MIL-E-16400H(NAVY)
13 July 1987
SUPERSEDING
MIL-E-16400G(NAVY)
24 December 1974
(See 6.9)

MILITARY SPECIFICATION

ELECTRONIC, INTERIOR COMMUNICATION AND NAVIGATION EQUIPMENT, NAVAL SHIP AND SHORE: GENERAL SPECIFICATION FOR

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 Naval ship and shore electronic, interior communication and navigation equipment, and those units of other Naval ship and shore equipment that utilize electronic technology (see 6.1). Guidance is provided in 6.4.1 for the selective application and tailoring of requirements to the equipment development phase and the equipment installation site.

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 specification to the extent specified herein. Unless otherwise specified, the issues of these documents shall be those listed in the issue of the Department of Defense Index of Specifications and Standards (DoDISS) and supplement thereto, cited in the solicitation.

SPECIFICATIONS

FEDERAL

J-W-1177 - Wire, Magnet, Electrical.
W-F-406 - Fittings for Cable, Power, Electrical and Conduit, Metal, Flexible.
HH-P-96 - Paper, Gasket; Fiber (Animal or Plant), Sheet.

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

AMSC N/A AREA GDRQ

FEDERAL (Continued)

QQ-A-200/1 - Aluminum Alloy 3003, Bar, Rod, Shapes, Tube and Wire, Extruded.
QQ-A-200/4 - Aluminum Alloy 5083, Bar, Rod, Shapes, Tube and Wire, Extruded.
QQ-A-200/8 - Aluminum Alloy 6061, Bar, Rod, Shapes, Tube and Wire, Extruded.
QQ-A-225/2 - Aluminum Alloy Bar, Rod, and Wire; Rolled, Drawn, or Cold Finished, 3003.
QQ-A-225/7 - Aluminum Alloy 5052, Bar, Rod, and Wire; Rolled, Drawn, or Cold Finished.
QQ-A-225/8 - Aluminum Alloy 6061, Bar, Rod, Wire and Special Shapes; Rolled, Drawn or Cold Finished.
QQ-A-250/2 - Aluminum Alloy 3003, Plate and Sheet.
QQ-A-250/8 - Aluminum Alloy 5052, Plate and Sheet.
QQ-A-250/11 - Aluminum Alloy 6061, Plate and Sheet.
QQ-A-591 - Copper-Silicon, Copper-Zinc-Silicon, and Copper-Nickel-Silicon Alloys: Rod, Wire, Shapes, Forgings, and Flat Products (Flat Wire, Strip, Sheet, Bar, and Plate).
QQ-A-596 - Alumimum Alloy Permanent and Semipermanent Mold Casting.
QQ-A-601 - Aluminum Alloy Sand Castings.
QQ-B-613 - Brass, Leaded and Nonleaded: Flat Products (Plate, Bar, Sheet, and Strip).
QQ-B-626 - Brass, Leaded and Nonleaded: Rod, Shapes, Forgings, and Flat Products With Finished Edges (Bar and Strip).
QQ-B-637 - Brass, Naval: Rod, Wire, Shapes, Forgings, and Flat Products With Finished Edges (Bar, Flat Wire, and Strip).
QQ-B-639 - Brass, Naval: Flat Products (Plate, Bar, Sheet, and Strip).
QQ-B-654 - Brazing Alloys, Silver.
QQ-B-728 - Bronze Manganese; Rod, Shapes, Forgings, and Flat Products (Flat Wire, Strip, Sheet, Bar, and Plate).
QQ-B-750 - Bronze, Phosphor; Bar, Plate, Rod, Sheet, Strip, Flat Wire, and Structural and Special Shaped Sections.
QQ-C-320 - Chromium Plating (Electrodeposited).
QQ-C-502 - Copper Rods and Shapes; and Flat Products With Finished Edges (Flat Wire, Strips and Bars).
QQ-C-530 - Copper-Beryllium Alloy Bar, Rod, and Wire (Copper Alloy Numbers 172 and 173).
QQ-C-533 - Copper-Beryllium Alloy Strip (Copper Alloy Numbers 170 and 172).
QQ-N-281 - Nickel-Copper Alloy Bar, Rod, Plate, Sheet, Strip, Wire, Forgings, and Structural and Special Shaped Sections.
QQ-N-286 - Nickel-Copper-Aluminum Alloy, Wrought (UNS N05500).
QQ-N-288 - Nickel-Copper Alloy and Nickel-Copper-Silicon Alloy Castings.
QQ-N-290 - Nickel Plating (Electrodeposited).

FEDERAL (Continued)

QQ-S-365 - Silver Plating, Electrodeposited: General Requirements for.
TT-C-490 - Cleaning Methods for Ferrous Surfaces and Pre-treatments for Organic Coatings.
TT-E-490 - Enamel, Silicone Alkyd Copalymer, Semigloss (for Exterior and Interior Use).
TT-P-664 - Primer Coating, Synthetic, Rust-Inhibiting, Lacquer-Resisting.
TT-P-1757 - Primer Coating, Zinc Chromate, Low-Moisture-Sensitivity.
WW-T-700/2 - Tube, Aluminum, Alloy, Drawn, Seamless, 3003.
WW-T-700/4 - Tube, Aluminum Alloy, Drawn, Seamless, 5052.
WW-T-700/6 - Tube, Aluminum Alloy, Drawn, Seamless, 6061.
PPP-C-1842 - Cushioning Material, Plastic, Open Cell (for Packaging Applications).

MILITARY

MIL-T-27 - Transformers and Inductors (Audio, Power, and High-Power Pulse), General Specification for.
MIL-P-116 - Preservation, Methods of.
MIL-B-117 - Bags, Sleeves and Tubing-Interior Packaging.
MIL-V-173 - Varnish, Moisture- and Fungus-Resistant (for Treatment of Communications, Electronic, and Associated Equipment).
MIL-S-901 - Shock Tests, H.I. (High-Impact); Shipboard Machinery, Equipment and Systems, Requirements for.
MIL-C-915 - Cable and Cord, Electrical, for Shipboard Use, General Specification for.
MIL-S-1222 - Studs, Bolts, Hex Cap Screws, Socket Head Cap Screws and Nuts.
MIL-E-2036 - Enclosures for Electric and Electronic Equipment, Naval Shipboard.
MIL-C-2212 - Controllers, Electric Motor, A.C. or D.C., and Associated Switching Devices.
MIL-R-2765 - Rubber Sheet, Strip, Extruded, and Molded Shapes, Synthetic, Oil Resistant.
MIL-G-3036 - Grommets, Rubber, Hot-Oil and Coolant Resistant.
MIL-D-3464 - Desiccants, Activated, Bagged, Packaging Use and Static Dehumidification.
MIL-G-3787 - Glass, Laminated, Flat; (Except Aircraft).
MIL-C-3849 - Cord, Electrical (Tinsel).
MIL-S-4040 - Solenoid, Electrical, General Specification for.
MIL-C-5015 - Connectors, Electrical, Circular Threaded, AN Type, General Specification for.
MIL-G-5514 - Gland Design: Packings, Hydraulic, General Requirements for.
MIL-C-5541 - Chemical Conversion Coatings on Aluminum and Aluminum Alloys.
MIL-P-7788 - Panels, Information, Integrally Illuminated.
MIL-A-8625 - Anodic Coatings, for Aluminum and Aluminum Alloys.

MILITARY (Continued)

MIL-S-8660 - Silicone Compound, NATO Code Number S-736.
MIL-C-11693 - Capacitors, Feed Through, Radio-Interference Reduction AC and DC (Hermetically Sealed in Metal Cases), Established and Non-Established Reliability, General Specification for.
MIL-C-14550 - Copper Plating, (Electrodeposited).
MIL-P-15024 - Plates, Tags and Bands for Identification of Equipment.
MIL-P-15024/5 - Plates, Identification.
MIL-E-15090 - Enamel, Equipment, Light-Gray (Formula No. 111).
MIL-R-15624 - Rubber Gasket Material, 50 Durometer Hardness (Maximum).
MIL-C-15726 - Copper-Nickel Alloy, Rod, Flat Products (Flat Wire, Strip, Sheet, Bar, and Plate) and Forgings.
DOD-P-16232 - Phosphate Coatings, Heavy, Manganese or Zinc Base (for Ferrous Metals).
MIL-F-16552 - Filters, Air Environmental Control System, Cleanable, Impingement (High Velocity Type).
MIL-F-17111 - Fluid, Power Transmission.
MIL-I-17214 - Indicator, Permeability; Low-Mu (Go-No Go).
MIL-B-17931 - Bearings, Ball, Annular, for Quiet Operation.
MIL-C-18388 - Coils, Tube Deflection; and Coils, Tube Focusing.
MIL-H-19457 - Hydraulic Fluid, Fire-Resistant, Non-Neurotoxic.
MIL-S-19622 - Stuffing Tubes, Nylon; and Packing Assemblies; General Specification for.
MIL-C-20159 - Copper-Nickel Alloy Castings (UNS no. C96200 and C96400).
MIL-A-21180 - Aluminum-Alloy Castings, High Strength.
MIL-W-21965 - Water Cooling of Shipboard Electronic Equipment, General Specification for.
MIL-C-22087 - Copper Alloy Investment Castings.
MIL-C-22520 - Crimping Tools, Terminal Hand or Power Actuated, Wire Termination, and Tool Kits General Specification for.
MIL-G-22529 - Grommets; Plastic.
MIL-P-23377 - Primer Coatings, Epoxy-Polyamide, Chemical and Solvent Resistant.
MIL-C-24231 - Connectors, Plugs, Receptacles, Adapters, Hull Inserts, and Hull Insert Plugs, Pressure-Proof, General Specification for.
MIL-P-24441 - Paint, Epoxy-Polyamide, General Specification for.
MIL-P-24441/1 - Paint, Epoxy-Polyamide, Green Primer, Formula 150, Type I.
MIL-P-24441/6 - Paint, Epoxy-Polyamide, Exterior Topcoat, Dark Gray, Formula 155-R_o = 6, Type I.
MIL-C-24640 - Cable, Electrical, Lightweight, for Shipboard Use, General Specification.
MIL-C-24643 - Cable and Cord, Electrical, Low Smoke, for Shipboard Use General Specification for.
MIL-P-25732 - Packing, Preformed, Petroleum Hydraulic Fluid Resistant, Limited Service at 275°F (135°C)
MIL-C-26074 - Coatings, Electroless Nickel, Requirements for.

MILITARY (Continued)

MIL-C-28777 - Cable Assembly, Electronic Test Equipment, (3 Wires, 125 and 250 Volts AC and 28 Volts DC) Grounding Plug Connector, General Specification for.
MIL-C-28790 - Circulators, Radio Frequency, General Specification for.
MIL-C-28840 - Connectors, Electrical, Circular Threaded, High Density, High Shock, Shipboard, Class D, General Specification for.
MIL-G-45204 - Gold Plating, Electrodeposited.
MIL-R-46085 - Rhodium Plating, Electrodeposited.
MIL-H-46855 - Human Engineering Requirements for Military Systems, Equipment and Facilities.
MIL-C-49055 - Cables, Power, Electrical, (Flexible, Flat, Unshielded), (Round Conductor), General Specification for.
MIL-C-49059 - Cable, Electrical (Flexible, Flat, Unshielded), (Flat Conductor), General Specification for.
MIL-C-55514 - Capacitors, Fixed, Plastic (or Metalized Plastic) Dielectric, DC or DC-AC, in Nonmetal Cases, Established Reliability, General Specification for.
MIL-G-81168 - Gyroscope, Rate Integrating.
MIL-C-81562 - Coatings, Cadmium, Tin-Cadmium and Zinc (Mechanically Deposited).
MIL-B-81705 - Barrier Materials, Flexible, Electrostatic-Free, Heat Sealable.
MIL-P-81728 - Plating, Tin-Lead (Electrodeposited).
MIL-P-81997 - Pouches, Cushioned, Flexible, Electrostatic-Free, Reclosable, Transparent.
MIL-C-83286 - Coating, Urethane, Aliphatic Isocyanate, for Aerospace Applications.
MIL-P-83461 - Packing, Preformed, Petroleum Hydraulic Fluid Resistant, Improved Performance at 275°F (135°C).

STANDARDS

FEDERAL

FED-STD-H28 - Screw Thread Standards for Federal Services.
FED-STD-H28/2 - Unified Inch Screw Threads - UN and UNR.
FED-STD-H28/7 - American Standard Pipe Threads, (Except Dryseal and Hose Coupling Types).
FED-STD-141 - Paint, Varnish, Lacquer and Related Materials: Methods of Inspection, Sampling and Testing.
FED-STD-313 - Material Safety Data Sheets, Preparation and the Submission of.
FED-STD-595 - Colors.

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MIL-STD-108 - Definitions of and Basic Requirements for Enclosures for Electric and Electronic Equipment.
MIL-STD-129 - Marking for Shipment and Storage.

MILITARY (Continued)

MIL-STD-167-1	- Mechanical Vibrations of Shipboard Equipment (Type I - Environmental and Type II - Internally Excited).
MIL-STD-188-124	- Grounding, Bonding and Shielding for Common Long Haul/Tactical Communication Systems, Including Ground Based Communications-Electronic Facilities and Equipments.
MIL-STD-242	- Part 5-Electronic Equipment Parts Selected Standards, Microcircuits and Semiconductors.
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-469	- Radar Engineering Design Requirements, Electromagnetic Compatibility.
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.
MIL-STD-781	- Reliability Testing for Engineering Development, Qualification, and Production.
MIL-STD-785	- Reliability Program for Systems and Equipment Development and Production.
MIL-STD-810	- Environmental Test Methods and Engineering Guidelines.
MIL-STD-965	- Parts Control Program.
MIL-STD-1275	- Characteristics of 28 Volt DC Electrical Systems in Military Vehicles.
MIL-STD-1310	- Shipboard Bonding, Grounding, and Other Techniques for Electromagnetic Compatibility and Safety.
MIL-STD-1326	- Test Points, Test Point Selection and Interface Requirements for Equipments Monitored by Shipboard On-Line Automatic Test Equipment.
MIL-STD-1364	- Standard General Purpose Electronic Test Equipment.
MIL-STD-1395	- Filters and Networks, Selection and Use of.
DOD-STD-1399,	- Interface Standard for Shipboard Systems.
Section 070	- Part 1 - D.C. Magnetic Field Environment. (Metric)
Section 300	- Electronic Power, Alternating Current. (Metric)
Section 301	- Ship Motion and Attitude. (Metric)
Section 406	- Digital Computer Grounding. (Metric)
Section 441	- Precise Time and Time Interval (PTTI).
Section 532	- Cooling Water for Support of Electronic Equipment. (Metric)

MILITARY (Continued)

MIL-STD-1399, - Interface Standard for Shipboard Systems.
Section 072 - Part 1 - Blast Environment, Missile Exhaust.
Part 2 - Blast Environment, Gun Muzzle.
Section 102 - Dry Air for Support of Electronic Equipment.
Section 103 - Electric Power, Alternating Current.
Section 105 - Sea Water Service for Surface Ships.
Section 106 - Compressed Air Service for Surface Ships.
Section 702 - Synchro Data Transmission.
MIL-STD-1472 - Human Engineering Design Criteria for Military Systems, Equipment and Facilities.
MIL-STD-1633 - Interface Standard for Shipboard Emission Monitor-Control Set, AN/SSQ-82(V) Mute System.
MIL-STD-1661 - Mark and Mod Nomenclature System.
MIL-STD-1683 - Connectors and Jacketed Cable, Electric, Selection Standard for Shipboard Use.
DOD-STD-1686 - Electrostatic Discharge Control Program for Protection of Electrical and Electronic Parts, Assemblies and Equipment (Excluding Electrically Initiated Explosive Devices). (Metric)
DOD-STD-2000 - Soldering Technology, High Quality/High Reliability.
DOD-STD-2143 - Magnetic Silencing Requirements for the Construction of Nonmagnetic Ships and Craft. (Metric)

HANDBOOKS

MILITARY

MIL-HDBK-225 - Synchros, Description and Operation.
MIL-HDBK-237 - Electromagnetic Compatibility Management Guide for Platforms, Systems and Equipment.
MIL-HDBK-241 - Design Guide for Electromagnetic Interference (EMI) Reduction in Power Supply.
MIL-HDBK-251 - Reliability/Design Thermal Applications.
DOD-HDBK-263 - Electrostatic Discharge Control Handbook for Protection of Electrical and Electronic Parts, Assemblies and Equipment (Excluding Electrically Initiated Explosive Devices). (Metric)
MIL-HDBK-278 - System Design Guide for Applying Fiber Optic Technology to Shipboard Systems.
MIL-HDBK-722 - Glass.

2.1.2 Government drawings and publications. The following Government drawings and publications form a part of this specification to the extent specified herein. Unless otherwise specified, the issues shall be those in effect on the date of the solicitation.

DRAWINGS

NAVAL SEA SYSTEMS COMMAND (NAVSEA)

803-5001027 - Cable End Preparation for Open Equipment, General Drawing.
9000-S6202-73724 - Salt Spraying Machine.
9000-S6504-73687 - Dial Markings for IC Telegraph.

PUBLICATIONS

NAVSEA

SE 010-AA-SPN-010 - Standard Power Supply Program, General Specification for Power Supplies.
0967-LP-597-1011 - Electronic Equipment Parts Application, and Reliability Information for Navy.
S9407-AB-HBK-010 - Shipboard Electromagnetic Shielding Practices.

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

2.2 Other publications. The following documents form a part of this specification to the extent specified herein. Unless otherwise specified, the issues of the documents which are DoD adopted shall be those listed in the issue of the DoDISS specified in the solicitation. Unless otherwise specified the issues of documents not listed in the DoDISS shall be the issue of the nongovernment documents which is current on the date of the solicitation.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

A 153 - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware. (DoD adopted)
B 545 - Standard Specification for Electrodeposited Coatings of Tin. (DoD adopted)
B 633 - Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel. (DoD adopted)
D 714 - Standard Method of Evaluating Degree of Blistering of Paints. (DoD adopted)
D 1141 - Standard Specification for Substitute Ocean Water. (DoD adopted)
D 1868 - Standard Method for Detection and Measurement of Partial Discharge (Corona) Pulses in Evaluation of Insulation System.

(Application for copies should be addressed to the American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103.)

ELECTRONIC INDUSTRIES ASSOCIATION (EIA)

RS-310 - Racks, Panels, and Associated Equipment.

(Application for copies should be addressed to the Electronic Industries Association, 2001 Eye Street, Washington, DC 20006.)

THE INSTITUTE FOR INTERCONNECTING AND PACKAGING ELECTRONIC CIRCUITS (IPC)

D-350 - Printed Board Description in Digital Form. (DoD adopted)
D-351 - Printed Board Drawings in Digital Form. (DoD adopted)
D-352 - Electronic Design Data Description for Printed Boards in Digital Form. (DoD adopted)

(Application for copies should be addressed to the Institute for Interconnecting and Packaging Electronic Circuits, 7380 N. Lincoln Avenue, Lincolnwood, IL 60646.)

(Nongovernment standards and other publications are normally available from the organizations which prepare or which distribute the documents. These documents also may be available in or through libraries or other informational services.)

2.3 Order of precedence. Unless otherwise specified herein, when the requirements of the contract, the equipment specification or referenced specifications are in conflict, the following order of precedence shall apply:

(a) Contract.
(b) Equipment specification and documents referenced therein.
(c) This specification.
(d) Referenced specifications in this specification.

3. REQUIREMENTS

3.1 First article. When specified in the contract or purchase order, a sample shall be subjected to first article inspection (see 4.4.1 and 6.3).

3.2 Parts. Parts selected in accordance with this specification shall not relieve the contractor of his responsibility of complying with the equipment performance requirements and the other requirements of the individual equipment specification.

3.2.1 Parts selection and application. Selection of parts shall be made from those listed in MIL-STD-242, part 5. When MIL-STD-242 does not provide sufficient selection guidance, parts shall be selected as specified in table I and other requirements herein. Application of parts shall be as specified in the MIL-STD-454 requirements listed in table I and other requirements herein. When a conflict exists between application criteria, the requirements of this specification shall govern.

3.2.1.1 Standard parts. Standard parts shall be as specified in 3.2.1.

3.2.1.2 Parts control. The parts to be incorporated in the equipment shall be controlled in accordance with MIL-STD-965, procedure I or II to the extent specified in the individual equipment specification.

3.2.1.3 Used or damaged parts. Used or damaged parts or materials shall not be used.

3.2.1.4 Parts derating. Derating of parts shall be in accordance with NAVSEA 0967-LP-597-1011.

3.2.1.5 Interchangeability. Interchangeability shall conform to requirement 7 of MIL-STD-454.

3.2.1.6 Obsolescence or nonavailability. The contractor's design and method of part selection shall minimize the impact of parts obsolescence or nonavailability, as specified in the individual equipment specification or contract (see 6.2.1).

