INCH-POUND
MIL-C-23952C(SH)
18 November 1992
SUPERSEDING
MIL-C-23952B(SH)
10 May 1976
(See 6.17)

MILITARY SPECIFICATION

CONTROL EQUIPMENT AUTOMATIC DEGAUSSING (AUTO DEG), TYPE SSM

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

1. SCOPE

1.1 Scope. This specification covers the design, construction, and test of automatic degaussing control equipment for ship degaussing system, including the interface requirements between ship and equipment and between personnel and equipment to minimize the impact of configuration variations on training and logistics. Only one classification of control equipment is covered by this specification.

2. APPLICABLE DOCUMENTS

2.1 Government documents.

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

SPECIFICATIONS

FEDERAL

UU-P-268 - Paper, Kraft, Wrapping.

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, Attn: 05Q42, 2531 National Center, Bldg. 3, Washington, DC 20362-5160 by using the self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

AMSC N/A FSC 1075

FEDERAL (Continued)

PPP-C-850 - Cushioning Material, Polystyrene, Expanded, Resilient (for Packaging Uses).
PPP-C-1120 - Cushioning Material, Uncompressed Bound Fiber for Packaging.
PPP-C-1842 - Cushioning Material, Plastic, Open Cell (For Packaging Applications).

MILITARY

MIL-P-116 - Preservation, Methods of.
MIL-B-117 - Bags, Sleeves and Tubing.
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-E-2036 - Enclosures for Electric and Electronic Equipment.
MIL-R-6130 - Rubber, Cellular, Chemically Blown.
MIL-P-15024 - Plates, Tags and Bands for Identification of Equipment.
MIL-P-15024/5 - Plates, Identification.
MIL-M-16034 - Meters, Electrical-Indicating (Switchboard and Portable Types).
MIL-E-17555 - Electronic and Electrical Equipment, Accessories, and Provisioned Items (Repair Parts): Packaging of.
MIL-R-20092 - Rubber or Plastic Sheets and Assembled and Molded Shapes, Synthetic, Foam or Sponge, Open Cell.
MIL-S-20708 - Synchros, General Specification for.
MIL-P-26514 - Polyurethane Foam, Rigid or Flexible, for Packaging.
MIL-H-46855 - Human Engineering Requirements for Military Systems, Equipment and Facilities.
MIL-B-81705 - Barrier Materials, Flexible, Electrostatic-Free, Heat Sealable.
MIL-P-81997 - Pouches, Cushioned, Flexible, Electrostatic-Free Reclosable, Transparent.
MS90363 - Box, Fiberboard with Cushioning For Special Minimum Cube Storage and Limited Re-Use Application.

STANDARDS

MILITARY

MIL-STD-108 - Definitions of and Basic Requirements for Enclosures for Electric and Electronic Equipment.
MIL-STD-129 - Marking for Shipment and Storage.
MIL-STD-167-1 - Mechanical Vibrations of Shipboard Equipment (Type I - Environmental and Type II - Internally Excited).

MILITARY (Continued)

MIL-STD-454	- Standard General Requirements for Electronic Equipment.
MIL-STD-461	- Electromagnetic Emission and Susceptibility Requirements for the Control of Electromagnetic Interference.
MIL-STD-462	- Electromagnetic Interference Characteristics, Measurement of.
MIL-STD-471	- Maintainability Verification/Demonstration/ Evaluation.
MIL-STD-740-1	- Airborne Sound Measurements and Acceptance Criteria of Shipboard Equipment.
MIL-STD-740-2	- Structureborne Vibratory Acceleration Measurements and Acceptance Criteria of Shipboard Equipment.
DOD-STD-1399 Section 070, Part 1	- Interface Standard for Shipboard Systems Section 070, Part 1 D.C. Magnetic Field Environment. (Metric)
DOD-STD-1399 Section 300	- Interface Standard for Shipboard Systems Section 300 Electric Power, Alternating Current. (Metric)
MIL-STD-1472	- Human Engineering Design Criteria for Military Systems, Equipment, and Facilities.
MIL-STD-1629	- Procedures for Performing a Failure Mode, Effects and Criticality Analysis.
MIL-STD-2036	- General Requirements for Electronic Equipment Specifications.
MIL-STD-2073-1	- DOD Materiel, Procedures for Development and Application of Packaging Requirements.

HANDBOOKS

MILITARY

MIL-HDBK-217	- Reliability Prediction of Electronic Equipment.
MIL-HDBK-225	- Synchros Description and Operation.
MIL-HDBK-263	- Electrostatic Discharge Control Handbook for Protection of Electrical and Electrical and Electronic Parts, Assemblies and Equipment (Excluding Electrically Initiated Explosive Devices) Metric
MIL-HDBK-472	- Maintainability Prediction.

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

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

DRAWINGS

NAVAL SEA SYSTEMS COMMAND (NAVSEA)
403-2274294 - System Interconnection Block Diagram SSM Degaussing.

(Application for copies should be addressed to: Commander, Portsmouth Shipyard, Code 202.2, Portsmouth, NH 03801.)

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

3. REQUIREMENTS

3.1 First article. When specified (see 6.2), a sample shall be subjected to first article inspection (see 6.5) in accordance with 4.4.

3.2 Reliability and maintainability. The contractor shall conduct the following reliability and maintainability assurance tasks:

(a) Design review (see 3.2.2).
(b) Reliability prediction (see 3.2.3).
(c) Failure mode, effects, and criticality analysis (see 3.2.4).
(d) Maintainability prediction (see 3.2.7).
(e) Reliability demonstration (see 4.6.2.1).
(f) Maintainability demonstration (see 4.6.2.2).

3.2.1 Mean time between failures. The equipment mean time between failures (MTBF) for a 4-coil system (see 3.4.1.2) shall be 2000 hours.

3.2.2 Design review. The contractor shall conduct a design review (see 6.15).

3.2.3 Reliability prediction. The contractor shall predict reliability of the equipment and of each modular assembly (see 3.5.1) by the parts stress analysis method in accordance with MIL-HDBK-217 (see 6.3). The predicted MTBF shall be based on all parts in the equipment. Parts shall not be classified as critical or noncritical or by equipment operational mode. Part failure rates shall be based on stress factors and on naval sheltered environmental conditions.

3.2.4 Failure mode, effects and criticality analysis. The contractor shall conduct a failure mode, effects and criticality analysis in accordance with MIL-STD-1629 (see 6.3). The analysis shall be based on a replaceable subassembly indenture level and a 60-day mission time.

3.2.5 Failure. Failure is defined as occurring when the equipment ceases to function or its performance degrades below the requirements of this specification (see 6.3 and 6.9).

3.2.6 Mean time to repair. The mean time to repair (MTTR) shall be less than or equal to 1.0 hour.

3.2.7 Maintainability prediction. The contractor shall predict maintainability parameter values for the equipment (see 6.3). The corrective maintenance geometric mean time to repair ($MTTR_G$) shall be predicted in accordance with part A, procedure II of MIL-HDBK-472 and the criterion specified in 3.2.7.1.

3.2.7.1 Equipment method of repair. Equipment "method of repair" shall be by replacing "plug-in" modular subassemblies or by replacing both "plug-in" modular subassemblies and individual parts that are not located in modular subassemblies. "Plug-in" modular subassemblies shall be treated as parts for purposes of this prediction. Failure rates used for the maintainability prediction shall be the same as calculated for the reliability prediction (see 3.2.3). Maintenance task times shall be based on the criterion that the enclosure is closed and secured. Maintenance task times shall be based on the following functional levels:

(a) Each functional unit (see 3.4.1.4) shall be considered a "unit".
(b) Components in units (plug-in subassemblies, other subassemblies, parts) shall be considered "subassemblies," "stages," or "parts" as defined in MIL-HDBK-472.

3.2.8 Life. Equipment shall have an expected life of 5 years (40,000 hours) of continuous operation without benefit of overhaul and an expected life of 20 years with benefit of overhaul.

3.3 Parts and materials. The selection and application of parts and materials shall be in accordance with MIL-STD-2036.

3.3.1 Electron tubes. Electron tubes shall not be used.

3.3.2 Number of nonstandard parts. The number of nonstandard parts used shall be the minimum number necessary to meet the requirements for the equipment (see 6.3). Use of two different nonstandard parts will not be accepted if one of the two can be used for both applications.

3.3.2.1 Matched parts. If matched parts are required for proper performance of the equipment, the matched parts shall be treated as nonstandard parts and acceptance obtained prior to their use in the equipment. Sets of matched parts shall be identified by a unique part number and packaged in such a manner that the set can be removed, acquired, and replaced as a subassembly.

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

3.4 Design and construction.

3.4.1 Equipment description.

3.4.1.1 Type SSM. The type SSM auto deg control equipment described herein (see 6.3 and appendix A) shall be used on ships in a degaussing system comprised of:

(a) Control equipment, type SSM (see 3.4.1.1.2).
(b) Equipment manual.
(c) Allowance parts list (APL) and repair parts.
(d) Degaussing coil installation.
(e) Compass compensation coils and control boxes.
(f) Ship's degaussing folder.

3.4.1.1.1 Government furnished equipment. The control equipment and manual shall be furnished by the contractor. The APL and repair parts are essentially Government furnished equipment (GFE). They are based, in part, on the contractor's recommendations, and some of the repair parts will be acquired from the contractor as specified in the contract or purchase order. Degaussing coil installation, compass compensation coils, and the degaussing folder are GFE and are described herein to the extent necessary to define the requirements for the control equipment (see 6.14).

3.4.1.1.2 Type designation. The complete control equipment type designation (example: type SSM-3A) will be furnished after the award of the contract (see 6.14). The contractor shall include type designation on identification plates.

3.4.1.2 Degaussing control equipment. Degaussing control equipment shall furnish controlled current to the ship's degaussing coils and shall provide the means for setting and monitoring these currents. The type SSM equipment shall be installed on ships with a three-coil installation; such as, M, FI-QI, and FP-QP coils, and on ships with a four-coil installation; such as, M, FI-QI, FP-QP, and A coils. The functions of these degaussing coils are to produce magnetic fields to counteract the ship's magnetization as follows:

(a) Field of the M coil counteracts the ship's vertical magnetization. The current in this coil shall be a function of the operating latitude of the ship and ship's permanent vertical magnetization.
(b) Field of the FI-QI coil counteracts the ship's induced longitudinal magnetization. The current in this coil shall be a function of the operating latitude of the ship and of the cosine of the angle of heading of the ship relative to magnetic north (magnetic heading) measured clockwise from magnetic north to heading of the ship.
(c) Field of the FP-QP coil counteracts the ship's permanent longitudinal magnetization. The current in this coil shall be a function of the ship's longitudinal permanent magnetization.
(d) Field of the A coil counteracts the ship's induced athwartship magnetization. The current in this coil shall be a function of the operating latitude of the ship, the sine of the angle of heading of the ship relative to magnetic north, and the ship's permanent athwartship magnetization.

3.4.1.3 Degaussing system. The degaussing system shall be capable of both automatic and manual operation. Automatic operation is the mode of operation where the current in the FI-QI coil or the A coil or both are controlled by the own ship's heading (OSH) signals from a ship's gyro synchro transmitter. Manual operation is the mode of operation where the current in the FI-QI coil or A coil or both are controlled by manually inserted, simulated, heading signals. Automatic operation shall be the normal mode of operation. Manual operation shall be used only when the loss of the OSH signal or a malfunction in equipment makes it impossible to operate in the automatic mode.

3.4.1.4 Control equipment. Control equipment shall be functionally divided into units as illustrated on figure 1. Equipment installed on each ship will consist of one degaussing switchboard unit, one remote control unit, and one power supply unit for each degaussing coil installed on the ship. Since the number of installed coils varies, the degaussing switchboard and remote control unit shall be supplied in two different configurations; namely, three-coil unit or four-coil unit. Since the required degaussing coil currents for the various coils vary with ship size, power supplies shall be supplied in nine different sizes (see 3.4.1.7.2), each size with a different rated output current and power, and each size capable of being used with any coil having a similar current rating. The configuration of the switchboard and remote control, and number and size of the power supplies shall be as specified (see 6.2).

3.4.1.4.1 Interchangeability of units. Each unit of each set of degaussing control equipment ordered to this specification shall be physically and electrically interchangeable with corresponding units of all other degaussing equipment ordered to this specification. Physical size, outline dimensions, mounting dimensions, and cable entry shall be in accordance with figures 2 through 6 for corresponding units. The arrangement and location of terminal boards, megger links, and fuses for connection of interconnecting cables shall be as illustrated on these figures. Interconnections between units, and the designations of terminals and other connection points in units shall be in accordance with Drawing 403-2274294.

3.4.1.4.2 Three-coil units. Switchboard units and remote control units configured for three coils shall be identical to switchboard units and remote control units configured for four coils, except that parts, controls, switch positions, and the like, used exclusively with or for the A coil, shall not be provided.

3.4.1.5 Degaussing switchboard unit. The degaussing switchboard shall contain all devices and features required to make the equipment complete, except those devices and features specified to be included in other units. The switchboard shall contain controls required to operate equipment, trouble indicators for indicating trouble and localizing faults, and circuits and devices required to provide control signals to power supply units. The upper portion of the switchboard shall be sectionalized with respect to function into the "coil control section", "computer section", and "ground detector and alarm section." Parts and devices associated with each of these functions shall be located or grouped in a manner that will facilitate operation and maintenance of equipment. The lower part of the switchboard shall contain terminal boards for interconnections and storage compartments for equipment manual, ground detector nomographs (see 3.4.1.5.4.2), and test extender cables (see 3.5.4). Storage compartments shall be

designed such that the manual and nomographs are available to the operator without the use of tools. The operating time meter (see 3.4.1.5.6), switchboard power available light (see 3.4.1.5.8) and fuses shall be located on the lower switchboard front panel. Equipment operating instructions (see 3.4.1.5.5) shall be located on the upper switchboard front panel.

3.4.1.5.1 Switchboard outputs. Output of the switchboard shall be control signals to each of the power supplies. These control signals or voltages shall be functions of the ship's magnetic heading and the settings of operator controls as specified in the following formulas:

$$V_M = K_M V$$

$$V_F = K_F V \cos a \qquad \text{(for automatic operation)}$$

$$= K_{FM} V K_{EMF} \qquad \text{(for manual operation)}$$

$$V_P = K_P V$$

$$V_A = K_A V \sin a + K_B V_B \qquad \text{(for automatic operation)}$$

$$= K_{AM} V K_{EMA} + K_B V_B \qquad \text{(for manual operation)}$$

Where:

V_M, V_F, V_P, and V_A = output voltage or control signal to the M, FI-QI, FP-QP, and A coil power supplies, respectively.

V and V_B shall be as follows:

$$5.0 \text{ volts} \leq V \leq 5.5 \text{ volts.}$$

$$2.5 \text{ volts} \leq V_B \leq 2.75 \text{ volts.}$$

a = angle of heading of the ship relative to magnetic north measured clockwise from magnetic north to heading of the ship.

K_F and K_A = gain constants for automatic operation. The numerical values of these constants will range between zero and 1.0. These constants will be set during system calibration (see 6.6.1).

K_M, K_{FM}, K_P, K_{AM}, and K_B = various current constants. The numerical values of these constants will range between zero and 1.0. The magnitudes and polarity of these constants shall be a function of operator control adjustments (see 3.4.1.5.2).

K_{EMF} and K_{EMA} - ship's heading constants. The magnitude and polarity of these constants shall be a function of the eight-course emergency control switch position (see 3.4.1.5.3.3).

3.4.1.5.1.1 Automatic operation. Equipment shall receive an OSH signal from the ship's gyro synchro transmitter, convert this signal to represent the ship's magnetic heading by correcting for magnetic variation in accordance with 3.4.1.5.3.2, and amplifying and rectifying the signal as necessary, such that the outputs to the FI-QI and coil power supplies are in accordance with requirements specified in 3.4.1.5.1. Conversion of the ship's heading signal to a proportional signal shall be accomplished with solid state devices or a motor-driven resolver. Torque receivers shall not be used.

3.4.1.5.1.2 Manual operation. Manual control of each of the outputs to the FI-QI and A coil power supplies shall be provided for emergency operation in the event of malfunction in the automatic control circuits or loss of OSH signal or gyro reference power. Manual control circuits shall be independent of the OSH signal, gyro reference source, and as much of the automatic operation circuitry as possible.

3.4.1.5.1.3 Perm bias. Means shall be provided for manually setting a positive or negative bias in the output to the A coil power supply. This permanent component, or bias, (K_B V_B) shall be known and referred to as perm bias.

3.4.1.5.1.4 Output limiting. Means shall be provided for limiting the output voltage to the A coil power supply (V_A) to 5.5 volts even though the sum of the induced component (K_A V sina or K_{AM} V K_{EMA}) and permanent component is greater than 5.5 volts. This shall prevent overloading the power supplies at extreme latitudes, and still allowing induced and perm (I and P) current at lesser latitudes totaling greater than 100 percent of rated zone currents. For example, at a latitude requiring only 60 percent of capacity for I current, 40 percent of capacity is available for P; but as the ship changes latitude and more I current is called for by the setting, the self-limiting prevents overloading.

3.4.1.5.1.5 Output ripple. Peak-to-peak ripple voltage from the switchboard unit shall not exceed 0.25 volt for any output voltage between zero and maximum voltage, when measured with the unit supplying a purely resistive load. Peak-to-peak values of any and all periodic and random deviations from nominal output voltage (including hum, noise, and spikes) shall be considered.

