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SUPERSEDING
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(See 6.6)

MILITARY SPECIFICATION

CHARGER, BATTERY, AUTOMATIC, PORTABLE,

RECTIFIER TYPE

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 This specification covers an automatic portable rectifier type battery charger for charging lead acid batteries.

2. APPLICABLE DOCUMENTS

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

SPECIFICATIONS

FEDERAL

UU-P-268 - Paper Kraft, Wrapping.
PPP-C-850 - Cushioning Material, Polystyrene Expanded, Resilient (For Packaging Uses).
PPP-C-1120 - Cushioning Material, Uncompressed Bound Fiber For Packaging.

MILITARY

MIL-R-19 - Resistor, Variable, Wire-Wound (Low Operating Temperature) General Specification For.
MIL-R-22 - Resistor, Variable (Wirewound, Power Type), General Specification For.
MIL-C-25 - Capacitor, Fixed, Paper-Dielectric, Direct-Current (Hermetically Sealed in Metallic Cases), General Specification For.
MIL-R-26 - Resistor, Fixed, Wirewound (Power Type), General Specification For.
MIL-C-62 - Capacitor, Fixed, Electrolytic (DC, Aluminum, Dry Electrolyte, Polarized), General Specification For.
MIL-B-117 - Bag, Sleeves and Tubing - Interior Packaging.
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 for (Naval Shipboard Use).
MIL-I-1361 - Instrument Auxiliaries, Electrical Measuring: Shunts, Resistors, and Transformers.
MIL-E-2036 - Enclosures for Electric and Electronic Equipment, Naval Shipboard.
MIL-R-2726/36 - Receptacle, Electrical, 40 Ampere, 125 Volt, Single Pole, Panel Mounted, Male Type (Symbol No. 1213.3 - Red) and (Symbol No. 1213.5 - Black).
MIL-L-3661 - Lampholders, Indicator Lights, Indicator-Light Housings, and Indicator-Light Lenses, General Specification For.

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 3112, Department of the Navy, Washington, DC 20362 by using the self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

MILITARY (Continued)

MIL-S-3786 - Switches, Rotary (Circuit Selector, Low-Current Capacity), General Specification For.
MIL-R-6130 - Rubber, Cellular, Chemically Blown.
MIL-M-10304 - Meters, Electrical Indicating, Panel Type, Ruggedized, General Specification For.
MIL-P-15024 - Plates, Tags and Bands for Identification of Equipment.
MIL-P-15024/5 - Plates, Identification.
MIL-R-15109 - Resistors and Rheostats, Naval Shipboard.
MIL-F-15160 - Fuses; Instrument, Power and Telephone - General Specification For.
MIL-S-15291 - Switches, Rotary, Snap Action.
MIL-O-16485 - Ohmmeters, Insulation Resistance-Indicating, Portable.
MIL-E-17555 - Electronic and Electrical Equipment, Accessories, and Repair Parts; Packaging and Packing of.
MIL-S-19500 - Semiconductor Devices, General Specification For.
MIL-C-19978 - Capacitors, Fixed Plastic (or Paper-Plastic) Dielectric (Hermetically Sealed in Metal, Ceramic, or Glass Cases), Established and Non-Established Reliability, General Specification For.
MIL-R-20092 - Rubber Sheets and Molded Shapes, Cellular, Synthetic Open Cell (Foamed Latex).
MIL-P-26514 - Polyurethane Foam, Rigid or Flexible For Packaging.
MIL-M-38510 - Microcircuits, General Specification For.
MIL-C-39003 - Capacitors, Fixed, Electrolytic Tantalum, Solid Electrolyte, Established Reliability, General Specification For.
MIL-R-39008 - Resistors, Fixed, Composition (Insulated), Established Reliability General Specification For.
MIL-T-55164 - Terminal Boards, Molded, Barrier, Screw and Stud Types, and Associated Accessories, General Specification For.
MIL-B-81705 - Barrier Materials, Flexible, Electrostatic-Free, Heat Sealable.
MIL-P-81997 - Pouches, Cushioned, Flexible, Electrostatic-Free, Reclosable Transparent.

STANDARDS

MILITARY

MIL-STD-167-1 - Mechanical Vibrations of Shipboard Equipment (Type I - Environmental and Type II Internally Excited).
MIL-STD-461 - Electromagnetic Interference Characteristics Requirements for Equipment.
MIL-STD-470 - Maintainability Program Requirements (For Systems and Equipments).
MIL-STD-471 - Maintainability Verification/Demonstration/Evaluation.
MIL-STD-701 - Lists of Standard Semiconductor Devices.
MIL-STD-740 - Airborne And Structureborne Noise Measurements And Acceptance Criteria of Shipboard Equipment.
MIL-STD-785 - Reliability Program (For Systems and Equipments Development And Production.
MIL-STD-883 - Test Methods and Procedures For Microelectronics.
DOD-STD-1399, Section 300 - Electric Power, Alternating Current (Metric).
MIL-STD-1472 - Human Engineering Design Criteria For Military Systems, Equipment And Facilities.
MS 90363 - Box Fiberboard, With Cushioning for Special Minimum Cube Storage and Limited Reuse Applications.

PUBLICATIONS

NAVAL SEA SYSTEMS COMMAND

NAVSEA 0967-LP-312-8010 - Electronic Equipment, Shipboard, Maintainability Design Criteria Handbook, For Designers Of.

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

3. REQUIREMENTS

3.1 Qualification. Battery chargers furnished under this specification shall be products which are qualified for listing on the applicable qualified products list at the time set for opening of bids (see 4.3 and 6.3).

3.2 General requirements. The equipment shall meet the requirements of MIL-E-917, and the requirements of this specification except as otherwise specified in the contract or order. If any requirement specified herein conflicts with the requirements of MIL-E-917, the requirements of this specification shall govern.

3.3 Detail requirements. Battery chargers shall be as specified in table I.

TABLE I. Detail requirements.

Parameter		Requirement
A.c. input:	Volts	115±5 percent
	Frequency	60 hertz (Hz) ±5 percent
	Phase	1
D.c. output:		
	Volts	Charging voltage as selected for charging 1, 3, 4, 6, 12, and 18 cells
	Current	Charging current limiting as selected for ampere ranges (see 6.1)
Efficiency		Losses at any load condition, 450 watts, maximum
Duty		Continuous
Charging period		8 hours (see 3.3.2)(12 hours for 300 Ah Battery)
Enclosure		Dripproof protected (see 3.3.9)
Ambient temperature		-7°C to 50°C (20°F to 122°F) (see 3.3.11)
Ventilation		Natural draft
Mounting		Deck or bulkhead and portable Provision for stacking chargers 3 high, directly above one another (see 3.3.9)
Rectifying element		Silicon rectifiers
Control element		Silicon controlled rectifiers
Weight		Maximum 125 pounds
Size		Maximum volume of 2.5 cubic feet
Meters		D.c. voltmeter and d.c. ammeter

3.3.1 D.c. output. The direct current (d.c.) output voltage and current shall be as necessary to give the charging operation specified in 3.3.2. Selector switches shall be provided for selection of charging voltage by the number of cells in the battery and maximum charging current by ampere-hour rating.

3.3.2 Operation (battery charging). When adjusted by correct setting of control switches to conditions (number of cells and ampere-hour rating) required by a battery to be charged, the charger shall automatically regulate output voltage and current to such values as necessary to fully charge the connected battery in the following manner. The charger shall deliver a charging current to the battery in the range (see 6.1), set by the charging current selector switch. This current shall be maintained until the voltage required to supply this current reaches 2.35 volts-per-cell ± 0.02 volts-per-cell at 25°C (see 3.3.2.3), as selected by the series cells selector switches. At or before the end of the normal charging period, the charge current shall be limited to a value not exceeding 1/60 of the battery ampere-hour battery rating. Charging current shall be limited so that no detrimental overcharging of the battery shall occur if the battery remains connected to the battery charger for 24 hours after charging current has been decreased to the above value. Battery temperature rise (excluding temperature change due to ambient temperature change) shall not exceed 9°C during the charging period. The regulated output voltage of 2.35 volts-per-cell (finishing or end of charge voltage) shall be compensated automatically for variations in ambient temperature of the battery by reducing to finishing voltage 5.4 to 7.2 millivolts per °C per cell. This amounts to a negative temperature coefficient, and shall be minus 5.4 to minus 7.2 millivolts per cell per °C (see 3.3.2.4). The voltage and current shall be smoothly controlled without the use of moving parts.

3.3.2.1 Reversed battery. Battery charger and operator shall sustain no damage/injury when, the charger is connected with incorrect polarity to any battery of up to 18 series-connected cells in any combination of switch settings.

3.3.2.2 Misoperation. Battery charger, shall sustain no damage and operator shall not be exposed to hazard if the charger is connected to or disconnected from any battery of up to 18 series-connected cells, regardless of setting of control switches, and regardless of whether the alternating current (a.c.) input is energized.

3.3.2.3 Internal adjustment. By operation of an internally accessible rheostat (slotted shaft for screwdriver adjustment) the finishing voltage of 2.35 volts-per-cell shall be adjustable over the range of 2.20 to 2.50.

3.3.2.4 Temperature compensation. The output voltage of the battery shall be automatically compensated for ambient temperatures affecting the temperature of the battery. The compensation shall be minus 5.4 to minus 7.2 millivolts per cell per °C.

3.3.2.5 Output protection. The charger circuitry shall not be damaged by either of the following:

(a) Disconnecting the output cable from the battery while charging is in progress.
(b) Turning on the charger input power when the output cable is not connected to a battery.
(c) Connecting the battery to the output cable before turning on the charger input power.

3.3.3 Switches. The following switches shall be provided and installed on the enclosure front:

(a) A.c. input switch, 2-pole in accordance with MIL-S-15291.
(b) Output voltage control switch, rotary, 6-position, to select the number of battery cells in series to be charged. This switch shall also select the voltmeter range.
(c) Output current limit control switch, rotary, 5-position, to select the maximum charging current to be supplied to a battery connected to the output of the charger. This switch shall also select the ammeter range.
(d) Switches of (b) and (c) shall be in accordance with MIL-S-3786.