3.2.1.7 Marking of electrostatic discharge (ESD) components. Enclosures, assemblies, and subassemblies containing ESD components, class I or II parts or assemblies shall be marked in accordance with MIL-STD-129 sensitive electronic device symbol. Also, an ESD caution as shown below shall be readily visible to personnel prior to gaining access to class 1 and class 2 parts or assemblies.

CAUTION

THIS EQUIPMENT CONTAINS PARTS AND ASSEMBLIES SENSITIVE
TO DAMAGE BY ELECTROSTATIC DISCHARGE (ESD). USE ESD
PRECAUTIONARY PROCEDURES WHEN TOUCHING, REMOVING OR INSERTING.

3.2.1.8 Electrostatic discharge. Electrostatic discharge control shall be in accordance with DOD-STD-1686 using the guidance of DOD-HDBK-263. When metal oxide semiconductor parts and other parts sensitive to electrostatic discharge are utilized in the equipment, protective circuits shall be incorporated in the equipment to ensure that ESD sensitive parts and subassemblies are protected in all phases of handling and testing. Warning labels shall be affixed to the protective packaging and to the equipment. Warnings shall be provided in all relevant areas of the equipment technical manual. Identification markings shall be affixed on all ESD sensitive subassemblies visible to maintenance personnel prior to maintenance handling in the equipment. Spare parts, modules, printed circuit board subassemblies, and so forth, shall be protected from ESD damage.

TABLE I. Parts selection and application requirements.

Item	MIL-STD-457 requirement	Additional requirements	See
Batteries	27		
Bearings Noise tested	6	Bearings for use in noise critical applications shall conform to MIL-B-17931.	
Capacitors	2		3.2.2 3.2.3
Circuit breakers	37		
Circulators		Shall conform to MIL-C-28790.	
Clamp, cable entrance		Shall conform to W-F-406.	

TABLE I. Parts selection and application requirements. - Continued

Item	MIL-STD-454 requirement	Additional requirements	See
Connectors	10	MIL-C-5015 and MIL-C-28840 connectors shall be selected and applied in accordance with MIL-STD-1683.	3.2.4 3.2.5 3.2.6 3.2.7 5.4
Banana plugs and jacks		Shall not be used.	
Pressure proof		For submarine hull penetration, shall be in accordance with MIL-C-24231.	
Controllers, electric motors		Shall conform to MIL-C-2212.	
Controls	28		
Cordage tinsel		For low voltage audio frequency use. Shall conform to MIL-C-3849.	
Couplers, directional (coaxial and waveguide)	53		
Crystals, quartz	38		
Fastener hardware	12		
Filters, air		Shall conform to MIL-F-16552.	3.2.11
Filters, electrical		Shall conform to MIL-STD-1395.	
Fuses and fuseholders	39	Spare fuses and fuseholders shall be provided. Fuseholders, except the spares, shall provide blown fuse indication.	
Gears and cams	48	Positive locking devices shall be used to secure gears, cams, collars and similar devices to shaft.	
Grommets		Shall conform to MIL-G-3036 or MIL-G-22529.	
Gyroscopes, rate integrating		Shall conform to MIL-G-81168.	

TABLE I. Parts selection and application requirements. - Continued

Item	MIL-STD-454 requirement	Additional requirements	See
Indicator lights	50	Shall conform to the color coding requirements of MIL-STD-1472.	
Isolators	53		
Meters, electrical indicating and accessories	51	Shall not be of the electro-chemical type.	
Microelectronic devices	64		
Modules, electronic	73		
Motors, dynamotors and rotating devices	46	Shall be marked to show the direction of rotation.	
Readouts	68		
Relays	57		
Resilient mounts		Approval for use is required.	
Resistors	33		
Semiconductors	30	Except that unless otherwise specified (see 6.2.1) only JANTX and JANTXV types shall be selected for Naval shipboard equipment.	
Servo devices	56		
Shunts	40		
Sockets and accessories	60		
Solenoids		Shall conform to MIL-S-4040.	
Springs	41		
Stuffing tubes		Shall be selected from MIL-S-19622 and installed in accordance with Drawing 803-5001027.	3.6.3.5
Switches	58		

TABLE I. Parts selection and application requirements. - Continued

Item	MIL-STD-454 requirement	Additional requirements	See
Terminations	19	Terminal boards and strips shall have 10 percent, minimum of 2, unused terminals.	3.2.9
Time totalizing meter	51	Shall be used to indicate elapsed time for both standby and operate. Circuits to be monitored shall be specified on equipment specifications. Shall not be electrochemical type.	3.6.8.11
Transformers			
Inductors and coils	14		
Coils, tube deflection and focusing		Coils shall conform to MIL-C-18388.	
Tubes, electron	29		
Tuning, dial mechanism	42		3.6.8.9
Vibrator power supply		Shall not be used.	
Wire and cable			
Cable coaxial	65		
Cable flat		Shall conform to MIL-C-49055 for cables with round conductors and MIL-C-49059 for cables with flat conductors.	
Cable interconnecting	71	Cables shall be selected from MIL-C-24643. If not therein, then from MIL-C-915. For lightweight cables with conductor sizes AWG 12 or smaller, cables shall be selected from MIL-C-24640.	
Cable multiconductor (internal)	66		
Wire internal, hook-up	20		
Wire magnet		Shall conform to J-W-1177.	
Wire printed	17		

3.2.2 Electrolytic capacitors. The use of fixed, dry, electrolytic (aluminum foil) capacitors shall be restricted to power filter applications.

3.2.3 Paper capacitors. Paper or paper-plastic fixed capacitors with nonmetallic cases shall not be used, except that nonmetallic-plastic wrapped capacitors conforming to MIL-C-55514 may be used in encapsulated or hermetically sealed assemblies.

3.2.3.1 Paper dielectric. Fixed paper dielectric capacitors shall not be used except as feedthrough radio interference capacitors, and these shall conform to MIL-C-11693.

3.2.4 Connector contacts, energized. Connector plug or receptacle contacts which remain energized after unmating shall be inaccessible to the fingertips.

3.2.5 Mating connector plugs. Mating connector plugs and backshells shall be furnished with connector receptacles. The mating connector plugs and backshells shall be compatible with the cables required by table I without modification of either the connector or the cable, and without the use of adapters (except RF) or special tools (other than crimping tools conforming to MIL-C-22520).

3.2.6 Connector keying. Multi-contact connectors, including printed circuit assembly connections, shall be keyed, polarized, or of a contact configuration to prevent improper connection positioning or mating.

3.2.7 Connectors, crimped type. Unless otherwise specified (see 6.2.1), crimped type connectors used internal or external to the equipment shall be of a type whose contacts can be crimped with a tool conforming to MIL-C-22520.

3.2.8 Unused cable conductors. Unused cable conductors shall be available for future use. The minimum quantity shall be:

Total number of used conductors in cable	Required number of unused conductors
1 thru 25	2
26 thru 100	4
101 and over	6

The unused cable conductors shall be terminated in the unused connector contacts which shall be grounded.

3.2.9 Terminal lugs. Terminal lugs for fitting to ships cables shall not be supplied.

3.2.10 Transformers. When grade 4 of MIL-T-27 transformers and inductors are used in the equipment at an internal operating ambient temperature of 65 degrees Celsius (°C) or higher, potting or liquid fillings are prohibited. Class S of MIL-T-27 (or any other class conforming to MIL-T-27, with a maximum operating temperature greater than 130°C, selected from requirement 14 of MIL-STD-454) shall be used when equipment is required to operate at an internal operating temperature of 65°C or higher.

3.2.11 Air filters. Air filters shall be mounted to enable examination and replacement from the outside of the equipment.

3.3 Materials. Use of materials shall be selected and applied as specified in the MIL-STD-454 requirements listed in table II and other requirements herein.

TABLE II. Materials.

Item	MIL-STD-454 requirement	Additional requirements	See
Adhesives	23		
Aluminum alloy bars, rods and shapes		Shall conform to QQ-A-200/1, QQ-A-200/4, QQ-A-200/8, QQ-A-225/2, QQ-A-225/7, or QQ-A-225/8.	
Aluminum alloy castings		QQ-A-591, alloys 360, 13, 218; QQ-A-596, alloys 214A, 356A, 413; QQ-A-601, alloys 356A, B443 or MIL-A-21180, alloys A356, A357, 359	
Aluminum alloy plates and sheet		Shall conform to QQ-A-250/2, QQ-A-250/8 or QQ-A-250/11.	
Aluminum alloy tubing		Shall conform to WW-T-700/2, WW-T-700/4 or WW-T-700/6.	
Arc resistant	26		
Beryllium-beryllium compound		Shall be identified (by labeling, and so forth).	
Brass		Shall conform to QQ-B-613, QQ-B-626, QQ-B-637 or QQ-B-639.	
Brittle		Should not be used.	3.3.5.1
Bronze		Shall conform to QQ-B-728, or QQ-B-750.	
Copper		Shall conform to QQ-C-502.	
Copper-beryllium alloy		Shall conform to QQ-C-530, QQ-C-533 or MIL-C-22087.	
Copper-nickel alloy		Shall conform to MIL-C-15726 or MIL-C-20159.	
Copper-nickel-zinc alloy		Shall conform to MIL-C-15726 or MIL-C-20159.	

TABLE II. Materials. - Continued

Item	MIL-STD-454 requirement	Additional requirements	See
Desiccants		Shall conform to MIL-D-3464.	
Encapsulation and embedment (potting)	47		
Ferrous alloys	15		
Flammable	3		
Fungus-inert	4		
Gaskets and seals			
Dial window		Shall conform to MIL-R-2765 for other than low temperature (-28.9°C minimum) applications.	
Flat gaskets		Shall conform to MIL-R-15624.	3.3.1
Motion, reciprocating or rotary		O-ring gaskets conforming to MIL-P-25732 or MIL-P-83461 shall be used for reciprocating motion seals (push-button shafts) and for rotary motion seals where the rotational speed is less than 10 r/min.	3.3.2
Static			3.3.3
Glass		Shall conform to class 1, type I, MIL-G-3787.	3.3.4
Hydraulic fluid		Shall conform to MIL-F-17111 or MIL-H-19457.	
Hydraulic or pneumatic packing		Shall conform to MIL-G-5514 or HH-P-96.	
Insulating, electrical	11		
Lubricants	43		
Nickel-copper alloy		Shall conform to QQ-N-281, QQ-N-286 or QQ-N-288.	
Plastic		Shall not be used for viewing windows. Shall be coated with varnish conforming to MIL-V-173, if porous.	

TABLE II. Materials. - Continued

Item	MIL-STD-454 requirement	Additional requirements	See
Silver brazing alloys		Shall conform to QQ-B-654.	
Unacceptable		Use of the following materials is prohibited: Adhesive tape, except for coil wrapping and conductor markers Aluminum alloy, type 2024 for above deck applications Aluminum electrical conducting wire Asbestos; asbestos compounds; and asbestos-filled molding compounds Cadmium, where it may be necessary to heat it for soldering, brazing or welding during installation or repair Cellulose, acetate Cellulose, nitrate Use of the following materials is prohibited: Cellulose, regenerate Cotton filled molding compounds Cork Felt, hair or wool Fiber Fragile or brittle Jute Leather Linen	

TABLE II. Materials. - Continued

Item	MIL-STD-454 requirement	Additional requirements	See
Unacceptable		Linen filled molding compounds Lithium and lithium compounds Magnesium or magnesium alloys Mercury or its compounds and amalgams Organic fiberous materials Paper and cardboard Plastic having a cotton fabric base laminate Polychlorinated biphenyls (PCB) Radioactive material Wood and wood-flour-filled molding compound Zinc or zinc alloys unless otherwise specified	

3.3.1 Flat gaskets. The use of flat gaskets shall be held to a minimum and shall be used only between smooth regular surfaces. Consideration shall be given to the degree of enclosure required and the accessibility required. Gaskets which are not penetrated by mounting screws are preferred.

3.3.2 O-ring gaskets. Installation of O-ring gaskets shall be as specified in MIL-G-5514. Lubrication shall be in accordance with MIL-S-8660 except where lubrication in service is required which shall be as provided for pneumatic seals specified in MIL-G-5514.

3.3.3 Static seals. For static seals (between case and cover), O-ring gaskets in accordance with MIL-P-25732 or MIL-P-83461 shall be used. The inside radius of corners shall be 0.5 inch minimum. Lubrication shall be in accordance with MIL-S-8660.

3.3.4 Glass. Glass shall be used in accordance with MIL-HDBK-722.

3.3.4.1 Glass windows. The thickness of glass windows (not withstanding a pressure differential) shall depend upon the minimum linear dimension in accordance with the following:

Dimension of window (inches)	Thickness (inch)	Tolerance (inch)
Less than 7	0.250	+0.016, -0
7 to 10	0.375	+0.016, -0
Over 10 to 15	0.500	+0.031, -0
Over 15	0.625	+0.031, -0

3.3.5 Metals and alloys. Metals and alloys shall be corrosion-resistant or shall be given a corrosion-resisting treatment or coating.

3.3.5.1 Brittle materials. Strength members shall not be fabricated from cast iron possessing elongation capabilities of less than 10 percent.

3.3.6 Dissimilar metals. The selection and protection of dissimilar metals combinations shall be in accordance with requirement 16 of MIL-STD-454.

3.3.7 Insulation of dissimilar metals. Where it would otherwise be necessary that dissimilar metals be assembled in intimate contact with each other, an interposing material compatible to each shall be used. Insulating material is not required between corrosion-resisting steel inserts and aluminum castings when the inserts are integrally cast in the aluminum.

3.3.8 Material safety data sheet. The contracting activity shall be provided a material safety data sheet (MSDS) at the time of contract award. The MSDS is Form OSHA-20, found in and part of FED-STD-313. The MSDS shall be included with each shipment of the material covered by this specification (see 6.6).

3.4 Processes. Processes, except painting, shall be in accordance with MIL-STD-454 and table III. A protective plating or coating shall be applied to all metals which are not corrosion-resistant except for the following:

(a) Items bathed in lubricants.
(b) Interior surfaces of tube, relay or coil shields.
(c) Items which are potted, encapsulated or hermetically sealed.
(d) Where electric grounding through the surface is required.

TABLE III. Processes.

Item	MIL-STD-454 requirement	Additional requirements
Anodizing for painted surfaces		Shall conform to MIL-A-8625 or chemical treatment conforming to MIL-C-5541
Brazing	59	
Cadmium plating		Shall be used as specified in the individual equipment specification (see 6.2.1) on fasteners (as required) or government standard parts.

TABLE III. Processes. - Continued

Item	MIL-STD-454 requirement	Additional requirements
Castings	21	Zinc alloy and magnesium alloy castings shall not be used.
Chromium plating		Shall conform to QQ-C-320.
Copper plating		Shall conform to MIL-C-14550.
Corrosion protection	15	
Gold plating		Shall conform to type II or type III of MIL-G-45204, depending on application.
Nickel plating		Electroplating shall conform to QQ-N-290. Electroless shall conform to MIL-C-26074.
Phosphate coating		Shall conform to DOD-P-16232.
Rhodium plating		Shall conform to class 3 of MIL-R-46085.
Silver plating		Shall conform to QQ-S-365.
Soldering	5	Shall conform to DOD-STD-2000-1, -2, -3, or -4.
Tin plating		Shall conform to ASTM B 545.
Aliphatic urethane plating		Shall conform to MIL-C-83286.
Welding	13	
Welds, resistance	24	
Zinc coating		Shall conform to ASTM A 153 (hot dip galvanizing), ASTM B 633 (electrodeposited), or MIL-C-81562 (mechanically deposited).
Zinc plating	15	

3.4.1 Painting. The exterior and interior surfaces of metallic enclosures shall be painted as specified herein, except the interior of treated aluminum enclosures for sheltered locations need not be painted. Prior to painting, the applicable pretreatment and primer shall have been completed. Plastic enclosures normally will not be painted.

3.4.1.1 Aluminum and aluminum alloy pretreatment. Aluminum and aluminum alloy pretreatment shall be as follows:

(a) Cleaning. The basic metal shall be cleaned to remove grease, oil, welding flux, or other foreign matter.

(b) Application:

(1) Protected equipment (interior use). For protected equipment (interior use), aluminum and aluminum alloy shall be anodized in accordance with MIL-A-8625 or chemically treated in accordance with MIL-C-5541.

(2) Exposed equipment (exterior use). For exposed equipment (exterior use), aluminum and aluminum alloys shall be chemically treated in accordance with MIL-C-5541.

3.4.1.2 Ferrous metal pretreatment. Ferrous metal pretreatment shall be as follows:

(a) Cleaning. After all machining, welding, and brazing operations are completed, rust or other corrosion products and flux shall be removed by abrasive blasting, sanding, wire brushing, or other mechanical means. Surfaces shall be cleansed of all grease, oil, and dirt by solvent wiping and rinsing, vapor degreasing, or caustic washing followed by rinsing.

(b) Application. Ferrous metals shall be pretreated in accordance with type I or III of TT-C-490.

3.4.1.3 Protected equipment (interior use) (except Marine Corps and ordance).

3.4.1.3.1 Primer. One coat of primer conforming to TT-P-1757 or TT-P-664 shall be applied. The primer shall have a dry film thickness of 0.0006 to 0.0008 inch.

3.4.1.3.2 Enamel. Enclosures shall be painted with two continuous film coats of gray enamel conforming to MIL-E-15090. Each coat shall have a minimum thickness of 0.001 inch, dry film thickness. Enamel for shipboard portable equipment enclosures shall conform to class 1 of MIL-E-15090. Enamel for other protected equipment enclosures shall conform to class 2 of MIL-E-15090.

3.4.1.4 Exposed equipment (exterior use) (except Marine Corps). Equipment or units thereof, exposed to the weather shall be finished with four coats of paint in accordance with MIL-P-24441 as follows:

1st coat:	Green epoxy-polyamide primer in accordance with MIL-P-24441/1 (thickness 0.003 to 0.004 inch dry film thickness).
2nd coat:	Dark gray epoxy-polyamide top coat in accordance with MIL-P-24441/6 (thickness 0.002 to 0.003 inch dry film thickness).
3rd to 4th coat:	Haze gray silicone alkyd enamel in accordance with TT-E-490, color 26270 in accordance with FED-STD-595 (thickness 0.001 to 0.0015 inch dry film). The total dry film thickness shall be 0.007 to 0.010 inch.

3.4.1.4.1 Adhesion and blister resistance. When specified in the individual equipment specification (see 6.2.1), paint systems prepared for exposed shipboard equipment shall show no blistering or adhesive failure when tested (see 4.6.8.18).

3.4.1.5 Marine Corps equipment.

3.4.1.5.1 Primer. Prior to painting, primer conforming to MIL-P-23377 shall be applied to enclosures for Marine Corps equipment. The primer shall have a dry film thickness of 0.0006 to 0.0009 inch.

3.4.1.5.2 Enamel. Two coats of Marine Corps green urethane topcoat conforming to MIL-C-83286 shall be applied. Each coat shall have a minimum thickness of 0.001 inch.

3.5 Electrical design and construction. The electrical design and construction shall be as specified in 3.5.1 through 3.5.14.

3.5.1 Input power. The input power characteristics shall be in accordance with 3.5.1.1 through 3.5.1.5.1.5 (see 6.2.1).

3.5.1.1 Shipboard ac power. The equipment shall operate from and be compatible with alternating current (ac) power in accordance with section 300 of DOD-STD-1399.

3.5.1.2 Shore-station ac power. Equipment intended for fixed shore installations shall operate from the applicable type of ac power source shown in table IV.

TABLE IV. Ac power source types for fixed shore installations.

Ac power source parameters	Equipment power rating		
	Less than 1 kVA	1 kVA to 100 kVA	Greater than 100 kVA
Nominal voltage (volts - rms)	120 or 240 single phase	277 or 480 3-phase 1/	As specified in the individual equipment specification (see 6.2.1)
Nominal frequency (Hz)	60	60	
Voltage regulation (percent)	± 10	± 10	
Frequency regulation (percent)	± 5	± 5	

1/ For three-phase systems, a 4-wire grounded wye distribution scheme is used.

3.5.1.3 Shipboard/shore-station direct current (dc) power. Dc power shall be as specified in the individual equipment specification (see 6.2.1). For each dc input, the equipment shall contain reverse polarity protection.

3.5.1.4 Vehicular dc power. Equipment intended to utilize military vehicular electrical power shall function within performance limits over the steady state voltage range of 20 to 30 volts (V), from electrical power having characteristics specified in MIL-STD-1275.

3.5.1.5 Submarine dc power. Equipment intended for submarine installation shall operate from and be compatible with the following dc power characteristics:

Characteristic	Value
Nominal user voltage	270 Vdc
User voltage tolerance	plus or minus 12 percent
System voltage ripple (rms)	3.5 percent
Voltage transient	
(a) Voltage transient limits	plus or minus 16 percent
(b) Voltage transient recovery time	0.25 seconds
Voltage spike (peak value)	1200 volts (see figure 1)
Dc ground isolation	>200 kilo ohms
Ac ground isolation	<25 microfarad (μF) measured at 1 kHz
Power system source impedance	(see figure 2)
Power continuity (vital loads only)	0.0 to 3 milliseconds (see 3.5.1.5.1.6)
Distribution system	2-wire ungrounded

3.5.1.5.1 Equipment constraints. When using submarine dc power, the equipment operation shall be constrained to figures 1 and 2.

