

MIL-S-24188(SHIPS)
1 December 1965

MILITARY SPECIFICATION
SYNCHRONIZING CONTROL EQUIPMENT. 60 CYCLES,
450 VOLTS, NAVAL SHIPBOARD

1. SCOPE

1.1 This specification covers general requirements for generator synchronizing monitor protective equipment for use with generator sets rated up to 2500 kilowatts (kw), 450 volts, 3 phase, 60 cycle.

2. APPLICABLE DOCUMENTS

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

SPECIFICATIONS

MILITARY

- MIL-R-11 - Resistors, Fixed, Composition (Insulated), General Specification for.
- MIL-R-22 - Resistors, Variable (Wirewound, Power Type).
- MIL-C-25 - Capacitors, Fixed, Paper-Dielectric, Direct Current (Hermetically Sealed in Metallic Cases), General Specification for.
- MIL-R-26 - Resistors, Fixed, Wirewound (Power Type).
- MIL-R-94 - Resistors, Variable, Composition, General Specification for.
- MIL-I-631 - Insulation, Electrical, Synthetic-Resin Composition, Nonrigid.
- MIL-S-901 - Shock Tests, H.I. (High Impact); Shipboard Machinery, Equipment and Systems, Requirements for.
- MIL-E-917 - Electric Power Equipment, Basic Requirements (Naval Shipboard Use).
- MIL-D-963 - Drawings, Electrical, Hull and Mechanical Equipment for Naval Shipboard Use.
- MIL-R-2033 - Relays for Naval Shipboard Electrical Service.
- MIL-E-2036 - Enclosures for Electric and Electronic Equipment, Naval Shipboard.
- MIL-C-2174 - Controllers, Direct-Current, Naval Shipboard.
- MIL-C-2212 - Controllers, Alternating-Current, Naval Shipboard.
- MIL-C-3965 - Capacitors, Fixed, Nonsolid Electrolytic (Tantalum, Foil and Sintered-Slug), General Specification for.
- MIL-P-15024 - Plates, Identification-Information and Marking for Identification of Electrical, Electronic and Mechanical Equipment.
- MIL-M-15071 - Manuals, Equipment and Systems.
- MIL-R-15109 - Resistors and Rheostats (Naval Shipboard Use).
- MIL-P-15137 - Provisioning Technical Documentation for Repair Parts for Electrical and Mechanical Equipment (Naval Shipboard Use).
- MIL-S-15291 - Switches, Rotary, Snap Action.
- MIL-S-16036 - Switchgear, Power, Naval Shipboard.
- MIL-I-16104 - Indicators, Synchronization.
- MIL-T-16784 - Terminal Boards.
- MIL-E-17555 - Electronic and Electrical Equipment and Associated Repair Parts, Preparation for Delivery of.
- MIL-S-18396 - Switches, Meter and Control, Naval Shipboard.
- MIL-R-19523 - Relays, Auxiliary, Naval Shipboard.
- MIL-M-23313 - Maintainability Requirements for Shipboard and Shore Electronic Equipment and Systems.

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STANDARDS

MILITARY

- MIL-STD-16 - Electrical and Electronic Reference Designations.
- MIL-STD-167 - Mechanical Vibration of Shipboard Equipment.
- MIL-STD-242 - Electronic Equipment Parts (Selected Standards).
- MIL-STD-761 - Electric Power, Alternating Current for Shipboard Use. Characteristics and Utilization of.

HANDBOOK

MILITARY

- MIL-HDBK-217 - Reliability Stress and Failure Rate Data for Electronic Equipment.

DRAWINGS

BUREAU OF SHIPS

- 9000-S6201-74453 - Navy Standard Switchboard Units.
- 9000-S6202-73907 - Light Indicator, Switchboard, 2 Lamp - SPF, Types B-27A through B-27G.

PUBLICATIONS

- NAVSHIPS-93820 - Handbook for Prediction of Shipboard and Shore Electronic Equipment Reliability.

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

2.2 Other publications. - The following document forms 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.

OFFICIAL CLASSIFICATION COMMITTEE

Uniform Freight Classification Ratings, Rules and Regulations.

(Application for copies should be addressed to the Official Classification Committee, 1 Park Avenue at 33rd Street, New York, N. Y. 19916.)

3. REQUIREMENTS

3.1 General requirements. - This synchronizing control equipment is intended for mounting in the generator switchboard and arranged to electrically prevent closing of the generator circuit breaker, bus tie circuit breaker or shore power circuit breaker unless the energized systems are properly synchronized. The control equipment shall perform its function through control of power to the breaker closing coil and shall be designed to operate on either 450 or 115 volts alternating current (a. c.).

NOTE: In general, three components should comprise one complete unit: one device with all operating components and terminal board for input and output signals; one operating switch with "operating", "test" and "off" positions; one transfer switch suitable for connecting the equipment to generator circuit breakers, shore power circuit breakers or bus tie circuit breakers with input signals appropriately connected to generator and bus circuitry.

The control equipment shall be arranged for back of the board mounting. The switches shall be arranged for back of switchboard mounting with operating handles at front of board. The equipment shall be designed to withstand frequent use for long periods under service conditions without benefit of overhaul and with limited maintenance. The environmental conditions are outlined herein and the functional requirements are set forth in the individual equipment specifications. The final product shall reflect the utmost in simplicity, have maximum reliability and be easy to install and maintain.