3.3.3.1 Switch plates. Switches used for control of output voltage and current shall be fitted with information plates as shown on figure 1. The dimension "L" (see figure 1) represents the "sweep" diameter of the control knob as it is rotated through the various positions. Thus the control knob pointer shall extend to, but no portion of the knob shall extend over, the outer ring of the switch plate. The overall diameter "D" of the switch plate shall be a minimum of 3 inches. The markings of the switch plates should correspond with the detents of the switches used. The arc of the ranges shown in figure 1 are for illustration purposes only.

3.3.4 Meters and meter accessories. Meters and meter accessories shall be furnished as an integral part of the equipment. When meters are specified this shall be understood to include any necessary meter accessories. Meters shall be in accordance with MIL-M-10304 (with external zero adjustor). Meter accessories (shunts, resistors, and similar items) shall be in accordance with MIL-I-1361. Meter range shall be as appropriate for the application to give approximately two-thirds full scale deflection at full load conditions. A voltmeter and ammeter shall be provided for measuring the total output current and output voltage. Meters shall be ruggedized (HI shockproof), 3-1/2 inch round panel type in accordance with MIL-M-10304. Ammeters shall operate from a 50 millivolt external shunt. Voltmeter ranges shall be 0-10 volts and 0-50 volts. Ammeter ranges shall be 0-20 amperes and 0-50 amperes.

3.3.4.1 Power on indicator lights. Each battery charger shall be provided with an indicator light in accordance with MIL-L-3661 and shall have push-to-test provision. The indicator light shall be connected to indicate when the battery charger is energized. The indicator light shall be mounted on the front exterior of the battery charger enclosure.

3.3.5 Fuses and fuseholders. The a.c. input and d.c. output circuits shall be provided with fuses as required (for the protection specified in 3.3.2.1) mounted on the main terminal board. Fuses shall be in accordance with MIL-F-15160. Fuses shall be readily accessible (see 3.3.9). The fuseholders shall be the clip type and readily accessible.

3.3.6 Warning plate. A warning plate shall be mounted on the front panel stating the following:

"Compartment ventilation system must be in operation when batteries are being charged."

3.3.7 Receptacles and connections.

3.3.7.1 A.c. input. Charger shall be provided with a terminal board for connection of the a.c. input leads. Input power shall be in accordance with DOD-STD-1399, section 300, type I.

3.3.7.2 D.c. output. Charger shall be provided with two output receptacles in accordance with MIL-R-2726/36 (one black, 1213.5 and one red, 1213.3). Color coding shall be: positive, red; negative, black.

3.3.8 Semiconductor devices. Semiconductor devices shall be silicon types and shall be selected from MIL-STD-701. These devices shall comply with the requirements of applicable specification sheets of MIL-S-19500. Operational amplifiers shall comply with MIL-M-38510 and MIL-STD-883. For applications which require semiconductor components of ratings other than those listed in MIL-STD-701, the contractor shall obtain components as required by MIL-E-917, and further, acquisition shall be made to the general requirements of MIL-S-19500 and, for specific electrical characteristics, to the specification in the contractor's latest advertised data sheet.

3.3.8.1 Use of semiconductor devices as control elements in power circuits. Adjustments, regulation and control of power supply output voltage may be accomplished by magnetic amplifiers or saturable reactors, or by silicon controlled rectifiers, or equivalent switching-type semiconductor devices.

3.3.9 Enclosure. Charger enclosure shall be dripproof protected as defined in MIL-E-2036. Handles shall be installed at the sides to facilitate portability and provision shall be made for either deck mounting or bulkhead mounting by stacking up to three units high as preferred by the installing activity. Where units are stacked one above another, mechanical support shall be provided by mounting means. Chargers shall not support each other. The enclosure shall be provided with a hinged front access door. The manual controls and meters shall be mounted on the door. Adjustments, fuses, and test points shall be readily accessible inside the front access door. The enclosure shall have a maximum volume of 2.50 cubic feet with height as the maximum of the three dimensions. Dimensions shall include extensions due to carrying handles, dryshields, ventilation louvers, and protruding components such as meters, indicator lights, switch handles, and similar items but shall exclude extensions due to mounting supports.

3.3.10 Shock and vibration. Shock and vibration requirements shall be as follows:

(a) Shock. Charger shall be capable of passing the shock requirements specified in MIL-S-901 for grade A, class 1 equipment.
(b) Vibration. Damage shall not occur or malfunction be caused either by internally excited vibrations, or by the environmental vibrations specified in MIL-STD-167-1 for frequencies up to and including 33 hertz (Hz).

3.3.11 Environmental requirements. Charger shall operate as specified over a range of ambient temperature from minus 7°C to 50°C. For purposes of temperature compensation of battery charging characteristics, charger and battery shall be assumed to be in the same ambient temperature.

3.3.11.1 Airborne and structureborne noise.

3.3.11.1.1 Airborne noise. Airborne noise generated by the battery chargers under any operating conditions shall not exceed the limits of grade B of MIL-STD-740.

3.3.11.1.2 Structureborne noise. Structureborne noise shall not exceed the limits of type 3 equipment of MIL-STD-740.

3.3.11.1.3 Use of resilient mounting of battery charger components. The preferred method of equipment noise reduction shall be by design and construction of circuits and components used therein. Where components are mounted in the charger assembly by resilient mounting means (sound isolators), exposed metal parts of such components (for example, transformer cores) shall be connected to the equipment frame by a grounding lead, to reduce potential electric shock hazard.

3.3.11.1.4 Electromagnetic interference (EMI). The EMI requirements for the battery chargers shall conform to MIL-STD-461, equipment class IIB, except as modified herein:

(a) CE01 test requirements shall be as modified by figure 4.
(b) CE03 test requirements shall be as modified by figures 5 and 6.

3.3.12 Material and component requirements.

3.3.12.1 Insulation. Insulation shall be class A, B, or H in accordance with MIL-E-917.

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

3.3.12.3 Dielectric strength. Equipment shall be constructed so as to withstand for a period of 1 minute a dielectric test voltage to ground as follows:

A.c. (rms) input or output voltage[1/]	Test voltage (rms)
60 and under	600
61 to 90	900
90 to 600	1000 plus twice rated
Over 600	2000 plus 2-1/2 times rated

[1/] Dependent upon the individual component and its rated voltage (see 4.8.1.4).

There shall be no evidence of damage or breakdown as a result of voltage application. Any evidence of arcing, corona (visible, audible or smell), flashover, punctured insulation or tripping of circuit breakers associated with the instrument shall be interpreted as a failure of the test (see 4.8.11).

3.3.12.4 Inclined operation. Equipment shall have no change in operation when inclined at any angle from zero to 45 degrees from the vertical in any direction.

3.3.12.5 Miscellaneous component parts. To meet the requirements specified herein and to allow for state-of-art improvements, 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 temperature controls (including temperature compensating devices), special timing devices, special switches and special relays. Miscellaneous component parts shall be in accordance with MIL-E-917 insofar as practicable. 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 command or agency concerned. Supplemental tests may be required on miscellaneous component parts to confirm suitability. These tests shall be conducted by the manufacturer as requested by the command or agency concerned.

3.3.12.6 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-26, MIL-R-22, MIL-R-39008, and MIL-R-19 may be substituted.

3.3.12.7 Capacitors. Capacitors conforming to MIL-C-39003 (solid tantalum) are preferred. Capacitors conforming to MIL-C-19978 (plastic dielectric), MIL-C-25 (paper dielectric) or MIL-C-62 (electrolytic) are acceptable. Where the required capacitance is too large to be covered by MIL-C-62 (using up to ten capacitors in parallel), it is permissible to use special sizes, providing construction is similar to MIL-C-62. When any specification which forms a part of this specification requires that the product be subjected to and pass qualification tests, only products which are listed on the applicable Qualified Products List on the date of invitation for bids or request for proposal, or which may be added to that Qualified Products List subsequent to that date shall be utilized in the construction of equipment specified to be in accordance with this specification. In the event no Qualified Products List has been issued, the contractor shall request instructions as to what testing will be required to determine whether the product meets the requirements of this specification.

3.3.12.8 Terminals, connections and wiring.

3.3.12.8.1 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 control circuits for making measurements of voltage, current, and resistance as necessary for trouble shooting and adjusting operation of the equipment. 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. Terminal lugs installed by the manufacturer shall be of solderless type. Connections using wire over 4000 circular mils (cmils) 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-55164 (with insulation as specified in MIL-E-917) except (a) where the terminal board is integral and considered a part of another component and (b) where the application rating of space configuration makes their use impractical.

3.3.12.8.2 Wiring. Wiring in the equipment shall be of sufficient capacity for rated duty of the equipment and shall conform to MIL-E-917. 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 and to insulate the terminal. Sleeving shall be type F, grade a, form U, class II, category 1, color 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 exposure to grease. Markings shall correspond to lead numbers of wiring diagram.

3.3.12.8.3 Cable entrance. A blank gasketed plate shall be provided in the left side panel of the enclosure to permit the drilling of a cable entrance by the installing activity.

3.3.12.9 Humidity. Equipment shall withstand 100 percent relative humidity for a period of 168 hours at room temperature plus or minus 10°C. During this period the insulation resistance between all transformer and reactor windings and ground and between insulated windings of the same transformer or reactor shall not be lower than the values shown on figure 2 as represented by the "minimum value curve." Also the dissipation factor for the same transformers and reactors shall not exceed the values shown on figure 3 as represented by the "maximum value curve." Following humidification there shall be no evidence of material damage or corrosion of any components or hardware. The electrical performance shall not be affected as a result of humidification.

3.3.12.10 Painting. Painting shall be in accordance with MIL-E-917, except that only one coat of gray enamel shall be applied. Marks or scratches due to handling during fabrication and testing shall be repainted by either complete repainting of equipment or by touch-up method.

3.3.12.11 Heating. Heating tests on completely assembled chargers shall be in accordance with 4.8.4.1 through 4.8.4.5.2. The starting temperature, the temperature rise, and the final temperature shall be noted. The temperature of each shall remain below the rated temperature of that component.

3.3.12.12 Ventilation. Ventilation shall be natural draft. The dimensions of the equipment shall include any necessary allowance for air intake and discharge. Natural draft cooling shall be capable of giving maximum cooling of components with minimum size and weight. This shall be accomplished by construction of enclosure and arrangement of components to give a chimney effect natural draft with height of equipment the maximum dimension.