3.5.1.5.1.1 Inrush current. The peak amplitude of the inrush current shall not exceed 200 percent of the nominal load current. The rate of change of the inrush current (d_I/dt) shall not exceed the following values:

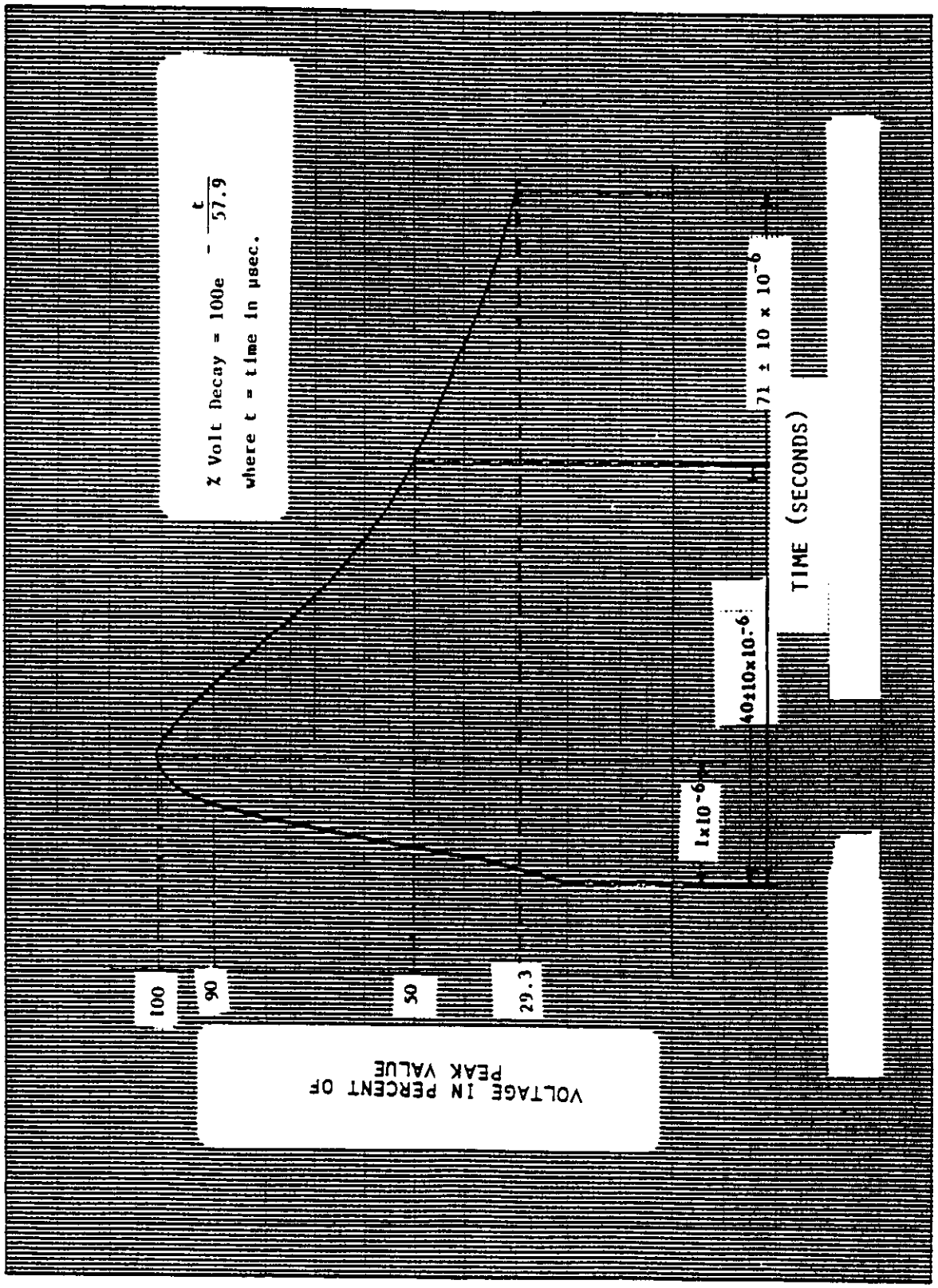

FIGURE 1. Voltage spike (short time transient).

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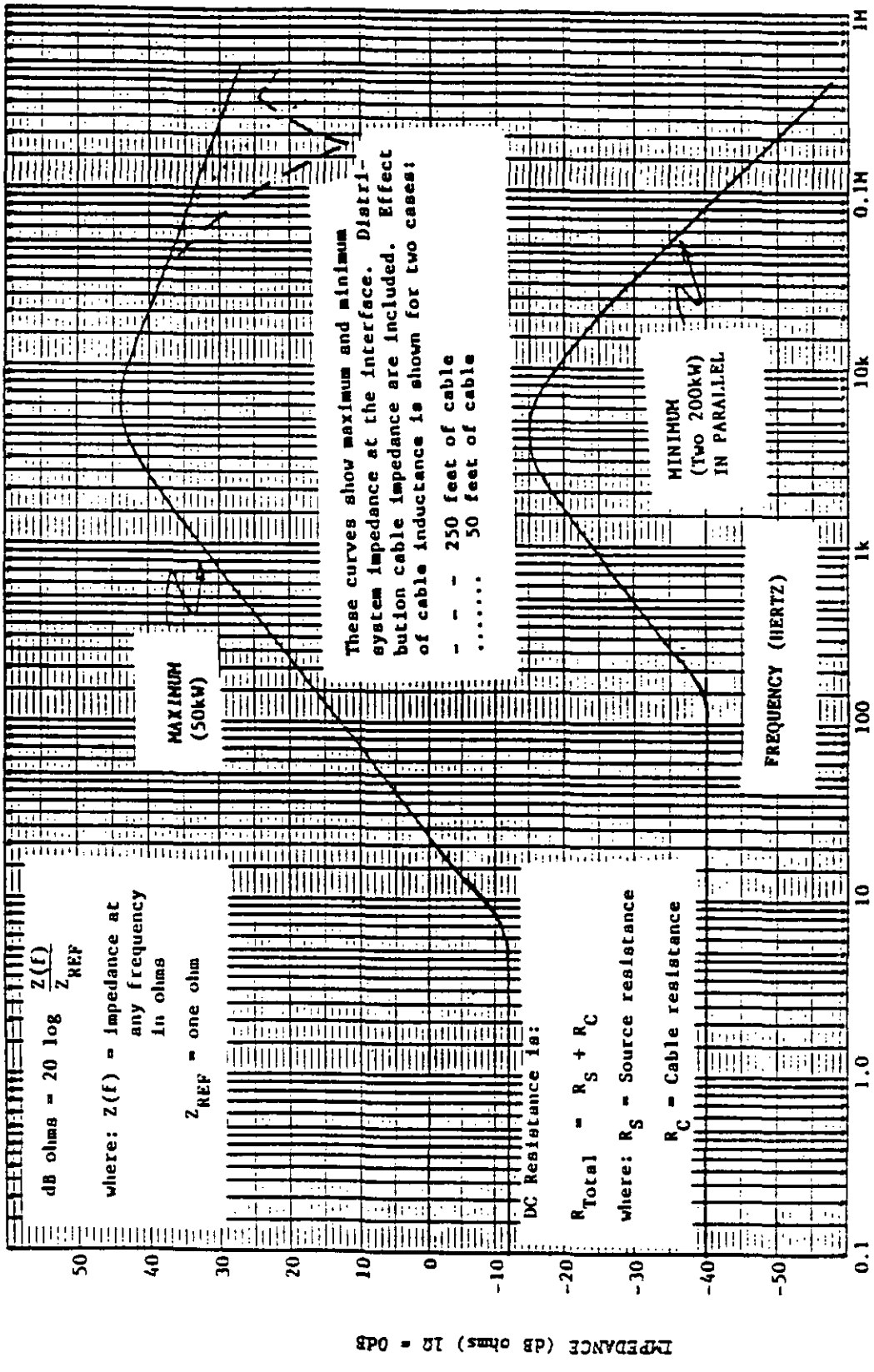

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FIGURE 2. Power system Z versus frequency.

Nominal rated load current at interface (amperes)	d_I/dt (amperes per millisecond)
1 to 37	3.5
37 to 92	13.0
92 to 185	32.0
185 to 275	52.0
275 to 370	77.0
370 and higher	100.0

3.5.1.5.1.2 Load current. The peak amplitude of the load current, excluding inrush current, shall not exceed 150 percent of the nominal load current. The rate of change of the load current (d_I/dt) shall not exceed the following values:

Nominal rated load current at interface (amperes)	d_I/dt (amperes per millisecond)
1 to 37	1.8
37 to 92	6.5
92 to 185	16.0
185 to 275	26.0
275 to 370	38.5
370 and higher	50.0

3.5.1.5.1.3 User equipment dc ground isolation. Each user equipment dc input power line at the interface shall be isolated from hull ground by a dc resistance greater than 100 megohm-kilowatt (kW) per kW of connected load for each 270 volts direct current (Vdc) input line.

$$\text{Isolation resistance} = \frac{\text{100 megohm - kW}}{\text{connected load in kW}}$$

Example: If connected load is 20 kW,

$$\text{Isolation resistance} = \frac{\text{100 megohm - kW}}{\text{20 kW}} = 5 \text{ megohms}$$

3.5.1.5.1.4 User equipment electromagnetic interference (EMI) filtering. The use of line-to-ground filters shall be minimized. If filters are used, the sum of the leakage capacitance and the filter capacitance from each line-to-ground at the user interface shall not exceed 0.075 µF/kW of connected load measured at 1 kilohertz (kHz). If filters are not used, the leakage capacitance from each line-to-ground at the user interface shall not exceed 0.02 µF/kW of connected load measured at 1 kHz.

3.5.1.5.1.5 User equipment input/output isolation. User equipment 270 Vdc input terminals shall be isolated from all user equipment loads, for example, power conversion equipment outputs, by a dc resistance greater than 200 megohm-kW of connected load.

3.5.1.5.1.6 Continuity of power. In order to obtain maximum reliability and continuity of power supplied during certain operating conditions (such as a battle or major casualties), all vital loads are provided with a limited break power supply. This is accomplished by diode OR'ing two or more independent power sources. On loss of one of the power sources, critical loads are transferred to the other power sources. From 0.0 to 3.0 milliseconds are required for transferring the load from one power source to another. During transfer the voltage transient shall not exceed the upper transient limit specified in table I. However, the voltage may drop from plus 270 (Vdc), plus or minus 12 percent to as low as minus 3.0 volts, depending on the load and distribution configuration as the instant power is transferred. Negative transients greater than minus 3.0 volts are prevented by a freewheeling or catch diode which is connected across the power source output terminals after the OR'ing diodes. The cathode of the diode is connected to the positive bus and the anode is connected to the return bus. The OR'ing and freewheeling functions shall be accomplished at the switchboard where the multiple sources are landed.

3.5.2. Battery overcharge protection. Battery charging systems shall be provided with built-in protection to prevent damage to batteries due to overcharge or thermal runaway.

3.5.3 Equipment warm-up. Unless otherwise specified (see 6.2.1) in the equipment specification, the equipment shall reach stable operation within 30 minutes after input power is applied. Stable operation means that the specified operational characteristics shall not vary more than 10 percent of the nominal value.

3.5.3.1 Equipment restart. Unless otherwise specified in the equipment specification, after subsecond power interruptions lasting 0.1 second or less, the equipment shall automatically resume specified performance without delay and after power interruptions lasting more than 0.1 second, the equipment shall resume specified performance in the shortest time possible. The equipment restart time shall be no greater than the power interruption time or the equipment warm-up time, whichever is less.

3.5.3.2 Data base retention. Unless otherwise specified (see 6.2.1) in the equipment specification, the equipment shall retain the data base (digital) which defines its operational status during power interruptions lasting 500 milliseconds or less.

3.5.3.3 Battle override. The equipment shall be equipped with interlock bypass switches.

3.5.4 Internal wiring practices. Internal wiring practices shall conform to requirement 69 of MIL-STD-454 and the requirements below (see 6.2.1).

3.5.4.1 Input power connections. The input power connector pin assignments and conductor color code shall be as shown:

Equipment power supply	Conductor assignment	Connector pin designation	Cable color code
Single-phase	115/440Vac	A	White
	115/440Vac	C	Black
	Safety ground	B	Green
Three-phase	Phase A	A	Black
	Phase B	B	White
	Phase C	C	Red
	Safety ground	D	Green
Dc power	Positive	A	Black
	Negative	C	White
	Ground	B	Green

The color code for conductors shall be maintained from the input power connections to all components having the same voltage and frequency as the input power.

3.5.5 Electrical overcurrent protection. Multiphase circuit breakers shall disconnect all phases when an overload occurs in any one phase. Protective devices shall not be installed in the neutral unless neutral power sensing is essential to proper operation of the equipment and the overcurrent protective device simultaneously opens all conductors of the circuit and is so designed that no pole can operate independently. When electrical overcurrent protection devices are used internally, the status (that is, open or closed) shall be displayed on the operating panel and the restoration of the device can be controlled from the front panel (see 6.2.1).

3.5.6 Main power on-off. The main power on-off switch located on the equipment shall de-energize the equipment. The main power on-off switch shall be clearly labeled as such. A green lamp shall be mounted near the equipment to indicate when the equipment is energized. The lamp shall be connected to the load side of the switch (see 6.2.1).

3.5.7 Dielectric withstanding voltage. The equipment shall prevent electrical breakdown such as corona (defined in ASTM D 1868), flashover (surface discharge), sparkover (air discharge) or breakdown (puncture discharge) when the electrical power circuits are subjected to the dielectric test voltages shown in table V (see 6.2.1).

TABLE V. Dielectric test voltages.

Circuit voltage of equipment tested (volts)	Rms value of dielectric test voltage (volts)	Environmental service conditions
Less than 60	450	As specified in equipment specification.
60 to 120	900	
Above 120 and less than 240	1200	
240 to 480	1500	
Above 480	Twice rated plus 1000	

3.5.8 Insulation resistance. Insulation resistance of the equipment shall meet the requirement specified in DOD-STD-1399, section 300 and shall not be less than 10 megohms at specified environmental service conditions (see 6.2.1). In addition, shipboard equipments shall not be damaged by the testing conditions specified in 4.6.3.7.

3.5.9 Synchro data transmission systems. Synchro data transmission systems shall conform to the interface characteristics and constraints of section 702 of DOD-STD-1399. Units shall be aligned using electrical zeroing methods of MIL-HDBK-225. Synchro capacitors shall be rated at 600 Vdc for 60 hertz (Hz) synchros and 1000 Vdc for 400 Hz synchros.

3.5.10 Power receptacles. Convenience power receptacles shall not be provided for shipboard equipment.

3.5.11 Emission control. Unless otherwise specified (see 6.2.1), all shipboard electronic equipment which transmits acoustic or electromagnetic energy shall meet the interface requirements of MIL-STD-1633.

3.5.12 Power supply design and manufacturing requirements. Design for low voltage power supplies delivering up to 5 kW at 300 Vdc or less shall be as specified in NAVSEA SE 010-AA-SPN-010 and 3.5.12.1 through 3.5.12.11 (see 6.2.1).

3.5.12.1 Power density. The power density shall be defined as output power supply envelope volume, including EMI filtering where required. Power density exceeding 2 watts per cubic inch shall require the approval of the contract activity.

3.5.12.2 Junction temperature. Junction temperature of semiconductor and microelectronic devices (diodes, transistors, hybrid and integrated circuits, and so forth) shall not exceed 100°C under worst-case conditions.

3.5.12.3 Case/hot spot temperatures. Case/hot spot temperatures shall not exceed 40°C rise above ambient temperature with a maximum temperature of 110° for parts less than or equal to 3 watts of dissipation; 55°C rise above ambient with a maximum temperature of 125°C for parts greater than 3 watts of dissipation; 30°C rise above part ambient with a maximum temperature of 100°C for transformers; and 10°C rise above ambient, due to 100°C for transformers; and 10°C rise above ambient, due to self-heating, with a maximum temperature of 85°C for capacitors.

3.5.12.4 Power supply maintainability. Power supplies shall be designed to be maintainable at either intermediate or depot level; they shall not be limited by design to repair by the manufacturer.

3.5.12.5 Embedded power supplies. Power supplies shall not be encapsulated or embedded (potted) unless it can be shown by analyses and testing to be necessary for heat removal or dissipation. This requirement shall not exclude conformal coating.

3.5.12.6 Power supply manufacturing. Power supply manufacturing shall include random vibration and temperature cycling of every unit, under full electrical load; this may be done in the end item but shall be performed on a unit basis for spare parts.

3.5.12.7 Power supply interface. Equipment incorporating power supplies shall operate from type I power specified in section 300 of DOD-STD-1399. Power supplies shall be tested with the end equipment, or shall be tested as a unit by duplicating the input and output power of the power supply as installed for operation in the end equipment.

3.5.12.8 Power supply EMI. EMI requirements shall be tailored for the power supply which will enable the end equipments to meet the class of MIL-STD-461 required by its specification. EMI specifications shall be developed for the power supply which will permit the power supply to be acquired separately from the end equipment.

3.5.12.9 Open short circuit. Power supplies shall withstand damage by any load between an open circuit and a short circuit.

3.5.12.10 Reserve load capacity. Power supplies shall provide a reserve load capacity of 20 percent.

3.5.12.11 Power supply reliability requirements. Low voltage power supplies delivering up to 5 kW at 300 Vdc or less shall have a mean-time-between-failure (MTBF) of not less than 40,000 hours (upper test MTBF, as defined in MIL-STD-781) for Naval sheltered equipment at a temperature of 55°C.

3.5.13 Electrical signal interface characteristics. When specified (see 6.2.1), the equipment shall be in accordance with 3.5.13.1 through 3.5.13.3.1.

3.5.13.1 Synchro data. When specified (see 6.2.1), the equipment shall meet the requirements as specified in MIL-HDBK-225. Synchro capacitors shall be rated at 600 Vdc for 60 Hz synchros and 1000 Vdc for 400 Hz synchros.

3.5.13.2 Digital data. The equipment shall be compatible with the data format as specified in the equipment specification.

3.5.13.3 Precise time and time interval. When specified in the equipment specification, the equipment shall be compatible with the requirements of DOD-STD-1399, section 441.

3.5.13.3.1 Digital form of documentation. Printed wiring board descriptions in digital (numerical) form shall be in accordance with IPC-D-350. See also IPC-D-351 and IPC-D-352 for further details.

3.5.14 Digital computer grounding. When identified in the equipment specification as equipment used for the processing, recording or storage of digital or TEMPEST information, the equipment shall be compatible with the requirements of DOD-STD-1399, section 406.

3.6 Mechanical design and construction. The mechanical design and construction shall be as specified in 3.6.1 through 3.6.1.2.5.

3.6.1 Size and weight. The size and weight of the equipment shall be constrained as specified in 3.6.1.1 through 3.6.1.2.5 (see 6.2.1).

3.6.1.1 Weight. Equipment weight shall be within the limits specified in the individual equipment specification (see 6.2.1). The weight of all equipment shall be clearly identified in the external surface of the equipment and readily visible during installation and removal. Design of rack-mounted and console equipment shall maintain the center of gravity as low as practicable.

3.6.1.2 Size. Equipment size limitations shall be as specified herein. Size limits may be achieved by use of separable units.

3.6.1.2.1 Maximum height. Equipment intended for installation within internal shipboard spaces shall be not over 72 inches overall height, including stacked units and resilient mounts when their use is permitted (see 3.6.4.7).

3.6.1.2.2 Surface ship installation. Equipment intended for installation within internal surface ship spaces shall be constructed to pass through a doorway 26 inches wide by 45 inches high (reduced further by round corners on an 8-inch radius) and through a hatch 30 inches long by 30 inches wide (reduced further by round corners on a 7-1/2 inch radius).

3.6.1.2.3 Submarine installation. Unless otherwise specified (see 6.2.1), equipment intended for installation within internal submarine spaces shall be constructed to pass through a circular tube (submarine entrance hatch) 25 inches in diameter and through a doorway 20 inches wide by 38 inches high (reduced further by round corners on a 10-inch radius).

3.6.1.2.4 Other installations. The maximum size limitations of equipment intended for other than surface ship or submarine installations shall be as specified in the individual equipment specification (see 6.2.1).

3.6.1.2.5 Handling. The equipment shall incorporate the design features for efficient handling of MIL-STD-1472.

3.6.2 Support services. When specified (see 6.2.1) in the individual equipment specification, the support services shall be as specified in 3.6.2.1 through 3.6.2.4.