3.1.1 Reliability and maintainability. - It is imperative that reliability of operation be considered of prime importance in the design and manufacture of the equipment. The contractor shall employ all reasonable methods possible in the process of manufacture which will assure quality and maximum reliability consistent with the state of the art. In the functional application of parts to equipment circuits, adequate factors of safety shall be provided by suitable derating from parts specification values where required in order to ensure high equipment reliability under all service conditions. The design shall include all possible features which will result in reliable and stable operation with reduced requirements for adjustment and alignment, reduced requirements for maintenance and simplified maintenance, thus reducing requirements for highly skilled maintenance personnel.

3.1.1.1 The reliability for the synchronizing control equipment shall be predicted in terms of mean time between failure (MTBF). The reliability (R) of the synchronizing control equipment is the probability of the synchronizing control equipment operating without failure for a specified period of time (t). For a predicted MTBF, the reliability is given by

$$R = e^{-t/MTBF}$$

The MTBF shall be predicted using method D of NAVSHIPS 93820. Failure rate data used shall be as given in NAVSHIPS 93820, MIL-STD-242 and MIL-HDBK-217, choosing the rate which most nearly corresponds to the application conditions of a given part in the power supply. If parts are used for which no failure rate data is given in the above sources, failure rate data from other sources may be used, but justification for its applicability shall be provided. For parts for which no failure rate data is available, a failure rate shall be estimated, and the basis for the estimate stated. The derating factor which is used for each part shall be stated in the reliability calculations. The stress levels at which each part is operating shall be stated. The stress levels shall be those obtained from test insofar as such information is available. In those instances where test data is not available, design data shall be used. The stress levels shall be identified as whether from test or from design.

3.1.1.2 The reliability prediction shall be made for the continuous operating mode of this specification.

3.1.1.3 A mode failure is defined as occurring when the collective or individual component performance degrades below the operating requirements of this specification.

3.1.1.4 The maintainability of the synchronizing control equipment shall be predicted in terms of geometric mean time to repair (MTTRG). The MTTRG shall be determined in accordance with maintainability evaluation procedure specified in MIL-M-23313. The failure rates used shall be those which have been determined in the reliability prediction.

3.1.1.5 The contractor's report on reliability and maintainability factors and calibrations shall be submitted with the detail drawings for review and approval action.

3.1.2 Life. - The equipment shall be designed for an expected 30-year life based on an average of, but not limited to, 10 operations per day.

3.1.3 Fail safe design. - The design of the equipment shall be such that failure of parts or sub-assemblies will not result in unsafe operating condition of the generating system. Fail safe features shall not cause undue complexity or excessive increase in size or weight.

3.2 Environmental conditions. - All of the requirements of the individual specifications shall be met under any combination of the environmental conditions specified in 3.2.1 through 3.2.6.

3.2.1 Temperature conditions. -

3.2.1.1 Ambient temperature. - Equipment shall be designed for an ambient temperature of 65°C.

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3.2.2 Humidity. - Operation shall be possible at relative humidities up to 100 percent for both continuous and intermittent periods, including conditions wherein condensation takes place on the equipment cover.

3.2.3 Inclined operation. - Equipment shall give no change in operation when inclined at an angle of 60 degrees from vertical in any direction.

3.2.4 Roll and pitch. - The equipment shall not be damaged or caused to malfunction when subjected to values of roll and pitch up to 60 degrees from vertical. No favorable orientation may be assumed.

3.2.5 Vibration. - Equipment shall be designed to operate during and after the type I vibration test of MIL-STD-167.

3.2.6 Shock. - Equipment shall be designed to be grade A, class I, type A in accordance with MIL-S-901.

3.3 Electrical design. - The equipment shall be in accordance with MIL-E-917, except as otherwise specified herein. If any requirement specified herein conflicts with the requirements of MIL-E-917, the requirements of this specification shall govern.

3.3.1 The equipment shall operate over the range of the type I power system characteristics specified in MIL-STD-761.

3.3.2 Electron tubes and printed circuits. - Electron tubes and printed circuits shall not be used.

3.3.3 The equipment shall operate with electrically operated circuit breakers whose maximum breaker operating closing time is 500 milliseconds.

3.3.4 The equipment shall detect the difference in frequency between the oncoming generator and the bus and prevent paralleling (closing of the electrically operated generator circuit breaker) unless the difference in frequency is less than 0.2 cycle per second (c. p. s.).

3.3.5 The equipment shall detect the difference in voltage between the bus and the oncoming generator and operate to prevent closing of paralleling breaker unless this difference is within 5 percent of rated voltage.

3.3.6 The equipment shall detect the difference in phase angle between the oncoming generator and the bus and prevent paralleling (closing generator breaker) except when the phase angle difference is between minus 30 and zero electrical degrees.

3.3.7 The equipment shall prevent closing of the generator breaker if the breaker control switch is closed outside the limiting conditions noted in 3.3.4 through 3.3.6 herein. The circuitry shall further require reset of the breaker control switch to the "off" position before paralleling (closing of the breaker) is again possible.

