --- |
| 10 | 40 lagging | 50 | --- | 50 |

(h) Where isochronous parallel operation is specified (see 6.2), the test shall be repeated with the governing systems in the isochronous mode and the real differential compensation circuits in operation. Additionally, steps (i) through (l) shall be demonstrated.

(i) Load one generator set to 100 percent rated load in isochronous mode.

(j) Parallel a second generator set in isochronous mode and verify that load is properly shared (50/50), and that only minimal adjustment is required to oncoming generator for compensation of speed differential during paralleling.

(k) Transfer one generator set to droop mode and verify that it sheds all but approximately 5 percent of its load, and that the transfer is smooth and without oscillation. Verify that load can now be controlled with speed changer.

(l) Parallel generator set in droop mode with shore power (utility), and verify that no oscillation or generator set overloading occurs. Verify that load can be controlled with speed changer.

4.6.18 Maintainability demonstration test. Maintainability shall be demonstrated in accordance with MIL-STD-471 (see 3.3.2.3.1 and 6.3).

4.6.19 Electric performance tests. Quality conformance test may be conducted without the use of the generator set (open loop) as specified in footnote 2 to table II. These tests shall ensure that the requirements of the governing system are met, when operated with the intended prime mover. The following list is furnished for guidance to illustrate the nature of the tests that are to be conducted (see 6.3). The test procedures shall include a brief description of the manner in which each test will be conducted including sketches or diagrams, as necessary. The composite test shall be of such nature as to ensure that all polarity and phase sequential connections within the equipment are correct:

(a) Speed changer range.
(b) Speed regulation changer range.
(c) Speed load characteristic.
(d) Speed governor (input-output characteristics).

4.6.20 Electromagnetic interference characteristics tests. All components of the governor system will be tested in accordance with MIL-STD-462 to verify compliance with MIL-STD-461.

4.7 Inspection of packaging. Sample packages and packs, and the inspection of the preservation, packing and marking for shipment and storage shall be in accordance with the requirements of section 5 and the documents specified therein.

5. PACKAGING

(The packaging requirements specified herein apply only for direct Government acquisition. For the extent of applicability of the packaging requirements of referenced documents listed in section 2, see 6.9.)

5.1 General.

5.1.1 Navy fire-retardant requirements.

(a) Treated lumber and plywood. Unless otherwise specified (see 6.2), all lumber and plywood including laminated veneer material used in shipping containers and pallet construction, members, blocking, bracing, and reinforcing shall be fire-retardant treated material conforming to MIL-L-19140 as follows:

Levels A and B - Type II - weather resistant.
Category 1 - general use.
Level C - Type I - non-weather resistant.
Category 1 - general use.

(b) Fiberboard. Unless otherwise specified (see 6.2), fiberboard used in the construction of class-domestic, non-weather resistant fiberboard and cleated fiberboard boxes including interior packing forms shall meet the flamespread index and the specific optic density requirements of PPP-F-320 and amendment thereto.

5.2 Packaging requirements. The packaging (preservation, packing, and marking) requirements shall be in accordance with MIL-E-17555 for the level of preservation (A, B, C, or commercial), level of packing (A, B, C, or commercial), and marking including bar coding and other packaging acquisitioning options therein as specified (see 6.2).

6. NOTES

(This section contains information of a general or explanatory nature that may be helpful, but is not mandatory.)

6.1 Intended use. The governing systems are intended to control the speed of ships service and emergency generators on military ships, and to control real load division when generators are operated in parallel.

6.2 Acquisition requirements. Acquisition documents must specify the following:

(a) Title, number, and date of this specification.
(b) Type required (see 1.2).
(c) Issue of DoDISS to be cited in the solicitation, and if required, the specific issue of individual documents referenced (see 2.1.1 and 2.2).
(d) Whether first article inspection is required (see 3.1).
(e) Ship's service or emergency application.
(f) Mounting arrangement required (see 3.3.3.2).
(g) Type of cooling required (see 3.3.3.2.3).
(h) Parallel operation required (see 3.3.3.7(a), 3.5.7, and 4.6.17(h)).
(i) Specify the speed for the motor operated speed changer when the set is secured (see 3.3.3.8.2.2).
(j) If an alternate type of droop control adjusting device is required (see 3.3.3.8.3).
(k) If standby speed control is required (see 3.3.3.9.2).
(l) For Diesel generators specify details of automatic acceleration control during start-up (see 3.3.3.9.8).
(m) Type GT system requirements.