3.3.12.13 Reliability and maintainability. The principle of maximum reliability is paramount and no compromise of this principle shall be made with any other basic requirement of design. It is the intention of this specification to obtain equipment of such design that it will have an operating life of at least 175,200 hours (20 years). The basis for design of replaceable parts shall be an equivalent of 3 years of ship operation (approximately 21,000 hours) before replacement is necessary.

3.3.12.13.1 The designer shall take cognizance of the conditions under which the equipment will be maintained and repaired on shipboard, and of the fact that the personnel responsible for maintenance and repair may not be seasoned mechanics. Human engineering design criteria and principles shall be applied in the design of the battery charger so as

to achieve safe, reliable and effective performance by the operator and maintenance personnel, and to optimize personnel skill requirements. MIL-STD-1472 shall be utilized as guidelines in applying human engineering design criteria.

3.3.12.13.2 Reliability. The contractor shall establish and maintain an effective reliability program in accordance with MIL-STD-785 and shall include the following:

(a) Design reviews. The reliability assurance program shall include provisions for the reliability review and evaluation of design as an integral part of the contractors engineering design procedures. Design or engineering change occurring during development or production shall be subjected to comparable review procedures.

(b) Production control and monitoring. The reliability assurance program shall provide an economical and effective system of production control and monitoring to assure that reliability achieved in design is maintained during production.

(c) Subcontractor and vendor reliability. The reliability assurance program shall include provisions to assure subcontractor and vendor selection and performance consistent with the reliability requirements of the contract and applicable portions of this specification.

(d) Reliability analysis. The contractor shall analyze those factors affecting reliability. The reliability analysis shall include, but shall not be limited to the following:

(1) List of those parts which experience and judgment show are subject to wear, material deterioration, and service failures.

(2) Specific design features employed to attain the required service life of the parts with due consideration of shipboard environment and resultant conditions. Some suggested design features are choice of materials, hardness surface finishes, fits, clearances, fastenings, equipment protection fail-safe features, reparability and accessibility.

(3) Show by calculation or other means that the design does in fact fulfill the design requirements with the criteria chosen.

(4) Preventive maintenance and servicing requirements necessary to the achievement of reliable equipment. Any unusual steps or precautions necessary in carrying out maintenance and servicing requirements shall be pointed out.

(e) Failure reporting, analysis, and feedback. The reliability assurance program shall incorporate a formalized system for recording, collecting, and analyzing all failures that occur during testing, installation, and operation through the tenure of the contract. Analysis shall be fed back to the contractor's engineering management, and production activities on a timely basis. Failure reports received from using activity shall be integrated into this program for trouble analysis and for experience consideration for future design review.

3.3.12.13.3 Maintainability. The manufacturer shall establish and conduct a maintainability program in accordance with MIL-STD-470. The battery charger shall be capable of being maintained by easy replacement of removable parts or modules. The design shall conform to the design-for-maintainability requirements of MIL-STD-470 and NAVSEA 0967-LP-312-8010. The equipment repair time (ERT) shall be 1 hour and shall be demonstrated in accordance with method 4 of MIL-STD-471. The construction of the battery charger (see 3.4) shall be such that wiring, terminals, and electrical connections shall be accessible for servicing and for test purposes without requiring the removal of a part or an assembly from the unit enclosure.

3.3.12.13.3.1 Test equipment. The battery charger shall be capable of being maintained, alined, calibrated, and repaired with the aid of the following test equipment:

(a) Clamp-on volt ammeter, 0 to 600 amperes and 0 to 600 volts, a.c., Weston model 633, or equal.

(b) Multimeter, 0 to 1000 volts, d.c. at 20,000 ohm/volt, 0 to 1000 volt a.c. at 5,000 ohm/volt, 0 to 10 amperes d.c. and 0 to 20 megohm, Simpson model 260, or equal.

(c) Oscilloscope, 500 kilohertz (kHz), single trace, 0.05 to 20 volt/div, 1 megohm input impedance, Tektronix model 212, or equal.

(d) Milliammeter, 0 to 150 ma. d.c., Weston model 931-4904003, or equal.
(e) Voltmeter, 0 to 600 volts a.c. and d.c., Weston model 341-1909003, or equal.
(f) Ammeter, 0 to 300 amperes d.c., Weston model 901-2904001 with shunt, Weston model 41227, or equal.

3.3.13 Ripple content. The ripple content of the output voltage (rms) shall not exceed 2 percent of the charger's maximum output voltage while charging at the maximum current rate.

3.3.14 Creepage and clearance distances. Creepage and clearance distances between energized parts shall conform to the requirements of table entitled "Electrical creepage and clearance distances" specified in MIL-E-917.

3.3.15 Diagrams, identification, and information plates.

3.3.15.1 Connection diagram. Each equipment shall contain a diagram of electrical connections with each terminal and lead designated to correspond to markings as shown on the equipment. In addition, a schematic circuit diagram and description of operation shall be included. Diagrams and instruction sheets shall be secured and protected in accordance with MIL-E-2036.

3.3.15.2 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 stencilling the required following minimum information:

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

If stamping or stencilling is done it shall be applied and protected in such a manner as to be completely legible after 10 years of service life. Identification and information plates of the constant frequency control equipment shall be either type A, B, or C in accordance with MIL-P-15024 and MIL-P-15024/5. Black enamel shall be used for filling markings on metal plates. The size of plates and identification shall conform to standard dimensions of MIL-P-15024. 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 10 years service life in a position that is readily accessible where they can be read at all times without danger to personnel.

3.4 Onboard repair parts. Onboard repair parts shall be supplied as shown in table II.

TABLE II. Onboard repair parts.

Part	Number of battery chargers installed per ship		
	1 to 5	6 to 10	11 or more
Semiconductor devices, each size and type	1	2	3
Resistors and capacitor units, each size and type	1	2	3
Switches, each type (NAVSEA design)	1	1	2
Potted assemblies	1	1	2

3.5 Technical data. The contractor shall prepare engineering drawings, technical manuals, and provisioning parts list in accordance with the data ordering documents included in the contract or order (see 6.2.2) and as specified in 3.5.1 and 3.5.2.

3.5.1 Drawings, microfilm and data. In addition to the drawing content required by the data ordering document (see 6.2.2) the unique features specified in 3.5.1 through 3.5.1.1 shall be included. Drawings shall be on sheets of the same size and shall be not smaller

than 17 by 22 inches nor larger than 28 by 40 inches. The size drawing scale shall be such that the number of sheets required shall be the minimum consistent with contents and clarity. In addition drawings and microfilm shall contain the following minimum data:

(a) List of descriptive data of the equipment including:
  (1) Complete rating showing (a) input voltage, frequency, and number of phases (b) input kW, kV-A, current, and power factor at full load (c) output voltage and current at full load and (d) efficiency at full load.
  (2) Duty.
  (3) Shock classification.
  (4) Enclosure classification.
  (5) Ventilation.
  (6) Type of load (indicate resistive load ratings as well as types and ratings of batteries).
  (7) Ambient temperature range.
  (8) Notation of corrosion-resistant treatment of hardware.
  (9) Special features.

(b) Finish, including method of treatment of enclosure for paintings, color and applicable specification of paint.

(c) List of material excluding items of hardware (identify repair parts).

(d) Mounting clearances for access and ventilation.

(e) Outline of equipment showing overall and principal dimensions of front view, side view, top view, and sectional views, as necessary, to show approximate mounting arrangement and location of components of the list of material. Components shall be flagged by item or piece number. Views shall show identification and information plates with data to appear thereon. Locate center of gravity.

(f) A table of insulation indicating the location, class of insulation, insulation material and applicable specification and remarks.

(g) A table or list of component units such as transformers, relays, contactors, switches, fuses, semiconductors, resistors, capacitors, motors and similar items giving piece number, type, NSN, and rating of each. This data may be incorporated in the list of material. Ratings shall include both manufacturer's rating and the specific application rating.

(h) Sufficient detail of component locations and mounting means to aid in any disassembly likely to be needed for maintenance.

(i) Transformer and reactor data:
  (1) Core material and core or lamination form and size (including stack height). If core boxes are used, the material and size of the box should be given.
  (2) Winding data including number of turns, taps, wire size and specification type designation, insulation, method of impregnation and treatment, and d.c. resistance at a specified temperature.
  (3) If potted, the method of potting and potting compound should be identified.
  (4) Identification as to where used (circuit designation, for example: Transformer T1).

(j) Semiconductor data:
  (1) General information including the name of manufacturer, manufacturer's identification number, circuit connection, number of devices per equipment and identification as to where used.
  (2) Manufacturer's rating at a specified ambient temperature with a resistive load including maximum voltage, current, nominal reverse current (if applicable) duty if other than continuous, cooling of other than convection cooled and maximum operating temperature.
  (3) Suppliers application data including voltage, current, reverse current requirements (if any), duty, type of load, and ambient temperature of device with equipment at full load at rated ambient.

(k) Curves on operating characteristics of magnetic amplifiers where applicable, including the following:
  (1) Plot of load current as a function of control ampere turns (per core) for 90, 100 and 110 percent rated voltage and at rated load and frequency.
  (2) Plot of load current as a function of control ampere turns (per core) 95 and 105 percent rated frequency and at rated load and voltage.
  (3) Plot of the 63 percent response time as a function of circuit turns squared per ohm at rated supply voltage and frequency and rated resistance load.

Note: The control circuit turns squared per ohm at which the curves of items (k) (1) and (2) are taken shall be shown and shall be the same for each condition. The same control windings shall be used for taking the data for all of the curves and shall be identified. In determining the value of turns, squared per ohm, the turns per core and the d.c. resistance of the complete control circuit including the signal source shall be used.

(l) Detailed dimensioned sketch, with terminal markings, of terminal boards for input and output connections and test points.

(m) Schematic electrical diagram arranged in simplified form. Components and windings shall be identified by appropriate symbols corresponding to their identification in the description of operation.

(n) Wiring diagram indicating markings of terminals, leads, and component parts. Each lead shall be shown by number designation. The wiring diagram shall show components and wiring in the approximate same physical location with respect to one another as mounted in the equipment.

(o) Description of operation covering manual procedures required of an operator, adjustments and a general theory of operation.

3.5.2 Technical manuals. A preliminary manual shall be submitted to NAVSEA for review prior to delivery of two final manuals. The final manuals shall be submitted to NAVSEA for information and file not later than the time required by the contract or order for delivery of the equipment. Data items (h) through (r) of 3.5.1 may be included in the final manual in lieu of on the final drawings.