3.3.8 The equipment shall prevent the operator from using the synchronizing circuit as an automatic synchronizing device.

3.3.9 A synchronizer control switch shall be provided in accordance with MIL-S-15291 or MIL-S-18396 for switchboard mounting and shall have "operation", "test" and "off" positions.

3.3.9.1 It shall be possible to transfer control of the switch from "operation" to "test" to "off" and reverse without affecting any systems component while the generating equipment is operating at any load from no load to rated load.

3.3.10 An indicator light shall be included to indicate when this synchronizing control equipment is energized. The indicator light shall be in accordance with Drawing 9000-S6202-73907.

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3.3.11 Enclosure shall be dripproof protected in accordance with MIL-E-2036. Ready accessibility of all 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 is considered desirable and shall be used if structurally suitable. Enclosure shall be of the dead-front type.

3.3.12 The synchronizing control equipment shall perform its primary electrical function through the use of approved solid state devices. Relays may be employed only where approved by the bureau or agency concerned. Vacuum tubes or similar thermionic devices shall not be used. Selenium rectifiers shall not be used.

3.3.13 Miscellaneous component parts. - To best meet the requirements specified herein, it may be desirable to make use of component parts not covered herein by referenced specifications. These parts shall be considered as miscellaneous component parts and may include such items as special semiconductors, special timing devices, special switches and special relays. The use of miscellaneous component parts shall be permitted only when requested and when determined by the bureau or agency concerned that its use is necessary or desirable. Miscellaneous component parts shall be in compliance with MIL-E-917 insofar as practicable with deviations approved by the Bureau of Ships in each specific application. To determine the need for and suitability of miscellaneous component parts, the manufacturer shall furnish technical data justifying its use and suitability and such other related data as may be requested by the Bureau of Ships. Supplemental tests may be required on miscellaneous component parts to confirm suitability. These tests shall be conducted by the manufacturer as requested by the bureau or agency concerned.

3.3.14 Resistors and rheostats. - Resistors and rheostats shall be in accordance with MIL-R-15109. Where the required resistance and approximate wattage value is not covered by MIL-R-15109, resistors in accordance with MIL-R-11, MIL-R-22, MIL-R-26 and MIL-R-94 may be substituted upon specific approval by the bureau or agency concerned.

3.3.15 Capacitors. - Capacitors shall be in accordance with MIL-C-3965 and MIL-C-25 for electrolytic and paper-dielectric types, respectively.

3.3.16 Transformers, reactors and inductors. - Transformers, reactors and inductors shall conform to MIL-E-917. All units shall meet the minimum material requirements. Transformers shall have electrically isolated windings (primary and secondary). Neither autotransformers nor open-delta connected transformers shall be used.

3.3.17 Contactors and relays. - Contactors, relays and other contact-making control devices shall be in accordance with MIL-C-2212, MIL-C-2174, MIL-R-2033 or MIL-R-19523, as applicable. The use of other special control devices, not covered by referenced specification herein, will be subject to specific approval by the bureau or agency and will be considered for use only when it has been determined that the use of components, as specified, is not practicable.

3.3.18 Terminals, connections and wiring. -

3.3.18.1 Terminals and connections. - Equipment shall be completely wired internally and to terminals provided for external connections. Terminals provided for external connections shall be arranged on a terminal board located to provide ready accessibility for making connections. Test points shall be provided for all control circuits for making measurements of voltage, current, and resistance as necessary for trouble shooting and adjusting operation of the equipment. All test points shall be provided at terminals arranged on a terminal board located in a readily accessible position at a hinged access door of the enclosure. Terminal lugs shall be provided for all leads except for the main power input and power output leads. All terminal lugs installed by the manufacturer shall be of solderless type. All connections using wire over 4000 circular mils (c.m.) shall be provided with efficient locking devices to prevent their becoming loosened by shock or vibration. When terminal studs, binding screws or other similar attachments are used as conductors, the material shall be nonferrous conducting. Plug type connectors shall not be used. Terminal boards shall be in accordance with MIL-T-16784 (with insulation as specified in MIL-E-917), except (a) where the terminal board is integral and considered a part of another approved component (that is, contactors as specified in MIL-C-2212) and (b) where the application rating or space configuration makes their use impractical.

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3.3.18.2 Wiring. - All wiring in the equipment shall be of sufficient capacity for rated duty of the equipment and shall conform to MIL-E-917. All wires shall be marked at each end by stamping the wire number on the wire terminal or on an insulated sleeve which shall be slipped over the wire close to the terminal. The sleeving shall fit tightly over the wire or over the round portion of the terminal to prevent the sleeving from sliding on the wire to insulate the terminal. Sleeving shall be type F, form U, grade A, class II, category 1, white, in accordance with MIL-I-631. Markings shall be permanently stamped on the sleeving in such a manner as to remain legible after repeated handling and atmospheric exposure. Markings shall correspond to lead numbers of the wiring diagram.

3.3.19 The equipment shall be designed for installation in switchgear as shown on Drawing 9000-S6201-74453 and operation with devices and equipment as required in MIL-S-16036. The manufacturer shall provide sufficient information on drawings and modify one synchronizing meter which will allow modification of installed synchronizing meters, procured under MIL-I-16104, in order to have the necessary information presented more appropriate to the synchronizing control equipment provided. The equipment shall be designed to smallest dimensions and weight practical.