3.4.1.5.2 Coil control section. Controls, devices, and features associated with a particular coil shall be located in the coil control section. Each of the following listed front panel controls and indicators shall be provided for the coils specified. Controls and indicators for a particular coil shall be adjacently located and symmetrically arranged. The function of each of these devices shall be identified by marking the front panel with the words, symbols and abbreviations capitalized in quotation marks as follows:

(a) Coil "POWER" switch with "ON-OFF" positions. One rotary switch for each coil for controlling alternating current (ac) power to the power supply and the control circuits in the switchboard for a particular coil. This switch operates main power contactor or circuit breaker in the power supply.
(b) Direct current (dc) ammeter, "DC AMPERES." One ammeter for each coil. Shunts for these meters shall be located in the respective power supplies (see 3.4.1.12).
(c) "AUTOMATIC INDUCED MAGNITUDE" controls for setting gain constants K_F and K_A. One screwdriver adjust control shall be provided for the FI-QI coil and one for the A coil.
(d) "MANUAL INDUCED MAGNITUDE" controls for setting current constants K_{FM} or K_{AM}. One control shall be provided for the FI-QI coil and one for the A coil.
(e) "INDUCED MAGNITUDE" controls for setting current constants K_M and K_P. One control shall be provided for the M coil and one for the FP-QP coil.
(f) "PERM MAGNITUDE" control. A screwdriver adjust control for setting the magnitude and polarity of the permanent portion of the A coil current (current constant K_B) shall be provided.
(g) "OPERATION SWITCH" with "AUTOMATIC-MANUAL" positions. Two rotary switches, one for FI-QI coil and one for A coil shall be provided to transfer from automatic to manual operations.
(h) "POLARITY" switches with "NEGATIVE CURRENT-OFF-POSITIVE CURRENT" positions for controlling polarity of M or FP-QP coil currents (polarity of current constants (K_M or K_P) shall be provided for M and FP-QP coils.
(i) One "POWER ON" indicator light for each coil for indicating that ac power is energizing the applicable power supply and control circuits in switchboard.
(j) One "POWER SUPPLY OVERHEATING" indicator light for each coil for indicating when applicable power supply is overheating (see 3.4.1.10).
(k) One "INTERLOCK BYPASS" indicating light for each coil for indicating when applicable interlocks are bypassed.
(l) One "POWER SUPPLY EXCESS ERROR" indicator light for each coil for indicating malfunction of applicable power supply (see 3.4.1.8).
(m) "SIGNAL EXCESS ERROR" indicator lights for indicating malfunction of automatic control circuits in switchboard (see 3.4.1.8) shall be provided for FI-QI and A coils.
(n) Blown fuse indicator lights for each fuse in applicable power supply and control circuits in switchboard.

3.4.1.5.3 Computer section. Controls, devices, and features common to both the A coil and FI-QI coil shall be located in the computer section. Each of the following listed front panel controls and indicators shall be provided in the computer section. The function of each of these devices shall be identified by marking front panel with the words, symbols, and abbreviations capitalized in quotation marks as follows:

(a) One gyro reference "POWER ON" indicator light.
(b) One "MAGNETIC HEADING" indicator (see 3.4.1.5.3.1).
(c) One "MAGNETIC VARIATION" dial (see 3.4.1.5.3.2).

(d) One eight-course emergency manual control switch (see 3.4.1.5.3.3). Designation and marking of this switch shall be in accordance with figure 7.
(e) One "H-ZONE" switch with "0.05 - 0.10 - 0.20 - 0.25 - 0.30 - 0.35 - 0.40" positions (see 3.4.1.5.3.4).
(f) One "TEST OPERATE" switch with "OFF - OPERATE - TEST I 0° - TEST I 90° - TEST PERM" positions (see 3.4.1.5.3.5).
(g) One "LOCAL-REMOTE TRANSFER" switch with "LOCAL-REMOTE" positions (see 3.4.1.5.3.6).
(h) Fuse indicators and interlock indicators necessary to make the computer section complete.

3.4.1.5.3.1 Magnetic heading indicator. One indicator dial shall be provided for indicating the magnetic heading (signal received from the gyro synchro transmitter plus variation correction). This dial shall be calibrated in 1 degree increments from 0 to 360 degrees.

3.4.1.5.3.2 Magnetic variation. A magnetic variation control for manually converting the ship's gyro heading signal to a ship's magnetic heading signal shall be provided on the front of the computer section. This control shall provide for setting the magnetic variation to any value between zero and 180 degrees east, and zero and 180 degrees west, in increments not exceeding 1 degree. A control knob and a dial or indicator for showing the setting shall be provided. A means of locking the control at the desired setting shall be provided.

3.4.1.5.3.3 Eight course emergency control switch. An eight-position heading switch for setting polarity and magnitude of the constant K_{EMF} and K_{EMA} shall be provided with the FI-QI and A coils. This switch shall be common to the control circuits of both the FI-QI and A coils, but shall only affect the coil for which transfer to manual operation has been made. Magnitude and polarity of each of the positions shall be as specified in table I.

TABLE I. Eight-course emergency control switch operation.

Ship's heading (degrees-magnetic)	Switch position	Magnitude and polarity of K_{EMF} and K_{EMA} (percent)	
		FI-QI coil (K_{EMF})	A Coil (K_{EMA})
340-20	N	100	0
20-70	NE	70	70
70-110	E	0	100
110-160	SE	-70	70
160-200	S	-100	0
200-250	SW	-70	-70
250-290	W	0	-100
290-340	NW	70	-70

3.4.1.5.3.4 H-zone switch. This control shall be provided for varying magnitude of gain constants K_F, K_{FM}, K_A, and K_{AM} as ship's magnetic latitude varies. One H-zone control, common to both the FI-QI and A coils, shall be provided for reducing the maximum amplitude of each of the switchboard outputs to the FI-QI and A coil power supplies (V_F and V_A) in eight equal steps of 12.5 percent each from maximum output (H = 0.40) to 12.5 percent of maximum output (H = 0.05). This control shall function during automatic and manual operation of one or both of the FI-QI and A coils. This control shall have a detent or rotary snap switch type action.

3.4.1.5.3.5 Test-operate switch. This control shall be provided for setting the automatic induced magnitude controls and perm magnitude control (see 3.4.1.5.2) independent of ship's heading. With the switch in "off" position, OSH signal and gyro reference power shall be disconnected from control circuits. In "test I 0°" and "test I 90°" positions (magnetic north and magnetic east, respectively), the permanent component of the A coil signal (K_B V_B) shall be disconnected and OSH signals shall be simulated by varying the magnetic variation dial to any desired heading. In "test perm" position, all heading signals shall be disconnected and only the permanent component of the A coil signal (K_B V_B) provided. This switch and the described features shall be used as an instrument in checking for correct operation of the equipment.

3.4.1.5.3.6 Local-remote transfer switch. This control shall be provided to select the control station for manual operation of the FI-QI or A coil. This switch shall connect the eight-course switch in computer section (see 3.4.1.5.3) or the eight-course switch in the remote unit (see 3.4.1.6) such that manual operation is possible only at one location, that is, either at the switchboard unit or at the remote control unit.

3.4.1.5.4 Ground detector and alarm section. The switchboard unit shall contain a voltmeter type ground detector and an alarm bell for indicating overheating of any power supply. The ground detector shall be used to determine the insulation resistance of the degaussing cable, to ground, while the degaussing system is in operation. The alarm bell and its associated cutoff switch shall operate in conjunction with the temperature alarm circuits specified in 3.4.1.10. Parts and features associated with these features shall be symmetrically arranged and adjacently located in a ground detector section and a high temperature alarm section. Each of the listed front panel controls and indicators shall be provided, and the function of each shall be identified by marking the front panel with the words, symbols, and abbreviations capitalized in quotation marks as follows:

(a) One dc voltmeter "DC VOLTS" with three full-scale voltage ranges of 50, 100, and 250 volts. The voltmeter impedance shall be 1000 ohms/volt. The voltmeter shall be zero center and shall measure both positive and negative voltages without the need for a polarity switch.
(b) One "METER RANGE" switch with "250 V - 100 V - 50 V" positions.
(c) One "POLARITY" switch with "E_n-Off-E-OFF-E_p" positions.
(d) One "COIL SELECTOR" switch with "M - OFF - FP-QP - OFF - FI-QI - OFF - A" positions.
(e) One power supply temperature alarm bell (see 3.4.1.10).
(f) One alarm "BELL" cutoff switch with "OFF-ON" positions.

3.4.1.5.4.1 Ground detector. The ground detector shall provide the means for measuring the power supply dc output voltage (E), the dc voltage from the negative output terminal to ground (E_n) and the dc voltage from the positive output terminal to ground (E_p) from each of the power supplies. Switches shall be provided so that each of the above voltages can be determined for each of the degaussing coils. These switches shall have "OFF" positions and be wired such that there are no grounds on the degaussing system due to the ground detector except when actually in use. Nomographs for readily converting voltmeter readings to insulation resistance shall be provided as information plates stored in the switchboard (see 3.4.1.5.4.3).

3.4.1.5.4.2 Nomographs. Three nomographs, one for each voltmeter range, shall be provided. The nomographs for the 100 volt range shall be the same as illustrated on figure 8. The 50 and 250 volt nomographs shall also be as shown on figure 8, except the $E_p + E_n$ scale shall be 0 to 100 volt and 0 to 250 volt, respectively, and the Rx scale shall be modified as required for these ranges.

3.4.1.5.4.3 Information plates. Ground detector operating instructions and nomographs shall be provided on two type F (laminated plastic) information plates in accordance with MIL-P-15024 and MIL-P-15024/5. These plates shall be approximately 8.5 inches wide by 11 inches high and one plate shall have 100 volt nomographs on one side and 250 volt nomographs on other. The other plate shall have a step by step procedure for measuring insulation resistance using ground detector on one side and the 50 volt nomograph on the opposite side.

3.4.1.5.5 Operating instructions. Abridged operating instructions shall be located on the front of the switchboard unit. Instructions for a four-coil unit (see 3.4.1.4) are illustrated on figure 9, and shall be used verbatim as shown. Instructions for a three-coil unit shall be the same as for a four-coil unit except all reference to the A coil, to A coil switches, and to A coil set up (set up steps 5, 6 and 9) shall be deleted. The equipment operation shall be consistent with those instructions. The operation information included in the equipment manual shall also be consistent with these instructions.

3.4.1.5.6 Time meter. One time totalizing meter shall be provided to indicate equipment operating time in hours. The function of this device shall be indicated by marking front panel with words "EQUIPMENT OPERATING TIME." This meter shall be connected such that it indicates total operating time of the M coil power supply.

3.4.1.5.7 Switchboard unit. The switchboard unit shall be designed such that it can be operated and tested as a separate unit. Outputs described in 3.4.1.5.1 shall be available without connecting switchboard to power supplies or remote unit. Power for circuits in the switchboard shall be obtained from 440 or 115 volt power inputs described in 3.6.1.1 and 3.6.1.1.1, respectively.

3.4.1.5.8 Power available light. One "POWER AVAILABLE" light shall be provided on the switchboard to indicate that the 440 volt power source is available to the switchboard.

3.4.1.6 Remote control unit. The remote control unit shall provide indicating devices to enable an operator to monitor equipment status and degaussing coil currents and an eight-course emergency operation switch to manually control the degaussing coil currents normally controlled automatically. The remote control unit shall be designed for use in dark adapted areas. These controls and lights shall be symmetrically arranged with indicators for a particular coil adjacently located. Each of the listed controls and indicators shall be provided on the front panel and functions of each shall be identified by marking the front panel with the words, symbols, and abbreviations capitalized in quotation marks as follows:

(a) One dc ammeter, "DC AMPERES", for reading output currents of all power supplies (see 3.4.1.12).
(b) One meter multiplying factor identification plate (see 3.4.1.12).
(c) One coil selector switch for selection of degaussing coil for current readings marked with "M - FI-QI - OFF - FP-QP - A" positions.
(d) One eight-course emergency control switch (see 3.4.1.5.3.3). Designation and marking of this switch shall be in accordance with figure 7.
(e) One "REMOTE OPERATION" light to indicate control of coil currents by manual operation has been transferred to the remote control unit from the switchboard unit located in the engineering spaces.
(f) "AUTOMATIC OPERATION" and "MANUAL OPERATION" lights for indicating the operational mode for both the FI-QI and A coils. A total of four lights is required.
(g) "POWER SUPPLY EXCESS ERROR" lights. One light for each power supply (see 3.4.1.8).
(h) "SIGNAL EXCESS ERROR" lights. One light each for the FI-QI and A coils (see 3.4.1.8).

3.4.1.7 Power supply units. Power supplies shall not contain control devices or operator adjustments; and they shall be configured such that they can be considered black boxes by operating personnel. Power supplies shall receive power from the ship service power distribution system and control signals from the degaussing control unit. They shall automatically supply controlled current to a degaussing coil and trouble indication and fault isolation signals to the switchboard units.

3.4.1.7.1 Bipolar operation of power supplies. Power supplies shall be designed for bipolar operation with the output current capable of being varied continuously from maximum positive to maximum negative while passing smoothly within accuracy requirements (see 3.6.1.3.2) through zero. The output currents shall be a function of the control signal as specified in the following formula:

For all control signals in the following range

$$-5 \text{ Vdc} \leq V_S \leq +5 \text{ Vdc}$$

The output current shall be:

$$I = 1/5\ I_R\ V_S$$

Where:

V_S = control signal from degaussing control unit (dc volts)
I = power supply output current (dc amperes)
I_R = rated power supply output current (dc amperes)

3.4.1.7.2 Output ratings. Rated output voltage of the power supplies shall be 220 volts direct current (Vdc) at rated output current. Rated output current shall be of one of the values specified in table II. Rated load resistance is the rated output voltage divided by rated output current. Power supply units shall be furnished for the coils and with the rated output currents as specified (see 6.2).

TABLE II. Power supply ratings.

Rated output current dc amperes	Approximate kilowatt rating	Power supply input kilovoltamperes maximum
14	3	4.3
23	5	7.0
36	8	11.0
55	12	16.8
73	16	22.3
91	20	27.8
118	26	36.1
145	32	44.3
182	40	55.6

3.4.1.7.3 Type of load. The degaussing coil will constitute a resistive and inductive load on the power supply. The load resistance may be any value in the range between 50 and 100 percent of rated load resistance. The load inductance may be of any value between zero and 100 millihenries.

3.4.1.7.4 Output ripple current. The peak-to-peak ripple current shall not exceed 2 percent of the rated output current for any load from no-load to full-load, when measured with the equipment supplying a purely resistive load. Peak-to-peak values of any and all periodic and random deviations from nominal output current (including hum, noise, and spikes) shall be considered.

3.4.1.7.5 Output circuit. The output circuit shall be electrically isolated from the ship service power source and from the control signal input to power supply. The output circuit shall not be fused.

3.4.1.7.5.1 Output circuit adjustment and limiting features. The power supply shall operate with a load resistance of any value within the range specified in 3.4.1.7.3. The maximum output current shall be limited to less than 150 percent of rated output current during fault conditions that is, all primary control elements on or shorted).

3.4.1.7.5.2 Output circuit contactors. Contactors, for use in reversing the degaussing coil current, shall not depend upon actuation of auxiliary contacts for limiting steady-state contactor coil current. Contactors shall have mechanical interlocks to prevent simultaneous operation of both polarities.

3.4.1.7.6 Control circuits. Each power supply shall operate from any of the switchboard outputs described in 3.4.1.5.1. Power supplies shall also operate with a test input control voltage signal from a rectified, full wave, 60 hertz (Hz) source with no filter (that is, 48 percent root mean square (rms) ripple). Output impedance of test source may be any value between a short circuit and an open circuit. Power supply control circuit dc input impedance shall be between 100 and 1000 ohms.

3.4.1.7.7 Duty. Power supplies shall be designed for continuous duty at any load from no-load to rated-load. Overload capacity shall be provided to protect equipment when operating at 110 percent rated current under limiting conditions specified in 3.4.1.5.1.4. Power supplies shall comply with all performance requirements, except life and reliability, when operating at 110 percent of rated output current.

3.4.1.7.8 Degaussing compass compensation. A means shall be provided for supplying 60 watts of power for compass compensation. The voltage to the compass compensation coils (V_c) shall be directly proportional to the output current of the power supply. The maximum voltage (V_c max) shall be 12 Vdc when the power supply is supplying rated current. The maximum peak-to-peak ripple voltage shall not exceed 0.12 volt. The maximum compass compensation current shall be 5 amperes dc. This current will vary with compass compensation circuit resistance and it may be any value from zero to 5 amperes. A means shall be provided for setting V_c max to 6, 9, or 12 volts when the power supply is installed. This shall be accomplished by strapping terminals or inputs, and not with adjustable circuit elements. The setting of V_c max shall not be affected by or during repair of power supply. Interconnections and wiring shall be such that compass compensation power is available at terminals in the switchboard unit as illustrated on figure 7.

3.4.1.7.9 Megger links. Access door and connecting links or knife blade switches shall be provided for easily disconnecting the degaussing coil feeder cables for maintenance tests on degaussing cable installation. This feature shall be designed such that feeders can be disconnected and reconnected without disassembling any part of power supply or removing feeder cable connections.

3.4.1.7.10 Power-available light. One power-available light shall be provided on each power supply unit to indicate that the 440-volt power source is available to power supply.

3.4.1.8 Fault indication features. Fault circuits and fault indicators shall be provided to indicate trouble or fault if the degaussing system's performance or integrity is affected in any way. Faults indicated shall include:

(a) Control signal errors (see 3.4.1.8.1).
(b) Power supply errors (see 3.4.1.8.2).
(c) Overheating conditions (see 3.4.1.5.4 and 3.4.1.10).
(d) Power supply ripple conditions (see 3.4.1.8.2).
(e) Blown fuses (see 3.6.1.4.2).

3.4.1.8.1 Control signal error. Fault circuits and features shall be provided to monitor automatic control circuits in the switchboard and light the "Signal Excess Error" light (see 3.4.1.5.2) if any one or more errors exceed the limits specified below. The servo amplifier error, the resolver outputs (cos a and sin a), the demodulator outputs, and the control signals to the FI-QI and A coil power supplies shall be monitored. An excess servo amplifier error or incorrect resolver outputs shall light both the FI-QI and A coil "Signal Excess Error" lights.