4. QUALITY ASSURANCE PROVISIONS

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

4.1.1 The contractor shall prepare a test plan and a test/inspection report in accordance with the data ordering document included in the contract or order (see 6.2.2).

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

(a) Qualification inspection (see 4.3).
(b) Quality conformance inspection (see 4.5).

4.3 Qualification tests. Qualification tests shall be conducted at a laboratory satisfactory to NAVSEA. Qualification tests shall consist of the examination and tests specified in 4.4.

4.3.1 Prior to authorization of qualification tests, the contractor shall submit drawings (see 3.5.1) and a test plan to NAVSEA. Manufacture of equipment for tests shall not begin until drawings and test plan are reviewed by NAVSEA (except for prototype breadboard samples which may be built any time by the contractor to prove certain operating features and circuitry). The test plan shall detail the following:

(a) Method of performing each test.
(b) Test instrumentation to be used.
(c) The specifications of the test equipment (accuracy, range, and frequency response, if applicable).
(d) Diagrams showing the connections to be made to the test instruments.
(e) Sequence of tests.

4.4 Qualification, routine, and periodic inspection. Inspection shall consist of the examination and tests specified in table III. Unless otherwise specified in the contract or order, all inspections requiring electrical loading (except routine inspection) of the equipment shall normally be performed using a battery load for uniformity. Heating, shock and vibration tests shall be performed with resistive load. Resistive loading may be used for routine inspection.

TABLE III. Qualification, routine, and periodic inspection.

Inspection	Qualification	Routine	Periodic	Requirements paragraph	Inspection paragraph
Examination	X	X	X	-----	4.7
Efficiency	X	X	X	3.3	4.8.1
Insulation resistance	X	X	X	3.3.12.2	4.8.2
Effectiveness of enclosure	X	-----	X	3.3.9	4.8.3
Heating	X	-----	X	3.3.12.11	4.8.4
Weight	X	-----	X	3.3	4.8.5
Shock	X	-----	X	3.3.10	4.8.6
Vibration	X	-----	X	3.3.10	4.8.7
Ripple content	X	-----	X	3.3.13	4.8.15
Battery charging	X	-----	X	3.3.2	4.8.9
Creepage and clearance distance	X	-----	X	3.3.14	4.8.10
Dielectric	X	X	X	3.3.12.3	4.8.11
Environmental	X	-----	-----	3.3.11 and 3.3.12.9	4.8.12
Inclined operation	X	X	X	3.3.12.4	4.8.8
Airborne noise	X	-----	X	3.3.11.1.1	4.8.13.1
Structureborne noise	X	-----	X	3.3.11.1.2	4.8.13.1
Electromagnetic interference	X	-----	X	3.3.11.1.4	4.8.14.1
Reversed battery	X	-----	X	3.3.2.1	4.8.16
Misoperation	X	-----	X	3.3.2.2	4.8.17
Internal adjustment	X	-----	-----	3.3.2.3	4.8.18
Temperature compensation	X	-----	-----	3.3.2.4	4.8.19

4.5 Quality conformance inspection.

4.5.1 Sampling for quality conformance inspection.

4.5.1.1 Lot. All equipment of the same design offered for delivery at one time shall be considered a lot for purposes of quality conformance inspection.

4.5.1.2 Sampling for examination and routine inspection. A random sample of completely assembled equipment shall be selected from each lot in accordance with table IV, and each unit of the sample shall be examined in accordance with 4.7 and tested in accordance with 4.4. Any equipment containing one or more defects and any equipment failing in one or more examination or test, shall not be offered for delivery. If the number of such defective equipments in any sample exceeds the acceptance number for that sample, the lot represented by the sample shall not be offered for delivery.

TABLE IV. Sampling for examination and routine inspection.

Lot size	Sample number	Acceptance number (defectives)	Rejection number (defectives)
1 to 5	All	---	---
6 to 8	5	0	1
9 to 15	8	0	1
16 to 25	10	0	1
26 to 40	13	0	1
41 to 65	17	0	1
66 to 110	22	1	2
111 to 180	28	1	2
181 to 300	35	1	2
301 or more	Not less than 10 percent	1	2

4.6 Periodic inspection. A periodic inspection shall be required after any change in design which affects the performance characteristics. If routine inspection data reveals variations beyond a normal manufacturing tolerance, it may be required that any or all of the periodic inspection be made on a particular equipment to demonstrate that it conforms to this specification. The periodic inspection procedure is based on quantity production. If more than 18 months elapse until the contractor again supplies the specific design of

equipment, the periodic inspection, except for shock and vibration (see 4.8.6 and 4.8.7) shall be conducted on the equipment of the subsequent contract or order.

4.7 Examination. Each sample equipment selected in accordance with 4.5.1.2 shall be subjected to an 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 parts as are likely to require replacement during the normal service life of the equipment. Specific observation shall be given to the following:

(a) Components are mounted as shown on the drawing.
(b) Parts which require servicing, repair, replacement, or periodic adjustment during the life of the equipment are readily accessible.
(c) Components are marked with identifying symbols and these symbols agree with those used on the drawing.
(d) Terminals of components and terminal boards are marked with identifying letters and numbers or both, and this identification agrees with those used on the drawing.
(e) Wire used for interconnecting components is of the type shown on the drawing.
(f) Wiring is neatly formed into groups and laced with nonflammable glass cord and supported or clamped in a manner which will prevent chafing of the insulation due to vibration and shock.
(g) Cable clamps used are of nonflammable material.
(h) There are no splices in any of the wires.
(i) Wire groups from hinged doors and panels are formed and clamped in a manner that sharp bends do not occur with the panel or door in either the open or closed position.
(j) Sufficient slack in wiring is allowed so that the weight of the harness is not supported by the terminal connections and so that at least two replacements can be made if lugs are clipped off at the wire end.
(k) Cable entrance provisions are as shown on the drawing.
(l) Sufficient space is provided to bring external cables through these cable entrances, support them within the enclosure, and make connections at the appropriate terminals.
(m) Wherever wires run through holes in metal partitions or chassis, grommets are provided for mechanical protection.
(n) Wires are not bent around sharp corners which may injure the insulation.
(o) Wires are connected by either bolted or soldered connections.
(p) Bolted connections are provided with locking devices.
(q) Both ends of wires are marked with designations as shown on the drawing.
(r) Hinged doors and panels do not bind when opening.
(s) Identification, information, and label plates are furnished as shown on the drawing.

4.8 Test methods.

4.8.1 Efficiency. The equipment shall be loaded with battery load during the test. The only exception to battery loading is the routine inspection (see 4.5.1.2) for efficiency. Meters shall be inserted in a.c. input for reading voltage, current and wattage. Installed meters may be used to determine output conditions. Readings shall be made with charger charging 3 cells at 3 amperes, 12 cells at 15 amperes and 18 cells at 44 amperes or the equivalent resistive load for routine inspection. Results shall be expressed in "watts loss" rather than "percent efficiency".

4.8.2 Insulation resistance. Insulation resistance shall be as specified in 3.3.12.2. The measurement of insulation resistance shall be made with 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. Insulation resistance shall be measured with an insulation-resistance-indicating meter conforming to type GC of MIL-O-16485. 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.

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

4.8.4 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 4.8.4.1 through 4.8.4.5.2.

4.8.4.1 Assembly and mounting of equipment. Heating tests shall be made only with the equipment completely 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 are separately qualified under its individual specification. For those components which are given exceptions based on separate qualification, 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.

4.8.4.2 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 component 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.

4.8.4.3 Duration of test. The heating test shall be continued until the temperature rise of components that can be observed during test have attained a steady final value.

4.8.4.4 Method of loading. The equipment shall be loaded with rated applied input voltage and frequency at 18 cells, 40-45 amperes output load. The type of load shall be resistive.

4.8.4.5 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.

4.8.4.5.1 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 the 5°C, during a period of 6 hours or a proportional change of runs of shorter duration, shall in no case be exceeded.

4.8.4.5.2 Starting temperature. Heat runs shall not 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.

4.8.5 Weight. The weight of the equipment shall be taken and recorded. The weight of the equipment shall not exceed 125 pounds.

4.8.6 Shock tests. Shock tests (electrical operation and mechanical damage) shall be conducted in accordance with MIL-S-901, type A equipment and table V lists the specific conditions (switch settings, load resistance and blow axis) under which the equipment is shock tested.

TABLE V. Conditions for shock testing.[1/]

Shock blow number	Test drop in feet	Axis	Switch setting (number of cells)	Switch setting (ampere hours)	Output volts	Output amperes	Load resistance ohms	"On - off" switch
1	1	Back	12	50	28.2	8-10	3.52	On
2	3	Back	3	15-20	7.05	3-4	2.35	On
3	5	Back	3	15-20	0.0	0	Open	Off
4	1	Top	3	100	7.05	15-20	0.47	On
5	3	Top	18	130	0.0	0	Open	Off
6	5	Top	18	200-300	42.3	40-45	0.96	On
7	1	Side	18	50	0.0	0	Open	Off
8	3	Side	6	50	14.1	8-10	1.76	On
9	5	Side	6	130	14.1	25-30	0.47	On

1/ Actual voltages and currents and corresponding switch settings shall be recorded on data sheets.

4.8.6.1 Test features. Test features shall be as follows:

(a) General. Type A test shall be performed under light weight classification. In all cases the battery charger shall be checked for specified electrical operation following the shock test. The battery charger shall be operating at full load during the shock test. Electrical tests as required shall be made to determine satisfactory performance following or during shock test.

(b) Definition of failure to perform principal functions:

(1) Breakage of 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 battery charger as specified.

(2) Appreciable distortion of parts, including enclosure and framework.

(3) A value of insulation resistance lower than that permitted by this specification (see 3.3.12.2).

(4) Low dielectric strength. After shock tests the dielectric test shall be conducted at a voltage equal to 65 percent of the voltage specified in 3.3.12.3. Failure to pass this test shall be cause for rejection.

(5) Failure to pass visual examination. The battery charger shall be carefully examined after removing all removable panels and doors to ascertain mechanical damage. When required, partial disassembly shall be performed to aid in determining possible damage.

(6) Failure to perform the required electrical tests, during and following shock tests. No adjustment or replacement of damaged parts shall be permitted during shock test unless permitted by NAVSEA.

(c) Number of battery chargers to be shock tested. One battery charger of each type shall be shock tested during qualification or periodic tests.