3.3.20 Sensing for the equipment shall be between the generator terminals and the ship's bus bars located in the ship's switchgear.

3.3.21 Insulation resistance. - The insulation resistance of all circuits shall be not less than 10 megohms when measured with all circuits cold.

3.3.22 Dielectric strength. - All equipment shall be so designed and constructed as to withstand for a period of 1 minute a dielectric test voltage to ground as follows:

<u>A. c. (r. m. s.) input or output voltage</u>	<u>Test voltage (r. m. s.)</u>
60 and under	600
61 to 90	900
90 to 600	1000 plus twice rated

3.3.23 Packaging. - The packaging of the equipment and circuitry shall employ the principle of a unitized design; i. e., the four basic circuits (outputs, frequency difference, voltage difference and phase angle) should be mounted on individual component boards in order to facilitate trouble shooting, repair, replacement and maintenance.

3.4 Drawings. -

3.4.1 General. - Drawings shall conform to MIL-D-963 and to the detail requirements specified herein. Drawings are intended to:

- Provide design information to assure conformance to requirements including compatibility with ships and ship system.
- Evaluate the suitability of the design for the intended use.
- Evaluate performance and maintenance capability.
- Enable shipyard installation by qualified electricians.
- Enable ship and shore activities to repair and maintain the equipment without assistance from the original suppliers.

3.4.2 Approval procedures (preliminary drawings). - Preliminary drawings shall be submitted to the bureau or agency concerned via the cognizant Government inspector for approval within 60 days after effective date of contract.

3.4.2.1 Preliminary drawings are those drawings required for design approval and release for manufacture and shall include the drawings specified in 3.4.2.1.1 and 3.4.2.1.2.

3.4.2.1.1 Outline drawing. - Outline drawing shall contain the following information as applicable:

- (a) Dimensional front and plan views and sufficient additional views showing overall and principal dimensions in sufficient detail to establish the limits of space in all directions required for installation, operation and servicing.
- (b) All information necessary for preparation of foundation drawings, including mounting plate details and drilling drawings with dimensions and tolerances and information as to optional mounting methods.
- (c) Location, type and dimensions of cable entrances, access plates, mounting pads and holes and terminal boards.
- (d) Any special instructions for installation.
- (e) A list of reference drawings.
- (f) Description of system operations.

3.4.2.1.2 Design drawings. - Design drawings shall include the following minimum information, as applicable:

- (a) Descriptive data for the equipment.
 - (1) Type of equipment.
 - (2) Environment classification.
 - (3) Enclosure.
 - (4) Design ambient temperature.
 - (5) Shock and vibration classification.
 - (6) Manufacturer's designation.
 - (7) Mounting.
- (b) A statement that the equipment is in accordance with the individual equipment specifications (listing same) or this specification if there is no individual equipment specification and a list of the exceptions to this specification and referenced specifications.
- (c) A list of reference drawings.
- (d) List of material.
- (e) A table of revisions-- the Government inspector shall validate the drawings in the revision column; entries shall be (1) the approval letter (2) the Government inspector's name, title and district office (3) date of validation.
- (f) Assembly views consisting of plan elevation and section views as required to show clearly the details of the mechanical design, construction and assembly of the equipment and to identify each part and its location. Each part shall be identified by its reference designation and by its piece number as assigned in the list of materials. The following minimum data shall be included in the assembly views:
 - (1) Overall dimensions, mounting dimension and size of mounting hole.
 - (2) Weight of complete assembly.
 - (3) Sectional views or notes as necessary to show or explain special mounting provisions or installation procedures required for proper operation of the parts.
- (g) Information on parts and subassemblies. The data required shall be presented in tabular form wherever practical. Each part shall be identified by its reference designation. (Application data required are actual circuit values as used in the equipment.)
 - (1) Transformer, reactor, inductor and miscellaneous coil data:
 - a. Core material, core or lamination form and dimensions (include small dimensional sketch if necessary for clarity).
 - b. Winding data, including the number of turns, taps, wire size and type, terminal identification, direct current (d. c.) resistance between terminals at 25°C.
 - c. Nominal voltage between terminals, volt-ampere rating for potential transformers, current ratio for current transformers.
 - d. Complete construction and material detail, including applicable specification for material used. Details of core boxes, layer and coil insulation, ground insulation, method of impregnation and treatment, potting methods and material, terminal boards, grommets, leads, mechanical construction details.