3.6.2.1 Compressed air. Compressed air shall be in accordance with MIL-STD-1399, section 106.

3.6.2.2 Dry air. Dry air shall be in accordance with MIL-STD-1399, section 102.

3.6.2.3 Seawater. Saltwater equipment shall be in accordance with MIL-STD-1399, section 105.

3.6.2.4 Cooling water. When specified (see 6.2.1) in the equipment specification, cooling water equipment shall be in accordance with DOD-STD-1399, section 532.

3.6.3 Enclosures. The equipment enclosures shall be in accordance with MIL-STD-108 and MIL-E-2036 (see 6.2.1).

3.6.3.1 Hazardous atmosphere. When specified (see 6.2.1) in the individual equipment specification, the equipment or portions thereof shall be protected against a hazardous atmosphere (see 6.5.2) by one of the following methods:

(a) Enclosed in a heavy-duty, explosion-proof housing as defined by MIL-STD-108.
(b) Hermetically sealed conforming to the hermetic enclosure requirement of MIL-STD-108.
(c) Embedded (potted).

3.6.3.2 Degree of enclosure. When specified (see 3.6.1) in the equipment specification, the degree of enclosure shall conform to the requirements of table VI.

3.6.3.3 Watertight joints. Gaskets for watertight joints shall not be displaced when the door or cover is removed. The design shall prevent lateral flow of the gasket when under compression.

3.6.3.4 Moisture pockets. The preclusion of moisture pockets within equipment enclosures shall conform to requirement 31 of MIL-STD-454.

TABLE VI. Degrees of enclosure.

Degree of enclosure (MIL-STD-108)	Installation environment
Watertight	Exposed to weather
Dripproof 15°	Surface ship internal installation
Dripproof 45°	Submarine internal installation

When the equipment operational conditions or installation environment require other degrees of enclosures, they shall be as specified in the equipment specification.

3.6.3.5 External connections. Unless otherwise specified (see 6.2.1) in the individual equipment specification, the method of external connections to equipment enclosures shall be made by the use of connectors and shall conform to applicable requirements (see table I). Terminal boards or stuffing tubes shall be used when specified (see 6.2.1) in the individual equipment specification and the applicable requirements (see table I). Unless otherwise specified (see 6.2.1) in the individual equipment specification, external connections, excluding test connections, shall not be located on the front or back of the enclosures.

3.6.3.5.1 Cable entrance stuffing tube (cast enclosure). On cast enclosures with a wall thickness greater than 0.19 inch, bosses, drilled and tapped with type NPT pipe threads, conforming to FED-STD-H28 and FED-STD-H28/7 for the stuffing tube to be used, shall be provided in the top, bottom or sides of the enclosure. Plastic protective cap plugs (Ca-Plugs, or equal) shall be installed in cable entrance holes to provide protection during shipment or handling prior to equipment installation.

3.6.3.5.2 Cable entrance plates, stuffing tube. The enclosure shall be provided with cable entrance plates capable of preserving the degree of enclosure specified. Space shall be provided inside the enclosure between the stuffing tubes and the terminal boards so that the wiring will not be crushed or distorted when the internal subassembly is mounted in the enclosure. All stuffing tubes for an enclosure shall be mounted on a plate having enough spare area to accommodate an additional stuffing tube of the largest size mounted thereon. This plate shall be on either of at least two sides of the enclosure. The unused stuffing tube mounting plate areas on the enclosure shall be covered with blank plates of the same configuration as the stuffing tube plate.

3.6.3.5.3 Terminal board accessibility. Access to terminal boards and test points shall not be dependent upon removal of cable entrance plates and cables.

3.6.4 Equipment mounting. The method of equipment mounting shall be as specified (see 6.2.1) in the individual equipment specification, and shall conform to one or more of the mounting arrangements specified in 3.6.4.1 through 3.6.4.8.

3.6.4.1 Bulkhead mounting. Equipment intended for bulkhead mounting (except switchboards) shall have mounting pads on the rear surfaces of the enclosure. A minimum of two pads shall be above the center of gravity of the enclosed equipment and additional pads positioned to transmit loads to the supporting structure.

3.6.4.2 Deck or table mounting. Equipment intended for deck or table mounting shall have mounting features which permit through bolts to be installed perpendicular to the mounting surface and additional features to provide for installing sway braces to the upper rear of the equipment enclosure when necessary for stability. Deck or table mounting shall be in accordance with table VII.

3.6.4.3 Panel mounting. Equipment intended for front panel mounting shall incorporate a flange for securing the panel in a vertical position in the enclosure. The enclosure shall not project more than 1-1/2 inches from the face of the panel (not including operating handles). Design of rack-mounted and console equipment shall maintain the center of gravity as low as practicable.

3.6.4.4 Overhead mounting. Equipment enclosures intended for overhead mounting shall be limited to lightweight devices as specified (see 6.2.1) in the individual equipment specification, and shall incorporate mounting features located to suspend the enclosure and to transmit the load to the overhead structure. Overhead mounting shall be in accordance with table VII.

TABLE VII. Equipment mounting.

Equipment mounting method	Order of preference	Maximum weight (lbs)	Applicable paragraph
Deck or table	1	No limit	3.6.4.2
Panel	2	As specified in EIA RS-310	3.6.4.3
Bulkhead	3	200	3.6.4.1
Overhead	4	50	3.6.4.4

3.6.4.5 Through bolting. Through bolting or through threading into watertight enclosures shall not be permitted. Bosses shall be provided in cast enclosures to preclude through bolting or threading. Blind tapped continuous welded buttons shall be used in sheet metal enclosure.

3.6.4.6 Mounting bolts. Calculations for the proper size of deck and bulkhead attachment bolts shall be based on the minimum elastic-proof load for grade 2 carbon and alloy steel as specified in MIL-S-1222.

3.6.4.7 Resilient mounts. Unless otherwise specified (see 6.2.1), resilient mounts shall not be used.

3.6.4.8 Sliding drawer mounts. Equipment design shall include provisions to prevent accidental derailing and detachment or pulling off slides of equipment mounted on drawer slides.

3.6.5 Mounting of parts. Parts weighing 0.25 ounce (7.1 grams) or more per lead shall be supported by clamps or other specified means. This will ensure that soldered joints and leads are not relied upon for mechanical strength. Ceramic or composition resistors which are secured by screws shall have pliable washers inserted under the screws to prevent undue stress on resistors.

3.6.5.1 Part replacement. The arrangement of parts on repairable items shall be such that replacement of any part is possible without removal of or damage to adjacent parts.

3.6.6 Airborne noise. Equipment shall withstand airborne noise in accordance with MIL-STD-740-1, for the grade specified in the equipment specification (see 6.2.1).

3.6.7 Structureborne noise. Equipment shall withstand structureborne noise in accordance with type III equipment of MIL-STD-740-2 (see 6.2.1).

3.6.8 Controls, indicators and panel layout (see 6.2.1).

3.6.8.1 Illumination. Illuminated controls, switches, and dials shall be illuminated by lighting sources integral to associated equipment. Dials and other displays illuminated with white light shall be readable in all levels of incident illumination below 28 footcandles. Red illuminated dials and displays shall be readable in all levels of incident illumination up to 0.03 footcandle. Where the observation of an object or surface is critical to the operation of equipment, the illumination shall be from two or more sources.

3.6.8.2 Panel illumination. Integrally illuminated panels shall be in accordance with MIL-P-7788.

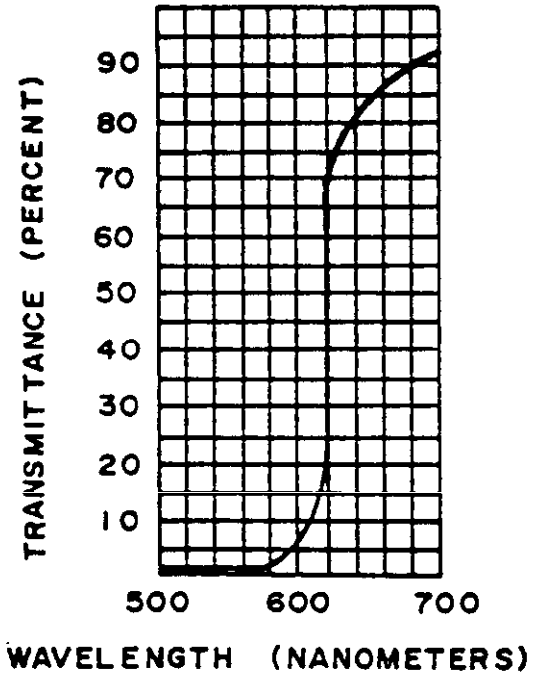
3.6.8.3 Dial lamps.

3.6.8.3.1 Incandescent lamps. Unless otherwise specified (see 6.2.1) in the individual equipment specification, incandescent dial lamps for controls, switches and dials shall be energized from the secondary of a transformer, and the lighting circuit shall be equipped with a control device to vary light intensity from maximum value to minimum discernible intensity when all lamps or when 50 percent of the lamps are operative. The control device may be electrical or optical. At the nominal system operating voltage, and with the maximum number of lamps operative for a typical situation, the lamp socket voltage shall not exceed the rated value of the lamp.

3.6.8.4 Design for dark adapted areas. Equipment designed for use in dark adapted areas shall use clear lamps with red filters and stencil type material having transmission characteristics that essentially conform to the curve of figure 3. There shall be no bright reflective surface visible to the equipment operator.

3.6.8.5 Selection of color for indicating and display. The selection of colors for indicating and display shall conform to MIL-STD-1472.

3.6.8.6 Dials and pointers for units having self-contained red illumination. Dials and pointers for units having self-contained red illumination shall have dark faces and white numerals, graduations and lettering when viewed under high level ambient illumination and shall present red numerals, graduations and lettering when the internal illumination is energized and viewed under low level ambient illumination. In units having a single indication, the pointer shall have a white border. In units having two concentric indications, distinctive numerals and shapes in addition to a white border shall be as specified (see 6.2.1) in the individual equipment specification.



Note: Cut-off: 590 Nanometers
Peak: 700 Nanometers

Transmission characteristics shall essentially follow the curve shown hereon.

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FIGURE 3. Curve of light transmission of red material.

3.6.8.7 Dials and pointers for units not having self-contained illumination. Dials and pointers for units not having self-contained illumination shall have white faces with black numerals, graduations, and lettering. In units having a single indicator, the pointer shall be black. In units having two concentric indicators, the numeral and pointer colors shall be as specified (see 6.2.1) in the individual equipment specification.

3.6.8.8 Dials and pointers. Dial markings for interior communications, order, and indicating systems shall be in accordance with Drawing 9000-S6504-73687. The markings shall be free from distortion with clear and sharp edges. The width of the pointer tip shall be the same width as the minimum dial graduations. The pointer shall not cover the graduations to which it refers but shall extend only to the nearer edge of the graduations.

3.6.8.9 Tuning dial mechanisms. Tuning dial mechanisms shall conform to requirement 42 of MIL-STD-454.

3.6.8.10 Windows. Where operating controls are so arranged as to require the reading of dials through windows in the panels or the control housings, the window shall be provided with glass (see table II) secured to the panels by means of clips or other mechanical devices. The use of cement alone for securing the glass is not acceptable.

3.6.8.11 Time totalizing meters. Time totalizing meters shall be provided to indicate elapsed time for both standby and operation. Time meters shall not be of the electrochemical type. Circuits to be monitored by the time meters shall be as specified (see 6.2.1) in the individual equipment specification. Time meters shall not be mounted on removable assemblies.

3.6.9 Balancing. Rotatable and rotating parts, except locking adjustment controls, shall be statically and dynamically balanced and supported to prevent damage or unintentional movement under any environmental condition specified herein. If weights are necessary for balancing, they shall be securely mounted to prevent dislodgement during operational or environmental conditions specified herein.

3.6.10 Dc magnetic requirements for minesweeper equipment. When specified (see 6.2.1) in the individual equipment specification, equipment shall conform to the requirements of DOD-STD-2143.

3.6.11 External connections. Unless otherwise specified (see 6.2.1) in the equipment specification, external connections to equipment enclosures shall be made by the use of connectors conforming to table I.

3.6.11.1 Stuffing tubes. When specified (see 6.2.1) in the equipment specification, stuffing tubes shall be selected and applied in accordance with the requirements of table I.

3.6.11.2 Location. Unless otherwise specified (see 6.2.1) in the equipment specification, external connections (excluding test connections) shall not be located on the front or back of the equipment.

3.7 Thermal design and construction. Thermal design shall be in accordance with requirement 52 of MIL-STD-454 and as specified herein.

3.7.1 Heat removal. MIL-HDBK-251 shall be used as guidance in the design and selection of the heat removal method (see 6.2.1).

3.7.1.1 Forced air cooling. Forced air cooling is the preferred cooling method. When the inlet and outlet temperature differential exceeds 14°C then water cooling (see 3.7.1.2) shall be used.

3.7.1.1.1 Inlet/outlet location. Unless otherwise specified (see 6.2.1), the inlet air port shall be located on the bottom of the equipment, the discharge port shall be located on the top of the equipment.

3.7.1.2 Water cooling. Water cooling shall conform to MIL-W-21965 and the interface compatibility requirements of section 532 of DOD-STD-1399.

3.7.2 Parts application. The operating temperature of heat dissipating and heat sensitive parts shall be within the thermal stress identified in the reliability prediction report, when applicable, and the part derating requirement of NAVSEA 0967-LP-597-1011.

3.7.3 Thermal sensor location. Sensing elements shall be installed at appropriate locations inside the equipment to detect abnormal temperatures and to operate automatic alarms and protective devices. The number and location of these devices shall be such that failure of any portion of the heat removal system will be detected. The temperature sensing device shall render the configuration item inoperative but shall not disenable any internal cooling devices.

3.7.3.1 Overtemperature alarm. An alarm shall be provided to aurally and visually indicate the overtemperature. A positive action switch (battleshort) shall be provided for manually overriding the temperature sensing devices. The temperature sensing devices shall be capable of being reset from the front panel.

3.8 Human engineering. Human engineering design criteria and principles shall conform to requirements of MIL-H-46855 and MIL-STD-1472.

3.9 Quantitative reliability requirement. Quantitative reliability requirements shall be as specified (see 6.2.1) in the individual equipment specification.

3.10 Quantitative maintainability requirements. Quantitative maintainability requirements shall be as specified (see 6.2.1) in the individual equipment specification.

3.11 Maintenance design. Equipment design for maintainability shall be in accordance with MIL-STD-1472 and shall meet the reliability and maintainability requirements of the equipment specification (see 3.5.12.11).

3.11.1 Test provisions. Test provisions of the equipment shall be in accordance with requirement 32 of MIL-STD-454. The specific test capability and class of test provisions shall be as specified (see 6.2.1) in the individual equipment specification. Equipment which is required to be tested by on-line automatic test equipment (ATE) shall be provided with test points in accordance with MIL-STD-1326. The test provisions of the equipment shall provide the capability for a straightforward, logical, step-by-step testing sequence, as well as providing for an end-to-end performance check.

3.11.2 Test equipment. Test equipment required for calibration, operation, and maintenance shall be as specified in MIL-STD-1364.

3.11.3 Special tools. Special tools shall be in accordance with MIL-STD-454, requirement 63. Special tools are defined as those tools not listed in the Federal Supply Catalog (copies of this catalog may be consulted in the office of the Defense Contract Administration Services Management Area (DCASMA).

3.11.4 Test cables. Test cables and extender cards shall be provided and fitted with connectors to allow removable subassemblies to be electrically reconnected for maintenance.

3.11.5 Accessibility. Accessibility shall be in accordance with MIL-STD-454, requirement 36.

3.12 Safety criteria. Safety criteria shall be applied during equipment hardware design, selection, and construction to eliminate or control hazards that could cause injury to personnel during transportation, storage, installation, operation, maintenance or disposal, or damage to equipment or property (see 6.2.1).

3.12.1 Safety (personnel hazard). Safety (personnel hazard) shall conform to requirement 1 of MIL-STD-454 and as specified herein.

3.12.2 Safety, electrical power. Switches for disconnecting equipment from electrical power systems shall break all power conductors of the circuit.

3.12.3 Safety ground, internal. A ground terminal shall be provided on equipment that is powered from an ac power source. The ground terminal shall be located on the power input connector or on the equipment terminal board and shall connect to internal chassis by means of conductors at least equal in size to one of the power input conductors. Safety grounding within the equipment shall terminate on the ground terminal.

3.12.4 Safety ground, external. Unless otherwise specified (see 6.2.1) in the individual equipment specification, when ac power is routed externally between individual units of an equipment, a ground conductor shall be included with the power conductors and shall connect to the ground terminal of individual units.

3.12.5 Safety ground, power cable assemblies, single-phase. A safety ground conductor shall be included in power cable assemblies that connect to ac convenience outlets. The safety ground conductor shall be provided by utilizing three-pin connectors and three-conductor cables having conductors color-coded in accordance with 3.5.4.1. The green wire shall be connected to the grounding blade or pin for the type connector used. Input power cable assemblies shall conform to type I of MIL-C-28777.

3.12.6 Safety interlock indicator light. Safety interlock indicator lights shall be provided and located in a position clearly visible to personnel. The light shall be on the chassis associated with the safety interlock and shall indicate when the interlock has been disabled.

3.12.7 Reference and signal voltages. Equipment utilizing external reference or signal voltages in excess of 30 volts shall have the provision for interrupting the reference and signal voltages during maintenance actions.

3.12.8 Leakage current (equipment). The leakage current (vector sum of all phases) of the equipment, when EMI filtering is not required, shall not exceed 5 milliamperes (mA). When EMI filtering is required, line-to-line filters are preferred to line-to-ground filters. The maximum line-to-ground capacitance shall not exceed the values given in MIL-STD-461. All shipboard equipment shall also meet the leakage current requirements specified in 3.5.1.1.

3.12.8.1 Warning plate. For equipment - with or without EMI filtering - whose leakage current is in excess of 5 mA, a warning plate conforming to MIL-P-15024. The warning plate shall be affixed to the front of the equipment and shall be inscribed:

Danger: Do not energize this equipment unless the frame and all metal parts are grounded.

3.12.8.2 Isolation transformers. On equipment with EMI filtering whose leakage current is in excess of 30 mA, the isolation technique of section 300, DOD-STD-1399 shall be used. When necessary, the isolation transformer shall be part of the equipment configuration.

3.13 Environmental service conditions. The equipment, or portions thereof to be utilized in sheltered or exposed areas as specified (see 6.2.1) in the individual equipment specification, shall operate reliably within the performance limits specified in the individual equipment specification, under the environmental conditions specified herein. The equipment shall operate within tolerances throughout the tests specified, without alignment or adjustment, other than accessible controls normally employed for operation of the equipment.

3.13.1 Temperature ranges. The equipment, or portions thereof, shall operate over the temperature ranges shown in table VIII for the environmental service condition as specified (see 6.2.1) in the individual equipment specification.

TABLE VIII. Temperature ranges (ambient).

Range	Environmental condition	Operating °C	Nonoperating °C
1	Exposed-unsheltered (ship or shore)	-54 to +65	-62 to +71
2	Exposed-unsheltered (ship)	-28 to +65	-62 to +71
3	Sheltered noncontrolled environment (shore)	-40 to +50	-62 to +71
4	Sheltered controlled environment (ship or shore)	0 to +50	-62 to +71

3.13.2 Altitude, non-operating. The equipment performance shall not be degraded after an 8-hour exposure to an altitude of 40,000 feet.

3.13.3 Humidity. The equipment shall maintain the specified performance when exposed to a relative humidity of 95 percent, including conditions wherein condensation takes place in and on the equipment in the form of both water and frost.

3.13.4 Salt fog (spray). When specified (see 6.2.1) in the individual equipment specification, equipment or portions thereof, as specified herein, shall operate in a salt fog environment.

3.13.5 Solar radiation. The exposed equipment, or portions thereof, shall not be damaged when exposed to the sun at its service location and shall maintain the specified performance during the sunshine test of 4.6.8.7.

3.13.6 Fungus. The equipment shall not support fungal growth (see 4.6.8.8).

3.13.7 Wind velocity. The exposed equipment, or portions thereof, shall operate within performance limits in winds having a relative velocity of 75 knots and shall withstand, without damage, winds having a relative velocity as great as 100 knots.

3.13.8 Icing. The exposed equipment, or portions thereof, shall withstand an ice load of 4.5 pounds per square foot (lb/ft^2) of exposed surface without structural damage. Moving junctions shall be housed or provided with heating elements to allow essential motion when subjected to icing conditions.

3.13.9 Hydrostatic pressure. Parts of the equipment that will be immersed in seawater shall withstand the hydrostatic pressure as specified (see 6.2.1) in the individual equipment specification, without physical or electrical damage and without leakage.

3.13.10 Greenwater loading. Equipment parts exposed to greenwater loading shall show no mechanical or electrical damage when the mean greenwater load is 9 pounds per square inch (lb/in^2).