3.4.1.8.2 Power supply errors. Fault circuits and features shall be provided to monitor output current ripple and error and light the "Power Supply Excess Error" light (see 3.4.1.5.2) if either the ripple or the error exceed the limits specified below. The current error is defined as the normalized difference between the control signal into the power supply and the output current from the power supply. The indicator lights shall indicate for substandard performance as follows:

(a) OFF for ripple or errors less than or equal to 4 percent.
(b) ON or OFF for ripple or errors between 4 and 8 percent.
(c) ON for ripple or errors greater than or equal to 8 percent.
(d) OFF for $[(\cos a)^2 + (\sin a)^2]^{\frac{1}{2}} = \text{constant}$
(e) ON for $[(\cos a)^2 + (\sin a)^2]^{\frac{1}{2}} \neq \text{constant}$

3.4.1.9 Remote alarms. A means shall be provided to actuate two alarms in the ship's common alarm panel, one in the event of a degaussing system fault or failure (see 3.4.1.8), the other in the event that the control unit or any power supply is de-energized (due to a power failure or turning off). A set of electrically isolated, normally open contacts, with a 6800-ohm, 5-watt resistor connected across the contacts, shall be provided for each alarm circuit. The normally open contacts, when closed, shall operate the remote alarm.

3.4.1.10 Temperature alarm. Devices and circuits shall be provided to actuate the temperature alarm bell and applicable power supply overheating light in the switchboard when the fan stops or the power supply overheats. An alarm bell cutoff switch shall be provided in the bell circuit to allow the bell, but not the lights, to be turned off until trouble is cleared.

3.4.1.11 Interconnection resistance. Interconnecting cabling between units shall not require a maximum resistance value of less than 1.0 ohm per pair of conductors. This limitation shall not impair the system operation by sacrificing power gain, stability, or degree of accuracy specified. The purpose of this requirement is to minimize the size of interconnecting cables between units where the units of the system are installed remote from each other.

3.4.1.12 Ammeters. One ammeter for each degaussing coil shall be located on the degaussing switchboard and shall be electrically connected in the particular output circuit. The remote panel shall have one ammeter with a scale marking 100 and shall have a switch to monitor all output currents. An identification plate shall state full scale output current rating for each of the supplies and the required meter reading multiplying factor. Three-ohm calibrating spools shall be provided for each coil. One shunt for each ammeter shall be provided; the shunts shall be located in the respective power supply unit. Ammeters shall be in

accordance with MIL-M-16034 and shall contain the following special features: zero center scale, external 100-millivolt shunts, internal 3-ohm calibrating resistance spool to compensate for shunt leads, high-impact (H.I.) shockproof, 4.5 inch switchboard meter, flush mounted, a 250-degree nominal scale, and shall have white dials and black figures. The ammeter dial shall be marked with "+" on the right side to indicate positive current and "-" on the left side to indicate negative current. The scale shall be chosen from the following, choosing the range which is equal or the next highest to the rated output current of the respective power supply unit: (values in amperes) 15, 25, 40, 60, 80, 100, 130, 160, 200. Ammeters shall be mounted in a manner as to be easily removable.

3.4.1.13 Equipment similarities. Switchboards configured for different ship types shall be the same except for ammeter scales. The same functional block diagrams and schematic diagrams shall be applicable for all power supply sizes. The same parts and modular subassemblies shall be used in various units to the maximum feasible extent.

3.4.2 Controls, indicators, and panel layouts. Controls, indicators, and panel layouts shall be in accordance with MIL-STD-2036, the detail requirements specified in 3.4.1, and as follows:

(a) Locking devices shall be provided for all controls.
(b) Controls, switches, and dials shall not be illuminated.
(c) The remote control unit shall be designed for use in dark adapted areas.

3.4.2.1 Current/gain controls. Induced magnitude, perm bias, and other current controls shall provide the means of adjusting currents from zero to the maximum rated current in increments not exceeding 1.5 percent of the maximum rated current. A continuous type of control rather than a switching arrangement shall be provided. Electrical alignment of equipment shall not be affected by a change in current magnitude.

3.4.3 Design application of semiconductor devices. Semiconductor device ratings are based on the absolute system and shall not be exceeded under any service or test condition. Further, no two of the rated values (for example, voltage and current) shall be imposed at the same time even under extreme or abnormal conditions. Application stresses shall be conservative in all cases. The equipment designer shall be responsible for selecting and applying devices at stress levels which allow for sufficient safety margin below the device ratings and the specified rerating limits, to ensure that the life and high degree of reliability required in this equipment shall be delivered under the adverse service condition to which it may be subjected throughout the lifetime of a combatant ship.

3.4.3.1 Semiconductor devices. Semiconductor devices shall be applied in such a way that the stress limits specified in table III shall not be exceeded under any conditions of normal operation or standby, and during tests specified for the equipment with any available setting of adjustable circuit components or controls. Surge voltage and current transients, resulting from ship service power

supply transients and interruptions and resulting from switching transients generated in the equipment, shall be considered during design. Equipment design shall include features to limit or suppress these transients such that the surge voltage and current transients impressed on the semiconductor devices do not exceed the limits specified in table III.

TABLE III. Application stress limits and rerating factors.

Stress factor	Stress factor limit in relation to rating factor		Rerating factor
	Lower	Upper	
Rectifiers and thyristors silicon control rectifiers (SCRs).			
Working peak reverse voltage	---	0.5	Peak reverse voltage
Nonrepetitive peak reverse voltage		1.0	Peak reverse voltage
Dc blocking voltage		0.4	Peak reverse voltage
Working peak forward voltage (SCRs)		0.5	Forward breakdown voltage.
Nonrepetitive peak forward voltage (SCRs):			
(a) Self-firing unacceptable	---	0.8	Forward breakover voltage.
(b) Occasional self-firing acceptable	---	1.0	Forward breakover voltage.
(c) Same as (b) and di/dt = 0.3 maximum allowable	---	1.0	Peak forward blocking voltage.
Reapplied forward blocking voltage (SCRs)	---	0.7	Forward blocking voltage at rated dv/dt, junction temperature, and turn-off time.
Minimum duration of voltage reversal (SCRs)	2.0	---	Turn-off time.
Maximum rate of rise of forward blocking voltage (SCRs)	---	0.5	Minimum rate of rise, forward blocking voltage (dv/dt).
Average forward current:			Forward current derated for conduction angle, wave form, stud or case temperature T_C (ambient temperature T_A for lead-mounted devices) and duty cycle.
(Nominal value)	---	0.7	
(Maximum value)	---	1.0	

TABLE III. Application stress limits and rerating factors - Continued.

Stress factor	Stress factor limit in relation to rating factor		Rerating factor
	Lower	Upper	
Repetitive peak forward current:			Repetitive peak forward current at maximum case temperature (maximum ambient temperature for lead-mounted devices).
(Nominal value)	---	0.7	
(Maximum value)	---	1.0	
Surge current			Surge current, peak, half-cycle (1/120 second), nonrepetitive.
(Peak, one cycle, nonrepetitive)	---	0.7	
(Effective peak and cycles duration)	---	0.2 + .28 log (f/n)	(Log = logarithm to base 10, f = pulse frequency in Hz, n = number of pulses,
(Effective amplitude and duration, sub-cycle)	---	1.0 - 0.6t	t = time in milliseconds).
Peak current during turn-on (SCRs)	---	0.7	Peak current during turn on.
Maximum rate of current rise during turn-on (SCRs)	---	0.5	Maximum rate of current rise during turn-on.
Peak forward gate current (SCRs):			
Maximum (for firing)	---	0.7	Peak forward gate current.
Minimum (for firing)	2.0	---	Forward gate current minimum to cause firing.
Maximum (during blocking)	---	0	Forward gate current minimum to cause firing.
Peak forward gate voltage (SCRs):			
Maximum (for firing)	---	0.7	Peak forward gate voltage.
Minimum (for firing)	2.0	---	Minimum firing voltage.
Maximum (during blocking)	---	0	Minimum firing voltage.
Peak reverse gate voltage (maximum) (SCRs)	---	0.7	Peak reverse gate voltage.
Maximum gate power dissipation (SCRs):			
(Average)	---	0.7	Average gate power dissipation.
(Peak)	---	1.0	Peak gate power dissipation.

TABLE III. Application stress limits and rerating factors - Continued.

Stress factor	Stress factor limit in relation to rating factor		Rerating factor
	Lower	Upper	
Voltage reference diodes:			
Bias current	0.8	1.2	Zener test current (value for rated Zener voltage).
Diode reverse current (Zener current):			
Minimum	0.1	---	Zener test current (value for rated Zener voltage).
Maximum (peak)	---	0.5	Maximum Zener current.
Maximum (average)	---	0.3	Maximum Zener current.
Voltage regulator diodes:			
Diode reverse current (Zener current):			
Minimum	0.1	---	Zener test current (value for rated Zener voltage).
Maximum (peak)	---	0.5	Maximum Zener current.
Maximum (average)	---	0.3	Maximum Zener current.
Surge	---	0.5	Surge current.
Transistors:			
Collector to emitter voltage	---	0.5	Collector to emitter voltage, VCED.
Collector current	---	0.5	Maximum collector current.
Collector power dissipation:			
Maximum (steady-state average)	---	0.5	Collector power dissipation, Pc, derated for T_C or T_A.
Peak	---	0.7	
Junction temperature (calculated):			NOTE: T_j = maximum junction temperature
Voltage reference diodes	---	100°C	
Silicon controlled rectifiers (only)	---	T_j-30°C	
All other			
(Average, steady-state)	---	T_j-50°C	
(Peak)	---	T_j-25°C	

3.4.3.2 Stress limits and rerating factors. Application stress limits and rerating factors given in table III are based on the actual temperature to which the semiconductor device will be exposed; however, in no case shall a temperature of less than 65 degrees Celsius (°C) (50°C ambient plus 15°C internal rise in enclosure) be used as the maximum ambient temperature of a semiconductor device within the enclosure.

3.4.3.3 Application limitations. The following limitations and design guides shall apply in the application of semiconductor devices:

(a) Devices designed and rated for conduction cooling shall be mounted on metallic heat dissipators. Materials and finish coolings used shall be compatible with one another. Connections and joints shall be designed such that their effectiveness shall be maintained for the life of the equipment under adverse shipboard conditions, including shock, vibration, thermal cycling, high and low humidity, and salt-laden atmosphere. Means of maintaining positive contact pressure on all bolted or clamped joints, under all service conditions, taking into account the aging (including creep, cold flow, relaxation, fatigue, shrinkage, and so forth) of materials, shall be included.

(b) Direct mounting of devices to their heat dissipator with electrical insulation of heat dissipators, as necessary, is preferred to the use of intervening electrical insulating material between the devices and their heat dissipators. This preferred arrangement shall be used except where it is impractical to insulate the heat dissipators, or where other technical considerations make electrical insulation of the semiconductor device from its mounting surface necessary.

(c) Where parallel operation of devices is necessary to provide current capacity, provision shall be made in the equipment design to force current sharing between or among the paralleled devices. Device matching to provide improved load-sharing capabilities is expressly prohibited. Voltage reference diodes and voltage regulator diodes shall not be paralleled to obtain higher current capacity.

(d) Insofar as practical, devices loaded in parallel shall share the same heat dissipator (that is, shall be mounted on a single heat dissipator which is common to all devices loaded in parallel) to help stabilize the effects of thermal differences on load division.

(e) Gate, or control signals shall be provided simultaneously to all controllable semiconductor devices that are operated in parallel. Slave or sequential firing or control of devices operating in parallel shall not be used.

(f) Where series operation of rectified diodes or controlled rectifiers is necessary, provision shall be made in the equipment design to force both transient and steady-state voltage sharing between, or among, devices operated in series. This applies to operation of the devices in the blocking condition, but is not limited to so-called blocking applications.

(g) Gate signals shall be provided simultaneously to all controlled rectifiers that are operated in series. Slave or sequential firing of controlled rectifiers operating in series shall not be used.

3.4.3.4 Heat dissipators. Heat dissipators for semiconductor devices shall be constructed of metallic material which is either corrosion-resistant or which is treated or coated to resist corrosion under shipboard environmental conditions. Surfaces that contact the semiconductor device and surfaces to which electrical contacts are made shall not be painted or anodized, but shall be plated or otherwise coated to form surfaces to which the connections or junctions are made and which will retain their mechanical, thermal, and electrical effectiveness for the life of the equipment. Heat dissipators shall be sized to dissipate the heat generated by the device of highest losses that may be expected to meet the device specification, and to do so under the highest ambient temperature conditions without exceeding the limiting temperatures specified. Maximum power dissipation may be estimated from calculations taking into account the mode of operation of the devices in the circuit, the worst stress levels applied, and the limiting device characteristics as covered by the device specification. Maximum power dissipation may also be estimated by using published data for a particular brand of device, and scaling up the losses using a factor calculated from parameter limits applicable to the particular brand of device and specification limits, taking into account the influence of the parameters considered on the losses under the mode of operation in the circuit, and allowing for any difference in form factor involved in the way the values are given. Where maximum power dissipation at rated conditions is specified and controlled by the device specification, this value corrected for the stress levels of the application shall be used in the design.

3.4.4 Transformers, reactors, inductors, and chokes. Power transformers shall have electrically isolated primary and secondary windings. Open-delta connected transformers shall not be used. The temperature class of transformers or inductors shall be such that the maximum operating temperature for that class, as given in the transformer specification, shall not be exceeded under any condition of operation when the degaussing equipment is operating in the specified ambient conditions.

3.4.4.1 Transformers weighing less than 15 pounds. Transformers (audio, power, and pulse), inductors, magnetic amplifier reactors and saturable reactors that weigh less than 15 pounds shall be in accordance with requirement 14 of MIL-STD-454 for grade, class, and life expectancy.

3.4.4.2 Transformers weighing more than 50 pounds. Transformers (audio, power, and pulse), inductors, and saturable reactors that weigh more than 50 pounds shall conform to the following requirements:

(a) Be designed for a life expectancy of 40,000 hours minimum.
(b) Be constructed in accordance with the requirements (materials, wire, types, electrical insulation and insulating procedures, fastening devices, creepage and clearance distances, and so forth) of MIL-E-917.
(c) Survive without any degradation, whatsoever, equipment environmental tests (shock, vibration, humidity, dielectric strength, and so forth) when installed in the degaussing equipment.

3.4.4.3 Transformers weighing between 15 and 50 pounds. Transformers (audio, power, and pulse), inductors, and saturable reactors that weigh between 15 and 50 pounds shall be in accordance with the requirements of either 3.4.4.1 or 3.4.4.2.

3.4.5 Synchros. Synchros shall be in accordance with MIL-S-20708. Installation requirements shall be in accordance with MIL-HDBK-225. The secondary load impedance for the synchro control transformers shall be not less than 30,000 ohms.

3.4.5.1 Synchro capacitors. Power factor correction synchro capacitors shall be connected across the stator leads of all differential synchros and control transformers. Synchro capacitors shall be delta connected and shall be rated at 600 Vdc. The capacitors shall be matched to within 1 percent total variation before connections are made and to within 0.5 percent total variation when measured as a closed delta. Synchro capacitors shall have the following values within plus or minus 5 percent:

Synchro	Synchro capacitor (capacitance in microfarads (μF))
15CDX6	0.56-0.56-0.56
15CT6	.19- .19- .19
18CT6	.24- .24- .24
18CDX6	.75- .75- .75
23CT6	.27- .27- .27
23CDX6	1.31-1.31-1.31

3.4.5.2 Synchro electrical zero and equipment mechanical zero. In order that synchro components may work together properly in a system, it is essential that they be correctly connected and aligned with respect to each other and to the device or parent equipment with which they are used. Electrical zero is the reference point for alignment of all synchro components. The mechanical zero or reference point for the device or parent equipment using synchro components depends upon the particular application of the equipment involved. Whenever a synchro component is used, either as a transmitter or receiver, the synchro electrical zero and the equipment mechanical zero shall be physically positioned to the same point. Synchros shall be electrically zeroed by the method prescribed in MIL-HDBK-225 prior to delivery of equipment.

3.4.6 Indicator lights. Display type, two lamp indicator lights with legend shall be used for all indicator lights, except blown fuse indicators and power supply power available lights. The lights shall be standardized such that one type lamp is common for all applications. Indicator lights shall be furnished complete with lamps and globes. Color designations for all equipment except remote control unit shall be as follows:

(a) Red - excess error, power supply overheating, interlock bypassed, and remote blown fuse indicators.
(b) White - power on or power available.
(c) Green - automatic or manual operation.

3.4.7 Processes. Processes such as soldering, welding, corrosion-resisting treatments, painting, encapsulation, and so forth, shall be in accordance with requirements of MIL-STD-2036.

3.4.8 Safety.

3.4.8.1 Safety criteria. Safety criteria shall be in accordance with MIL-STD-2036. Interlocks with bypass devices shall be provided. Bypass warning indicator and means for providing interlock bypass warning indicator signal to control equipment shall be provided.

3.4.8.2 Safety analyses. Safety analyses shall be performed in accordance with MIL-STD-2036.

3.4.9 Human engineering participation. The contractor shall ensure that human engineering considerations specified in MIL-STD-1472 and MIL-H-46855 are not degraded during detail design and construction.

3.5 Design for maintenance.

3.5.1 Modular construction. Equipment shall use modular construction in accordance with MIL-STD-2036 and the detailed requirements specified herein.

3.5.1.1 Repairable replaceable subassemblies. Equipment shall be functionally divided into repairable subassemblies in a manner that will make it feasible for technicians with limited experience, using simple, readily available test equipment (see 3.5.2), to perform corrective maintenance on the equipment. Corrective maintenance on the equipment is any and all maintenance required to restore the equipment to a satisfactory condition, except maintenance associated with the repair of the replaceable "plug-in" subassemblies.

3.5.1.2 Modular subassemblies. "Plug-in" modular subassemblies shall be designed such that they can be interchanged between assemblies and equipment without any mechanical or electrical adjustment, and such that the system performance characteristics are identical to those obtained prior to the interchange of subassembly and equipment. "Plug-in" subassemblies shall be designed such that they cannot be inadvertently plugged into wrong location.

3.5.1.3 Test points. Test points for measuring all pertinent power and signal (input and output) levels throughout the equipment shall be provided. Using these test points and the test equipment specified (see 3.5.2), it shall be possible to determine the satisfactory or unsatisfactory condition of each unit, each major assembly, each replaceable subassembly and each part that is not located in a "plug-in" modular subassembly. These test points shall be accessible, with the enclosure open and equipment energized, without endangering personnel, and without removing any parts or subassemblies to gain access.