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- (2) Transistor application data:
 - a. Type number.
 - b. Steady state voltage between each terminal and ground.
 - c. Average and peak collector current.
 - d. Average wattage dissipation of collector.
 - e. Maximum case temperature.
 - f. Ambient case temperature in vicinity of coil.
- (3) Silicon rectifier and reference or regulating diode application data:
 - a. Type number.
 - b. Maximum nominal inverse voltage (peak value).
 - c. Maximum peak inverse voltage (including transient voltage).
 - d. Maximum average output current.
 - e. Duty.
 - f. Maximum case temperature.
 - g. Ambient case temperature in the vicinity of the device.
- (4) Resistor data including the type, resistance, and wattage ratings, and standard Military type designation or part number or both.
- (5) Capacitor data including the type, capacitance, voltage ratings, maximum applied d.c. and a.c. voltage and frequency (values include transient) and standard Military type designation or part number or both.
- (6) Switch data, including the type of switch, contact arrangement, number of poles, number of positions, voltage and circuit ratings of contacts and type of handle.
- (7) Relay data:
 - a. Rating data including the coil voltage, frequency, current and power, and the contact voltage and current rating.
 - b. Duty.
 - c. Shock classification.
 - d. Number of normally open and normally closed contacts.
 - e. Coil winding data, including the number of turns, taps, wire size and type, insulation, method of impregnation and treatment and d.c. resistance at 25°C.
 - f. Special features required, such as special pick-up and drop-out voltages.
- (h) An electrical schematic diagram, on a single sheet, to represent clearly the operation of the equipment. Notes describing circuit operation and arrow accentuated lines indicating the path of signal flow, shall be employed when necessary to clarify the operation of the equipment.
 - (1) A thin broken line shall be used to represent the boundaries of each assembly or sub-assembly which is intended for multiple use. All terminals with these markings shall be shown. Terminals for external connections shall also indicate the type of signal, power handled, and so forth. All unused terminals shall be shown and so marked.
 - (2) Each part, such as resistors, capacitors and relays, shall be given a reference designation and number as shown on MIL-STD-16.
- (i) A wiring diagram which includes the following information:
 - (1) All parts in correct relation to physical location. Terminals shall be clearly shown and marked and all wiring between parts shall be shown.
 - (2) Appropriate notes shall designate wire size and type.
 - (3) Reference designation of parts shall conform to those assigned in the schematic diagram.

3.4.3 Final drawings. - Final drawings shall consist of one set of black line prints of all finalized and approved preliminary installation and detail drawings suitable for microfilming, plus one complete set of reproducible drawings. Final drawings shall be furnished as required by the contract.

3.5 Manuals. - Manuals shall conform to type II of MIL-M-15071. The minimum data and the arrangement thereof to be included in the manuals shall be as specified in 3.5.1.

3.5.1 Arrangement of minimum data. - Arrangement of the minimum data shall be as follows:

Cover.
 Title page.
 General data.
 Safety notices.
 Component list.
 Title description of synchronizing control equipment.
 Navy type designation.
 Federal stock number.
 Dimensions.
 Weight (without packing).
 Input power requirements and heat dissipation.
 Salient design characteristics.
 Manufacturers type and catalog number.
 Table of contents, listing all divisions and primary and secondary subdivisions (such as chapters, sections, and so forth) with their corresponding page numbers.
 List of illustrations, photographs, and drawings.
 Introduction.
 General description.
 Input requirements and output rating.
 Detailed description.
 Synchronizing control equipment.
 Component parts.
 Installation instructions.
 Precautions.
 Preparation for use after storage.
 Mounting.
 Electrical connection.
 Check test to determine proper operation.
 Adjustments and tests.
 Principles of operation.
 Synchronizing control equipment and component parts.
Note. - This shall include a description of operation in sufficient detail for a clear understanding of the operation of the complete equipment and the various components.
 Operating instructions.
 Maintenance.
 Parts identification.
 Test data (including a complete set of test data. Table of representative test values may be included under the maintenance section above).
 Reduced size master drawings of synchronizing control equipment.
 Photographs (including a sufficient number of photographs of both external and internal views of the equipment to show construction details and location of component parts. Component parts shall be flagged).
 Appendix.
 Inserts on special components.

3.5.2 Preliminary manuals shall be forwarded to the Bureau of Ships for approval. The preliminary manual shall contain all the information required by the final manual with the exception of reduced size referenced drawings.

3.5.3 One final manual shall be forwarded with each equipment. Final manuals shall be furnished as required by the contract or order.

3.6 Repair parts. - Onboard repair parts shall be processed in accordance with MIL-P-15137 and furnished on a "set" basis.

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3.6.1 Repair parts per set. - Each set of onboard repair parts furnished with equipments shall consist of the following component parts, as modified by 3.6.1.1, 3.6.1.2 and 3.6.1.3:

- (a) One complete replacement of all contacts and springs (as applicable to contactors, relays, switches, rheostats, thermostats, push buttons, and similar items) except for overload devices furnished in accordance with MIL-R-2033, MIL-C-2212, MIL-C-2174 or MIL-R-19523 (see 3.6.1.1).
- (b) One complete switch of each type and size.
- (c) Resistor units (see 3.6.1.2).
- (d) Capacitor units (see 3.6.1.2).
- (e) One semiconductor device of each type and size and, where matching is required, matched sets of devices shall be furnished.
- (f) If potted assemblies or components are used, one potted assembly or component of each type and size shall be furnished.
- (g) Shunt coils (see 3.6.1.3).

3.6.1.1 If any of the repair parts listed herein form part of an assembly or subassembly and is not normally a replaceable part of the assembly or subassembly, then the complete assembly will be furnished in lieu thereof as a repair part. Also, in lieu of a complete set of contacts and springs (in such components as switches, thermostats, relays, contactors, rheostats, push buttons, and similar items), the contractor may furnish the complete component. If the complete component is furnished, the quantity shall be not less than 10 percent of the quantity of components of that type and size installed.