3.13.11 Underwater explosion. When specified (see 6.2.1) in the individual equipment specification, the equipment, or portions thereof, which are submerged and exposed to external sea pressure shall withstand the test of 4.6.8.12 without mechanical or electrical damage which would cause equipment malfunction or nonoperation.

3.13.12 Blast environment. When specified (see 6.2.1) in the equipment specification, the equipment shall meet the requirements of 3.13.12.1 through 3.13.12.3.

3.13.12.1 Missile exhaust. When specified the equipment shall meet the interface requirements of MIL-STD-1399, section 072, part 1.

3.13.12.2 Gun muzzle. When specified the equipment shall meet the interface requirements of MIL-STD-1399, section 072, part 2.

3.13.12.3 Nuclear effects. When specified (see 6.2.1) in the individual equipment specification, the equipment, or portions thereof, exposed to the weather shall withstand a nuclear blast environment without impairment which would cause equipment malfunction. The values for the peak overpressure, the peak dynamic pressure, the positive phase durations of figure 4, and the method of verification shall be as specified (see 6.2.1) in the individual equipment specification (see 4.6.8.14.1).

3.13.13 Shock. Shipboard equipment shall withstand the applicable shock test of 4.6.8.13. When specified (see 6.2.1) in the individual equipment specification, equipment for other than shipboard use shall withstand the applicable test of 4.6.8.13.

3.13.14 Vibration.

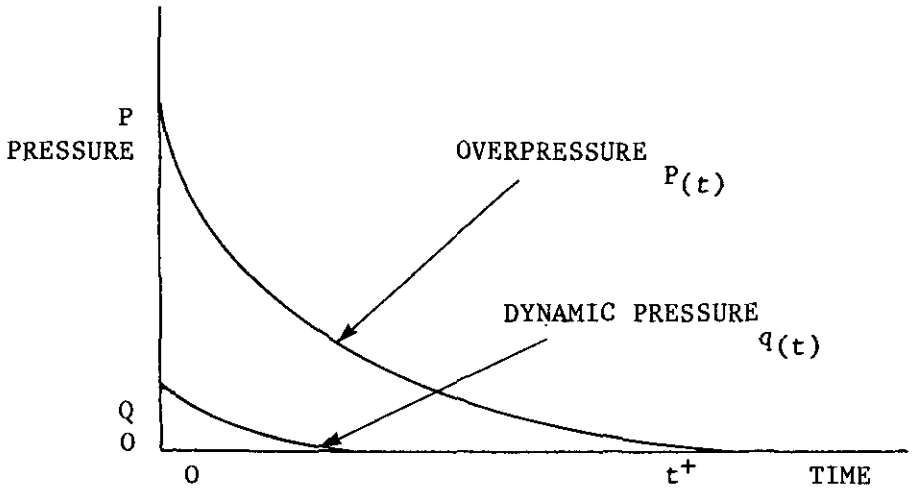
3.13.14.1 Environmental vibration. Shipboard equipment shall conform to the type I vibration requirements of MIL-STD-167-1. When specified (see 6.2.1) in the individual equipment specification, equipment for other than shipboard use shall withstand the applicable test of 4.6.8.14.1.

3.13.14.2 Internally excited vibration. When specified in the individual equipment specification, rotary units of shipboard equipment shall meet the type II balance and vibration requirements of MIL-STD-167-1.

3.13.15 Inclination (shipboard). The equipment shall operate in all altitudes encompassed by DOD-STD-1399, section 301.

3.13.16 Dc magnetic field environment. Shipboard equipment shall operate in the dc magnetic field values as characterized by DOD-STD-1399, section 070 part 1.

3.13.17 Dust (fine sand). When specified (see 6.2.1) in the individual equipment specification, equipment shall withstand the dust (fine sand) test of 4.6.8.17.



at $t = 0$, $P_{(t)} = P$, $q_{(t)} = Q$

for $t^+ > t > 0$, $P_{(t)} = P\left(1 - \frac{t}{t+}\right) e^{-\frac{t}{t+}}$

$$q_{(t)} = Q\left(1 - \frac{t}{t+}\right)^2 - \frac{2+}{t+}$$

Where:

$P_{(t)}$ and $q_{(t)}$ are the pressures at any time (t) after arrival of shock front

P = Peak overpressure, lb/in^2

Q = Peak dynamic pressure, lb/in^2

t^+ = Duration of positive phase, seconds

NOTE: The overpressure and dynamic pressure both rise from zero to peak value at time zero (t = o)

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FIGURE 4. Free field blast pressure.

3.13.18 Accelerated life. When specified (see 6.2.1) in the individual equipment specification, equipment shall withstand the accelerated life test of 4.6.8.18.

3.14 Identification and marking.

3.14.1 Nomenclature (item name and type designation). Nomenclature (item name and type designation) for the equipment shall be established in accordance with requirement 34 of MIL-STD-454. When specified (see 6.2.1) in the individual equipment specification, nomenclature shall be established in accordance with MIL-STD-1661.

3.14.2 Serial numbers. Serial numbers which are assigned by the Government shall be utilized for the items of the equipment to which the designation is assigned.

3.14.3 Marking. Marking of the equipment and items thereof shall conform to requirement 67 of MIL-STD-454 and as specified herein. Identification plates for equipment in temperature ranges 1 and 2 specified in table IX, shall be designed for severe service conditions as specified in MIL-P-15024/5. Identification plates for equipment in temperature ranges 3 and 4 shall be designed for normal service conditions as specified in MIL-P-15024/5.

3.14.3.1 Mounting and location. Identification plates and information plates shall be mounted in a conspicuous space generally on the front panel of the item level to which it applies, when possible.

3.14.3.2 Adhesive backed identification plates. Adhesive backed identification plates, type G of MIL-P-15024, shall not be used.

3.14.3.3 Lubrication points. Lubrication points shall be marked as such.

3.14.4 Electrical power source plates. Information plates, conforming to MIL-P-15024 and figure 5 shall be provided on each unit of the equipment that is powered from multiple electrical power sources.

CAUTION

This equipment energized from multiple sources. Turn off the following to fully de-energize this unit.

Circuit	Voltage	Switch location	Switch identification

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FIGURE 5. Electrical power source information plate.

3.15 Fiber optics. When specified (see 6.2.1) in the equipment specifications, the use of fiber optic systems shall conform to MIL-HDBK-278.

3.16 Electromagnetic environmental effects (see 6.2.1). An electromagnetic environmental effects program shall be established, maintained, and documented in accordance with MIL-HDBK-237 and the requirements of 3.16.1 through 3.16.4.

3.16.1 EMI control. EMI control shall conform to requirement 61 of MIL-STD-454.

3.16.2 Bonding and grounding. The enclosure shall be designed to permit bonding and grounding in accordance with MIL-STD-1310. The specific type of bond shall be as specified (see 6.2.1) in the individual equipment specification. Equipment for other than shipboard use shall include provisions for grounding in accordance with MIL-STD-188-124.

3.16.2.1 Cabinet bonding. Equipment cabinets shall be furnished with mounting holes or studs for bonding strap ground connector. The holes or studs for bonding strap connector shall not reduce the spray-tight, dripproof or watertight characteristic. The holes or studs shall not interfere with the extraction or insertion of the equipment into the cabinet or the placement of the cabinet in a rack or shock mounting.

3.16.2.1.1 Thick-walled cabinets. For thick-walled (over 0.38 inch) cabinets, suitably placed 3/8-16 UNC-2B tapped holes in accordance with FED-STD-H28/2, shall be provided.

3.16.2.1.2 Thin-walled cabinets. For thin-walled cabinets, suitably spaced 3/8-16 UNC-2A studs in accordance with FED-STD-H28/2, shall be spot welded to the cabinet.

3.16.2.1.3 Aluminum cabinets. For aluminum cabinets, welded aluminum straps with two holes or studs shall be provided to reduce contact resistance.

3.16.3 Power supply design. EMI reduction in power supply design shall be accomplished utilizing the guidance in MIL-HDBK-241.

3.16.4 EMI categories for cables. Cables shall be categorized in accordance with S9407-AB-HBK-010.

3.17 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 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 the specification where such inspections are deemed necessary to assure supplies and services conform to prescribed requirements.

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

4.1.2 Government verification. All quality and safety assurance operations performed by the contractor will be subject to Government verification at any time. Verification will consist of (a) surveillance of the operations to determine that practice, methods, and procedures of the quality and safety program requirements are being properly applied, (b) Government product inspection to measure quality and safety of product to be offered for acceptance, and (c) Government inspection of delivered items to assure compliance with this specification (not excluding any requirement of the specification for which detailed tests are not specified herein).

4.1.3 Failure criteria. Unless otherwise specified in the individual equipment specification, the equipment, or portions thereof, subjected to a test specified herein shall be considered to have failed the tests when any of the following occur:

(a) Performance parameters exceed limits specified in the individual equipment specification.
(b) Catastrophic or structural failure.
(c) Distortion or displacement of mechanical parts that cause difficulty of servicing or replacing a part.
(d) Any condition that results in a hazard to personnel or equipment safety.
(e) Deterioration, corrosion, or change in performance limits causing failure to meet operational service or maintenance requirements.
(f) Leakage or discoloration of impregnating compounds that would cause a decrease in service life or reliability.

4.1.4 Problem/failure reporting and corrective action. Problem/failure reporting and corrective action of any failure occurring as a result of tests performed during incoming inspection shall be in accordance with MIL-STD-785. In addition, the contractor shall determine and report the yield or percentage of failures that occurred for each level of hardware.

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

(a) Design verification inspection (see 4.3)

(1) Design qualification testing (see 4.3.1)
(2) Test, analyze, and fix (TAAF) test (see 4.3.2)

(b) Production verification inspection (see 4.4)

(1) First article inspection (see 4.4.1)
(2) Quality conformance inspection (see 4.4.2)
(3) Production quality conformance sampling inspection (see 4.4.3)
(4) Safety conformance verification

4.3 Design verification inspection.

4.3.1 Design qualification testing. The item designated for design qualification testing will normally be an engineering development model (EDM), or equivalent. Design qualification testing shall be performed prior to commitment to production. Design qualification testing shall include the examination and tests in table IX as specified in the individual equipment specification and shall be performed in accordance with the test procedures approved by the Command or agency concerned.

4.3.2 Test, analyze, and fix test (TAFF). The test of 4.3.1 applies to TAFF; however, selection of the item for testing should take into account possible accelerated aging effects or damage which would preclude further use of the equipment.

4.4 Production verification inspection.

4.4.1 First article inspection. The first article inspection shall be performed in conjunction with production contracts only. First articles shall be representative of items which will be produced under the production contract, and may include initial production samples, first lots, pilot models, and pilot lots. The items designated for first article inspection as specified (see 6.2.1) shall be subjected to examinations and tests to determine compliance with this specification and the individual equipment specification. First article inspection shall include the examination and tests in table IX and as specified in the individual equipment specification.

4.4.2 Quality conformance inspection. Quality conformance inspection and testing shall be performed on each item offered for delivery. It shall comprise examination and testing to prove the workmanship and reveal omissions or errors in the production process such as functional and performance tests which detect deviation from design, tests of controls and adjustments, and manufacturing screening testing for the purpose of stimulating latent defects in both parts and workmanship. Quality conformance shall include the examination and tests in table IX as specified in the individual equipment specification.

4.4.3 Production quality conformance sampling inspection. Sampling for production quality conformance inspection shall be as specified in the individual equipment specification. The inspection shall consist of examination and tests which encompass functional and performance tests throughout the entire range of operation. The inspection shall include tests which will detect any deterioration of the design by wear of such items as dies, molds, and jigs, and by the substitution of parts, tests which detect deviations in the processing of materials, and tests to determine temperature rise produced in equipment operation and the ability of equipment to withstand this heat. Unless otherwise specified herein, these tests shall be performed on each unit of the complete sample equipment as offered for delivery. Quality conformance sampling inspection shall include the examination and tests shown in table IX as specified in the individual equipment specification.

4.4.3.1 Design requalification. Additional testing shall be performed when the design of, or material used in, the equipment is changed and such change may affect the equipment's ability to comply with one or more of the environmental test requirements. Design requalification shall include examination and tests shown in table IX as specified in the individual equipment specification.

TABLE IX. Examination and tests.

Examination and tests	Requirement	Test method	Design qualification testing: First article inspection	Quality conformance inspection	Production quality conformance sampling inspection	Design requalification inspection
Examination						
Marking	3.14.3	4.6.1	X	X		
Parts and materials	3.2 and 3.3	4.6.1 and 4.6.9	X	X		
Processes	3.4	4.6.1	X	X		
Safety	3.12	4.6.1	X	X	X	
Size	3.6.1.2	4.6.1	X	X		
Weight	3.6.1.1	4.6.1	X	X		
Workmanship	3.17	4.6.1	X	X		
Performance						
Destructive physical analyses		4.5.1	X			
Electrical						
Dielectric withstanding voltage test	3.5.7	4.6.3.7	X	X		
Electromagnetic environmental effects	3.16	4.6.10	X		X	X
Electrostatic discharge test		4.6.3.9	X			
Insulation resistance	3.5.8	4.6.3.7.1	X		X	
Leakage current	3.12.8	4.6.3.8	X		X	
Power and power factor	3.5.1.1	4.6.3.6	X			X
Power interruption	3.5.1.1	4.6.3.5	X		X	
Spike voltage	3.5.1.1	4.6.3.4	X			X
Steady state voltage	3.5.1	4.6.3.1	X		X	
Transient frequency	3.5.1	4.6.3.2.3 and 4.6.3.2.4	X			X
Transient voltage	3.5.1	4.6.3.2.1 and 4.6.3.2.2	X			X
Mechanical						
Airborne/structureborne noise	3.6.6 and 3.6.7	4.6.4.2	X			X
Enclosures	3.6.3	4.6.4.1	X		X	

TABLE IX. Examination and tests. - Continued

Examination and tests	Requirement	Test method	Design qualification testing: First article inspection	Quality conformance inspection	Production quality conformance sampling inspection	Design requalification inspection
Mechanical						
Hydrostatic pressure	3.13.9	4.6.8.11	X			X
Inclination	3.13.15	4.6.8.15	X			X
Magnetic materials	3.6.10	4.6.4.3	X			X
Painting	3.4.1	4.6.8.19	X			X
Thermal design and construction	3.7	4.6.5	X			X
Water cooling	3.7.1.2	4.6.5.3	X			X
Welding	Table III	4.6.4.4	X		X	
Environmental						
Altitude	3.13.2	4.6.8.4	X			X
Dc magnetic field	3.13.16	4.6.8.16	X			X
Dust (fine sand)	3.13.17	4.6.8.17	X			X
Fungus	3.13.6	4.6.8.8	X			X
Blast environment	3.13.12	4.6.8.12 and 4.6.8.14	X			X
Humidity	3.13.3	4.6.8.5	X			X
Icing	3.13.8	4.6.8.10	X			X
Nuclear blast	3.13.12.3	4.6.8.15.1	X			X
Salt fog	3.13.4	4.6.8.6	X			X
Shock	3.13.13	4.6.8.13	X			X
Solar radiation	3.13.5	4.6.8.7	X		X	
Temperature - (low)	3.13.1	4.6.8.2	X		X	
Temperature - (high)	3.13.1	4.6.8.3	X		X	
Underwater explosion	3.13.11	4.6.8.12	X			X
Vibration	3.13.14	4.6.8.14	X			X
Wind velocity	3.13.7	4.6.8.9	X			X
Reliability and maintainability						
Accelerated life	3.13.18	4.6.8.18	X			X
Maintainability	3.10	4.6.7	X			X
Reliability	3.9	4.6.6	X			X

4.5 General test conditions. Unless otherwise specified herein or in the individual equipment specification, the test conditions shall be in accordance with the general requirements of MIL-STD-810.

4.5.1 Destructive physical analyses. Destructive physical analyses shall be performed on parts as specified in the individual equipment specification or contract.

4.6 Test methods.

4.6.1 Examination. The equipment shall be examined to determine compliance with requirements as specified below:

(a) Weight (see 3.6.1.1).
(b) Size (see 3.6.1.2).
(c) Parts (see 3.2).
(d) Materials (see 3.3).
(e) Processes (see 3.4).
(f) Identification and marking (see 3.14).
(g) Safety criteria (see 3.12).
(h) Workmanship (see 3.17).

In the process of examination, the item shall not be disassembled in a manner that will affect the performance, durability, or appearance of the item. The examination shall include a check of operating controls, circuit functions, test provisions and adjustments.

4.6.2 Performance test. The equipment shall be subjected to a performance test to determine compliance with the performance parameters of individual equipment specification.

4.6.3 Electrical tests.

4.6.3.1 Steady state voltage and frequency. The equipment shall be operated for at least 15 minutes in each of the conditions A through E shown in table X. Performance readings shall be measured and recorded for each condition. Failure in any performance parameter shall be cause for rejection.

TABLE X. Steady state voltage and frequency.

Condition	Voltage			Frequency		
	Lower limit	Nominal	Upper limit	Lower limit	Nominal	Upper limit
A (reference condition)		X			X	
B	X			X		
C			X	X		
D			X			X
E	X					X

4.6.3.1.1 Load characteristics. During all of the tests specified in 4.6.3.1, measurements of line currents, line current harmonics, power, and power factor, as necessary, to confirm compliance with the requirements specified in 3.5.1 for the type of power being used shall be made at nominal line voltage and frequency on each primary supply line to each unit of the equipment under each principle mode of operation of the equipment. All measurements taken shall be recorded and included in the inspection report. Current and power measurements shall be taken in a manner which permits construction of current and power profiles showing the amplitude, duration, timing, and synchronization of all current and power changes for each principle mode, and for switching between these modes.

4.6.3.2 Transient voltage and frequency. When required by 3.5.1 for the type power being used the following tests shall be performed.

4.6.3.2.1 Transient voltage upper limit. With the equipment operating at nominal frequency and the upper limit of the steady state voltage tolerance band, a transient voltage shall be superimposed on the input power line. This transient voltage shall have an amplitude equal to the maximum positive transient voltage and a duration equal to the transient voltage recovery time in accordance with 3.5.1. Equipment shutdown shall not occur due to the transient, and the equipment shall operate normally following the transient.

4.6.3.2.2 Transient voltage lower limit. With the equipment operating at nominal frequency and the lower limit of the steady state voltage tolerance band, a transient voltage shall be superimposed on the input power line. This transient voltage shall have an amplitude equal to the maximum negative transient voltage and a duration equal to the transient voltage recovery time in accordance with 3.5.1. Equipment shutdown shall not occur due to the transient, and the equipment shall operate normally following the transient.

4.6.3.2.3 Transient frequency upper limit. With the equipment operating at nominal voltage and the upper limit of the steady state frequency tolerance band, a transient frequency shall be superimposed on the input power line. This transient frequency shall have an amplitude equal to the maximum positive transient frequency, and a duration equal to the transient frequency recover time in accordance with 3.5.1. Equipment shutdown shall not occur due to the transient, and the equipment shall operate normally following the transient.

4.6.3.2.4 Transient frequency lower limit. With the equipment operating at nominal voltage and the lower limit of the steady state frequency tolerance band, a transient frequency shall be superimposed on the input power line. This transient frequency shall have an amplitude equal to the maximum negative transient frequency and a duration equal to the transient frequency recovery time in accordance with 3.5.1. Equipment shutdown shall not occur due to the transient, and the equipment shall operate normally following the transient.

4.6.3.3 Emergency voltage and frequency. When specified in 3.5.1 for the type power being used, the following tests shall be performed.

4.6.3.3.1 Emergency voltage upper limit. With the equipment operating at nominal frequency and the upper limit of the steady state voltage tolerance band, a transient voltage shall be superimposed on the input power line. This transient voltage shall have an amplitude equal to the maximum positive emergency voltage and a duration equal to the emergency voltage recovery time in accordance with 3.5.1. The equipment shall operate normally following the transient.

4.6.3.3.2 Emergency voltage lower limit. With the equipment operating at nominal frequency and the lower limit of the steady state voltage tolerance band, a transient voltage shall be superimposed on the input power line. This transient voltage shall have an amplitude equal to the maximum negative emergency voltage and a duration equal to the emergency voltage recovery time in accordance with 3.5.1. The equipment shall operate normally following the transient.

4.6.3.3.3 Emergency frequency upper limit. With the equipment operating at nominal voltage and the upper limit of the steady state frequency tolerance band, a transient frequency shall be superimposed on the input power line. This transient frequency shall have an amplitude equal to the maximum positive emergency frequency and a duration equal to the emergency frequency recovery time in accordance with 3.5.1. The equipment shall operate normally following the transient.

4.6.3.3.4 Emergency frequency lower limit. With the equipment operating at nominal voltage and the lower limit of the steady state frequency tolerance band, a transient frequency shall be superimposed on the input power line. This transient frequency shall have an amplitude equal to the maximum negative emergency frequency and a duration equal to the emergency frequency recovery time in accordance with 3.5.1. The equipment shall operate normally following the transient.