(d) Disposal of shock tested battery chargers. Battery chargers which have been subjected to HI shock test shall be accepted as production battery chargers of the contract or order only under the following conditions:

(1) That damaged parts are replaced.

(2) That post shock electrical tests show compliance with specified performance. (The extent of electrical testing, after shock, for specified operation shall be determined as necessary, in each instance and shall be dependent on the nature of required performance and inspection results of shock test.)

(3) That an identification plate is added identifying the battery charger as "HI shock tested".

(4) That the battery charger is subjected to the same guarantee by the manufacturer as other production battery chargers.

(5) That not more than one shock tested battery charger of a specific type or design per contract or order is being offered for acceptance following HI shock tests.

4.8.7 Vibration. Vibration tests shall be conducted in accordance with MIL-STD-167-1, type I. The battery charger selected for the vibration test shall be the same battery charger as selected for the shock test.

4.8.8 Inclined operation. The battery charger shall be inclined at 45 degrees (see 3.3.12.4) and the effect, if any, on performance noted (see 3.3.1).

4.8.9 Battery charging tests. Special performance tests on battery charging cycles shall include hourly measurements of charging voltage, charging current, battery temperature, and electrolyte specific gravity. Curves shall be plotted of all measurement results versus time. Battery charging tests shall be conducted as follows:

(a) Connected charger to battery for a length of time indicated in 4.8.9.1.
(b) Obtain hourly readings of data in (a) above.
(c) Vary input voltage and frequency at end of test to establish that output voltage is regulated as required in 3.3.

4.8.9.1 The test specified in 4.8.9 shall be performed on the following batteries, starting with completely discharged batteries. The batteries shall be at room temperature.

Total time connected, hours	Cells	Ampere-hour rating (approx.)
16	3	15
12	12	130
24	18	300

4.8.9.2 Electrical measuring meters. Unless otherwise specified herein, in the individual equipment specification, or the contract or order, indicating meters used for measurement of voltage and current throughout tests shall have an initial accuracy value not greater than one-fourth percent. Voltage and current recordings shall be made in determining conformance with specified transient performance requirements. 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.

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

4.8.11 Dielectric tests.

4.8.11.1 General. The dielectric test shall be made after all of the tests specified in 4.8.1 through 4.8.10 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.

4.8.11.2 Test voltage. The frequency of the testing voltage shall be 60 Hz plus or minus 5 percent and shall approximate a true sine wave. The value of test voltage shall be as specified in 3.3.12.3 and shall be applied continuously for a period of 1 minute.

4.8.11.3 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.

4.8.11.4 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.

4.8.12 Environmental test.

4.8.12.1 General. This test is conducted only as a qualification test and shall normally be conducted as the last test of the required series. Its purpose is primarily to determine: (a) if all transformers and reactors have received the proper insulation treatment and if the manufacturer's treatment process is completely effective to give the desired design life, (b) if all components and hardware have received the proper corrosion-resistant treatment and if the assembly procedures of the manufacturer in any way destroy the complete effectiveness of this treatment, (c) if any miscellaneous weaknesses exist in construction, and (d) if performance is affected by exposure to high humidity.

4.8.12.2 Procedure. Transformer and reactor windings shall be disconnected as necessary from other components to permit accurate measurements of insulation resistance and dissipation factor of the winding and ground insulation. Initial measurements of insulation resistance and dissipation factor shall be taken as well as the temperature and relative humidity of the surrounding air. The equipment shall next be conditioned for a period to arrive at a dry condition. Conditioning shall be obtained by placing the equipment in a heat chamber or drying over a period of 6 hours with temperature maintained at 105°C. At the end of this period the equipment is removed and after cooling (within 8 hours) the insulation resistance and dissipation factor are again measured. The equipment is then immediately placed in the humidity chamber for a period of 1 week (approximately 168 hours). While under humidification, daily measurements of ambient temperature, insulation resistance and dissipation factor shall be made. At the end of the seventh day humidification period and within 5 minutes after removal from the humidity chamber the insulation resistance and dissipation factor shall be measured. Following measurements the equipment shall be carefully examined for any signs of material damage and corrosion. The extent of any observed damage or corrosion shall be noted and cause determined if feasible. After examination, any disconnections or disassembly shall be reverted to original condition and the equipment shall be operated to determine if the electrical performance has in any way been affected as specified in (a) through (c) below. Also following operation, insulation resistance shall be measured and recorded between isolated circuits and between circuits and ground.

(a) Test current limit circuits by verifying that the charger limits the current to the limit indicated by each switch position for current.
(b) Charge a 300 Ah, 18-cell battery for 8 hours and verify the current tapering.
(c) Verify the end of charge voltage on 15 and 130 Ah batteries.

4.8.12.2.1 Recommended test apparatus. Recommended test apparatus shall be as follows:

(a) The humidity chamber can be made of steel or by placing a transparent plastic film having a low moisture permeability over a steel framework. The top of the chamber shall be slanting or peaked (or otherwise arranged) so that the excess condensate does not drip on the equipment. The humidity shall be maintained at 100 percent relative humidity by electrically heating an open pan of water within the chamber. The amount of exposed surface of the water shall be sufficient to produce minute droplets of condensate on the equipment and insulation surfaces under test. However, the amount of condensate shall be controlled so as not to produce puddles or streams of water on the insulation surfaces. The equipment door or panels shall be opened or removed to permit free access of the humidified air to all parts and surfaces.
(b) The insulation resistance measuring equipment shall be similar and equivalent in accuracy to the General Radio Megohm Bridge, type 544-B, 500 volt d.c. with a range from 0.1 to 1,000,000 megohms.
(c) The dissipation factor measuring equipment shall be similar and equivalent in accuracy to the General Radio Capacitance Test Bridge, type 740-BG, 60 Hz with a range of dissipation factor from 0 to 50 percent.

4.8.12.2.2 Methods of measurement. Methods of measurement shall be as follows:

(a) The insulation resistance measurement shall be made using a potential of 500 volts, d.c. applied for a 1 minute period. The insulation resistance shall be measured on all transformers and reactors. Measurements shall be made and recorded between each winding and ground and between insulated windings.
(b) The dissipation factor shall be measured with the capacitance test bridge with values read directly in percent from the bridge. Dissipation factor shall be measured on all transformers and reactors. Measurements

shall be made and recorded between each winding and ground and between insulated windings.

Note: Due to the need for exposing copper for the connections to the windings, a leakage path is produced by humidification over the various insulation surfaces between the base copper and other parts of the equipment that are otherwise insulated from the copper circuit. Therefore, leads should be held separated as much as possible and covered with a nonwetting grease which is wiped off with a clean dry rag upon removal from humidification. Measurements shall be made either with equipment in the humidity chamber or within 5 minutes after removal of the equipment from the humidity chamber.

4.8.13 Airborne and structureborne noise.

4.8.13.1 Measurements. Airborne and structureborne noise measurements shall be made and recorded in accordance with MIL-STD-740 with the battery charger operating at full load at rated input voltage and frequency.

4.8.14 Electromagnetic interference.

4.8.14.1 Measurements. Electromagnetic interference noise measurements shall be made and recorded in accordance with MIL-STD-461 with the battery charger operating at full load at rated input voltage and frequency.

4.8.15 Ripple content. Ripple content of output voltage rms shall be measured to determine conformance with 3.3.13.

4.8.16 Reversed battery test. Battery charger shall be connected to a d.c. voltage source simulating an 18-cell series connected battery, such that the polarity is reversed in relation to the correct charging polarity. The simulation shall include both a fully charged battery and a discharged battery for all possible switch combinations as shown in table VI and in accordance with the requirements of 3.3.2.1.

TABLE VI. Switch combinations for reversed battery test.

D.c. voltage set at 45 volts[1]					
Power switch on			Power switch off		
Test no.	Current	Number of cells	Test no.	Current	Number of cells
1	3-4	1	11	3-4	1
2	8-10	3	12	8-10	3
3	15-20	4	13	15-20	4
4	25-30	6	14	25-30	6
5	40-45	12	15	40-45	12
6	3-4	3	16	3-4	3
7	8-10	4	17	8-10	4
8	15-20	6	18	15-20	6
9	25-30	12	19	25-30	12
10	40-45	18	20	40-45	18

[1] Repeat tests 1 through 20 with d.c. voltage source set at 39.6 volts.

4.8.17 Misoperation. Three discharged batteries (15 Ah, 130 Ah, and 300 Ah) shall, each in turn, be connected to the charger with the correct setting of control switches (number of cells and ampere-hour rating) and shall be tested as follows:

(a) The charger shall be energized; 1 minute after start of charge for each respective battery, the output cable shall be disconnected from the battery while charging is in progress.
(b) The same three combinations of switch settings (for the 15, 130, and 300 Ah batteries) shall be respectively adjusted but no battery shall be connected to the charger in any case. The charger shall be turned on, as though charging a battery.

In either (a) or (b) above, no damage shall be done to the charger in conformance with the requirement of 3.3.2.2.

4.8.18 Internal adjustment. For each switch position controlling the number of series connected cells, a d.c. voltmeter (accurate to the nearest 0.1 volt), shall be connected across the output terminals and the charger turned on. For each setting the required adjustment specified in 3.3.2.3 shall be made to determine the adjustment capability. For example, with a setting of 12 cells, the total output voltage should be adjustable over the range from 24.4 volts to 30.0 volts.

4.8.19 Temperature compensation. The charging voltage and current output shall be automatically compensated for variations in the ambient temperature affecting the temperature of the battery being charged and its voltage. This may be accomplished by using a temperature sensing element placed at a position in the charger enclosure which is substantially unaffected by the heat dissipated by the other components of the charger.

4.8.20 Maintainability demonstration. The battery charger of each type shall be examined after testing, and the capability to maintain, disassemble, and repair the battery charger shall be demonstrated to a Government representative. The demonstration shall be conducted utilizing the recommended tools and with other than expert mechanics. The maintainability demonstration shall be in accordance with test method 4 of MIL-STD-471 (see 6.2.1) to determine conformance with 3.3.12.13.3.

4.8.20.1 Maintainability demonstration test plan. A maintainability demonstration test plan shall be prepared by the contractor in accordance with the data ordering document included in the contract or order (see 6.2.2) and submitted to NAVSEA for review before the tests commence. The plan shall define in detail the maintainability actions to be performed during the test. The test plan shall include a list of sample tasks for NAVSEA review. The list of tasks will be used by the Government, at the time of the demonstration to select the 20 tasks to be demonstrated in accordance with method 4 of MIL-STD-471.