3.6.1.2 The quantity of resistor units and capacitor units of each type and size furnished in a set of repair parts shall be not less than 10 percent of the quantity of units of that type and size installed in one equipment. When two or more identical elements are assembled to form a complete unit, the quantity of elements of each type and size furnished in a set of repair parts shall be not less than 10 percent of the quantity of that type and size installed in one equipment, and in no case shall it be less than the number of identical elements connected in a circuit arranged so that failure of one element will result in overloading and progressive failure of the remaining elements.

3.6.1.3 The quantity of shunt coils of each type and size furnished in a set of repair parts shall be not less than 10 percent of the quantity of shunt coils of that type and size installed in one equipment.

3.7 Painting. - Parts to be painted shall consist of those not having a corrosion-resisting treatment or not fabricated of corrosion-resisting materials of the types specified in MIL-E-917 and shall include exterior and interior surfaces of the enclosure. Painting shall be in accordance with MIL-E-917, except that only one coat of gray enamel need be applied. Marks or scratches made due to handling during fabrication and testing shall be repainted by either complete repainting of equipment or by touch-up method.

3.8 Identification and information plates. - Identification plates shall be furnished and installed on all components of the equipment and on the complete equipment assembly. Information plates shall be furnished and installed on the complete equipment assembly as necessary. Plates and marking of component assemblies such as semiconductors, contactors and similar items shall comply with the applicable referenced specifications. Identification of other components such as transformers and reactors shall be made by use of identification plates or by stamping or stenciling the required following minimum data:

- (a) Manufacturer's name and identification number as shown on application master drawing.
- (b) Title of component (that is, transformer, reactor, and similar items).
- (c) Federal stock number, if available.

If stamping or stenciling is done, it shall be applied and protected in such a manner as to be completely legible during full life of the equipment. Identification and information plates of the constant frequency control equipment shall be either type A, B or C in accordance with MIL-P-15024. Black enamel shall be used for filling markings on metal plates. The size of plates shall be approved by the bureau or agency concerned with identification plates conforming to standard dimensions of MIL-P-15024. All plates shall be furnished as part of the equipment and shall be attached to that part of the equipment which will not ordinarily be renewed during its normal service life in a position that is readily accessible where they can be read at all times without danger to personnel.

3.9 Workmanship. - Workmanship shall be first class in every respect.

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for inspection. - Unless otherwise specified in the contract or purchase order, the supplier is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified, the supplier may utilize his own facilities or any commercial laboratory acceptable to the Government. The Government reserves the right to perform any of the inspections set forth in the specification where such inspections are deemed necessary to assure supplies and services conform to prescribed requirements.

4.2 Individual components comprising this system shall be tested in accordance with the applicable specification for those components.

4.3 Examination. -

4.3.1 Synchronizing control equipment. - Each equipment shall be subjected to a thorough examination to ascertain that the material, workmanship, design and operation are in conformance with this specification. The fit of parts shall be observed with particular reference to the interchangeability of such parts as are likely to require replacement during the normal service life of the equipment. Specific observation shall be given to the following:

- (a) All wiring shall be checked for suitable layout and proper identification.
- (b) All terminals shall be checked for proper marking.
- (c) Wire connections (soldered and unsoldered) shall be checked for security.
- (d) Arrangement and layout of components shall be checked for conformance with applicable approved drawings.
- (e) Miscellaneous hardware, mounting supports and brackets shall be checked for proper corrosion resistant material or treatment in accordance with MIL-E-917.

4.3.2 Repair parts. - All repair parts shall be subjected to a careful examination to ascertain that the materials, workmanship and finish are first class in every respect and that they conform fully to the manufacturer's drawings as approved. The principal object of this examination shall be to determine if the repair parts are exact duplicates of those used in the equipment. If there is reason to doubt the ready interchangeability of the repair parts with the original equipment parts, a suitable demonstration of such interchangeability may be required.

4.4 Insulation resistance. - The measurement of insulation resistance shall be made with all circuits of equal voltage above ground connected together. Circuits, or groups of circuits, or groups of circuits of different voltage above ground shall be tested separately. The time of test voltage application shall be not less than 60 seconds. Measurements shall be made at any convenient ambient temperature with all circuits cold. The relative humidity and ambient temperature shall be recorded.

4.5 Effectiveness of enclosure. - Acceptance of the enclosure shall be based on inspection to ascertain that the enclosure effectively performs its specified function.

4.6 Heating. - Heating tests shall be made under conditions equivalent to normal operating conditions at maximum rated voltage, maximum rated load, and the duty specified. The test methods to be employed and the precautions to be observed shall be as specified in 4.6.1 through 4.6.5.4.

4.6.1 Assembly and mounting of equipment. - Heating tests shall be made only with the equipment assembled and mounted in the manner for which it is designed. Barriers shall be placed adjacent to the enclosure, at the manufacturer's recommended minimum clearance for adequate ventilation, to simulate shipboard space restrictions. Heating tests shall be made on all coil windings (including power transformers and reactors) and semiconductors except for those rectifier cells of control circuits which clearly do not contribute to the overall temperature rise within the equipment enclosure and except for those which are tested and given separate qualification approval under its individual specification. For those components which are given exception based on separate approval, it shall be determined that its adjacent ambient within the enclosure does not exceed the rated ambient of the component and that the application rating does not exceed the manufacturer's approved rating at the applied temperature ambient.