3.5.1.4 Test facilities. Built-in test facilities (other than those described in 3.4.1) to permit monitoring of various subassembly inputs and outputs on a "GO, NO-GO" basis, shall not be provided. Simple passive circuits, to condition signals to test points described in 3.5.1.3, such that test equipment described in 3.5.2 can be used to monitor these signals, shall be provided where necessary (see 6.11.2).

3.5.2 Test equipment. Equipment shall be designed so that all preventive and corrective maintenance (other than the repair of "plug-in" modular subassemblies) can be performed with the following test equipment:

(a) Digital multimeter - Fluke 8000A/BU or equivalent.
(b) Megger - PSM-1A or equivalent - For measuring degaussing coil insulation resistance.

3.5.2.1 Replaceable subassemblies. Replaceable subassemblies shall be designed so that all corrective maintenance can be performed with the test equipment listed in 3.5.2 and the following additional test equipment:

(a) Oscilloscope - AN/USM-368 or equivalent.

3.5.3 Servicing. Equipment shall be fully operable with covers, drawers, or doors open or withdrawn for servicing. This requirement shall be met without the use of accessory test cables.

3.5.3.1 Drawers and doors. Drawers and doors shall be provided with automatic locking devices to prevent accidental reclosing during inclination when the drawers or doors are fully opened or extended.

3.5.4 Test extensions. Test extensions shall be supplied for all "plug-in" subassemblies. Each extension shall provide electrical connection between the equipment and a remotely located subassembly to enable safe troubleshooting of each plug-in subassembly under its actual operation conditions but outside the equipment enclosure. An extension, or set of extensions, shall be provided for the switchboard unit and for each power supply. A single universal extension that can be used with all subassemblies in equipment is desirable.

3.5.4.1 Connectors. Test extensions shall be equipped with connectors to mate connectors in equipment and on subassembly. They shall be clearly and indelibly marked such that the appropriate extension can be quickly and easily identified. They shall be mounted and stored in the switchboard enclosure.

3.5.5 Internal controls and adjustments. The number of internal controls and adjustments shall be kept to a minimum consistent with the operation and maintenance of the equipment and elimination of all need for the individual selection of parts. Accuracies and long term stability shall be designed and constructed into the equipment by the use of feedback circuits where needed. Adjustable circuit elements shall not be used in feedback circuits. Each adjustment shall be independent of all other adjustments. Adjustments of one circuit element shall not affect the adjustment of any other circuit element.

3.5.5.1 Adjustment controls. Adjustment controls shall be of a size, location, and operation to facilitate use. Test point receptacles shall be provided to connect all test equipment required for making adjustments. Adjustable circuit elements and test points shall be located such that all adjustments can be made without endangering personnel, without removing any parts, subassemblies, wires, or connections to gain access, and without the use of test extensions specified in 3.5.4.

3.6 Performance.

3.6.1 Electrical design. Electrical design requirements shall be in accordance with MIL-STD-2036 and with the detailed requirements specified herein.

3.6.1.1 Power source. The degaussing equipment shall operate from and meet the constraints of a type I, 60-Hz, three-phase, ungrounded, ac shipboard power system in accordance with DOD-STD-1399, section 300. The equipment shall operate and maintain specified performance when the input voltage and frequency are within the user voltage tolerances (steady-state tolerance) specified by DOD-STD-1399, section 300. The equipment shall withstand, without damage, the transients and power interruptions specified by DOD-STD-1399, section 300.

3.6.1.1.1 Input protection. The equipment shall not be damaged due to momentary interruptions (up to 30 seconds), loss of single phase (with three-phase input), low input line voltage, or a short circuit on the input power lines.

3.6.1.1.2 Insulation resistance. Input power connections and chassis ground shall be isolated by greater than 10 megohm resistance at 500 Vdc. Input power connections and dc output voltage and return shall be isolated by greater than 10 megohm resistance at 500 Vdc.

3.6.1.1.3 Input capacitive loading. The capacitive loading on any input line to chassis ground shall be not greater than 0.01 μF.

3.6.1.1.4 Input current balance. The rms values of the input currents on the three-phase ac input lines shall be within 5 percent of each other when the source voltage is balanced within 1 percent between the input lines.

3.6.1.1.5 Spike voltage. The equipment shall withstand, without damage, the 2,500 volt spike specified in DOD-STD-1399, section 300.

3.6.1.1.6 Inrush current. The peak inrush current during the entire turn-on cycle shall be limited to ten times the input steady state true rms or dc current at maximum rated load and maximum rated input voltage.

3.6.1.1.7 Harmonic current limitation. The equipment shall minimize harmonic current distortion effects on the electrical system. The equipment shall be in accordance with the harmonic current limitation requirements specified in DOD-STD-1399, section 300.

3.6.1.1.8 Power factor. The power factor shall be between 0.8 and unity.

3.6.1.1.9 Electrical bonding. Equipment shall have a minimum of 1 zero-volt reference connector pin connected directly to all external parts of the unit (excepting other connector pins or parts requiring electrical isolation). Dc resistors between the connector pin and any part of the chassis shall be 1.0 ohm, maximum. Protective finishes shall be omitted (or removed) from bonding surfaces. Design shall ensure permanence of low impedance bond over long periods in the presence of humid and saline atmospheres.

3.6.1.1.10 Synchro circuits. Synchro circuits shall operate from a type I, 115 volts root mean square (Vrms), 60-Hz, single-phase, gyro reference source. The maximum power required from gyro reference source shall not exceed 100 watts.

3.6.1.1.11 Kva of power supplies. The Kva of each power supply shall not exceed the maximum value specified in table II.

3.6.1.1.12 Balanced three-phase load. Equipment shall operate as a balanced three-phase load on the power source. Criteria for balanced load shall be as defined in DOD-STD-1399, section 300.

3.6.1.1.13 Equipment connection. Equipment shall be connected by a three-wire, three-phase connection. The equipment shall not constitute a ground or require grounding, either directly or by means of filter capacitors, of the ship service power source.

3.6.1.2 Start-stop procedures. Special "turn-on" or "turn-off" procedures shall not be required. Equipment will normally be turned on and off with the coil "ON-OFF" switch in the coil control section. Equipment will occasionally be turned on or off with interlock switches.

3.6.1.3 Accuracy. Accuracies shall be designed and constructed into the equipment by use of feedback circuits. Accuracies shall be demonstrated for each unit (that is, switchboard and power supplies).

3.6.1.3.1 Accuracy of the switchboard unit. The actual magnitude of the switchboard unit output voltages or control signals to the power supplies shall not differ from the ideal output voltages, as defined in 3.4.1.5.1 on an instantaneous basis by more than 0.15 Vdc for any one or combination of the following conditions:

(a) Heading changes at any rate up to and including a maximum rate of 5 degrees per second.
(b) Power source voltage and frequency variations within tolerances referenced in 3.6.1.1.
(c) Temperature, humidity, and magnetic field variations within tolerances specified in 3.6.3.1, 3.6.3.2 and 3.6.3.3, respectively.
(d) Shock, vibration, and inclination conditions specified in 3.6.3.4, 3.6.3.5, and 3.6.3.7, respectively.
(e) Variations in degaussing coil resistance and inductance throughout the ranges specified in 3.4.1.7.3.

3.6.1.3.1.1 FI-QI and A coil currents. The FI-QI and A coil currents shall follow the ship's heading (OSH signal) within the specified tolerance during automatic operation as cited conditions are varied. The M and FP-QP outputs and FI-QI and A outputs during manual operation shall not change by more than the specified tolerance as the cited conditions are varied. The specified tolerance shall be applicable with any possible combination of control settings and with controls set for any output between zero and rated.

3.6.1.3.1.2 Operation switch accuracy. Accuracy of the eight-course emergency operation switch (see 3.4.1.5.3.3) and its associated circuits shall be such that the FI-QI and A coil outputs, obtained as this switch is rotated during manual operation, shall not differ from the ideal output by more than 0.10 volt.

3.6.1.3.2 Accuracy of power supplies. The actual magnitude of the power supply output current shall not differ from the ideal output current, as defined in 3.4.1.7.1, on an instantaneous basis by more than 3 percent of rated output current for any one or combination of conditions specified in 3.6.1.3.1.

3.6.1.3.3 Accuracy of ground detector. The ground detector shall read the insulation resistance to ground with the following tolerances:

(a) Insulation resistance up to 0.5 megohm within plus or minus 25,000 ohms.
(b) Insulation resistance between 0.5 and 2 megohms within plus or minus 100,00 ohms.
(c) Insulation resistance above 2 megohms within plus or minus 20 percent of actual value.

3.6.1.4 Equipment protection. Protective devices shall be provided for protection of the equipment from damage due to faults in the equipment, grounds in the ship service power source, open or shorted degaussing coils, grounded degaussing coils, or the loss of one phase of the three-phase power source.

3.6.1.4.1 Power and source interruptions. Equipment shall withstand, without damage, the tripping of circuit breakers or blowing of fuses, power source interruptions, transient variations, insulation resistance tests, or ground detector tests described in DOD-STD-1399, section 300. After restoration of power, the equipment shall automatically perform its intended function without any adjustments. The manual resetting of breakers, and the like, shall not be required.

3.6.1.4.2 Fuses. Blown fuse indicators shall be provided for all fuses.

3.6.1.4.2.1 Fuse application. Circuits shall be designed and fuses applied such that the random or unexplained blowing of fuses does not occur. The blowing of a fuse, due to causes other than part failure in equipment or shorts or open circuits in load, shall be considered an equipment failure.

3.6.1.4.2.2 Filter capacitors. Circuits with aluminum electrolytic filter capacitors shall be fused to protect against capacitor failure or excess leakage.

3.6.1.4.2.3 Fuse holders. Fuse holders shall be constructed of phosphor bronze.

3.6.1.4.3 Fail-safe features. Fail-safe features shall be included in the equipment design whenever feasible. Fail-safe operation is defined as the mode of operation where the degaussing coil current decreases to zero when equipment fails. The equipment shall be designed such that fail-safe operation is obtained whenever any of the protective devices open or operate.

3.6.1.5 Electrical creepage and clearance distances. Minimum creepage and clearance distances between circuits and between circuits and ground shall be in accordance with MIL-STD-2036.

3.6.1.6 Warm-up. Equipment shall operate normally immediately after being energized in any of the environments specified in 3.6.3. Immediately (within a few seconds) after being energized, degaussing coil currents shall be within 10 percent of the required currents. After a 30-minute warm-up period, degaussing coil currents shall be within 1 percent of the values set prior to energizing (during last period of operation) and equipment performance shall comply with the accuracy requirements specified in 3.6.1.3. Compliance with all of the requirements specified or referenced in this paragraph shall be obtained without making adjustments of any kind after energizing equipment or during warm-up period.

3.6.1.7 Dielectric withstanding voltage and insulation resistance. Dielectric withstanding voltage and insulation resistance requirements shall be in accordance with MIL-STD-2036.

3.6.1.8 Leakage current. Leakage current shall be in accordance with the requirements of MIL-STD-2036.

3.6.2 Mechanical design. Mechanical design requirements shall be in accordance with MIL-STD-2036 and detailed requirements specified herein.

3.6.2.1 Enclosures. Equipment shall be enclosed in dripproof protected (45-degree) enclosures in accordance with MIL-STD-108 and the class 1 requirements of MIL-E-2036. The switchboard and power supplies shall be enclosed in deck-mounted, dead-front enclosures and they shall be constructed such that they can be located in a row, side-by-side, with the back of the enclosure next to (or near) a bulkhead. The remote control unit shall be enclosed in a bulkhead-mounted, dead-front enclosure.

3.6.2.2 Size. Equipment size shall be as specified on figures 2 through 6.

3.6.2.3 Weight. Equipment weight shall be the minimum commensurate with requirements; however, unit weights shall not exceed the following:

(a) Degaussing switchboard - 1400 pounds.
(b) Remote control - 50 pounds.
(c) Power supply for 3 and 5 kilowatt (kW) - 1300 pounds.
(d) Power supply for 8, 12, and 16 kW - 1800 pounds.
(e) Power supply for 20 and 26 kW - 2000 pounds.
(f) Power supply for 32 and 40 kW - 3000 pounds.

3.6.2.4 Cooling. Switchboard unit, remote control unit, and 3 and 5 kW power supplies shall be cooled by natural draft. The larger power supplies, 8 through 40 kW, shall be forced air cooled. Forced air cooled units shall have air filters in accordance with MIL-STD-2036. Cabinets shall be such that the filters may be removed from the front and that no cooling air intake or exhaust shall be at rear.

3.6.2.5 Accessibility. Front access shall be provided to all parts and assemblies in the equipment. No side or back access shall be required for operation or maintenance of any unit of equipment.

3.6.2.6 Cable entrance. Cable entrance plates, located on the bottom of the enclosure, shall be provided for installing cable stuffing tubes. Plates shall be located as illustrated on figures 2 through 6.

3.6.3 Environmental conditions.

3.6.3.1 Temperature. Equipment shall be capable of continuous reliable operation throughout an ambient temperature range of 0 to 50°C. The equipment shall not be damaged nor shall the operational performance be degraded when restored to the operating temperature range after long periods of inoperation throughout an ambient temperature range of minus 62 to plus 71°C.

3.6.3.2 Humidity. Equipment shall be capable of continuous operation at relative humidities ranging up to 95 percent for both continuous and intermittent periods, including conditions where condensation takes place in and on the equipment in the form of both water and frost.

3.6.3.3 Magnetic environment. Equipment shall be capable of continuous operation in both an ambient steady-state magnetic field from 0 to 1600 amperes per meter (A/m) and a varying magnetic field having a maximum rate of change of 1600 A/m per second, in accordance with DOD-STD-1399, section 070.

3.6.3.4 Shock. The equipment shall be capable of continuous operation during and after high impact (H.I.) shock test in accordance with type A, grade A, class I requirements of MIL-S-901. Shock and vibration mountings shall not be used.

3.6.3.5 Vibration. The equipment shall be capable of continuous operation during and after type I vibration test of MIL-STD-167-1. Resilient mounts shall not be used or required.

3.6.3.6 Noise.

3.6.3.6.1 Airborne noise. The airborne noise requirements for the switchboard and remote control unit shall be in accordance with the grade A_{12} requirements of table I of MIL-STD-740-1. The airborne noise requirements for the power supplies shall be in accordance with the grade C requirements of table I of MIL-STD-740-1.

3.6.3.6.2 Structureborne noise. The structureborne noise requirements for the switchboard, remote control unit, and the power supplies shall be in accordance with the type II requirements of figure 2 of MIL-STD-740-2.

3.6.3.7 Inclination. The equipment shall be capable of continuous reliable operation when inclined up to 45 degrees in any direction.

3.6.3.8 Electromagnetic interference. The equipment shall be in accordance with the requirements of MIL-STD-461 for class A4 equipment. The equipment shall comply with the requirements for CE01, CE03, CS01, CS02, CS06, RE01, RE02, RS01, RS02, and RS03.

3.7 Identification plates. Identification plates and identification plate markings shall be in accordance with the type A, B, or C requirements of MIL-P-15024 and MIL-P-15024/5. The applicable stock number will be provided by the contracting activity for inclusion on the identification plate prior to shipping (see 6.14). Serial numbers shall be assigned in accordance with MIL-STD-2036.

3.7.1 Parts identification. Parts identification by reference designations and function identification of items shall be in accordance with MIL-STD-2036.

3.8 Training. Training shall be provided when and as specified (see 6.2).

3.9 Engineering services. When specified (see 6.2), the contractor shall provide engineering assistance during installation and adjustment of the degaussing control equipment. This assistance shall consist of the contractor's personnel visiting the location of installation and checking the proper operation of the degaussing equipment (see 6.3). The contractor shall furnish the engineering services specified herein above at the specific places and times designated by NAVSEA.

3.10 Workmanship. Workmanship shall be in accordance with requirement 9 of MIL-STD-454.

4. QUALITY ASSURANCE PROVISIONS

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

4.1.1 Responsibility for compliance. All items shall meet all requirements of sections 3 and 5. The inspection set forth in this specification shall become a part of the contractor's overall inspection system or quality program (see 6.3). The absence of any inspection requirements in the specification shall not relieve the contractor of the responsibility of ensuring that all products or supplies submitted to the Government for acceptance comply with all requirements of the contract. Sampling inspection, as part of the manufacturing operations, is an acceptable practice to ascertain conformance to requirements, however, this does not authorize submission of known defective material, either indicated or actual, nor does it commit the Government to accept defective material.

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

(a) First article inspection (see 4.4).
(b) Quality conformance inspection (see 4.5).

4.3 Inspection conditions and adjustments.

4.3.1 Inspection conditions. Except for those tests where the following factors are variables (or otherwise specified herein), tests shall be conducted with the equipment operating under the following conditions:

(a) Ambient temperature - 25 ± 5°C.
(b) Relative humidity - ambient.
(c) Supply voltage - 440 Vrms, 60 Hz, plus or minus 5 percent.
(d) Load resistance - maximum rated.

4.3.2 Adjustment, alignment, and repairs. Equipment shall be completely adjusted or aligned and have all features operating in accordance with the requirements of this specification before starting Government witnessed tests (see 6.3 and appendix B).

4.3.2.1 Adjustment and alignments during operating test. Adjustments and alignments made during the operating test (see 4.6.2.3) are not subject to the conditions specified in 4.3.2.

4.4 First article inspection. First article inspection shall consist of the examination and tests specified in table IV.

TABLE IV. First article inspection.