4.8.20.2 Maintainability demonstration test report. A maintainability demonstration test report shall be prepared by the contractor in accordance with the data ordering document included in the contract or order (see 6.2.2) and submitted to NAVSEA for review after completion of the maintainability demonstration.

4.9 Inspection of preparation for delivery. Sample packages and packs and the inspection of the preservation-packaging, 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 preparation for delivery requirements specified herein apply only for direct Government acquisition. For the extent of applicability of the preparation for delivery requirements of referenced documents listed in section 2, see 6.4.)

5.1 Preservation-packaging, packing, and marking. The battery chargers shall be individually preserved-packaged levels A or C; packed levels A, B, or C and marked as specified (see 6.2.1) in accordance with MIL-E-17555.

5.2 Repair parts. Repair parts shall be preserved-packaged, packed, and marked, in accordance with MIL-E-17555 in the levels specified for the use and destination as follows:

Destination	Level	
	Preservation-packaging	Packing
Onboard	A	C
Stock	A	B
Immediate use	C	C

Unless otherwise specified (see 6.2.1), repair parts shall be packaged one part per unit package, except that all parts comprising a single set or assembly shall be individually protected and packaged together. When unit packaged as a set, assembly, or quantities greater than one, each item shall be wrapped or cushioned to prevent direct surface contact with surface of adjacent parts.

5.2.1 Repairables. Repair parts subject for return to a repair facility for test, restoration and reissue shall be packaged and packed in materials and containers capable of reuse. Unless otherwise specified (see 6.2.1) packaging shall be in accordance with MS90363. For repairables requiring reusable containers, such containers shall be in accordance with the guidelines of MIL-E-17555. Containers shall be marked - "REUSABLE DO NOT DESTROY". Unless otherwise specified (see 6.2.1) packaging and transportation support data (see 6.2.2) shall be furnished for items falling in this category.

5.3 Cushioning and wrapping materials. Use of excelsior, newspaper, shredded paper (all types, including wax paper) and similar hygroscopic or nonneutral materials and all types of loose-fill materials for applications such as cushioning, filler, stuffing and dunnage for materials destined for shipboard stowage and use is prohibited except that vermiculite is approved for packaging applications of liquid (chemical, petroleum, etc.) products. Cushioning and wrapping materials selected shall incorporate properties/characteristics for resistance to fire, examples are:

UU-P-268	Paper, Kraft Wrapping Type II, Grade C or D
PPP-C-850	Polystyrene, Expanded Grade SE, Type I or II Only
PPP-C-1120	Bound Fiber, Uncompressed Type III or IV, Class C
MIL-R-6130	Cellular Rubber Grade A
MIL-R-20092	Cellular Rubber Class 1 or 4
MIL-P-26514	Polyurethane Foam (Rigid or Flexible)

5.4 Talc/Talcum used in the packaging process of item(s) shall be free of asbestos and asbestiform like materials.

6. NOTES

6.1 Intended Use. The battery charger is an automatically-regulated, selfcontained charger used for charging the following standard batteries covered in MIL-B-15072 in increments of 1, 3, 4, 6, 12, and 18 series-connected cells of the same ampere-hour rating:

Type of battery	Number of cells per battery	Ampere-hours, 10 hour rate	Charge current range, amperes
BB-254/U	1	20	3-4
BB-255/U	3	15	3-4
BB-252/U	3	50	8-10
BB-256/U	3	100	15-20
BB-257/U	3	130	25-30
BB-258/U	3	200	40-45
BB-253/U	3	205	40-45
BB-259/U	3	300	40-45

6.2 Ordering data.

6.2.1 Acquisition requirements. Acquisition documents should specify the following:

(a) Title, number, and date of this specification.
(b) Level of preservation-packaging, packing and marking required (see 5.1).
(c) Packaging other than MS90363 (see 5.2.1).
(d) Quantity of repair parts per package, other than specified (see 5.2).
(e) When packaging and transportation support data is not required (see 5.2.1).

6.2.2 Data requirements. When this specification is used in a contract which invokes the provision of the "Requirements for Data" of the Defense Acquisition Regulation (DAR), the data identified below, which are required to be developed by the contractor, as specified on an approved Data Item Description (DD Form 1664), and which are required to be delivered to the Government, should be selected and specified on the approved Contract Data Requirement List (DD Form 1423) and incorporated in the contract. When the provisions of the "Requirements for Data" of the DAR are not invoked in a contract, the data required to be developed by the contractor and required to be delivered to the Government should be selected from the list below and specified in the contract.

Paragraph	Data requirements	Applicable DID	Option
(a) 3.5	Provisioning parts list (PPL)	DI-V-7002	Level 3
(b) 3.5	Drawings, engineering and associated lists	DI-E-7031	Design activity designation - contractor Design activity drawing numbers - contractor Certification data sheets - required

Paragraph	Data requirements	Applicable DID	Option
(c) 3.5	Card, aperture/ tabulating	DI-E-20477	Microfilm of drawings - type I, class 1 delivered to: Commander Portsmouth Naval Shipyard (Code 282) Portsmouth, NH 03801 Director Naval Publication and Printing Service Office Washington Navy Yard Building 157 (Code 724) Washington, DC 20390
(d) 3.5.2	Manuals, technical preliminary	DI-M-2043	MIL-M-15071, type II
(e) 3.5.2	Manual, technical, standard, basic issue	DI-M-2044	MIL-M-15071, type II
(f) 4.1.1	Procedures, test	DI-T-23732	--------
(g) 4.1.1	Report, test/inspection	DI-T-23473	--------
(h) 4.8.20.1	Maintainability demonstration test plan	DI-R-23564	--------
(i) 4.8.20.2	Report maintainability demonstration	DI-R-2130	--------
(j) 5.2.1	Packaging and transportation support data	UDI-P-23508	--------

(Copies of data item descriptions required by the contractors in connection with specific acquisition functions should be obtained from the contracting activity or as directed by the contracting officer. Unless otherwise indicated, the issue in effect on date of invitation for bids or request for proposal shall apply.)

6.2.2.1 The data requirements of 6.2.2 and any task in section 3, 4, or 5 of the specification required to be performed to meet a data requirement may be waived by the contracting/acquisition activity upon certification by the offeror that identical data were submitted by the offeror and accepted by the Government under a previous contract for identical item acquired to this specification. This does not apply to specific data which may be required for each contract regardless of whether an identical item has been supplied previously (for example, test reports).

6.3 With respect to products requiring qualification, awards will be made only for products which are at the time set for opening of bids, qualified for inclusion in applicable Qualified Products List QPL-24095 whether or not such products have actually been so listed by that date. The attention of the contractor is called to this requirement, and manufacturers are urged to arrange to have the products that they propose to offer to the Federal Government tested for qualification in order that they may be eligible to be awarded contracts or orders for the products covered by this specification. The activity responsible for the Qualified Products List is the Naval Sea Systems Command, SEA 3112, Department of the Navy, Washington, DC 20362, and information pertaining to qualification of products may be obtained from that activity. Application for Qualification tests shall be made in accordance with "Provisions Governing Qualification SD-6" (see 6.3.1).

6.3.1 Copies of "Provisions Governing Qualification SD-6" may be obtained upon application to Commanding Officer, Naval Publications and Forms Center, 5801 Tabor Avenue, Philadelphia, Pennsylvania 19120.

6.4 Definitions. For the purpose of this specification, the definitions specified in 3.3.1 and 3.3.2 are applicable.

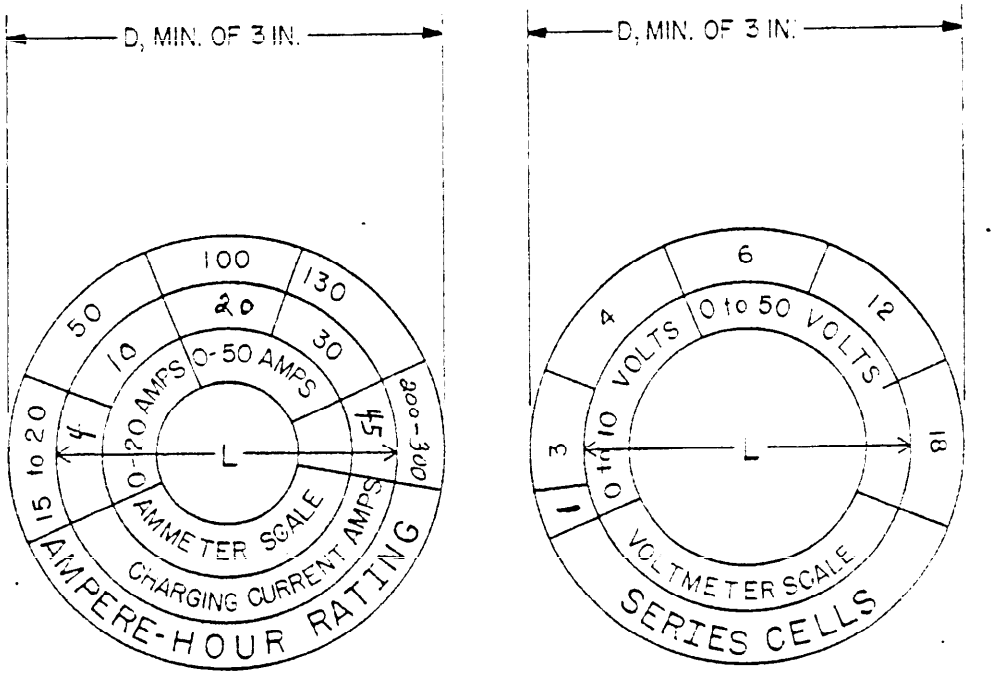
6.4.1 Complete discharge. Complete discharge is defined as a battery condition in which the volts-per-cell is 1.75 volts at a discharge load in amperes of 1/10 of the ampere-hour rating of the battery with an electrolyte temperature of 25° Celsius (°C).

6.4.2 Complete charge. Complete charge is defined as the battery condition following a charging period during which the integrated ampere-hour input is not less than 110 percent of the previous discharge to rated capacity.

6.5 Sub-contracted material and parts. The preparation for delivery 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.