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4.6.2 Method of temperature measurements.- The method of temperature measurement shall be either the thermometer method or embedded detector method in accordance with MIL-E-917. The temperature measuring elements shall be applied to the hottest accessible part of the components whose temperature is to be measured. The number of measuring elements shall be liberal and so placed as to ascertain the highest temperatures. Surface mounted thermometers or thermocouples shall have their bulbs covered by felt pads or by oil putty. The bulbs shall be placed in such a position that they make the maximum practicable line contact with the part whose temperature is to be measured, and they shall be so firmly supported that this degree of contact will not be altered by gravity and normal vibration. The temperature measuring devices shall be calibrated. When the thermometer method is used, the true temperature rise shall be determined by adding the value of temperature gradient to the indicated temperature rise. The temperature gradient shall be predetermined prior to assembly of equipment by taking measurements of maximum temperature of the components under rated application load by both the resistance method and the thermometer method. The difference in measurements between the thermometer method and the resistance method shall be the value of temperature gradient. When the embedded detector method is used, the true temperature rise shall be considered the indicated temperature rise of the detector element giving the maximum value.

4.6.3 Duration of test.- The heating test for continuous duty equipment shall be continued until the temperature rise of components that can be observed during test have attained a steady final value. The heating test for intermittent duty equipment shall be continued for the duty cycle specified for the equipment.

4.6.4 Method of loading.- The equipment shall be loaded with rated applied input voltage and frequency.

4.6.5 Ambient temperature.- The equipment shall be tested at any convenient room temperature above 10°C., but whatever the value of this ambient temperature, the maximum permissible temperature (hot spot temperature) as specified in MIL-E-917 for the class insulation used shall not be exceeded when converted to the rated ambient of the equipment. In order to avoid errors due to time lag, air stratification, and drafts, precautions as specified in 4.6.5.1 to 4.6.5.3, inclusive, shall be observed.

4.6.5.1 Ambient measurement.- The ambient or room temperature shall be measured by means of two or more thermometers placed at different points around and on a level with the equipment and at a distance of 3 to 6 feet from the enclosure. The thermometers shall be inserted in oil-filled cups not less than 1 inch in internal diameter and 2 inches high, and shall be protected from drafts and from heat radiation from the equipment under test or other sources. The value to be adopted from the ambient or room temperature during the test shall be the mean of the readings of the several thermometers, placed as stated, taken at four equal intervals of time during the last quarter of the duration of the test. The equipment under test shall be protected from drafts and heat radiation from outside sources.

4.6.5.2 Ambient variations.- The conditions in the testing room shall be such that the room temperature will not vary greatly during tests. A variation of more than 5°C., during a period of 6 hours or a proportional change for runs of shorter duration, shall in no case be exceeded.

4.6.5.3 Starting temperature.- No heat runs shall be undertaken on equipment which has recently been brought from a place varying in temperature by 5°C., or more, from that in which the test is to be made; or where the temperature of the room in which the equipment under test has stood varied 5°C., or more, during the preceding 2-hour period.

4.6.5.4 Corrections.- In determining temperature rise, no correction shall be made for barometric pressure, humidity, or for any deviation of the recorded ambient temperature from the standard ambient temperature of reference.

4.7 Weight.- The weight of the equipment and the weight of the onboard repair parts shall be taken and recorded separately.

4.8 Inclined operation.- The equipment shall be tested for inclined operation by operating at rated condition. Inclination of the equipment in the following positions shall not cause interruption of the output from the equipment while operating and while not operating shall not cause any change from the nonoperating condition:

Inclined 60 degrees forward.
Inclined 60 degrees backward.

Inclined 60 degrees to the right side.
Inclined 60 degrees to the left side.

4.9 Shock tests.- High impact (HI) shock tests (electrical operation and mechanical damage) shall be conducted in accordance with MIL-S-901 for grade A, class I, type A equipment.

4.9.1 Test features.- Test features shall be as follows:

- (a) Definition of failure to perform principal functions:
 - (1) Breakage of any parts, including mounting bolts. Minor chipping of parts, such as plastic knobs and cases and minor distortion of parts, will be permitted where such chipping or distortion cannot in any manner impair operation of the equipment as specified.
 - (2) Appreciable distortion of any parts, including enclosure and framework.
 - (3) A value of insulation resistance lower than that permitted.
 - (4) Low dielectric strength. After shock tests, the dielectric test shall be conducted at a voltage equal to 65 percent of the voltage. Failure to pass this test shall be cause for rejection.
 - (5) Failure to pass visual examination. The equipment shall be carefully examined after removing all removable panels and doors to ascertain any mechanical damage. When required, partial disassembly shall be performed to aid in determining any possible damage.
 - (6) Failure to perform any electrical tests during and following shock. No adjustment or replacement of damaged parts shall be permitted during shock test.
- (b) Mounting.- The equipment shall be mounted on the shock machines in a manner simulating shipboard installations, in accordance with MIL-S-901 for bulkhead mounted equipment.
- (c) Number of units to be shock tested.- One equipment shall be shock tested. However, after an equipment of a specific design has satisfactorily passed the HI shock test, subsequent HI shock tests will not be required.