4.6.3.4 Spike voltage test. The equipment shall be subjected to an input power supply line voltage spike of 2500 volts for 220 volts and 440 volts equipment and 1000 volts for 115 volts equipment. The wave shape shall correspond to the spike voltage (short time transient) wave shape figure of section 103 of MIL-STD-1399. This spike shall be superimposed at normal supply line voltage and frequency while the equipment is in operational status. The test shall be repeated, synchronized with the input waveform to occur at the positive and negative input voltage peaks and zero crossings. The equipment shall operate normally immediately following each test.

NOTE: When the spike occurs at the positive peak, it will result in total voltages of about 2600 volts and 1200 volts on 440 volts and 115 volts systems, respectively. The source impedance for the spike voltage as seen by the test subject shall not exceed 0.2 ohms. An alternative for high impedance loads is to increase the spike until the full spike voltage appears across the input terminals of the test subjects.

4.6.3.5 Power interruption. The equipment shall be operated for at least 15 minutes in condition A as specified in table X. The total electrical input power shall be interrupted and reapplied in a randomly short period (less than 1 second). After the equipment has been operated long enough to detect performance degradation and to include any recycle time, the power shall be suddenly interrupted and reapplied after a period of 20 seconds. During, and as a

result of these tests, damage to the equipment shall not occur, and any effects of the power interruption or reapplication shall fall within the performance limits of the individual equipment specification. Where an equipment has more than one significant operating mode, the power interruption tests shall be performed in each of the modes. Where many modes are required, significant testing modes shall be sufficient to assure acceptable operation.

4.6.3.6 Loss of phase voltage. The equipment shall be operated for at least 15 minutes in condition A as specified in table X. Power shall be interrupted for a 3-minute period on one phase of the supply and then reapply power on that phase. No equipment damage shall be sustained. Power shall be interrupted for 3 minutes and then reapplied on the remaining two phases one at a time. No equipment damage shall be sustained.

4.6.3.7 Dielectric withstanding voltage test. Dielectric withstanding voltage tests between electrical power circuits and ground shall be tested with a closely sinusoidal source of 60 Hz, having a capacity of at least 1 kW. Root mean square (rms) values of test voltage shall be as shown in table XI. Radio interference filters or capacitors having a voltage rating of less than the test voltage specified herein shall be disconnected from the equipment during this test. Synchros shall be disconnected during this test. In dielectric tests, the voltage shall be raised gradually to the specified value and shall be maintained at that value for the periods specified herein. For dielectric tests conducted as part of first article inspection, the test voltage shall be maintained at the specified value for 1 minute $\pm$ 5 seconds. For dielectric tests conducted as part of quality conformance inspection, the test voltage shall be maintained at the specified value for 5 $\pm$ 1 seconds. The dielectric test shall not be applied to electronic or electrical circuitry which uses low voltage parts such as transistors, electrolytic capacitors, diodes and other voltage sensitive parts. Chassis and other removable assemblies shall be removed during the tests. The tests shall be monitored for evidence of disruptive discharge and leakage current as specified in 3.12.8.

TABLE XI. Rms values of test voltage.

Circuit voltage of equipment tested (volts)	Rms value of dielectric test voltage (volts)
Less than 60	450
60 to 120	900
Above 120 and less than 240	1200
240 to 480	1500
Above 480	Twice rated plus 1000

4.6.3.7.1 Insulation resistance. The insulation resistance of electrical circuits following the dielectric test shall be not less than 10 megohms at 500 Vdc at standard ambient conditions (see 4.5). Each circuit shall be measured against all other circuits connected together and to the chassis.

4.6.3.8 Leakage current. Leakage current shall be measured at maximum steady state power line voltage and frequency for each voltage and frequency at which the equipment is designed to operate.

4.6.3.8.1 Equipment connections. After power removal, each equipment directly connected to an external power source and units deriving power from the equipment shall be placed on an insulated surface. All safety ground conductors between the equipment and units deriving power from the equipment shall be intact. The safety ground conductor between the equipment under test and the source power shall be opened during the test. OBSERVE WARNING STATEMENT. The equipment shall be connected as shown on figure 6 if it is connected to single phase power, as shown on figure 7, if connected to dc source power, and as shown on figure 8 if connected to three-phase source power. When dc measurements are performed, do not reverse polarity unless the equipment has reverse polarity protection.

WARNING

THIS TEST MAY BE HAZARDOUS DUE TO THE UNGROUNDED CONDITION OF THE EQUIPMENT DURING THE TEST. DO NOT TOUCH EXPOSED METAL SURFACES.

THE UNITED STATES GOVERNMENT NEITHER ASSUMES NOR ACCEPTS RESPONSIBILITY FOR ANY INJURY OR DAMAGE THAT MAY OCCUR DURING OR AS A RESULT OF THIS TEST.

4.6.3.8.2 Measurement. Leakage current shall be measured on equipment in its normal operating configuration. Equipment controls in each operating mode shall be such that maximum power will be utilized during leakage current measurements. The leakage current shall be determined by the voltage-drop method. A true rms voltmeter shall be used. The voltage measured across the 1500 ohm resistor, when equal to 7.5 volts, represents 5 milliamperes of leakage current. The overall measurement error shall not exceed 5 percent. The probe shall be used on all external conducting parts such as case, connector housings, recessed calibration or adjustment controls, and control shafts with knobs removed. The voltage is measured from each part to the source side of open safety ground for every combination of switch positions available in the test diagram. The open safety ground connector shall be reconnected immediately after the test is completed.

4.6.3.9 Electrostatic discharge (ESD) tests. Electrostatic discharge tests conducted to determine the classification of ESD-sensitive parts shall be in accordance with DOD-STD-1686.

4.6.4 Mechanical and structural tests.

4.6.4.1 Enclosures. Enclosures shall be subjected to a degree of enclosure test of MIL-STD-108 to determine conformance to 3.6.3 or 3.6.3.1(b). For drip-proof enclosures, tests shall be conducted after a completion of the vibration, inclination, shock, and noise tests, as applicable.

4.6.4.2 Airborne and structureborne noise. Equipment shall be tested in accordance with MIL-STD-740-1 to determine conformance to 3.6.6. Equipment shall also be tested in accordance with MIL-STD-740-2 to determine conformance to 3.6.7.

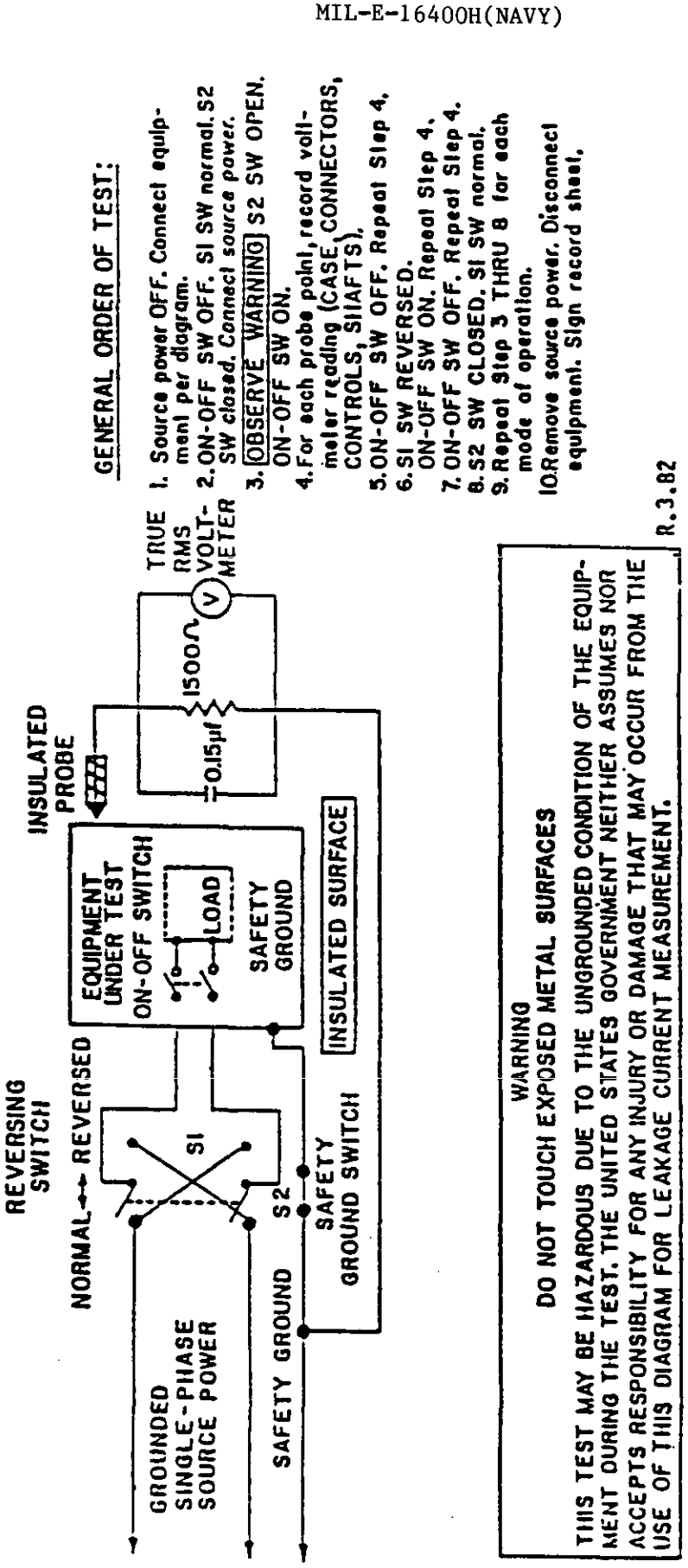

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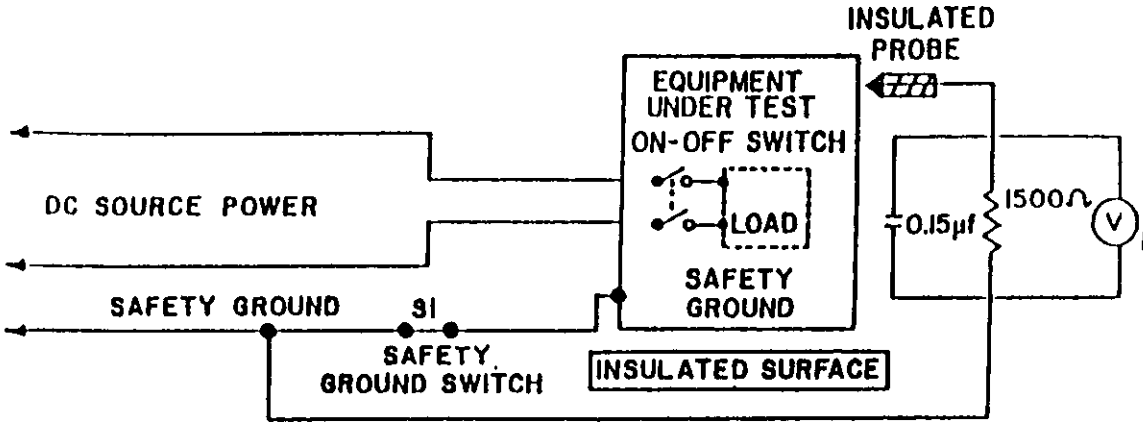
FIGURE 6. Single-phase test diagram for leakage current measurement.



GENERAL ORDER OF TEST:

1. Source power OFF. Connect equipment per diagram.
2. ON-OFF SW OFF. S1 SW closed. Connect source power.
3. OBSERVE WARNING S1 SW OPEN. ON-OFF SW ON.
4. For each probe point, record voltmeter reading (CASE, CONNECTORS, CONTROLS, SHAFTS).
5. ON-OFF SW OFF. Repeat Step 4.
6. S1 CLOSED. ON-OFF SW ON. Repeat Step 4 AND 5.
7. Remove source power. Disconnect equipment. Sign record sheet.

WARNING
DO NOT TOUCH EXPOSED METAL SURFACES

THIS TEST MAY BE HAZARDOUS DUE TO THE UNGROUNDED CONDITION OF THE EQUIPMENT DURING THE TEST. THE UNITED STATES GOVERNMENT NEITHER ASSUMES NOR ACCEPTS RESPONSIBILITY FOR ANY INJURY OR DAMAGE THAT MAY OCCUR FROM THE USE OF THIS DIAGRAM FOR LEAKAGE CURRENT MEASUREMENT.

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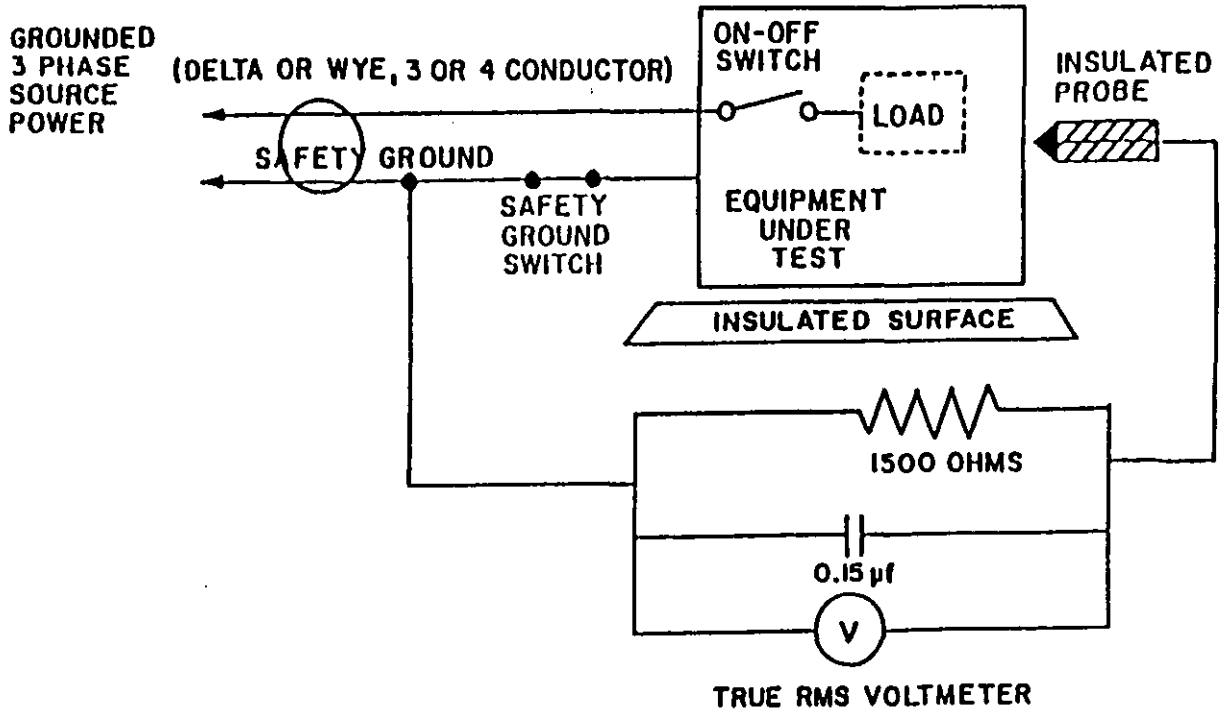
FIGURE 7. Dc test diagram for leakage current measurement.



GENERAL ORDER OF TESTS:

1. Source power OFF. Connect equipment per diagram.
2. ON-OFF SW OFF. Safety ground switch closed. Connect source power.
3. OBSERVE WARNING Safety ground switch OPEN. ON-OFF SW ON.
4. For each probe point, record voltmeter reading (CASE, CONNECTORS, CONTROLS, SHAFTS).
5. ON-OFF SW OFF. Repeat Step 4.
6. Safety ground switch closed.
7. Repeat Step 3 THRU 6 for each mode of operation.
8. Remove source power. Disconnect equipment. Sign record sheet.

NOTE: 1. All three phases shall be connected during measurement.
2. The safety ground conductor shall not carry load current.

WARNING
DO NOT TOUCH EXPOSED METAL SURFACES

THIS TEST MAY BE HAZARDOUS DUE TO THE UNGROUNDED CONDITION OF THE EQUIPMENT DURING THE TEST. THE UNITED STATES GOVERNMENT NEITHER ASSUMES NOR ACCEPTS RESPONSIBILITY FOR ANY INJURY OR DAMAGE THAT MAY OCCUR FROM THE USE OF THIS DIAGRAM FOR LEAKAGE CURRENT MEASUREMENT.

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FIGURE 8. Three-phase test diagram for leakage measurement.

4.6.4.3 Magnetic material test. Magnetic material tests to determine compliance with magnetic permeability requirements (see 3.6.10) shall be performed with a low-mu permeability indicator of the go-no go type conforming to MIL-I-17214.

4.6.4.4 Weld test. Samples representative of production and welded on production machines shall be tested to destruction to determine conformance to the welding requirement of table III.

4.6.5 Thermal test. The thermal performance test shall be conducted to determine conformance to 3.7. The test shall include the measurement and recording of:

(a) Operating temperature of parts that operate at 75 percent or more of rated value.
(b) Operating temperature of parts that dissipate 10 percent or more of the total power dissipated by the unit in which they are installed.
(c) Surface temperature of enclosures, front panels, and controls.
(d) Inlet and outlet temperature differentials when forced air cooling is utilized.

Upon completion of the thermal performance test, a visual examination shall be made to detect evidence of deterioration of parts and materials used in the equipment.

4.6.5.1 Test conditions. The thermal test shall be performed on equipment under the following conditions:

(a) Maximum operating temperature of the range, as specified in the individual equipment specification (see 3.13.1).
(b) Operating mode which will cause the maximum steady state power dissipation.
(c) Continuous equipment operation for a time span that will achieve thermal stabilization.
(d) Equipment cabinets closed.

4.6.5.2 Thermal instrumentation. Thermal instrumentation such as thermocouples, infrared photography, chemicals or calibrated thermal sensitive materials that will measure temperatures shall be utilized in the test. The method used to measure temperatures shall not affect the accuracy of the measurement.

4.6.5.3 Water cooling. When water is used as a cooling method, the equipment shall be subjected to the water cooling tests specified in MIL-W-21965. If at any time during the 8-hour period of the emergency cooling test, the internal equipment temperature exceeds the safe operating temperature, the test shall be terminated and the equipment shall be considered to have failed the test.

4.6.6 Reliability qualification test. Quantitative reliability requirements shall be verified with a reliability qualification test performed in accordance with MIL-STD-781 as specified in the individual equipment specification or contract.

4.6.7 Maintainability demonstration. Quantitative maintainability shall be verified with a maintainability demonstration test performed in accordance with MIL-STD-471, as specified in the individual equipment specification or contract.

4.6.8 Environmental tests.

4.6.8.1 Temperature test sequence. The operating and non-operating temperature test sequence shall be as specified herein.

4.6.8.2 Low temperature. The low temperature test shall be in accordance with the following procedures of method 502.2 of MIL-STD-810:

(a) All equipment - Procedure I, severe cold.
(b) Sheltered equipment - Procedure II, basic cold.
(c) Exposed equipment - Procedure II for severe cold followed by procedure III.

4.6.8.3 High temperature. The high temperature test shall be in accordance with method 501.2, procedure II, of MIL-STD-810, except as follows:

(a) Step 4 - Applicable high temperature for the range specified in the individual equipment specification (see 3.13.1).
(b) The combined duration of steps 4 and 5 shall be not less than 12 hours, at least 6 of which shall be in the stabilized condition prior to measuring performance parameters.
(c) Step 7 - The equipment shall operate for a period of at least 2 hours in the stabilized condition before the step 7 measurements are made.

4.6.8.4 Altitude. The de-energized equipment shall be subjected to reduced atmospheric pressure corresponding to an altitude of not less than 40,000 feet (12 kilometers) for not less than 8 hours.

4.6.8.5 Humidity. Humidity tests shall be in accordance with method 507.2, procedures I or II, as applicable, of MIL-STD-810.

4.6.8.6 Salt fog.

4.6.8.6.1 Exposed equipment. Equipment, or portions thereof, exposed to the weather shall be subjected to a salt fog test in accordance with one of the following procedures as specified in the individual equipment specification

(a) Procedure I - Method 509.2 of MIL-STD-810.

(b) Procedure II - The complete unit shall be subjected under continuous solar radiation, as specified in 4.6.8.7, to a 20 percent hot salt spray at 65°C for a period of 3 minutes, followed by a hot air blast at 65°C for a period of 2 minutes. The cycle shall be repeated continuously for 100 hours. Upon completion of the test, the unit shall be washed with fresh water, dried and examined. During the test, the equipment shall be mounted in its normal installed position. Test equipment shall be equivalent to the Navy standard salt spraying machine as shown on Drawing 9000-S6202-73724.

4.6.8.6.2 Sheltered equipment. The salt fog test specified in method 509.2 of MIL-STD-810 shall be applied to the finishes and coatings on parts and frame and enclosure structures as finally assembled for use. Sample corner structures and other critical sections may be used for the test. The test shall not be applied to the complete equipment.