6.6 Changes from previous issue. Asterisks (*) 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 6130-N201)



SH 10756

NOTE: DIMENSION "L" IS THE "SWEEP DIAMETER" (SEE 3.3.3.1).

FIGURE 1. Switch plates.

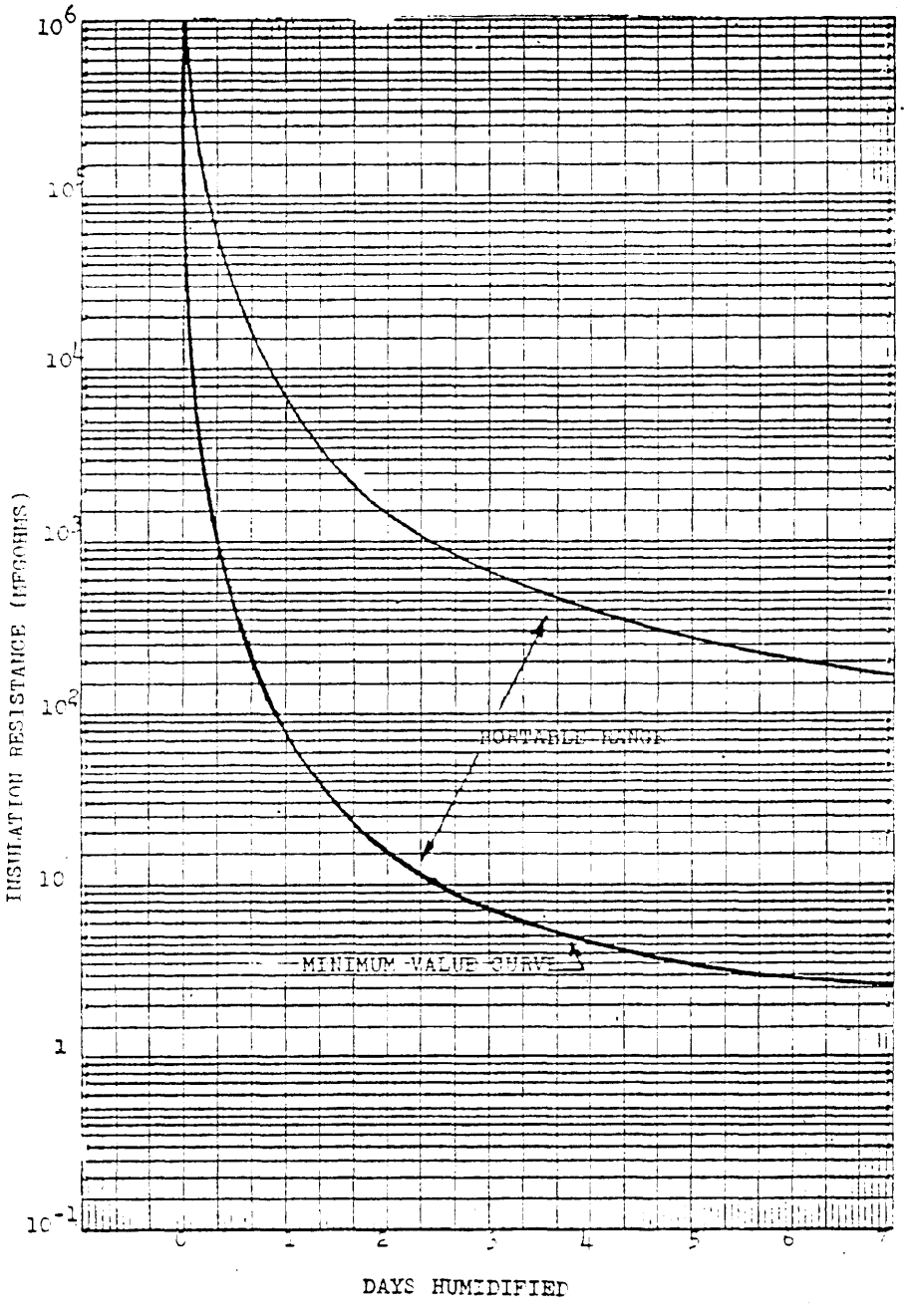


FIGURE 2. Insulation resistance.

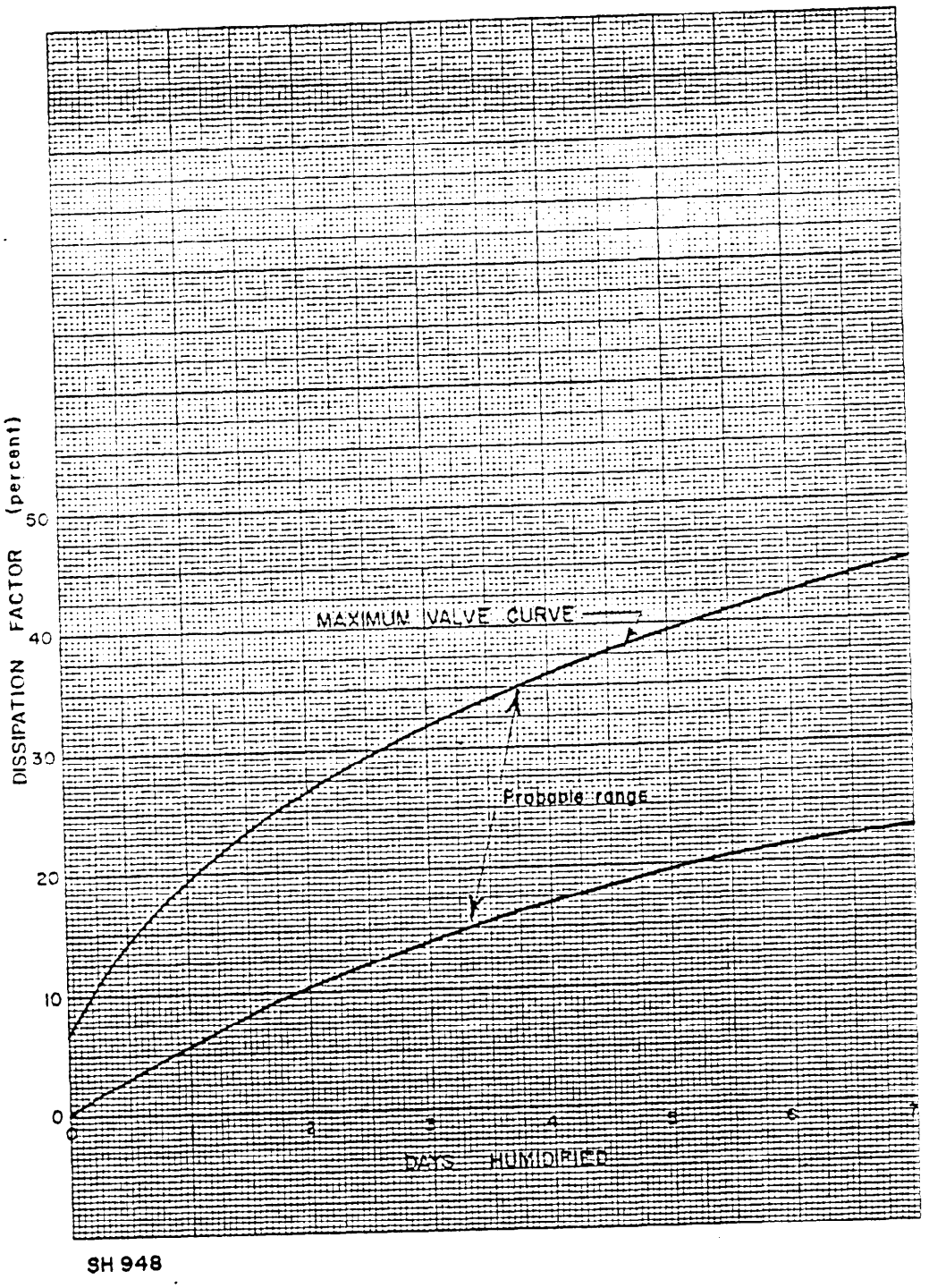


FIGURE 3. Dissipation factor.

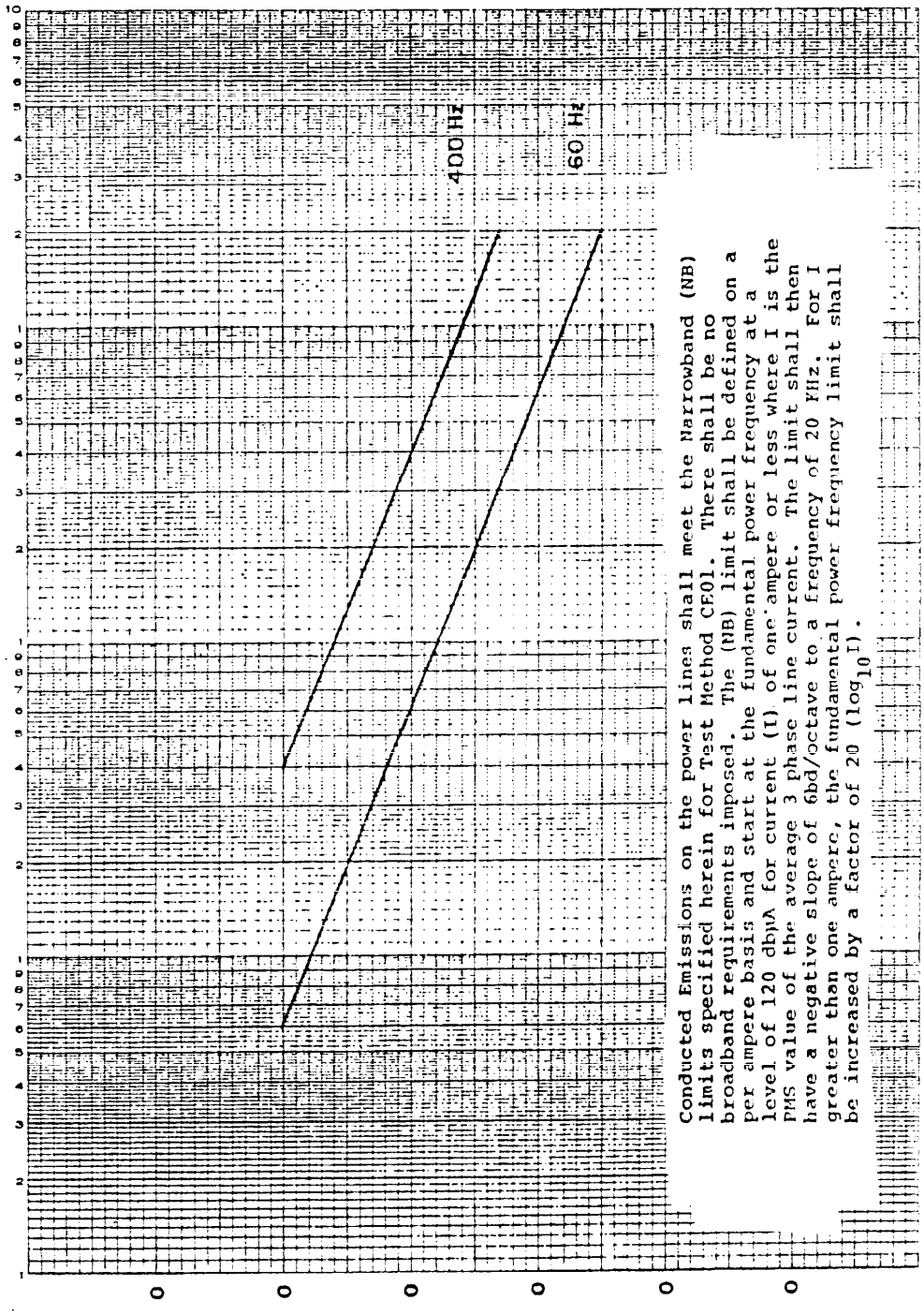


FIGURE 4. Test method CE01, cond 3 emissions, ac power lines, modified limits.