4.10 Vibration.- Vibration tests shall be conducted in accordance with type I requirements of MIL-STD-167. The test features as specified for shock tests (see 4.9.1) shall also apply to vibration tests. The unit of equipment selected for vibration test shall be the same unit as selected for HI shock tests.

4.11 Operation.- One equipment shall be operated at least 1000 times, without failure, in order to demonstrate the performance parameters specified in 3.3. The method of testing shall be submitted to and approved by the bureau or agency concerned.

4.12 Electrical measuring meters.- Throughout the testing, all indicating voltage and current meters shall have an initial accuracy value not greater than 1/4 percent. Meters used for making recordings shall consist of (a) string type oscillographs similar or equivalent in accuracy and response time to General Electric type PM-10 or (b) oscilloscope and camera combination similar or equivalent to Dumont type 512 oscilloscope and camera, Dumont catalog number 1765-K. Pen and ink type recorders shall not be used. The method of frequency measurement shall be as approved by the bureau or agency concerned. The method shall clearly demonstrate accuracy within specified limits.

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

4.14 Dielectric tests.-

4.14.1 General.- The dielectric test shall be made after all of the above tests (4.4 through 4.13) have been completed. If the insulation resistance of the windings is known to be lower than specified, due to dirt, moisture or damage to windings, this shall be remedied before the application of the dielectric test voltage. The dielectric test shall be made upon the completely assembled equipment and not upon individual parts, except in the case of repair parts which require dielectric tests.

4.14.2 Test voltage.- The frequency of the testing voltage shall be not less than 60 c.p.s. and shall approximate a true sine wave. The value of test voltage shall be applied continuously for a period of 1 minute.

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4.14.3 Measurement of test voltage. - The measurement of the voltage used in dielectric tests shall be made by the voltmeter method whereby the meter derives its voltage from the high-voltage circuit either directly or by means of a voltmeter coil placed in the testing transformer, or through an auxiliary ratio transformer.

4.14.4 Points of application. - The test voltage shall be successively applied between each electric circuit and all other electrical circuits and grounded metal parts not electrically connected to it.

5. PREPARATION FOR DELIVERY

5.1 Domestic shipment and early equipment installation and for storage of onboard repair parts. -5.1.1 Synchronizing control equipment. -

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

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

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

5.1.2 Onboard repair parts. - Onboard repair parts shall be preserved and packaged level A, packed level C and marked levels A and C, respectively, in accordance with MIL-E-17555.

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

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

5.2.1.1 Preservation, packaging and packing. - The synchronizing control equipment shall be preserved and packaged level A or C, packed level A, B or C and marked in accordance with MIL-P-16298.

5.2.2 Repair parts. - Repair parts shall be preserved and packaged level A, packed level A, B or C and marked in accordance with MIL-P-16298.

5.2.3 Manuals. - Manuals shall be packaged, packed and marked as specified in the contract in accordance with MIL-M-15071.

5.2.4 Drawings. - Drawing shall be packaged and packed in accordance with MIL-D-963.)

6. NOTES

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

- (a) Title, number and date of this specification.
- (b) Preservation, packaging, packing and marking requirements, if other than 5.1 (see 5.2).

Preparing activity:
Navy - SH
(Project 6110-N109Sh)

SPECIFICATION ANALYSIS SHEET		Form Approved Budget Bureau No. 119-R004
<p style="text-align: center;"><u>INSTRUCTIONS</u></p> <p>This sheet is to be filled out by personnel either Government or contractor, involved in the use of the specification in procurement of products for ultimate use by the Department of Defense. This sheet is provided for obtaining information on the use of this specification which will insure that suitable products can be procured with a minimum amount of delay and at the least cost. Comments and the return of this form will be appreciated. Fold on lines on reverse side, staple in corner, and send to preparing activity (as indicated on reverse hereof).</p>		
SPECIFICATION		
ORGANIZATION (of submitter)		CITY AND STATE
CONTRACT NO.	QUANTITY OF ITEMS PROCURED	DOLLAR AMOUNT \$
MATERIAL PROCURED UNDER A		
<input type="checkbox"/> DIRECT GOVERNMENT CONTRACT <input type="checkbox"/> SUBCONTRACT		
1. HAS ANY PART OF THE SPECIFICATION CREATED PROBLEMS OR REQUIRED INTERPRETATION IN PROCUREMENT USE? A. GIVE PARAGRAPH NUMBER AND WORDING.		
B. RECOMMENDATIONS FOR CORRECTING THE DEFICIENCIES.		
2. COMMENTS ON ANY SPECIFICATION REQUIREMENT CONSIDERED TOO RIGID		
3. IS THE SPECIFICATION RESTRICTIVE? <input type="checkbox"/> YES <input type="checkbox"/> NO IF "YES", IN WHAT WAY?		
4. REMARKS (Attach any pertinent data which may be of use in improving this specification. If there are additional papers, attach to form and place both in an envelope addressed to preparing activity)		
SUBMITTED BY (Printed or typed name and activity)		DATE

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