Test or examination	Requirement	Test method
Examination		
Visual	3.3, 3.4.7, 3.4.8 3.6.1.5, 3.7	4.6.1
Weights and dimensions	3.6.2.2, 3.6.2.3	4.6.1.1
Accelerated life (reliability)	3.2	4.6.2.1
Maintainability	3.2	4.6.2.2
Operating	3.4, 3.5	4.6.2.3
Pre-performance	3.4, 3.5, 3.6	4.6.2.4
Interchangeability	3.4.1.4.1, 3.5.1	4.6.2.5
Ripple	3.4.1.5.1.5, 3.4.1.7.4	4.6.2.6
Power	3.6.1.1	4.6.2.7
Harmonic current limitation	3.6.1.1.7	4.6.2.8
Accuracy	3.6.1.3	4.6.2.9
Equipment protection	3.6.1.4	4.6.2.10
Warmup	3.6.1.6	4.6.2.11
Dielectric withstanding voltage and insulation resistance	3.6.1.7	4.6.2.12
Leakage current	3.6.1.8	4.6.2.13
Effectiveness of enclosure	3.6.2.1	4.6.2.14
Temperature rise	3.6.3.1	4.6.2.15
Temperature and humidity	3.6.3.2	4.6.2.16
Shock	3.6.3.4	4.6.2.17
Vibration	3.6.3.5	4.6.2.18
Noise	3.6.3.6	4.6.2.19
Inclination	3.6.3.7	4.6.2.20
Electromagnetic interference	3.6.3.8	4.6.2.21

4.4.1 Order of tests. First article inspection may be conducted in any order or sequence convenient to the testing activity except as required for compliance with the following:

(a) The vibration test shall be conducted after the shock test to aid in the discovery of loose or weakened parts.
(b) Accelerated life test shall be conducted after all other tests.

4.5 Quality conformance inspection. Quality conformance inspection shall be conducted on each equipment offered for delivery. The equipment shall be subjected to the examination and tests specified in table V.

TABLE V. Quality conformance inspection.

Test or examination	Requirement	Test method
Examination	3.3, 3.4.7, 3.4.8 3.6.1.6, 3.7	4.6.1
Operating	3.4, 3.5	4.6.2.3
Ripple	3.4.1.5.1.5, 3.4.1.7.4	4.6.2.6
Accuracy	3.6.1.3	4.6.2.9
Dielectric withstanding voltage and insulation resistance	3.6.1.7	4.6.2.12

4.5.1 Quality conformance inspection procedures. Quality conformance inspection shall be conducted in accordance with the detailed inspection procedures used and accepted for first article inspection.

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

4.6 Methods of inspection.

4.6.1 Examination. Equipment shall be given a thorough examination to determine conformance to the applicable requirements and drawings for the following:

(a) Workmanship, assembly and fit (see 3.10).
(b) Materials and parts (see 3.3).
(c) Finishes (see 3.4.7).
(d) Safety requirements (see 3.4.8).
(e) Designations and markings (see 3.7).
(f) Creepage and clearance distances (see 3.6.1.5).

4.6.1.1 Weights and dimensions. The weights and dimensions (overall and mounting) of each unit of equipment shall be determined and compared with the applicable requirements and values given on the drawings and in the manual.

4.6.2 Test methods.

4.6.2.1 Accelerated life test. The equipment shall be subjected to accelerated life tests specified in MIL-STD-2036, except the test period shall be 500 hours in lieu of 360 hours. The test period shall be increased to 500 hours by repeating the high temperature voltage/frequency cycling tests at 95 percent relative humidity for 94 cycles instead of 59 cycles. The supply voltage shall be cycled (varied) plus or minus 5 percent; the supply frequency shall not be cycled (varied), and the relative humidity shall be ambient (uncontrolled) during all phases of test for which the specified relative humidity is less than 90 percent.

4.6.2.1.1 Induced magnitude controls. During the accelerated life test, the M and FP-QP induced magnitude controls shall be set such that the output current of the M coil power supply is equal to 70 percent of rated output current and the output current of the FP-QP power supply is equal to 100 percent of rated output current. The A and FI-QI controls shall be set for automatic operation and the A and FI-QI automatic induced magnitude controls shall be set for maximum rated current for A and FI-QI power supplies. The A and FI-QI circuits shall be operated with heading signals from a ship's gyro synchro transmitter varying at a rate of approximately 5 degrees per second. The A and FI-QI power supply currents shall vary between positive and negative maximum rated currents. Heading change direction shall be reversed once in each 24-hour period.

4.6.2.1.2 Output currents. The M and FP-QP output currents and the A and FI-QI maximum output currents shall be recorded at the specified intervals during test.

4.6.2.1.3 Retest of equipment. After completion of the accelerated life test, the equipment operation shall be completely tested to determine that the equipment was not damaged, and data for curves 1 and 2 (see appendix D) shall be taken to determine that equipment alignment and adjustments were not affected.

4.6.2.1.4 Shutdown. A malfunction causing "shutdown", the operation of a protective device (see 3.6.1.4), or "out of specified limit" performance during the accelerated life test shall be considered as a failure requiring corrective action. Upon completion of corrective action, the test shall be restarted and run according to the following conditions, until a satisfactory 500-hour run is completed.

(a) If failure occurs during the first 25 percent of the endurance test, restart the test from "0" time and continue test to complete the 500-hour test.
(b) If failure occurs between 25 and 100 percent of the endurance test, restart from time equal to hours when failure occurred minus 125 hours and continue test to complete the 500-hour test.
(c) A repeat failure of the same part, similar parts performing the same function, or similar parts performing dissimilar functions shall be cause to discontinue the test to correct the deficiency. If the test is discontinued, action shall be taken to determine the cause of failure and to correct the deficiency. Verification of the corrective action shall be accomplished by a continuation of test, wherein the test item shall accumulate at least 250 hours of test time without recurrence of the failure.

4.6.2.1.5 Equipment acceptance. The equipment shall be accepted upon successful completion of the 500-hour test with less than three failures. In the event that more than two failures occur, the test shall be discontinued (see 3.2.5, 6.9, and 6.11).

4.6.2.2 Maintainability test. The maintainability test shall be performed in accordance with MIL-STD-471. The MTTR shall be as specified in 3.2.6.

4.6.2.3 Operating test. Each complete set of degaussing equipment configured for and to be shipped to a particular ship (see 3.4.1.4) shall be interconnected, energized, and subjected to an operating test to ensure qualitatively the proper functioning of the equipment, including all test features, test controls, adjustments, indicating devices, trouble circuits, and safety features, such as interlocks and discharge circuits. This test shall demonstrate that all current controls provide for adjusting currents over the required range with the specified resolution. The equipment shall be tested to demonstrate that alignment procedure specified in the manual is adequate for aligning the equipment. The alignment procedure shall be included in the detailed test procedure. The set of equipment shall be operated for at least 1/2 hour with all currents adjusted for maximum rated current from all power supplies simultaneously.

4.6.2.3.1 Ground detector. The ground detector circuit shall be tested using known resistance values of 0.2, 0.5, and 2 megohms connected from load to ground. Measurements shall be made on each coil for each of the above specified resistance values.

4.6.2.4 Pre-performance. A pre-performance test shall be conducted in accordance with MIL-STD-2036 to determine compliance with the requirements of 3.4, 3.5, and 3.6.

4.6.2.5 Interchangeability test. Interchangeability test shall be performed to determine compliance with 3.4.1.4.1 and 3.5.1. The various assemblies and "plug-in" subassemblies shall be interchanged at random. The equipment shall then be tested to determine proper operation of the equipment. The tests shall then include as a minimum a pertinent operating test (see 4.6.2.3) and an accuracy test (see 4.6.2.9).

4.6.2.6 Ripple. The equipment shall be tested to determine compliance with requirements of 3.4.1.5.1.5 and 3.4.1.7.4. Measured ripple voltages shall be recorded for worst case conditions (for example: supply voltage, load resistance, and output current set for maximum ripple). Data shall be recorded to indicate worst case condition.

4.6.2.7 Power. Switchboard and power supply input voltages, currents and wattages, and output voltages and currents shall be measured and recorded for zero, one-half, and full-rated current output. The percent load unbalance shall be calculated in accordance with DOD-STD-1399, section 300 to determine compliance with 3.6.1.1.11.

4.6.2.8 Harmonic current limitation. Harmonic current limitation shall be tested in accordance with DOD-STD-1399, section 300 to determine compliance with 3.6.1.1.7.

4.6.2.9 Accuracy. The equipment shall be tested to determine compliance with requirements of 3.6.1.3 for various environmental conditions and operational modes (see 6.3 and appendix C).

4.6.2.9.1 Automatic operation. Equipment shall be set up for automatic operation and tests specified in 4.6.2.9.1.1 through 4.6.2.9.1.2.2 conducted at nominal supply conditions.

4.6.2.9.1.1 Static accuracy. Data for curves 1 through 6 shall be taken for FI-QI and A coils to demonstrate static accuracy. Data for curves 7 and 8 shall be taken for A coil to demonstrate static accuracy, limiting, and proper summation of induced and perm currents. Data for curve 9 shall be taken for both the FI-QI and A coils to demonstrate H-zone switch accuracy.

4.6.2.9.1.2 Dynamic accuracy. The OSH signal shall be varied and common time base oscillograph recordings of errors and outputs for both the FI-QI and A coils shall be taken to demonstrate dynamic accuracy of both switchboard and power supply outputs. Equipment shall be set up as specified for curves 1 and 2 and magnetic variation control locked at zero degrees. Power supplies shall be connected to an inductive load of 100 millihenries in series with the maximum rated-load resistance. The test shall be conducted with heading change rotating in a clockwise direction and repeated with heading change rotating in a counter-clockwise direction.

4.6.2.9.1.2.1 Switching and power supply errors. Provisions shall be made to record, on an oscillograph, the OSH signal to the switchboard, switchboard output voltages (V_F and V_A), power supply output currents, and actual errors (difference between normalized input and output) due to switchboard and power supply. Recordings of error and outputs shall be made simultaneously for the following conditions:

(a) Static response with OSH signal set for 0, 90, 180, and 270 degrees to obtain data to validate calibration of error and output traces. The recorder shall be run for a few seconds at each set point while output voltages and currents are measured with accurate meters. Measured values shall be written on the oscillograph.
(b) Dynamic response with heading changing at 5 degrees per second clockwise.
(c) Dynamic response with heading changing at 5 degrees per second counter-clockwise.
(d) Dynamic response with heading changing clockwise as required to obtain a 3 percent error (from either switchboard or power supply).
(e) Dynamic response with heading changing counter-clockwise as required to obtain a 3 percent error.

4.6.2.9.1.2.2 Oscillographs. Oscillographs shall be given an identifying number and annotated as required to record all significant information, such as: date, test operator, channel, equipment, oscillograph identification, scale factors, amplitudes, and frequencies.

4.6.2.9.2 Manual operation. The switchboard unit shall be set up for local, manual operations, and nominal supply conditions. The M and FP-QP induced magnitude controls and FI-QI and A manual induced magnitude controls shall be set for plus 5.0 volts from switchboard. The perm magnitude control shall be set for plus 2.0 volts. The H-zone switch shall be set to the 0.40 position. The eight-course switch shall then be switched through its eight positions and output voltages for each of the M, FI-QI, A, and FP-QP coils shall be recorded for each position. The eight-course switch shall then be set to NE position and the H-zone switch shall be switched throughout its eight positions. The FI-QI and A output voltages shall be recorded for each H-zone switch position.

4.6.2.9.3 Power supply accuracy. Each power supply not tested for accuracy during the automatic operation accuracy test of 4.6.2.9.1 shall be tested for accuracy as follows:

(a) Static accuracy shall be demonstrated by taking data for curve 10.
(b) Dynamic accuracy shall be demonstrated by testing as specified in 4.6.2.9.1.2, using an FI-QI or A output from switchboard unit, or an equivalent voltage, as a signal source. Power supply input voltage, output current, and actual error shall be recorded on oscillographs.

4.6.2.9.4 Accuracy versus supply variations. The tests listed below shall be conducted with each of the following supply conditions:

Supply condition	Voltage	Frequency
1	462	57 Hz
2	418	63 Hz

(a) Data for curves 1 and 2 shall be taken for the FI-QI and A channels with the equipment set up as specified in 4.6.2.9.1.1.
(b) Dynamic accuracy test of 4.6.2.9.1.2 shall be repeated for the A channel (if a 4-coil unit is supplied) or FI-QI channel (if a 3-coil unit is supplied).
(c) Stability of manual current settings versus supply shall be demonstrated by repeating test of 4.6.2.9.2. The current controls shall be set to the values specified with supply voltage and frequency set for 440 Vrms and 60 Hz, respectively.

4.6.2.10 Equipment protection. The equipment shall be tested to determine compliance with 3.6.1.4 when subjected to the following conditions:

(a) Open, grounded, and shorted load resistance.
(b) Power interruption, transient voltage, transient frequency and spike voltage tests in accordance with MIL-E-16400, except the 700-volt transient test shall not be performed.

The equipment shall be tested after being subjected to each of the above conditions as appropriate. After the equipment has been subjected to all above conditions, the accuracy test (curves 1, and 2 or curve 10 (see 4.6.2.9)) shall be repeated to establish that equipment was not damaged.

4.6.2.11 Warm-up time. The equipment shall be placed in an ambient temperature of minus 3 $\pm$ 5°C for a period of not less than 8 hours with the equipment deenergized. The equipment shall then be energized and the operation shall be monitored immediately to determine compliance with 3.6.1.6. After equipment has been energized for a 30-minute period, the output shall again be monitored to determine compliance with 3.6.1.6.

4.6.2.12 Dielectric withstanding voltage and insulation resistance. Electrical circuits connected to external power source (see 3.6.2.1) and degaussing coils (see 3.4.1.7.5) shall be subjected to dielectric withstanding voltage and insulation resistance tests in accordance with MIL-STD-2036 to determine compliance with the requirements of 3.6.1.7.

4.6.2.13 Leakage current. Power supply leakage current shall be tested in accordance with MIL-STD-2036 to determine compliance with 3.6.1.8.

4.6.2.14 Effectiveness of enclosure. The equipment shall be tested in accordance with MIL-STD-108 to determine compliance with 3.6.2.1.

4.6.2.15 Temperature rise. Temperature measuring detectors shall be placed at critical points throughout each unit of the equipment (except remote unit) covering suspected "hot spot" areas (both ambient and peak temperatures). At least ten detectors shall be used. Arrangements shall be made to measure temperature rise of large power transformers and reactors (see 3.4.4.2) by the "change-in-resistance" method. Data for curves of resistance versus time shall be taken such that hot resistance at instant of shutdown can be obtained by extrapolation. The equipment shall be completely assembled and mounted in a manner for which it is designed and arrangements shall be made to protect the equipment from drafts and heat radiation from other sources. The equipment shall be operated continuously with maximum output current in a constant ambient temperature (plus or minus 5°C) until a stable temperature condition has been reached. Temperature ratings shall be recorded at 30-minute intervals during test. The log of this data shall clearly identify the location of the temperature detectors, type of detector, method of locating or attaching detectors, temperatures measured (including local ambient), and date and time of measurement. The temperature of each point shall be determined to ensure that parts will operate within their allowable temperature limits at the maximum continuous design ambient temperature (see 3.6.3.1).

4.6.2.16 Temperature and humidity test. The equipment shall be subjected to the temperature and humidity test to determine compliance with the requirements of 3.6.3.1 and 3.6.3.2. The test shall be as specified in MIL-STD-2036, except that the storage or non-operating temperature tests (that is, 24 hours at minus 62°C and 48 hours at plus 71°C) shall not be performed and the relative humidity shall be ambient (uncontrolled) during all tests for which the specified relative humidity is less than 90 percent.

4.6.2.16.1 Reference measurements. Reference measurements to be made prior to, during, and after temperature and humidity tests shall consist of static accuracy tests as specified in 4.6.2.9.1.1 (curves 1 and 2) for FI-QI and A coils, as specified in 4.6.2.9.2 for manual operation of all coils, and as specified in 4.6.2.9.3 (a) for the M and FP-QP power supplies.

4.6.2.16.2 Equipment operation. After completion of the temperature and humidity tests, the equipment operation shall be completely tested to determine equipment was not damaged; and reference measurements, as specified in 4.6.2.16.1, shall be recorded to determine that equipment alignment and adjustments were not affected.

4.6.2.17 High impact shock test. The equipment shall be shock tested in accordance with MIL-S-901 for grade A, class I equipment. Features of the test shall be as follows:

(a) Required type of shock test. Type A.
(b) Weight designation. As applicable for the principal units tested.

(c) Equipment operational mode during tests. The equipment shall be energized and operating under full-load conditions during shock tests. The controls for the FI-QI and A coils on the switchboard unit shall be set up for automatic operation and set to obtain maximum output. The M and FP-QP coil controls shall be set for maximum output. The switchboard output voltages to the M, FI-QI, FP-QP, and A coil power supplies shall be recorded by means of a multi-channel oscillographic recorder immediately before, and supplying full-rated current and voltage to a resistive load during the shock and vibration tests. The power supply input voltage control signal and output current shall be recorded before, during, and after tests as specified. After completion of tests, equipment shall be retested to verify that the equipment was not damaged by the tests and that equipment adjustment, alignment, and accuracy were not affected by the tests.

(d) 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 herein.

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

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

(4) Failure to pass general examination. The equipment shall be carefully examined after removing all removable panels and doors to ascertain any mechanical damage. If requested by DCMAO, partial disassembly shall be performed to aid in determining any possible damage.

(5) Failure to perform any electrical tests requested by the Government during and following the shock. No adjustment or replacement of damaged parts shall be permitted during shock test, unless specifically permitted (see 6.11).

(e) Mounting. Equipment shall be mounted on the shock machine in a manner simulating shipboard installation in accordance with MIL-S-901. Equipment that is complete in more than one enclosure shall be tested as a complete unit by shock testing all assemblies.

(f) Disposal of shock tested equipment. Equipment that has been subjected to H.I. shock tests shall be accepted as production equipment of the contract or order only under the following conditions:

(1) Equipment meets all terms and conditions of the contract for acceptance and is restored to a like new condition.

(2) Not more than one shock tested equipment per contract or purchase order is being offered for acceptance following H.I. shock test.

(3) An identification plate is added identifying the unit as H.I. shock tested.

4.6.2.18 Vibration test. The equipment shall be subjected to type I vibration tests in accordance with the requirements of MIL-STD-167-1 to determine compliance with the requirements of 3.6.3.5. The upper limit of the vibration frequency shall be 33 Hz. The equipment operating during the test, the method of mounting, and the failure criteria shall be the same as specified for shock tests (see 4.6.2.17), except that an oscillograph need not be used to monitor outputs.

4.6.2.19 Airborne and structureborne noise. Equipment shall be tested for airborne and structureborne noise in accordance with MIL-STD-740-1 and MIL-STD-740-2 to determine compliance with the requirements of 3.6.3.6.