4.6.8.7 Solar radiation. The equipment shall be subjected to the sunshine test specified in method 505.2, procedure II of MIL-STD-810.

4.6.8.8 Fungus. The equipment shall be subjected to the fungus test specified in method 508.3 of MIL-STD-810.

4.6.8.9 Wind velocity. The equipment shall be subjected to the wind test as specified in the individual equipment specification.

4.6.8.10 Icing. The equipment shall be tested to determine conformance to 3.13.8 as specified in the individual equipment specification.

4.6.8.11 Hydrostatic pressure. The equipment shall be tested to determine conformance to 3.13.9 as specified in the individual equipment specification.

4.6.8.12 Underwater explosion. The equipment shall be subjected to one of the following conditions as specified in the individual equipment specification.

4.6.8.12.1 Actual condition. The item shall be mounted in the center of a steel plate having minimum dimensions of 3 feet in height, 3 feet in width and 1/4 inch in thickness. The plate shall be suspended vertically at a depth of 30 feet below the surface of the water. A 55-pound standard TNT charge shall be suspended at a depth of 30 feet below the surface of the water at a distance of 30 feet from the plate, on the same side of the plate as the item being tested, and on a line perpendicular to the face of the plate at the center. The total depth of water shall be in a minimum of 60 feet in the area of the test. The test consisting of the detonation of the charge, shall be performed a total number of four times.

4.6.8.12.2 Simulated condition. The equipment shall be tested using the hydraulic shock machine at the U.S. Naval Shipyard, Portsmouth, New Hampshire. The machine shall be adjusted to requirements as specified in the individual equipment specification.

4.6.8.13 Shock. Shipboard equipment shall be tested in accordance with the grade A, type A, class I shock test requirements of MIL-S-901. Equipment for other than shipboard use and shipboard equipment not tested to MIL-S-901 shall be shock tested in accordance with method 516.3 of MIL-STD-810; the applicable procedure shall be as specified in the individual equipment specification. The mounting fixture shall be as specified in the individual equipment specification. Simulated loads such as weights of other dummy masses shall not be used. The tests shall be performed with the normal assemblies and units in their functionally operating positions. Equipment weighing more than 600,000 pounds, or which, for any reason, cannot be tested to the requirements specified herein, shall be analyzed as specified in the individual equipment specification.

4.6.8.14 Vibration.

4.6.8.14.1 Environmental vibration. Shipboard equipment shall be subjected to the type I vibration test of MIL-STD-167-1. The upper vibration frequency limit shall be as specified in the individual equipment specification. Equipment for other than shipboard use shall be subjected to the vibration test of method 514.3, procedure I of MIL-STD-810. Simulated loads, such as weights or other dummy masses, shall not be used. The test shall be performed with the normal assemblies and units in their functionally operating positions. Stand mounted equipment shall be mounted on a stand for the test.

4.6.8.14.2 Internally excited vibration. Rotary units of shipboard equipment shall be subjected to the type II vibration test of MIL-STD-167-1. Unless otherwise specified in the individual equipment specification, the measurements shall be limited to the evaluation of first order vibration.

4.6.8.15 Inclination. The equipment shall be subjected to the test limits specified herein. The equipment shall be energized and fully operating during the applicable test.

4.6.8.15.1 Inclination test limits (except submarines). The equipment shall be inclined at the rate of 5 to 7 cycles per minute in one phase to angles of 45 degrees on both sides of the vertical for a minimum period of 30 minutes. During the inclination testing, equipment with drawer slides shall be extended on its slides. This is to verify that the slides have sufficient lateral strength to support the equipment with inclination in all test directions. The test shall be repeated with the equipment reoriented 90 degrees to the plane in which it was originally tested. At the conclusion of these cyclic tests, the cyclic motion shall be stopped and the inclination adjusted to an angle of 15 degrees. The equipment shall then be operated for a sufficient period to ensure that the continuous operation can be maintained. The equipment shall then be rotated through the vertical to 15 degrees in the opposite direction, and the test for continuous operation shall be repeated. The test shall be repeated with the equipment reoriented 90 degrees to the plane in which it was originally tested.

4.6.8.15.2 Inclination test limits (submarine installation). Equipment intended for submarine installations shall be subjected to the test of 4.6.8.15.1 except that the maximum angle shall be 60 degrees.

4.6.8.16 Dc magnetic field test. The dc magnetic field test shall be in accordance with the test procedure of section 070, part 1 of DOD-STD-1399.

4.6.8.17 Dust (fine sand). When specified in the individual equipment specification, the equipment shall be subjected to the blowing dust procedure test of method 510.2 of MIL-STD-810, except that performance requirements shall be made continuously during exposure to dust particles in the operating condition. Any change in orientation to the equipment during the test shall be as specified in the individual equipment specification.

4.6.8.18 Accelerated life tests. Accelerated life tests shall be performed for 360 hours, as specified herein, unless otherwise specified in the individual equipment specification.

4.6.8.18.1 Initial test conditions.

(a) Equipment set up in a temperature-controlled chamber at 25 ± 5°C and relative humidity of 45 to 55 percent.
(b) Equipment energized and frequency specified.
    (1) Nominal line voltage and frequency specified.
    (2) Cooling system in normal operation.
    (3) Fully operational for 2 hours.
(c) When equipment internal temperature has stabilized, performance parameters shall be measured and recorded as reference test data for comparison with subsequent tests.

4.6.8.18.2 Temperature conditions.

(a) Reduce chamber temperature, at a uniform rate in not less than 4 hours, to the lowest operating temperature of the range specified.
(b) Maintain chamber temperature at the lowest operating temperature of the range for 10 hours.
(c) Near the end of the 10-hour period, measure and record the performance parameters.
(d) Increase chamber temperature, at a uniform rate in not less than 6 hours, to the highest operating temperature of the range specified and maintain humidity at 45 to 55 percent.
(e) Maintain chamber temperature at the highest operating temperature of the range specified for 3 hours.
(f) Near the end of the 8-hour period, measure and record the performance parameters.
(g) Reduce chamber temperature, at a uniform rate in not less than 6 hours, to the lowest operating temperature of the range specified.
(h) Maintain chamber temperature at the lowest operating temperature of the range specified for 2 hours.

4.6.8.18.3 Voltage and frequency cycling conditions.

(a) After completion of the 2-hour low temperature conditioning period specified in 4.6.8.18.2(h), decrease the input voltage to the lower limit of the equipment voltage tolerance band.

(b) Operate for 1 hour and record performance parameters.
(c) Return input voltage to nominal value. Decrease input frequency to the lower limit of the equipment frequency tolerance band.
(d) Operate for 1 hour and record performance parameters.
(e) Return input frequency to nominal value.
(f) Increase temperature to 25 ± 5°C and maintain relative humidity at 45 to 55 percent. Maintain this condition for 2 hours.
(g) With equipment operating at 25 + 5°C and relative humidity at 45 to 55 percent, decrease input voltage and frequency to the lower limits of the equipment voltage and frequency tolerance bands. Maintain this condition for 1 hour and record performance parameters.
(h) Repeat 4.6.8.18.3(g) with input voltage at the upper limit of the equipment voltage tolerance band and input frequency at the lower limit of the equipment frequency tolerance band.
(i) Repeat 4.6.8.18.3(g) with input voltage and frequency at the upper limits of the equipment voltage and frequency tolerance bands.
(j) Repeat 4.6.8.18.3(g) with input voltage at the lower limit of the equipment voltage tolerance band and input frequency at the upper limit of the equipment frequency tolerance band.
(k) Repeat uniform temperature rise test of 4.6.8.18.2(d).
(l) Record performance parameters at the end of the uniform temperature rise test of 4.6.8.18.3(k).
(m) With equipment operating at the highest operating temperature of the range specified and relative humidity at 45 to 55 percent, increase input voltage the upper limit of the equipment voltage tolerance band, maintaining input frequency at the upper limit of the equipment frequency tolerance band.
(n) Operate for 8 hours and record performance parameters.
(o) Maintain voltage, and frequency conditions of 4.6.8.18.3(m) and increase relative humidity to between 90 to 100 percent.
(p) Operate for 2 hours and record performance parameters.
(q) Maintain input frequency at the upper limit of the equipment frequency tolerance band and relative humidity at 90 to 100 percent, but decrease input voltage to the lower limit of the equipment voltage tolerance band.
(r) Operate for 1 hour and record performance parameters.
(s) Maintain high temperature and humidity conditions but return input voltage and frequency to nominal values.
(t) Operate for 1 hour and record performance parameters.
(u) Repeat high temperature voltage and frequency cycling tests of 4.6.8.18.3 (o) through (t) with relative humidity at 10 to 20 percent for not less than 15 cycles.

4.6.8.19 Paint system test. Test panels composed of the same material as the exposed equipment shall be prepared and painted using the same methods that will be used on the equipment to be delivered. Where more than one type of material is used, test panels of each type shall be prepared and tested in accordance with one of the following procedures as specified in the individual equipment specification.

Procedure I:

(a) Panels shall be subjected to the salt fog test of method 509.2 of MIL-STD-810, except that a 20 percent salt solution shall be used, the duration of exposure shall be 5 days, and the following shall be performed after the wash in running water.
(b) Immerse panels in a 5 percent (by weight) solution of sulfuric acid for 30 minutes.
(c) Remove panels from the sulfuric acid solution and place them in a dry heat oven at 93°C for 1 hour.
(d) Remove panels from the oven and immediately immerse them in cold (9 to 14°C water for 10 minutes).
(e) Remove panels from the cold water and immerse them for 2 days in hot (80°C) synthetic seawater, conforming to ASTM D 1141.
(f) Determine adhesion and degree of blistering, as specified herein, to determine compliance with 3.4.1.4.1.

Procedure II:

(a) Condition panels for 1 week at 23 ± 3°C after application of the final coat.
(b) Immerse panels for 12 weeks in hot synthetic seawater conforming to ASTM D 1141.
(c) Determine adhesion and degree of blistering as specified herein to determine conformance with 3.4.1.4.1.

4.6.8.19.1 Blistering. The degree of blistering shall be determined in accordance with ASTM D 714. Blisters appearing within 0.25 inch from the edge of the panel shall be disregarded.

4.6.8.19.2 Adhesion. The loss of paint adhesion on both sides of each panel shall be determined in accordance with method 6301 of FED-STD-141, except the requirement for panel immersion shall be omitted.

4.6.9 Parts derating verification. Verification of parts derating requirements shall be demonstrated by test when specified in the individual equipment specification or contract. The derating requirements shall be demonstrated by actual measurement of components' stress levels as a verification of stress level calculations. The operating stress level and operating temperature of each selected part shall be measured. Corrective action shall be taken to assure that all parts meet the required derating requirements (see 3.2.1.4).

4.6.10 Electromagnetic interference characteristics.

4.6.10.1 Electromagnetic interference tests, first article. Electromagnetic interference tests conducted during first article inspection shall be performed in accordance with MIL-STD-462 and MIL-STD-469, as applicable.

4.6.10.2 Electromagnetic interference tests, quality conformance. Electromagnetic interference tests conducted during quality conformance inspection shall include, as a minimum, the following tests of MIL-STD-462:

(a) CE03
(b) CE06, where applicable
(c) RE02
(d) RS01, for submarine equipment
(e) RS03
(f) CS06
(g) CS09, where applicable
(h) CE01 (submarine equipment only)
(i) RE01 (submarine equipment only)

(See MIL-STD-461 tables for classes of equipment and test requirements applicable to equipment classes.)

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

5. PACKAGING

(The packaging requirements specified herein apply only for direct Government acquisition.)

5.1 Preservation, packaging, and packing. Preservation, packaging, and packing shall be as specified (see 6.2.1) in the individual equipment specification or contract.

5.1.1 Battery packaging. When equipment containing batteries is prepared for storage or shipment, the batteries shall be removed from the equipment and packaged separately in the same container as the equipment. The container shall be marked to indicate that batteries are included and shall identify the type of batteries.

5.2 Resilient mounts. Resilient mounts which have been utilized during shock tests shall be replaced by new mounts prior to offering equipment for delivery.

5.3 Sensitive electronic item protection. Unless otherwise specified (see 6.2.1) in the individual equipment specification or contract, sensitive electronic item protection and packaging shall be as specified in 5.3.1 through 5.3.1.7.

5.3.1 Packaging.

5.3.1.1 Lead and terminal protection. Lead or terminal configurations shall be maintained as manufactured without causing loads or stresses capable of causing damage to the item. Protection shall be by means of carrier, container design, or inserts of 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.

5.3.1.2 Carrier. Carriers, when used for additional protection of miniature electronic items, shall be of such strength to prevent damaging resonances, shocks, and electrostatic charges to the 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 shall be designed without sharp edges to preclude subsequent damage to the item and packaging materials method.

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

5.3.1.4 Unit protection. Sensitive electronic items subject to degradation from electrostatic, electromagnetic forces, or both, shall be unit protected in accordance with methods IA or II of MIL-P-116, except as specified under detail requirements (see 5.3.1.4.1). Unit packs shall be marked with the sensitive electronic device symbol in MIL-STD-129. Intermediate and exterior packs shall be labeled with the caution label of MIL-STD-129.

5.3.1.4.1 Electrostatic protection. Items adversely affected by electrostatic field forces shall be provided an initial wrap of material conforming to MIL-B-81705, type II, or cushioned in material conforming to PPP-C-1842, type III, style A or B, and unit packaged in heat-sealed bags conforming to MIL-B-117, type I, class F, style 1. Alternatively, reclosable cushioned pouches conforming to MIL-P-81997, type I or II may be used in lieu of the initial wrap or cushioning. Noncorrosive conductive material shall be applied to all exposed leads and connector pins to maintain a common potential. This is to protect the items from electrostatic charges that may be encountered during handling. DOD-STD-1686 and DOD-HDBK-263 identify class 1, 2 and 3 items sensitive to electrostatic discharges/field forces and provide guidance for ESD control problems.

5.3.1.5 Packaging materials. 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 not covered by a Government packaging material specifications are encouraged for use. Use of such modified or newly developed electrostatic-free packaging materials will be permitted subject to the contracting officer's determination that the physical properties of such materials are equal to or better than similarly constructed materials covered under a required Government packaging material specification and, that such materials satisfy the electrostatic decay rate requirement of MIL-B-81705. The decision of the contracting officer shall be final as to the acceptability or non-acceptability of the packaging material, and the decision shall not be subject to review under the disputes clause of the contract. When such materials are acceptable, unit packaging shall be in accordance with the procedures for electrostatic protection.

5.3.1.6 Electromagnetic protection. Items subject to damage by electromagnetic forces shall be unit packaged in heat-sealed, barrier bags conforming to MIL-B-117, type I or II, class E, style 1 or type I, class F, style 1. 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.

5.3.1.7 Electromagnetic and electrostatic protection. When the item requires both electromagnetic and electrostatic protection, unit packaging shall be as specified under electrostatic protection (see 5.3.1.4.1).

5.4 Protective caps. Externally mounted receptacles which are not in continuous use shall be provided with protective caps to prevent damage to the connector receptacles when the mating connector is not inserted. The protective cap shall be affixed adjacent to the connector receptacle.

6. NOTES

6.1 Intended use. MIL-E-16400 is a compendium of general requirements for Naval electronics equipments. It is intended to assist the acquisition manager in the preparation of equipment specifications. MIL-E-16400 does not set forth requirements for "end-use" equipments; rather, it establishes general characteristics which should be selected for inclusion in an equipment specification. Many of these characteristics are imposed by reference to some other standardization document (that is, MIL-C-24643, MIL-STD-454 or FED-STD-595). The acquisition manager should research each cited document and determine the extent to which its requirements should be involved in the equipment specification. MIL-E-16400 provides guidance in two ways: One, it provides criteria for selecting and modifying requirements from the referenced standardization documents; two, it specifies - where needed - those equipment characteristics which are necessary for sound Naval operations. MIL-E-16400 covers general requirements applicable to the following types of equipment that are designed to meet operational conditions anticipated in Naval ship and shore installations:

(a) Communications and data
(b) Countermeasures
(c) Fire control
(d) Interior-communications
(e) Navigation
(f) Radar and identification, friend or foe
(g) Sonar
(h) Units of other equipment that utilize electronic technology

6.1.1 Test equipment and airborne equipment. General requirements applicable to test equipment for testing equipment designed to this specification are covered by MIL-T-28800. General requirements applicable to airborne equipment are covered by MIL-T-5400.

6.2 Ordering data.

6.2.1 Acquisition requirements. Acquisition documents should specify the following:

(a) If first article inspection is required (see 3.1).
(b) Part design and part selection method (see 3.2.1.6).
(c) If other than JANTX and JANTXV semiconductors can be used for shipboard equipment (see 3.2.1.8).
(d) Type of crimped connector (see 3.2.7).
(e) Use of cadmium plating (see 3.4, table III).
(f) Type of paint system for exposed shipboard equipment (see 3.4.1.4.1).
(g) Input power (see 3.5.1).
(h) Equipment power rating when greater than 100 kVA.
(i) Dc power (see 3.5.1.3).
(j) Equipment warm-up (see 3.5.3).
(k) Data base retention, if other than specified (see 3.5.3.2).
(l) Internal wiring practices (see 3.5.4).
(m) Electrical overcurrent protection (see 3.5.5).
(n) Main power on/off (see 3.5.6).
(o) Dielectric withstanding voltage (see 3.5.7).
(p) Insulation resistance (see 3.5.8).
(q) Emission control (see 3.5.11).
(r) Power supply design and manufacturing requirements (see 3.5.12).
(s) Synchro data (see 3.5.13).
(t) Size and weight limitations (see 3.6.1).
(u) Characteristics of equipment for submarine installation, if other than specified (see 3.6.1.2.3).
(v) Maximum size limitations for other installations (see 3.6.1.2.4).
(w) Support services (see 3.6.2).
(x) Cooling water equipment (see 3.6.2.4).
(y) Equipment enclosure requirements (see 3.6.3).
(z) Hazardous atmosphere protection (see 3.6.3.1).
(aa) External connections, if other than specified (see 3.6.3.5).
(bb) Use of terminal boards or stuffing tubes (see 3.6.3.5).
(cc) Equipment mounting requirements (see 3.6.4).
(dd) Overhead mounting requirements (see 3.6.4.4).
(ee) If resilient mounts may be used (see 3.6.4.7).
(ff) Airborne noise (see 3.6.6).
(gg) Structureborne noise (see 3.6.7).
(hh) Controls, indicators, and panel layout (see 3.6.8).
(ii) Powering of incandescent lamps, if other than specified (see 3.6.8.3.1).
(jj) Special indicator requirements for units having two concentric indications (see 3.6.8.6 and 3.6.8.7).
(kk) Circuits monitored by time meters (see 3.6.8.11).
(ll) Dc magnetic requirements for minesweeper equipment (see 3.6.10).
(mm) External connection requirements (see 3.6.11 and 3.6.11.2).
(nn) When stuffing tubes are required (see 3.6.11.1).
(oo) Heat removal requirements (see 3.7.1).
(pp) Location of inlet air port, if other than specified (see 3.7.1.1.1).
(qq) Reliability requirements (see 3.9).
(rr) Maintainability requirements (see 3.10).
(ss) Safety criteria requirements (see 3.12 and 3.12.4).
(tt) Environmental service condition requirements (see 3.13 and 3.13.1).
(uu) When equipment should operate in a salt spray environment (see 3.13.4).
(vv) Hydrostatic pressure (see 3.13.9).
(ww) When underwater explosion testing is required (see 3.13.11).

(xx) When equipment should meet blast environment requirements (see 3.13.12).
(yy) When nuclear blast testing is required and its method of verification (see 3.13.12.3).
(zz) When equipment for other than shipboard use should be shock tested (see 3.13.13).
(aaa) When equipment for other than shipboard use should be vibration tested (see 3.13.14.1).
(bbb) When the dust (fine sand) test is required (see 3.13.17).
(ccc) When accelerated life testing is required (see 3.13.18).
(ddd) Identification and marking requirements (see 3.14.1).
(eee) Fiber optic systems (see 3.15).
(fff) Electromagnetic environmental effects requirements (see 3.16).
(ggg) Type of bond required (see 3.16.2).
(hhh) Preservation, packaging, and packing required (see 5.1).

6.3 First article. When a first article inspection is required, the items should be a first article sample. The first article should consist of two units. The contracting officer should 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.

6.4 Tailoring guidance (types of requirements). The requirements in MIL-E-16400 can be categorized as follows:

(a) Essential, if applicable (see 6.4.1).
(b) When specified (see 6.4.2).
(c) As specified (see 6.4.3).
(d) Unless otherwise specified (see 6.4.4).

To further aid in preparing an equipment specification, provisions in MIL-E-16400 have been listed by the categories indicated in items (a) through (d). Information on each provision is provided and should be used in conjunction with other factors that influence the requirements in the equipment specification.