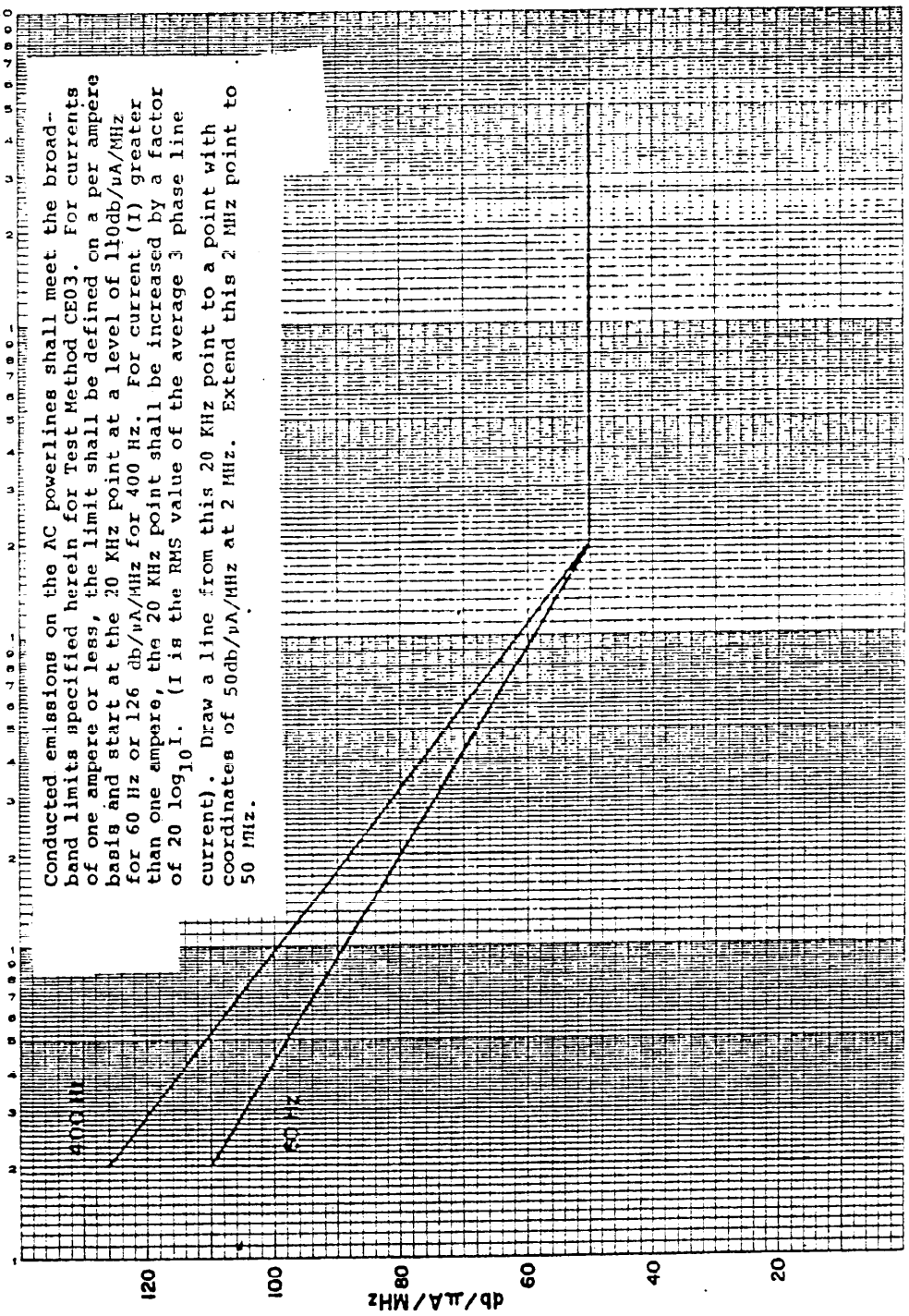


FIGURE 5. Test method CE03, conducted emissions, broadband (BB), modified limit.

Conducted emissions on the AC powerlines shall meet the narrowband limits specified herein for Test Method CE03. For currents of one ampere or less, the limit shall be defined on a per ampere basis and start at the 20 KHz point at a level of 70 db/μA for 60 Hz or 86 db/μA for 400 Hz. For current (I) greater than one ampere, the 20 KHz point shall be increased by a factor of 20 $\log_{10} I$. (I is the RMS value of the average 3 phase line current.) Draw a straight line from the adjusted 20 KHz point to a point with coordinates of 20 db/μA at 2 MHz. Extend the 20 db/μA, 2 MHz point to 50 MHz.

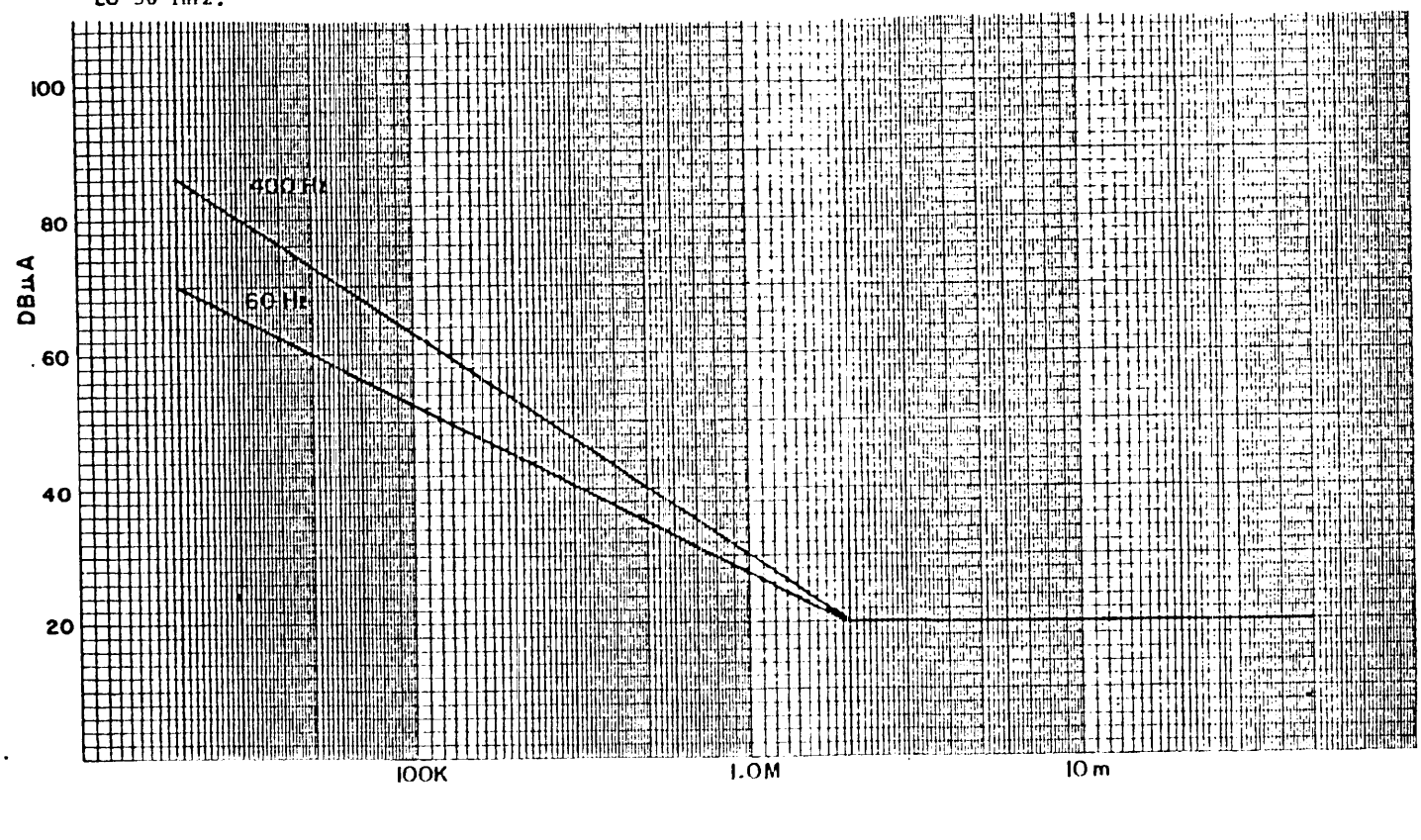


FIGURE 6. Test method CE03, conducted emissions, narrowband (NB) modified limit, 115 AC power lines.

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	☐ MANUFACTURER
	☐ OTHER *(Specify)*: _____

5. PROBLEM AREAS

a. Paragraph Number and Wording:

b. Recommended Wording:

c. Reason/Rationale for Recommendation:

6. REMARKS

7a. NAME OF SUBMITTER *(Last, First, MI)* – Optional	b. WORK TELEPHONE NUMBER *(Include Area Code)* – Optional
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