4.6.2.20 Inclination. The equipment shall be tested to determine compliance with the inclination requirements of 3.6.3.7. Static accuracy tests, as specified in 4.6.2.9.1.1, shall be performed in each inclined position.

4.6.2.21 Electromagnetic interference. The equipment shall be tested in accordance with MIL-STD-462 to determine compliance with the requirements of 3.6.3.8 for both conducted and radiated emissions and susceptibility of equipment.

5. PACKAGING

(The packaging requirements specified herein apply only for direct Government acquisition. For the extent of applicability of the packaging requirements of referenced documents listed in section 2, see 6.12.)

5.1 Preservation, packing and marking. Each automatic degaussing control equipment shall be preserved level A or C, packed level A, B, or C, and marked in accordance with MIL-E-17555, as specified (see 6.2).

5.1.1 First article sample. When level A preservation and level A or B packing are required by the contract or purchase order (see 6.2), a first article pack of one equipment and its shipping container shall be tested, as specified in MIL-E-17555, prior to beginning package production, unless otherwise specified (see 6.2).

5.1.1.1 Dummy load. Unless otherwise specified (see 6.2), a dummy or simulated load shall be used for the rough handling tests in accordance with the requirements of MIL-STD-2073-1.

5.1.2 Repair parts. Repair parts shall be preserved, packed and marked in accordance with MIL-E-17555, as applicable for the intended use and destination, as specified in table VI. Unless otherwise specified (see 6.2), repair parts shall be packaged one part to a unit package, except when used in quantities greater than one or parts comprising a single set, kit or assembly. Parts, sets, kits or assemblies shall be individually protected to prevent surface contact with surfaces of adjacent parts and shall be packaged together as a single unit.

TABLE VI. Packaging of repair parts.

Destination	Preservation	Packing
On board (accompanying equipment)	A	C
Stock	A	B
Immediate use	C	C

5.1.2.1 Repairables. Repair parts, subject to return to a repair facility for restoration, test repair and re-issue, shall be preserved and packed in materials and containers capable of reuse. Unless otherwise specified (see 6.2), 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 (see 6.3). Containers shall be marked "REUSABLE DO NOT DESTROY".

5.2 Sensitive electronic item protection. Items, such as, but not limited to, diodes, transistors, integrated circuits, and equipment incorporating such items, that are susceptible to damage from electrostatic, electromagnetic, or both field sources, shall be protected against such damage as follows:

(a) General requirements.

(1) Lead or terminal configuration shall be maintained as manufactured without causing loads or stresses capable of causing damage to the item. Protection shall be by means of a carrier, container design, or inserts of suitable noncorrosive electrostatic-free supporting materials. Materials used to maintain item position and lead or terminal configuration shall permit item removal and replacement without damage to the item.

a. Carriers, when used for additional protection of miniature electronic items, shall be of such strength to prevent damaging resonances, shocks, and electrostatic charges to sensitive items. Anchoring or securing of the item, leads, or terminals within the carrier by means of tape or adhesive is prohibited. The carrier shall maintain physical separation and manufactured configuration of the item leads or terminals during packaging, handling, transportation, storage/stowage, and for testing operations. The carrier shall permit safe and easy removal, inspection, and item replacement, and be designed without sharp edges to preclude subsequent damage to the item and packaging material/method.

b. Wraps and cushioning, when required for additional protection, shall be noncorrosive and in accordance with the requirements of MIL-P-116, and shall not crumble, flake, powder, or shed. Wraps or cushioning in direct contact with electrostatic sensitive items shall conform to the electrostatic protection requirements specified herein.

(b) Specific requirements.

(1) Items adversely affected by electrostatic field forces shall be provided an initial wrap of material in accordance with the type III, style A or B requirements of PPP-C-1842, and unit packaged in heat-sealed bags in accordance with the type I, class F, style I requirements of MIL-B-117. Alternately, recloseable cushioned pouches in accordance with the type I or II requirements of MIL-P-81997 may be used in lieu of the initial wrap or cushioning. Noncorrosive conducting materials shall be applied to all exposed leads or connector pins to maintain a common potential. This is to protect the items from electrostatic charges that may be encountered during handling. Packaging materials currently covered by title, scope, or intended use under Government specifications, but modified as electrostatic-free materials, or newly developed electrostatic-free packaging materials will be permitted subject to the contracting officer's determination that:

a. The physical properties of such materials are equal to or better than similarly constructed materials covered under a required Government packaging material specification, and

b. That such materials satisfy the electrostatic decay rate requirement in accordance with MIL-B-81705. When such materials are acceptable, unit packaging shall be in accordance with the procedures for electrostatic protection.

(2) Unless otherwise specified in the contract or purchase order (see 6.2), items subject to damage by electromagnetic forces shall be unit packaged in heat-sealed, barrier bags in accordance with the type I or II, class E, style 1 or type I, class F, style 1 requirements of MIL-B-117. When MIL-B-117 type I or II, class E, style 1 bags are selected and used, the barrier material shall also contain a laminate of aluminum foil as well as meeting the requirements of MIL-B-117.

(3) When the item requires both electromagnetic and electrostatic protection, unit packaging shall be as specified in 5.2 (b)(1).

(4) In addition to the markings required by MIL-STD-129 and the contract or purchase order, the MIL-STD-129 markings for sensitive electronic items shall apply, except as follows: The electronic device caution label, 2 by 2 inches or less, specified for intermediate packages, shall be used in lieu of the device symbol. In addition, special caution markings shall be placed on all unit and intermediate (interior) packages and shipping containers. Electrostatic sensitive item caution markings may be placed adjacent to the MIL-STD-129 sensitive electronic device caution label. Caution markings shall be as follows:

"CAUTION -- ELECTROSTATIC SENSITIVE DEVICE: Remove electrostatic protection at use or in protected area. Reuse packaging materials for the unserviceable item. See MIL-HDBK-263 for protective handling for this item."

(c) Cushioning, filler, dunnage, and wrapping material.

(1) Use of excelsior, newspaper, shredded paper (all types, including wax paper) and similar hygroscopic or non-neutral 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 have the properties and characteristics for resistance to fire of the following:

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).

(2) When loose-fill type materials are used for preservation and packing applications, such as cushioning, filler, or dunnage, all containers (unit, intermediate, and shipping) shall be marked or labelled with the following information:

"CAUTION

Contents cushioned with loose-fill material shall not be taken on board ship. Remove and discard loose-fill material. If required, recushion with cellulosic material, bound fiber, fiberboard, or transparent flexible cellular material."

Cushioning, filler, dunnage, and wrapping materials selected, whenever available, shall exhibit improved performance for resistance to fire.

(d) Talc/talcum used in the packaging process of items shall be free of asbestos or asbestiform like materials.

6. NOTES

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

6.1 Intended use. Type SSM automatic degaussing equipment is intended for use aboard steel-hulled ships of the U.S. Navy that contain three or four degaussing coils. The equipment, when in use, will reduce the overall magnetic signature of the ship.

6.2 Acquisition requirements. Acquisition documents must specify the following:

(a) Title, number, and date of this specification.
(b) Issue of DODISS to be cited in the solicitation, and if required, the specific issue of individual documents referenced (see 2.1.1).
(c) Whether first article is required (see 3.1).
(d) Configuration of the switchboard and remote control and number of power supplies (see 3.4.1.4).
(e) Power supply output current rating (see 3.4.1.7.2).
(f) Training requirements (see 3.8).
(g) Engineering services requirements (see 3.9).
(h) Levels of preservation, packing, and marking required (see 5.1 and 5.1.1).
(i) When first article preservation and packing test is not required (see 5.1.1).
(j) When dummy load is not required for testing (see 5.1.1.1).
(k) Quantity per package when other than specified (see 5.1.2).
(l) Whether packaging other than MS90363 is required (see 5.1.2.1).
(m) When heat-sealed, barrier bags are not required (see 5.2(b)(2)).

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

Reference Paragraph	DID Number	DID Title	Suggested Tailoring
3.2.3	DI-R-7082	Reliability predictions report	----
3.2.4	DI-R-7085	Failure mode, effects, and criticality analysis report	----
3.2.5 and 6.9	UDI-T-23724	Report, failure/ malfunction	----
3.2.7	UDI-R-23567	Report, maintainability prediction	----
3.3.2	DI-MISC-80071	Parts approval request	----
3.4.1.1 and appendix A	DI-DRPR-80651	Engineering drawings	----

Reference Paragraph	DID Number	DID Title	Suggested Tailoring
3.4.8.2	DI-SAFT-80102	Safety assessment report	----
3.9, 4.3.2, and appendix B	DI-MISC-80652	Technical information report	----
4.1.1	UDI-R-23743	Quality program plan	----
4.6.2.9 and appendix C	DI-MISC-80653	Test reports	----
5.1.2.1	DI-PACK-80120	Preservation and packaging data	----

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

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

6.4.1 Manual content. Manuals should contain the following information:

(a) Distribution statement. The distribution statement to be included on the title page should be as follows:

"This document is subject to special export controls and each transmittal to foreign governments or foreign nationals may be made only with prior approval of the Naval Sea Systems Command."

(b) General information. The General Information section of the manual should include information explaining the basic principles of and the need for degaussing (see 6.6.1). This information should be in addition to the overall description of the functions and purpose of the equipment.

(c) Test data. Test data, such as waveforms, voltages, currents, and resistance, included in the manual should be taken with the test equipment specified in 3.5.2.

(d) Measuring insulation resistance. Instructions for measuring degaussing coil insulation resistance using ground detector and nomographs (see 3.4.1.5.4 and 3.4.1.5.4.2) should be included in the scheduled performance tests. Weekly maintenance periodicity and reference standard of 100,000 ohms, minimum, should be specified in the equipment manual.

(e) Troubleshooting diagrams. Troubleshooting diagrams to be included in chapter 5 should consist of a power distribution diagram, maintenance schematic diagrams, intra-unit interconnection diagrams, and signal flow diagrams.

(f) Maintenance schematic diagrams. Maintenance schematic diagrams should be prepared so as to illustrate the functions of specific circuit arrangements and to facilitate tracing the circuit and its functions without regard to the actual physical size, shape, or location of assemblies or parts. Maintenance schematic diagrams should be drawn so as to illustrate major functional sections. Individual modules or printed circuit boards should not be illustrated by separate schematic diagrams.

(g) Intra-unit interconnection diagrams. Intra-unit interconnection diagrams should be prepared such that they illustrate the physical connections of all assemblies, subassemblies, and parts in such detail as needed to make or trace any and all connections in the equipment.

(h) Maintenance information. Equipment maintenance information submitted with the engineering drawings (see appendix A) should include the following:

(1) Functional description of the overall equipment, of each functional section and subsection, of each modular assembly, and of each circuit or stage in functional sections or modular assemblies.
(2) Functional block diagram for each unit, and simplified schematic diagrams for all circuits, or circuit stages, in each unit.
(3) Adjustment procedures for making all accepted adjustments (see 3.4.2.1).
(4) Explicit detailed instructions regarding mounting requirements including recommended corrosion inhibitors, thermal protection, lubricants, torque values, and torquing device.

(i) Submitted maintenance information. The maintenance information submitted need not be prepared in a manner that is suitable for inclusion in the equipment manual. However, the form and content of this information should be in accordance with the requirements for the technical manual. Functional descriptions, adjustment procedures, and simplified schematics should be identified by reference designations and functional names such that they can be related to each other and to block diagrams and maintenance schematic diagrams submitted as drawings. The information need not be assembled in any particular order and the simplified schematics may be legible sketches.

(j) Synchro data. Synchro interface data in accordance with DOD-STD-1399, section 702 should be included in the technical manual.

6.5 First article. When first article inspection is required, the contracting officer should provide specific guidance to offerors whether the item(s) should be a preproduction sample, a first article sample, a first production item, a sample selected from the first ____ production items, a standard production item from the contractor's current inventory (see 3.1), and the number of items to be tested as specified in 4.4. The contracting officer should also include specific instructions in acquisition documents regarding arrangements for examinations, approval of first article test results, and disposition of first articles. Invitations for bids should provide that the Government reserves the right to waive the requirement for samples for first article inspection to those bidders offering a product which has been previously acquired or tested by the Government, and that bidders offering such products, who wish to rely on such production or test, must furnish evidence with the bid that prior Government approval is presently appropriate for the pending contract. Bidders should not submit alternate bids unless specifically requested to do so in the solicitation.

6.6 Background information.

6.6.1 General information. General information on reasons for degaussing; on degaussing methods, systems, equipment, installations, and coils; on the earth's magnetic field and a ship's permanent and induced magnetization are given in NAVSEA 0901-LP-813-0002. Contractor personnel should familiarize themselves with the terminology and information given in this publication before trying to understand the requirements given herein or before contemplating the design of or a quote on the equipment described herein.

6.6.2 Calibration of the degaussing system. The degaussing system will be calibrated at a degaussing range. During calibration, coil current magnitudes, current polarities, and coil turns will be established for each of the coils for the various magnetic latitudes. Upon completion of system calibration, coils will be adjusted for proper turns; currents adjusted for proper magnitude and polarity; and the ship provided with a degaussing folder. This folder provides general information on the ship's degaussing installation and explicit information on turns connected in each coil, magnitude and polarity of various compensation and perm currents, and magnitude and polarity of the coil currents for the various magnetic latitudes. This information is used for manual operation, checking equipment operation, and corrective maintenance.

6.6.3 Operation of equipment. Equipment will be operated by electrician's mates. The equipment will be operated by turning it ON and periodically (daily, weekly) checking operation. Operating personnel will not stand by during operation. As ship's geographical location changes, operator personnel will reset the magnetic variation, H-zone, and M coil induced magnitude control to obtain the current specified in the ship's degaussing folder and suitable for the new location.

6.6.3.1 Faults. When a fault occurs, trouble indicators should sound alarm and localize the fault. In most instances, the electrician's mate should be able to quickly isolate fault, and repair equipment by the replacement of a modular assembly. Modular assemblies will be repaired when and where convenient (ship, depot, and so forth). Equipment should be designed and maintenance information prepared such that modular assemblies can be repaired by ship or depot personnel.

6.7 Drawings. The contractor's attention is invited to the fact that several drawings required for design evaluation purposes are also required for use as illustrations in the equipment manuals. The requirement to prepare these drawings so that they will be suitable for illustrations is included herein to reduce the time required to prepare and review both the drawings and manual and to improve the prospects for timely delivery of the manual. These drawings, when submitted, will be reviewed both for evaluation of the equipment and for conformance with the manual requirements.

6.8 Maintenance information. The maintenance information is intended for Government use to provide a means for evaluating compliance with the maintenance requirements specified herein at a time when it is still feasible to modify equipment design, and for improving the prospects for the timely delivery of the manual. It is intended that this information be prepared by design personnel who are designing the equipment and are responsible for the maintenance features provided. After acceptance, the information would be edited and assembled by personnel responsible for the manual such that it would be suitable for inclusion in the manual.

6.9 Failure/malfunction report. The failure/malfunction reports should include the following:

(a) Failure data collection, analysis, and corrective action should include a closed loop failure data system for collecting, analyzing, and recording data on all equipment failures (fuse blowing and unscheduled alignments or adjustments should be defined as failures and be included in the failure data system).
(b) Data should be recorded for failures discovered or occurring during:

(1) All phases of testing (in-plant or at Government facilities).
(2) Installation checkout of equipment by manufacturer's service engineers.
(3) Examination of equipment, subassemblies, or parts returned to manufacturer under warranty.

6.10 Definitions. The definitions of terms used in this specification should be in accordance with MIL-STD-2036 and MIL-STD-721.

6.11 NAVSEA approval and direction. Deviations from specified materials, procedures, and requirements and selection of specific alternative materials and procedures require NAVSEA approval or direction. Requests should include supporting documentation.

6.11.1 NAVSEA. The word "NAVSEA" as used herein refers to the Naval Sea Systems Command, Code 56Z22, Department of the Navy, Washington, DC 20362-5101.

6.11.2 Test circuits. Complex active circuits and switching circuits, provided only for test purposes, are not desired and are permitted only after adequate justification as to why they are required and possible alternates are provided by the contractor.

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

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

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

6.14 Government-furnished property. The contracting officer should arrange to furnish the property listed in 3.4.1.1.1 and information required in 3.4.1.1.2 and 3.7.

6.15 Design review. The contractor should establish and conduct a formal design review program. Participants should include qualified personnel from design, reliability, maintainability, and other pertinent areas of the contractor's organization. NAVSEA (see 6.11) representatives have the option to attend all formal design reviews. At least two formal design reviews should be scheduled to allow for design changes, if required, during the preliminary design stage and prior to final design. Typical items for discussion during the design review should be:

(a) Reliability prediction status.
(b) Maintainability prediction status.
(c) Failure mode, effects and criticality analysis.
(d) Maintenance requirements.
(e) Operational and support concepts and requirements.
(f) Personnel constraints.
(g) Constraints associated with test equipment and special tools specified herein and in MIL-STD-2036.
(h) Test points and test feature requirements associated with fault location and fault isolation specified herein and MIL-STD-2036.
(i) Safety requirements.