(1) Fuel controller not required (see 3.3.3.9.4).
(2) Turbine inlet temperature TIT controller not required (see 3.5.8.1).
(3) Fuel scheduling controller not required (see 3.5.8.2).
(4) Load limit controller not required (see 3.3.3.9.7).
(5) Standby speed controller not required (see 3.5.8.3).

(n) Type DE system requirements.

(1) Load limit controller required (see 3.3.3.9.7).
(2) Acceleration controller (see 3.5.9.1).
(3) Standby speed controller not required (see 3.5.9.2).

(o) Type ST system requirements.

(1) Load limit controller required (see 3.5.10.1).
(2) Standby speed controller required (see 3.5.10.2).

(p) Fire-retardant packing materials not required (see 5.1.1).
(q) Level of preservation, packing, and marking and other acquisitioning options required (see 5.2).

6.3 Consideration of data requirements. The following data requirements should be considered when this specification is applied on a contract. The applicable Data Item Descriptions (DID's) should be reviewed in conjunction with the specific acquisition to ensure that only essential data are requested/provided and that the DID's are tailored to reflect the requirements of the specific acquisition. To ensure correct contractual application of the data requirements, a Contract Data Requirements List (DD Form 1423) must be prepared to obtain the data, except where DoD FAR Supplement 27.475-1 exempts the requirement for a DD Form 1423.

| Reference Paragraph | DID Number | DID Title | Suggested Tailoring |
|---|---|---|---|
| 3.3.1 | DI-DRPR-81000 | Product drawings and associated lists | ---- |
| 3.3.2.2 | DI-R-7082 | Reliability predictions report | ---- |
| 3.3.2.2 | DI-R-7085 | Failure mode, effects, and criticality analysis report | ---- |
| 3.3.2.3.2 | DI-MNTY-80827 | Maintainability predictions report | ---- |
| 3.3.2.3.2 | DI-MNTY-80828 | Maintainability analysis report | ---- |
| 4.6.18 | DI-MNTY-80832 | Maintainability/testability demonstration test report | ---- |
| 4.6.19 | UDI-T-23732 | Procedures, test | ---- |

The above DID's were those cleared as of the date of this specification. The current issue of DoD 5010.12-L, Acquisition Management Systems and Data Requirements Control List (AMSDL), must be researched to ensure that only current, cleared DID's are cited on the DD Form 1423.

6.4 Technical manuals. The requirement for technical manuals should be considered when this specification is applied on a contract. If technical manuals are required, military specifications and standards that have been cleared and listed in DoD 5010.12-L, Acquisition Management Systems and Data Requirements Control List (AMSDL) must be listed on a separate Contract Data Requirements List (DD Form 1423), which is included as an exhibit to the contract. The technical manuals must be acquired under separate contract line item in the contract.

6.5 Provisioning. Provisioning Technical Documentation (PTD), spare parts, and repair parts should be furnished as specified in the contract.

6.5.1 When ordering spare parts or repair parts for the equipment covered by this specification, the contract should state that such spare parts and repair parts should meet the same requirements and quality assurance provisions as the parts used in the manufacture of the equipment. Packaging for such parts should also be specified.

6.6 First article. When first article inspection is required, the contracting officer should provide specific guidance to offerors whether the item(s) should be a preproduction sample, a first article sample, a first production item, a sample selected from the first production items, a standard production item from the contractor's current inventory (see 3.1), and the number of items to be tested as specified in 4.3. The contracting officer should also include specific instructions in acquisition documents regarding arrangements for examinations, approval of first article test results, and disposition of first articles. Invitations for bids should provide that the Government reserves the right to waive the requirement for samples for first article inspection to those bidders offering a product which has been previously acquired or tested by the Government, and that bidders offering such products, who wish to rely on such production or test, must furnish evidence with the bid that prior Government approval is presently appropriate for the pending contract. Bidders should not submit alternate bids unless specifically requested to do so in the solicitation.