6.16 Subject term (key word) listing.

Automatic operation
Degaussing system
Four-coil installation
Magnetic signature
Manual operation
Three-coil installation

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

Preparing activity:
Navy - SH
(Project 1075-NO56)

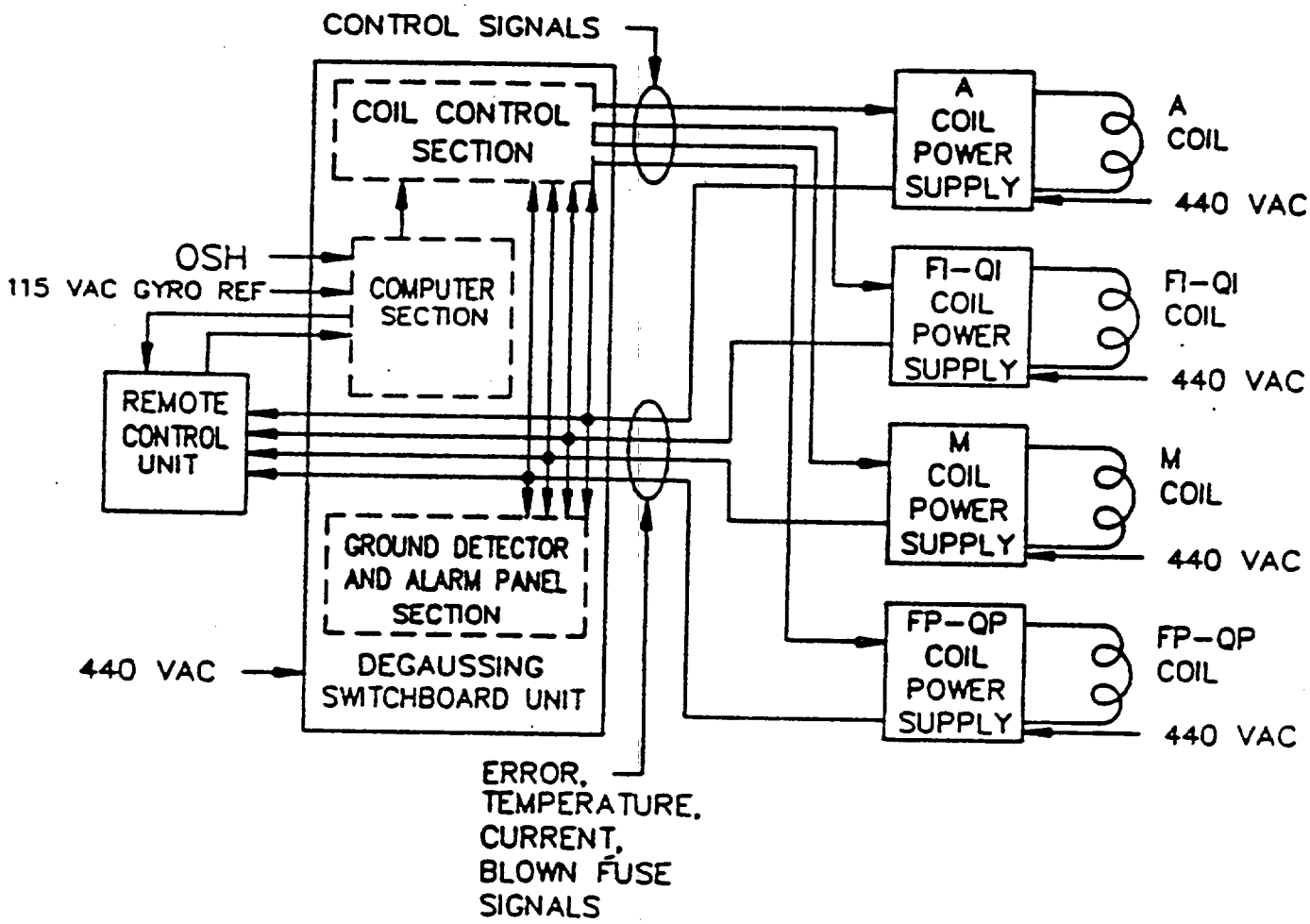


FIGURE 1. Functional block diagram.

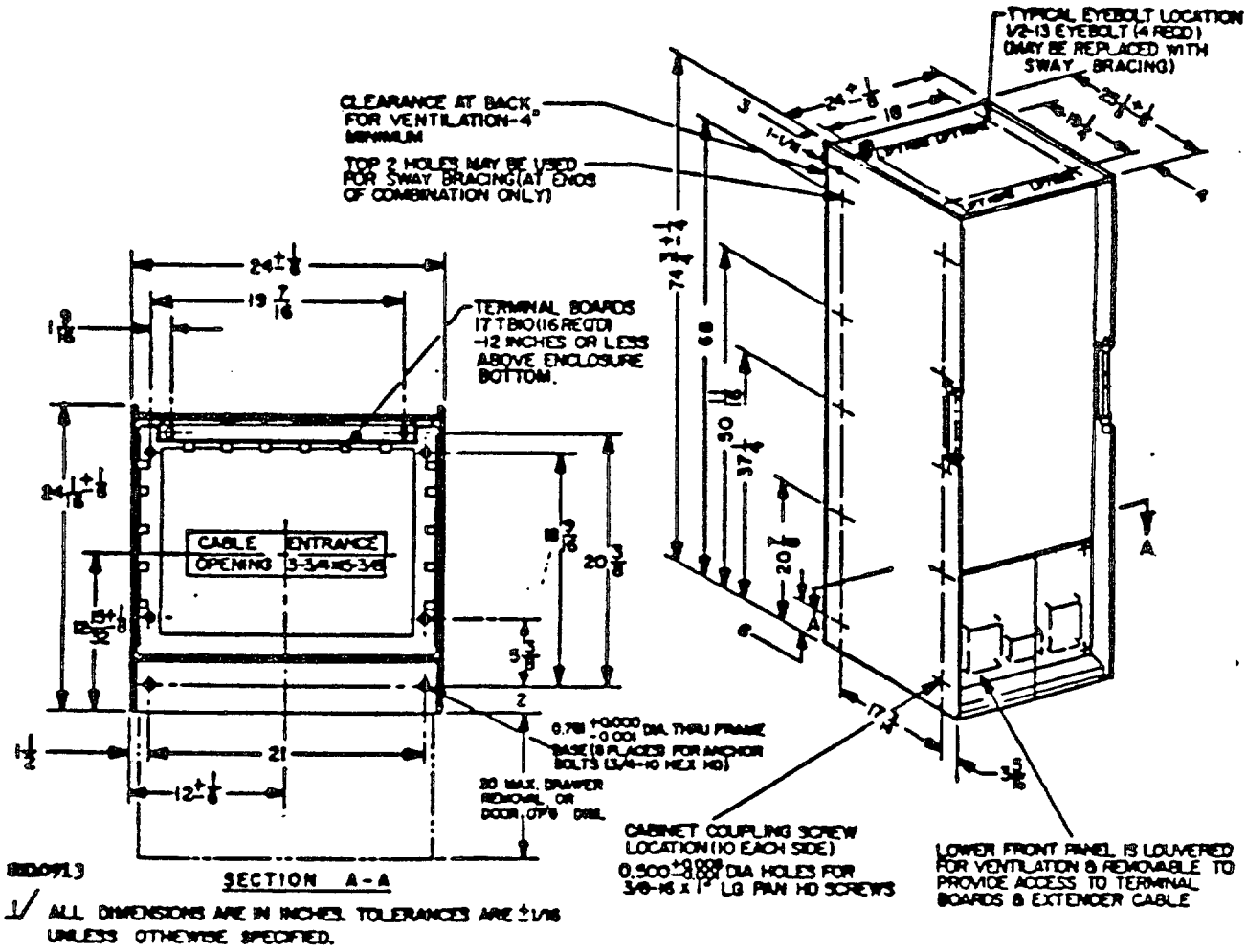


FIGURE 2. Switchboard unit, outline drawing.

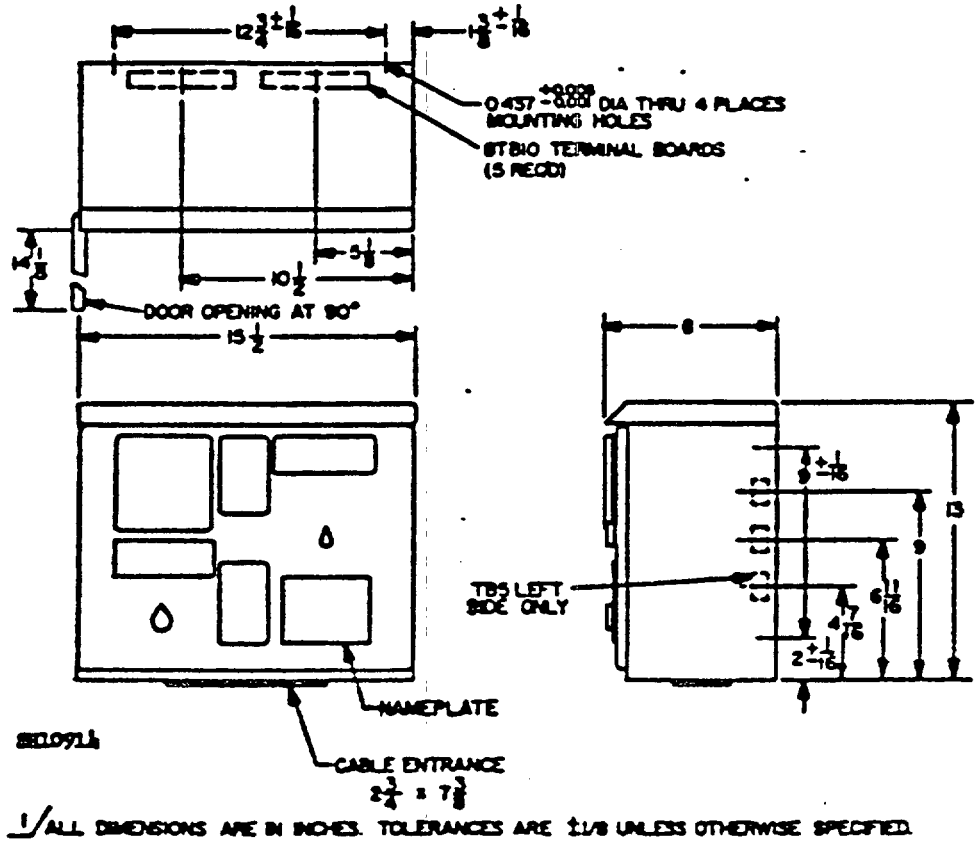


FIGURE 3. Remote control unit, outline drawing.

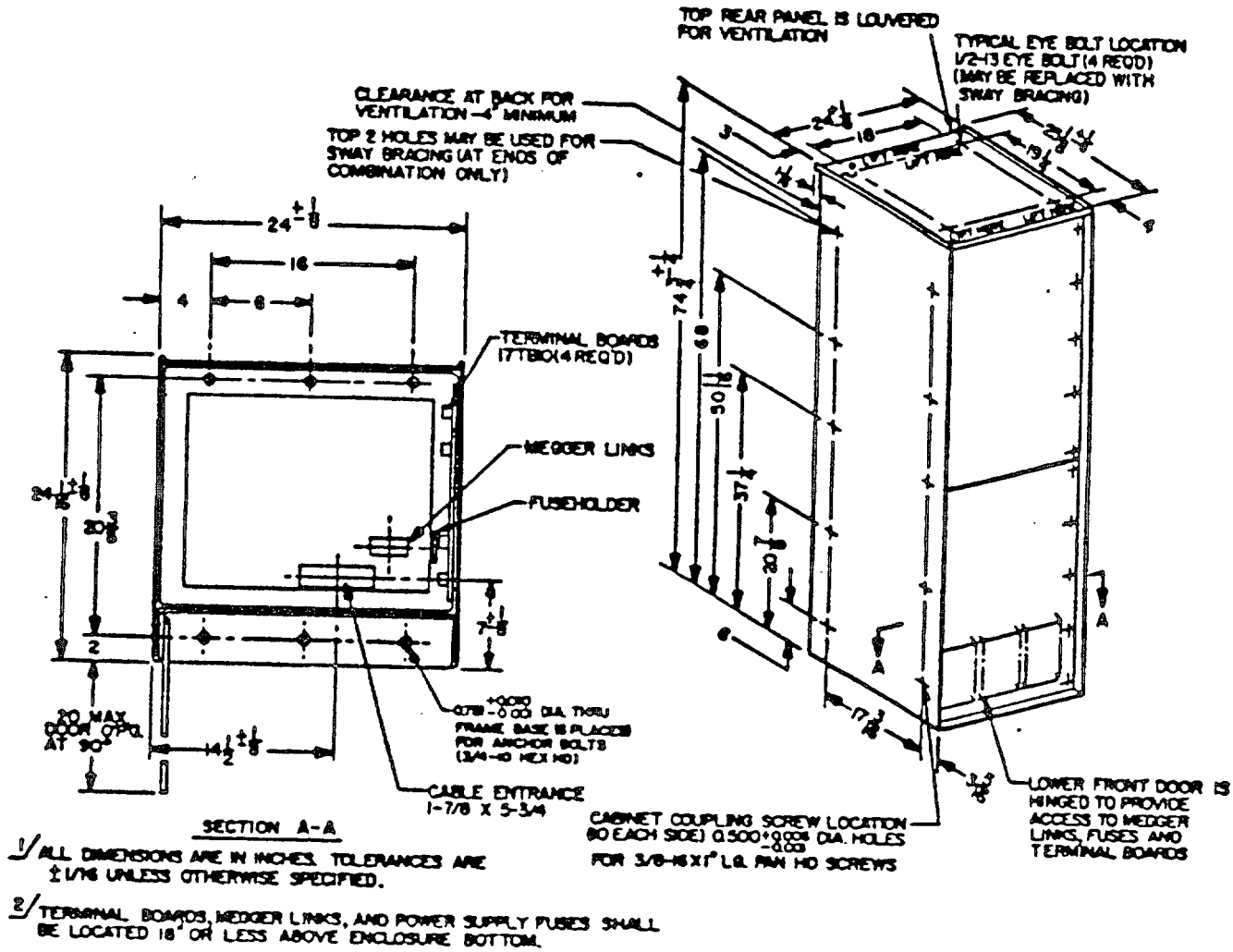


FIGURE 4. 3 and 5 kW power supply, outline drawing.

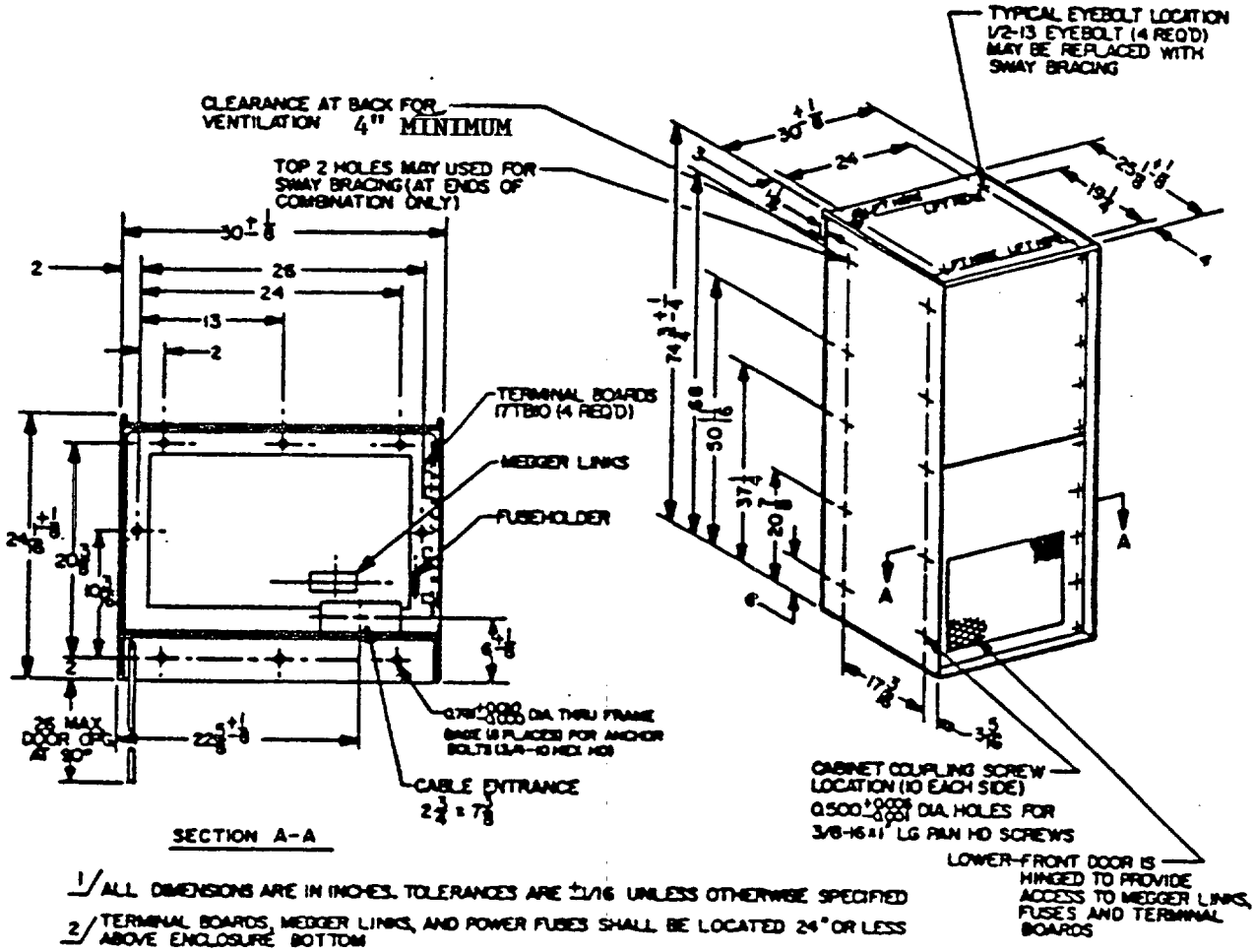
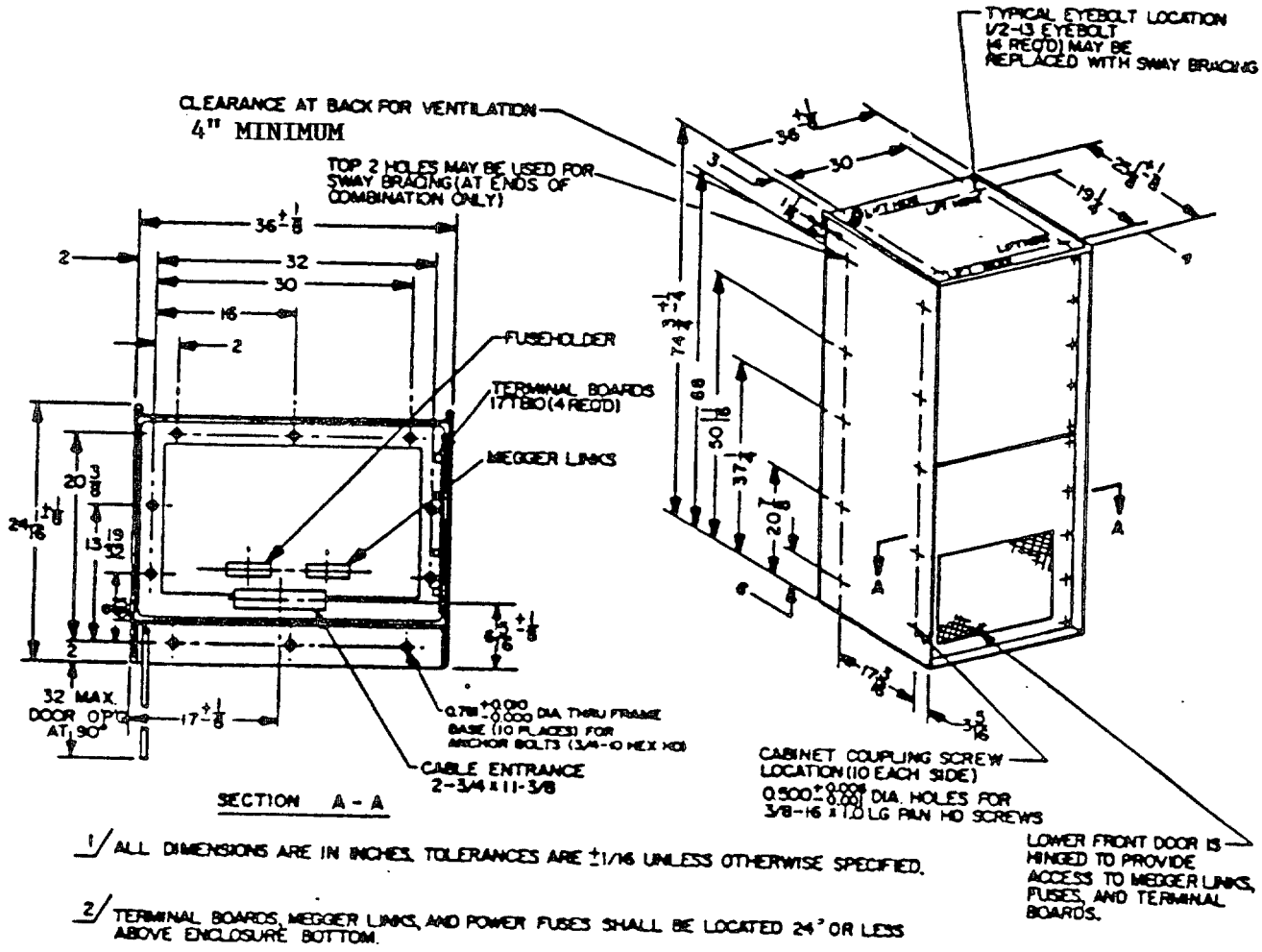


FIGURE 5. 8, 12, and 16 kW power supply, outline drawing.



1/ ALL DIMENSIONS ARE IN INCHES. TOLERANCES ARE ±1/16 UNLESS OTHERWISE SPECIFIED.

2/ TERMINAL BOARDS, MEGGER LINKS, AND POWER FUSES SHALL BE LOCATED 24" OR LESS ABOVE ENCLOSURE BOTTOM.

FIGURE 6. 20, 26, 32 and 40 kW power supply, outline drawing.

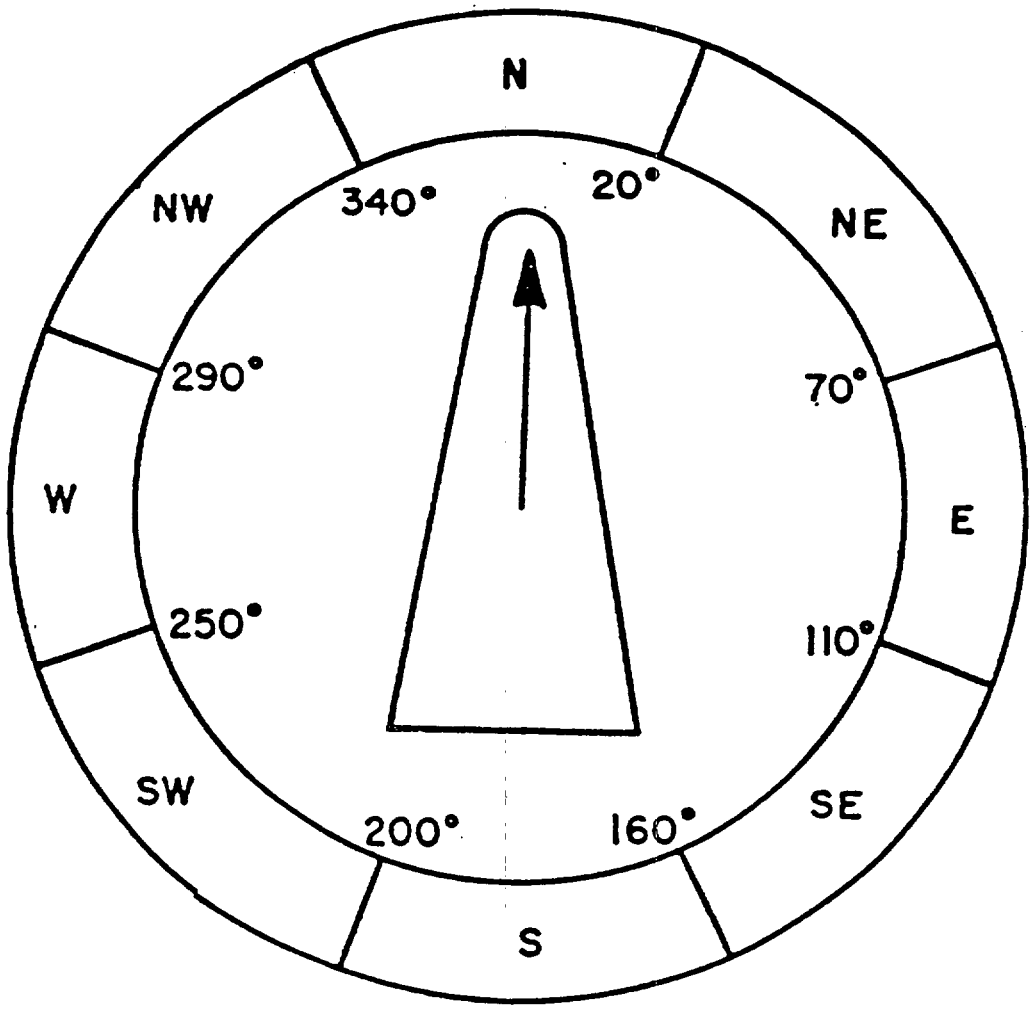


FIGURE 7. Designation and marking of eight-course emergency control switch.

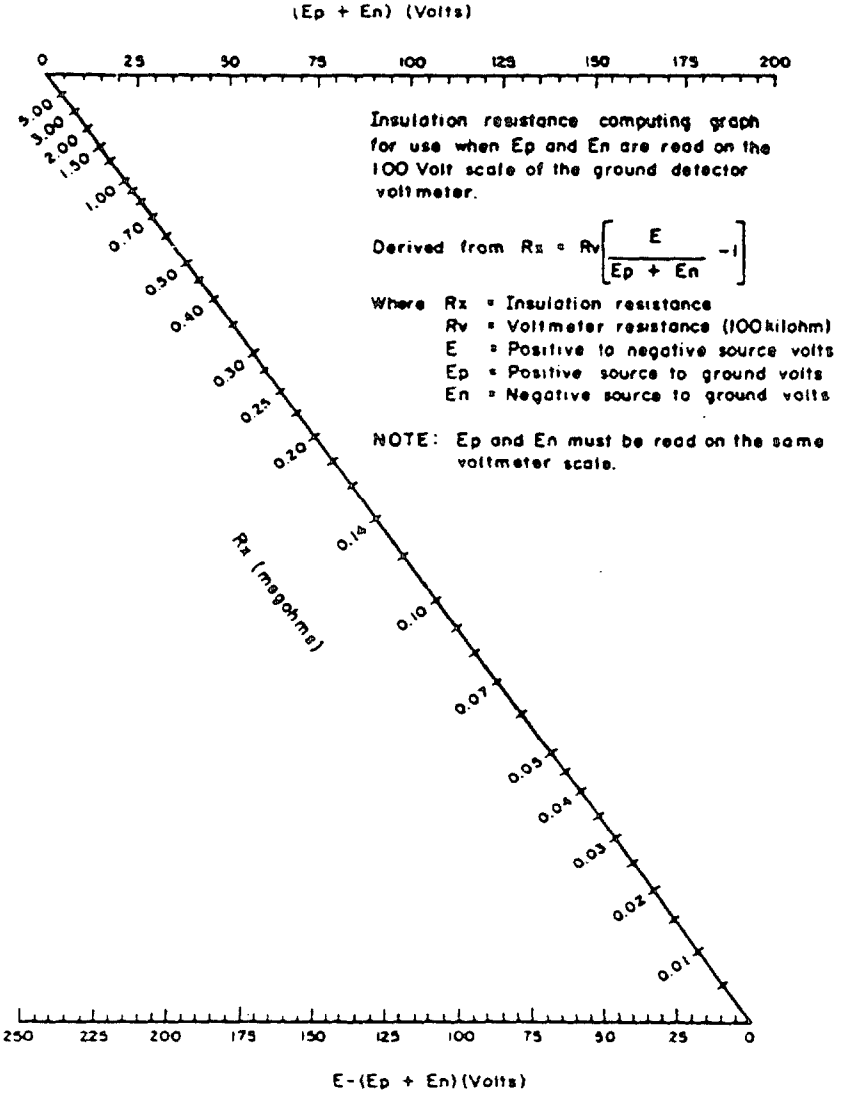


FIGURE 8. 100 volt nomograph.

TO SET UP:

1. Set MAGNETIC VARIATION TO 0 ° and M ZONE to .40.
2. Set FI-QI and A OPERATION SWITCHES to AUTOMATIC.
3. Turn FI-QI and A POWER switches to ON.
4. Set TEST-OPERATE switch to TEST I 0°. Check FI-QI current. Should be value specified (in ship's degaussing folder) for North Magnetic heading and .40 M zone. If not, adjust FI-QI AUTOMATIC INDUCED MAGNITUDE control.
5. Set TEST-OPERATE switch to TEST I 90°. Check A Induced current. Should be value specified for East magnetic heading and .40 M zone. If not, adjust A AUTOMATIC INDUCED MAGNITUDE control.
6. Set TEST-OPERATE switch to TEST PERM. Check A Perm current. Should be value specified. If not, adjust PERM MAGNITUDE control
7. Set TEST-OPERATE switch to OPERATE, LOCAL-REMOTE TRANSFER switch to LOCAL, and DEGAUSSING COIL HEADING SWITCH to N.
8. Set FI-QI coil OPERATION SWITCH to MANUAL. Adjust FI-QI MANUAL INDUCED MAGNITUDE control to obtain FI-QI current specified for North heading and .40 M zone. Lock control.
9. Set DEGAUSSING COIL HEADING SWITCH to E and A coil OPERATION SWITCH to MANUAL. Adjust A MANUAL INDUCED MAGNITUDE control to obtain A Induced current specified for East heading and .40 M. zone. Lock control.

TO OPERATE - AUTOMATIC:

1. Set MAGNETIC VARIATION, M ZONE, and M, and FP-QP POLARITY switches to settings corresponding to the ship's geographical location as obtained from the ship's degaussing folder.
2. Set TEST-OPERATE switch to OPERATE.
3. Set FI-QI and A coil OPERATION SWITCHES to AUTOMATIC.
4. Turn FI-QI, A, M, and FP-QP coil POWER switches to ON.
5. Adjust M and FP-QP INDUCED MAGNITUDE controls for proper current as obtained from ship's degaussing folder.
6. Turn BELL switch to ON.
7. Keep MAGNETIC VARIATION, M ZONE, M polarity, FP-QP polarity, M current, and FP-QP current set for ship's geographical location.

TO OPERATE - MANUAL: CHANGE MODE OF OPERATION OF FI-QI or A by:

1. Set LOCAL-REMOTE TRANSFER switch to LOCAL.
2. Set DEGAUSSING COIL HEADING SWITCH to position corresponding to magnetic heading of ship.
3. Set FI-QI or A OPERATION SWITCH to MANUAL.
4. Keep M ZONE set for ship's geographical location and DEGAUSSING COIL HEADING SWITCH set for ship's magnetic heading.

NOTE

DEGAUSSING COIL HEADING SWITCH at Remote station can be used for heading inputs by switching LOCAL-REMOTE TRANSFER switch to REMOTE.

TO SECURE - MANUAL OR AUTOMATIC:

1. Turn TEST-OPERATE switch to OFF.
2. Turn M and FP-QP POLARITY switches to OFF.
3. Turn FI-QI, A, M, FP-QP coil POWER switches to OFF.
4. Turn BELL switch to OFF.

WARNING

Power still exists at the Alarm Bell, Interlock Switches, and Fuse Indicator circuits in Switchboard, and at fuses in power supplies, after coil POWER switches are OFF.

TROUBLESHOOTING - See equipment manual.

WARNING

INTERLOCK BYPASSED light indicates high voltage present in opened units.

FIGURE 9. Operating instructions.

APPENDIX A

ENGINEERING DRAWINGS TECHNICAL CONTENT REQUIREMENTS

10. SCOPE

10.1 Scope. This appendix covers the technical requirements that should be included on drawings when required by the contract or order. This appendix is mandatory only when data item description DI-DRPR-80651 is cited on the DD Form 1423.

20. APPLICABLE DOCUMENTS

This section is not applicable to this appendix.

30. DRAWINGS

30.1 Engineering drawings. When required by the contract or order, engineering drawings shall include detail parts drawings, assembly drawings, control drawings, installation drawings, diagrammatic drawings, special purpose drawings, and parts lists. Contractor design activity identifiers and drawing numbers shall be assigned to all engineering drawings and lists. Mono-detail drawings are not required. Restrictive legends shall not be used. Specification control drawings or source control drawings shall be prepared for all vendor or commercial items that are not covered by Government or nationally recognized industry association standards or specifications. Parts list shall be prepared for all assembly and subassembly drawings. The parts lists may be integral with or separate from the drawings.

(a) Drawings shall be prepared so that the similarities are emphasized and obvious, and the number of drawings, pages, tables, and so forth, are reduced to a minimum.

APPENDIX B

TECHNICAL INFORMATION REPORTS TECHNICAL CONTENT REQUIREMENTS

10. SCOPE

10.1 Scope. This appendix covers the technical requirements that shall be included in reports when required by the contract or order. This appendix is mandatory only when data item description DI-MISC-80652 is cited on the DD Form 1423.

20. APPLICABLE DOCUMENTS

This section is not applicable to this appendix.

30. REPORTS

30.1 Engineering services report content. When required by the contract or order, engineering services reports shall contain the following information and unique features:

(a) Rate of travel, place, and ship visited.
(b) Number of mandays expended including travel time.
(c) Transportation costs.
(d) Technical details on the reasons motivating the requirements for service and corrective action taken.
(e) The listing of time in hours expended for the various tasks.
(f) Naval Sea Systems Command authority for trip.
(g) An advance copy of this report shall be submitted to the contracting activity not later than 10 days subsequent to the completion of the particular assignment. A copy of the trip report shall be forwarded to the contracting activity.
(h) Required measurements before making adjustments and reports (see 4.3.2(a)(c)).

30.2 Adjustment, alignment, and repairs. After testing is in progress, adjustment, alignments, or repairs (including the replacement of fuses and the adjustment of automatic induced magnitude controls) will be permitted only under the following conditions:

(a) Take and record required measurements before making adjustments and repairs.
(b) Notify and obtain Defense Contract Management Area Operations (DCMAO) acceptance before making adjustments or repairs.
(c) Record adjustments or repairs (or fuses replaced) made and why the adjustments or repairs were necessary.
(d) Repeat any testing already completed that could possibly be affected by the adjustment or repair.

APPENDIX C

TEST REPORTS TECHNICAL CONTENT REQUIREMENTS

10. SCOPE

10.1 Scope. This appendix covers the technical data requirements that shall be included in test reports when required by the contract or order. This appendix is mandatory only when data item description DI-MISC-80653 is cited on the DD Form 1423.

20. APPLICABLE DOCUMENTS

This section is not applicable to this appendix.

30. TEST REPORTS

30.1 Test report contents. When required by the contract or order, test reports shall contain the following information:

(a) Accuracy. Measurements (every 15 degrees plus switching points) shall be recorded such that the following curves can be drawn to demonstrate accuracy and limiting. Procedure shall be to set the independent variable (OSH signal, magnetic variation, or H-zone switch position) and record all dependent variables simultaneously. Recorded data shall include the setting (in degrees) of the device simulating the OSH signal; all parameters, such as supply voltage and frequency, perm bias setting, and load resistance; and all dependent variables, such as reading of the magnetic heading indicator dial, reading of the magnetic variation dial, switchboard output voltages, and power supply output currents.

(1) Curve 1 - Power supply output current versus OSH signal (0 to 360 degrees).
Curve 2 - Switchboard output voltage versus OSH signal (0 to 360 degrees).
With: Magnetic variation set to zero degrees, H-zone set to 0.40, K_F and K_A set for 5.0 volts and K_B set to zero.

(2) Curve 3 - Power supply output current versus magnetic variation (0 to 360 degrees).
Curve 4 - Switchboard output voltage versus magnetic variation (0 to 360 degrees).
With: OSH magnetic set to zero degrees, H-zone set to 0.40, K_F and K_A set for 5.0 volts and K_B set to zero.

(3) Curve 5 - Same as curve 1.
Curve 6 - Same as curve 2.
Except: Set H-zone to 0.05 instead of 0.40.

(4) Curve 7 - Same as curve 1.
Curve 8 - Same as curve 2.
Except: Set K_B for plus 3.0 volts.

(5) Curve 9 - Switchboard output voltage versus H-zone switch position.
With: OSH signal set to zero or 90 degrees as required; magnetic variation set to zero degrees; K_F, K_{FM}, K_A, and K_{AM} set to 1.0; and K_B set to zero.

(6) Curve 10 - Power supply output current versus power supply control signal, V_S (-5.5 Vdc to plus 5.5 Vdc in one volt increments plus switching points).