6.7 Definitions.

6.7.1 Real differential compensation. Real differential compensation is a system which provides for division of the real load of parallel generators in proportion to the kW capacity of each generator by introducing a corrective effect on the sensitive element in proportion to the difference in real load on each generator. A connection between the governors is used to provide the proper division of real load of the generator without the introduction of a drooping speed characteristic.

6.7.2 Hazardous material. A hazardous item is any substance, mixture, material, component, or equipment which may cause personal injury, property damage, or environmental deterioration through transportation, use, or disposal.

6.7.3 Isochronous mode. A generator set operates in the isochronous mode when the governor maintains a constant speed regardless of the load (within the capability of the prime mover).

6.8 Conditions for use of level B preservation. When level B preservation is specified (see 5.2), this level of protection should be reserved for the acquisition of governing systems for resupply worldwide under know favorable handling, transportation, and storage conditions.

6.9 Sub-contracted material and parts. The packaging requirements of referenced documents listed in section 2 do not apply when material and parts are acquired by the contractor for incorporation into the equipment and lose their separate identity when the equipment is shipped.

6.10 Subject term (key word) listing.

Governor
Governor, Electro-Hydraulic (EH)
Governor, Load Sharing
Governor, Speed
Regulator, Speed

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

Preparing activity:
Navy - SH
(Project 6115-N531)

# STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

## INSTRUCTIONS

1. The preparing activity must complete blocks 1, 2, 3, and 8. In block 1, both the document number and revision letter should be given.
2. The submitter of this form must complete blocks 4, 5, 6, and 7.
3. The preparing activity must provide a reply within 30 days from receipt of the form.

NOTE: This form may not be used to request copies of documents, nor to request waivers, or clarification of requirements on current contracts. Comments submitted on this form do not constitute or imply authorization to waive any portion of the referenced document(s) or to amend contractual requirements.

| I RECOMMEND A CHANGE: | 1. DOCUMENT NUMBER | 2. DOCUMENT DATE (YYMMDD) |
|---|---|---|
| | MIL-G-21410A(SH) | 91-12-23 |

3. DOCUMENT TITLE: GOVERNING SYSTEMS, SPEED & LOAD-SENSING NAVAL SHIPBOARD USE

4. NATURE OF CHANGE (Identify paragraph number and include proposed rewrite, if possible. Attach extra sheets as needed.)

5. REASON FOR RECOMMENDATION

6. SUBMITTER

| a. NAME (Last, First, Middle Initial) | b. ORGANIZATION | |
|---|---|---|
| c. ADDRESS (Include Zip Code) | d. TELEPHONE (Include Area Code)<br>(1) Commercial<br>(2) AUTOVON<br>(If applicable) | 7. DATE SUBMITTED (YYMMDD) |

8. PREPARING ACTIVITY

| a. NAME | b. TELEPHONE (Include Area Code)<br>(1) Commercial (2) AUTOVON |
|---|---|
| Technical Point of Contact (TPOC): George Rashi/Murphy (SEA 56Z31)<br>PLEASE ADDRESS ALL CORRESPONDENCE AS FOLLOWS: | TPOC: 703-602-3124 |
| ADDRESS (Include Zip Code)<br>Commander, Naval Sea Systems Command<br>Department of the Navy (SEA 55Z3)<br>Washington, DC 20362-5101 | IF YOU DO NOT RECEIVE A REPLY WITHIN 45 DAYS, CONTACT:<br>Defense Quality and Standardization Office<br>5203 Leesburg Pike, Suite 1403, Falls Church, VA 22041-3466<br>Telephone (703) 756-2340 AUTOVON 289-2340 |