6.4.1 Essential requirements. The essential requirements reflect policies relating to:

(a) Installation interfaces.
(b) Operational environment.
(c) Proven design practices.
(d) Standardization efforts.

The following requirements specified in MIL-E-16400 should be considered essential (when applicable to the equipment type being acquired) and should be included in the individual equipment specification. In other words, the following listing provides guidance for the selective application and tailoring of requirements to the equipment development phase and the equipment installation site.

Provision	Paragraph
Parts selection and application	3.2.1
Parts control	3.2.1.2
Modules, electronic	Table I
Materials, unacceptable	Table II
Processes	Table III
Shipboard ac power	3.5.1.1
Shore-station ac power	3.5.1.2
Vehicular dc power	3.5.1.4
Internal wiring practices	3.5.4
Electrical overcurrent protection	3.5.5
Dielectric withstanding voltage	3.5.7
Insulation resistance	3.5.8
Synchro data transmission system	3.5.9
Power receptacles	3.5.10
Size	3.6.1.2
Compressed air	3.6.2.1
Dry air (shipboard)	3.6.2.2
Enclosures	3.6.3
Mounting of parts	3.6.5
Part replacement	3.6.5.1
Airborne noise	3.6.6
Structureborne noise	3.6.7
Illumination	3.6.8.1
Panel illumination	3.6.8.2
Design for dark adapted area	3.6.8.4
Selection of color	3.6.8.5

Provision	Paragraph
Dials and pointers	3.6.8.8
Tuning dial mechanisms	3.6.8.9
Windows	3.6.8.10
Balancing	3.6.9
Thermal design and construction	3.7
Water cooling	3.7.1.2
Parts application	3.7.2
Thermal sensor location	3.7.3
Human engineering	3.8
Maintenance design	3.11
Safety criteria	3.12
Temperature ranges	3.13.1
Altitude, non-operating	3.13.2
Humidity	3.13.3
Solar radiation	3.13.5
Wind velocity	3.13.7
Icing	3.13.8
Shock	3.13.13
Environmental vibration	3.13.14.1
Inclination (shipboard)	3.13.15
Dc magnetic field environment	3.13.16
Nomenclature	3.14.1
Serial numbers	3.14.2
Marking	3.14.3
Electrical power source plate	3.14.4
Workmanship	3.17

Provision	Paragraph
Electromagnetic environmental effects	3.16
Contractor's quality program	4.1.1
Government verification	4.1.2
Problem/failure reporting and correcting action	4.1.4
Classification of inspection	4.2
Quality conformance inspection	4.4.2
Battery packaging	5.1.1
Resilient mounts	5.2
Lead and terminal protection	5.3.1.1
Carrier	5.3.1.2
Wraps and cushioning materials	5.3.1.3

6.4.2 "When specified" requirements. The following provisions of MIL-E-16400 are invoked only "when specified" in the equipment specification. The nature of the provisions preclude them from being mandatory for all of the types of equipment covered by MIL-E-16400. Therefore, the provisions should be carefully reviewed to determine the extent to which they should be applicable in the equipment specification. The applicability of the "when specified" requirements depends on the equipment to be acquired. Factors that determine their applicability are:

(a) Operational requirements.
(b) Platform on which equipment will be installed.
(c) Operational environment.

Provision	Paragraph	Applicability
Adhesion and blister resistance	3.4.1.4.1	Paint test will be required on surface ship exposed equipment.
Dc magnetic requirements for minesweeper equipment	3.6.10	Equipment designed specifically for minesweepers.
Hazardous atmosphere	3.6.3.1	Equipment or portions thereof exposed to hazardous atmosphere.
Safety criteria	3.12	Late development models when hazards other than electrical shock are expected.

Provision	Paragraph	Applicability
Salt fog (spray)	3.13.4	Ship and shore equipment that will be required to operate in this environment.
Underwater explosion	3.13.11	Units of equipment mounted on outside of submarine hull or outside of surface ship below the waterline.
Shock	3.13.13	See MIL-STD-810, method 516.3 for applicability of shock test procedures.
Internally excited vibration	3.13.14.2	Rotary units of shipboard equipment.
Dust (fine sand)	3.13.17	Equipment vehicular mounted, transported open, or operated in a dry dust (fine sand) laden atmosphere.
Accelerated life	3.13.18	When extensive test time is desirable. Normally not required when reliability test is required.
Nomenclature	3.14.1	When MIL-STD-1661 applies for nomenclature.
Weld test	4.6.4.4	
Dust (fine sand)	4.6.8.17	Required when equipment is used in areas exposed to sand and dust.
Parts derating verification	4.6.9	Verification of parts derating requirements demonstrated by test.

6.4.3 "As specified" requirements. The "as specified" requirements are those that would be incomplete without some amplifications in the equipment specification. Factors which have been considered will usually aid in determining what should be specified. In some cases, the document referenced for the requirement will also indicate alternatives that may be selected.

Provision	Paragraph	Additional information required
Parts control	3.2.1.2	Extent of required program.
Obsolescence, no-availability	3.2.1.6	

Provision	Paragraph	Additional information required
Shore-station ac power	3.5.1.2	Electrical power source for shore equipment greater than 100 kVA.
Cadmium plating process	Table III	Cadmium plating process used only as specified.
Shipboard/shore-station dc power	3.5.1.3	Dc power to be supplied to the equipment, if applicable.
Ac power source	Table IV	Parameters for power sources greater than 100 kVA.
Weight	3.6.1.1	
Size other than shipboard equipment	3.6.1.2.4	Size limitation.
Degree of enclosure other than shipboard equipment	3.6.3.2	Applicable degree of enclosure (see MIL-STD-108).
External connections	3.6.3.5	Specify the method of external connections to equipment enclosures if not connectors stuffing tubes or terminal boards.
Equipment mounting	3.6.4	Specify equipment mounting method; specify for each unit if different.
Dials and pointers (illuminated)	3.6.8.6	Distinctive numerals and shapes for units having two concentric indicators.
Dials and pointers (nonilluminated)	3.6.8.7	Colors for numerals and pointers for units having two concentric indicators.
Time totalizing meters	3.6.8.11	Circuits to be monitored by time totalizing meters.
Quantitative reliability	3.9	Quantitative reliability.
Maintainability	3.10	Quantitative maintainability requirement.
Test provisions	3.11.1	Test capability and class - (see MIL-STD-415).
Environmental service conditions	3.13	Equipment performance limits under environmental conditions.

Provision	Paragraph	Additional information required
Temperature ranges	3.13.1	Equipment temperature range - (see table VIII).
Hydrostatic pressure	3.13.9	Hydrostatic pressure capability of parts exposed to seawater.
Government verification	4.1.2	Government inspection of delivered items.
Design qualification testing	4.3.1	Table IX.
First article inspection	4.4.1	Applicable production inspection.
Quality conformance inspection	4.4.2	Production control inspection sampling plan.
Production quality conformance sampling inspection	4.4.3	Applicable production control inspections - (see table IX).
Design requalification	4.4.3.1	Tests in table IX.
Destructive physical analyses	4.5.1	Performed on parts.
Test conditions	4.6.5.1(a)	Maximum operating temperature range.
Reliability qualification test	4.6.6	Reliability test requirements.
Maintainability demonstration	4.6.7	Maintainability test requirements.
Salt fog	4.6.8.6	Applicable salt fog test procedure.
Wind velocity	4.6.8.9	Wind test velocity.
Icing	4.6.8.10	Ice test.
Hydrostatic pressure	4.6.8.11	Hydrostatic test requirement.
Underwater explosion	4.6.8.12	Applicable underwater explosion test procedure.
Requirements for simulated underwater explosion test	4.6.8.12.2	Whether nuclear blast resistance demonstration is to be by tests or calculations.
Shock - other than shipboard equipment	4.6.8.13	Applicable shock test procedure (see MIL-STD-810).

Provision	Paragraph	Additional information required
Shock - shipboard	4.6.8.13	Method of analyzing shock resistance quality of equipment weighing more than 60,000 pounds.
Vibration - shipboard equipment	4.6.8.14.1	Upper vibration frequency limit; normally 25 Hz submarine; 33 Hz surface ship.
Orientation change to equipment during dust (fine sand) test	4.6.8.17	When dust can enter equipment from more than one direction.
Paint system test	4.6.8.19	Applicable paint test procedure.
Preservation/packaging, packing	5.1	Applicable requirements.

6.4.4 "Unless otherwise specified" requirements. The "unless otherwise specified" requirements are those requirements that would apply unless an exception is specified in the individual equipment specification.

Option	Paragraph
First article	3.1
If other than JANTX and JANTXV semiconductors can be used for shipboard equipment	Table I
Connectors, crimped type	3.2.7
Power receptacles	3.5.10
External connections	3.6.3.5
Incandescent lamps	3.6.8.3.1
Safety ground external	3.12.4
Contractor quality program requirements	4.1.1
Failure criteria	4.1.3
Production quality conformance sampling inspection (if tests should not be performed on each unit of complete sample)	4.4.3
General test conditions	4.5
Internally excited vibration	4.6.8.14.2

6.5 Definitions. For the purpose of this specification, the following definitions shall apply:

6.5.1 Airborne noise grades.

(a) Grade A3 - Grade A3 equipment is that which is to be installed in spaces where direct speech communication must be understood with minimal error and without repetition over a distance of 6.5 feet or less.
(b) Grade A12 - Grade A12 equipment is that which is to be installed in spaces where direct speech communication must be understood with minimal error and without repetition over a distance greater than 6.5 feet.
(c) Grade B - Grade B equipment is that which will be placed in spaces where comfort of personnel in their quarters is the principal consideration.
(d) Grade C - Grade C equipment is that which will be placed in the sonar room, sick bay, library, or other spaces requiring low sound levels and which are not covered in other categories.
(e) Grade D - Grade D equipment is that which will be placed in spaces where avoidance of hearing loss is the prime consideration and intelligible speech communication is not normally required.
(f) Grade E - Grade E equipment is that which will be placed in high sound level areas where voice communication is accomplished with high vocal effort and where amplified speech and telephones are normally available.

6.5.2 Hazardous atmosphere. The term hazardous atmosphere is a vapor or gas mixture with air which, under normal conditions of temperature and pressure, can be ignited by a spark or flame to produce a sustained, self-propagating, combustion wave, or is toxic or asphyxiant.

6.5.3 Individual equipment specification. An individual equipment specification is the specification which defines the detailed characteristics and is used for acquisition of a particular equipment.

TABLE XII. Applicability of tests.1/

Examination and tests	Shipboard		Installation Shore		Vehicular Mounted or transported
	sheltered	unsheltered	sheltered	unsheltered	
Surface examination	X	X	X	X	X
Performance	X	X	X	X	X
Dielectric withstanding voltage	X	X	X	X	X
Electromagnetic environmental effects	X	X	X	X	X

See footnotes at end of table.

TABLE XII. Applicability of tests.[1/] - Continued

Examinations and tests	Shipboard		Installation Shore		Vehicular Mounted or tranported
	sheltered	unsheltered	sheltered	unsheltered	
Electrostatic discharge test	X	X	X	X	X
Insulation resistance	X	X	X	X	
Leakage current	X	X	X	X	
Power and power factor	X	X	X	X	
Power interruption	X	X	X	X	X
Spike voltage	X	X			
Loss of phase voltage	X	X	X	X	
Transient frequency	X	X	X	X	
Transient voltage	X	X	X	X	
Airborne noise	X		X		
Structureborne noise[2/]	X	X			
Enclosures	X	X	X	X	
Hydrostatic pressure		[3/]			
Inclination	X	X			
Magnetic material	X	X			
Painting		X			
Thermal design	X	X	X	X	X
Water cooling	X	X			
Welding	X	X	X	X	X
Altitude	X	X	X	X	X
Dust (fine sand)					X
Fungus	X	X	X	X	X

See footnotes at end of table.

TABLE XII. Applicability of tests.1/ - Continued

Examinations and tests	Shipboard		Installation Shore		Vehicular Mounted or transported
	sheltered	unsheltered	sheltered	unsheltered	
Humidity	X	X	X	X	X
Icing		X			
Dc magnetic field	X	X			
Nuclear blast		X		X	
Salt fog	X	X			
Shock	X	X	5/	5/	5/
Solar radiation		X		X	
Temperature	X	X	X	X	X
Underwater explosion			4/		
Vibration	X	X	5/	5/	5/
Wind velocity		X			
Accelerated life	X	X	X	X	X
Maintainability	X	X	X	X	X
Reliability	X	X	X	X	X
Parts derating verification	X	X	X	X	X
Test, analyze and fix	X	X	X	X	X
Temperature cycling	X	X	X	X	X

1/ "X" indicates that the test is normally applicable. However, an operational requirement may dictate that the specification writer invoke a test requirement that is normally not applicable. Section 3 of the individual equipment specification will also invoke the requirement for the test.
2/ Applicable to submarine equipment and equipment on ships that have an antisubmarine (ASW) mission.
3/ Applicable to parts equipment that are exposed to seawater pressure.
4/ Applicable to units or parts thereof that are submerged and exposed to external pressure.
5/ When specified in the individual equipment specification.

6.5.4 Item and levels, exchangeability, and models. The terms of item levels, item exchangeability, and models shall be as defined in MIL-STD-280 and as specified herein.

6.5.4.1 Equipment. The term equipment is generic and applies to any or all item levels as defined in MIL-STD-280.

6.6 Material safety data sheets. Contracting officers will identify those activities requiring copies of completed Material Safety Data Sheets (MSDS) prepared in accordance with FED-STD-313. The pertinent Government mailing addresses for submission of data are listed in appendix B of FED-STD-313. In order to obtain the MSDS, federal acquisition regulation (FAR) clause 52.223-3 must be in the contract.

6.7 Superseding data. This specification should be used for new design in lieu of the following:

(a) MIL-I-983 - Interior Commnication and Navigation Equipment
(b) MIL-F-18870 - Fire Control Equipment

6.8 Subject term (key word) listing.

Cable
Circuit breakers
Controllers
Meters
Motors
Power supply
Relays

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

Review activities:
Navy - EC, AS, OS

User activity:
Navy - MC

Preparing activity:
Navy - SH
(Project GDRQ-N004)

APPENDIX

ELECTRONIC EQUIPMENT, NAVAL SHIP AND SHORE, GENERAL
SPECIFICATION FOR (METRIC EQUIPMENT)

10. SCOPE

10.1 Scope. This appendix covers the general requirements for Naval electronic equipment expressed in metric units. All requirements of the basic specification apply, except that measurements shall be in metric units as stated herein.

20. APPLICABLE DOCUMENTS

20.1 Government documents.

20.1.1 Specifications and standards. Unless otherwise specified, the following specifications and standards of the issue listed in that issue of the Department of Defense Index of Specifications and Standards (DoDISS) specified in the solicitation, form a part of this specification to the extent specified herein.

SPECIFICATIONS

MILITARY

DOD-M-24680 - Metric Machinery/Equipment, General Requirements for.

STANDARDS

MILITARY

DOD-STD-1476 - Metric System, Application in New Design.
DOD-STD-1690 - Maritime Metric Practice Guide.

30. REQUIREMENTS

30.1 General. New equipment designed in metric units shall be in accordance with DOD-STD-1476. Where a metric component to a non-metric specification referenced in the basic specification is required, DOD-M-24680 shall be used in conjunction with the non-metric parent specification. Metric units shall be in accordance with DOD-STD-1690.

30.1.1 Static seals. The inside radius of corners shall be 15 millimeters (mm) minimum (see 3.3.3).

30.1.2 Glass windows. The thickness of glass windows not withstanding a pressure differential shall depend upon the minimum linear dimension in accordance with the following (see 3.3.4.1):

Dimension of window	Thickness	Tolerance
Less than 180	5	+0.5, -0
180 to 250	10	+0.5, -0
Over 250 to 380	13	+1.0, -0
Over 380	17	+1.0, -0

(NOTE: All dimensions in mm.)

30.1.3 Primer. The primer shall have a dry film thickness of 15 to 20 micrometers (µm) (see 3.4.1.3.1).

30.1.4 Enamel. Each coat shall have a minimum thickness of 25 µm, dry film thickness (see 3.4.1.3.2).

30.1.5 Exposed equipment (exterior use) (except Marine Corps). The first coat shall be formula 150 (thickness 75 to 100 µm), the second coat formula 155 (thickness of 50 to 75 µm), and the third coat formula 151 (thickness of 50 to 75 µm). The total dry film thickness shall be 175 to 225 µm (see 3.4.1.4).

30.1.6 Primer. The primer shall have a dry film thickness of 15 to 25 µm (see 3.4.1.5.1).

30.1.7 Enamel. Each coat shall have a minimum thickness of 25 µm (see 3.4.1.5.2).

30.1.8 Maximum height. Equipment intended for installation within internal shipboard spaces shall be not over 1800 mm overall height, including stacked units and resilient mounts when their use is permitted (see 3.6.1.2.1 and 3.6.4.7).

30.1.9 Surface ship installation. Equipment intended for installation within internal surface ship spaces shall be capable of passage through a doorway 650 mm wide by 100 mm high (reduced further by round corners on a 200-mm radius) and through a hatch 750 mm long by 750 mm wide (reduced further by round corners on a 180 mm radius) (see 3.6.1.2.2).

30.1.10 Submarine installation. Unless otherwise specified, equipment intended for installation within internal submarine spaces shall be capable of passage through a circular tube (submarine entrance hatch) 620 mm in diameter and through a doorway 500 mm wide by 950 mm high (reduced further by round corners on a 350-mm radius) (see 3.6.1.2.3).

30.1.11 Handling. Equipment or portions thereof weighing more than 45 kilograms (kg) shall be provided with lifting eyes which will accommodate a 25-mm circumference line (see 3.6.1.2.5).

30.1.12 Cable entrance stuffing tube (case enclosure). On case enclosures with a wall thickness greater than 5 mm, bosses, drilled and tapped with type NPT threads, conforming to FED-STD-H28 and FED-STD-H28/7 for the stuffing tube to be used shall be provided in the top, bottom, or sides of the enclosure (see 3.6.3.5.1).

30.1.13 Bulkhead mounting. Bulkhead mounting shall normally not be used for equipment weighing more than 100 kg (see 3.6.4.1).

30.1.14 Panel mounting. The enclosure shall not project more than 40 mm from the face of the panel (not including operating handles) (see 3.6.4.3).

30.1.15 Mounting of parts. Parts having a diameter of 15 mm or more or whose mass (weight) exceeds 3.0 gram per load or whose density exceeds 5 gram per cubic centimeter (g/cm^3) shall be securely fastened by clamps (see 3.6.5).

30.1.16 Illumination. Dials and other displays illuminated with white light shall be readable in all levels of incident illumination up to 300 lux; red illuminated dials and displays shall be readable in all levels of incident illumination up to 0.3 lux (see 3.6.8.1).

30.1.17 Altitude, non-operating. The equipment performance shall not be degraded after an 8-hour exposure to an altitude of 18,000 meters (see 3.13.2).

30.1.18 Icing. The equipment, or portions thereof, exposed to the weather shall be capable of withstanding an ice load of 22 kg/m^2 of exposed surface without structural damage (see 3.13.8).

30.1.19 Gunblast. Shipboard equipment, except loudspeakers, which may be exposed to gunblast, shall withstand a gunblast environment of 50 kilopascals (kPa) peak free field overpressure in accordance with 4.6.8.14. Loudspeakers shall withstand a peak air blast pressure front of 65 kPa when tested in accordance with 4.6.8.13 (see 3.13.12).

40. QUALITY ASSURANCE PROVISIONS

40.1 General. The requirements of section 4 of the basic specification apply, except as indicated herein.

40.1.1 Altitude. The de-energized equipment shall be subject to reduced atmospheric pressure (7.3 kPa) corresponding to an altitude of not less than 18,000 meters for not less than 8 hours (see 4.6.8.4).

40.1.2 Actual condition. The item shall be mounted in the center of a steel plate having minimum dimensions of 1 meter in height, 1 meter in width, and 6 mm in thickness. The plate shall be suspended vertically at a depth of 9 meters below the surface of the water. A 25 kg standard TNT charge shall be suspended at a depth of 9 meters below the surface of the water at a distance of 9 meters from the plate, on the same side of the plate as the item being tested, and on a line perpendicular to the face of the plate at the center. The total depth of water shall be a minimum of 18 meters in the area of the test (see 4.6.8.12.1).

40.1.3 Blistering. Blisters appearing within 5 mm from the edge of the panel shall be disregarded (see 4.6.8.19.1).

50. PACKAGING

50.1 General. The requirements of section 5 of the basic specification apply.

60. NOTES

60.1 Intended use. This appendix covers the general requirements for the types of electronic equipment listed in 6.1 of the basic specification, but designed in SI metric units of measurement.

60.2 General. The notes of section 6 of the basic specification apply, except as indicated herein.

60.2.1 "As specified" requirements (see 6.4.3).

Provision	Paragraph	Additional information required
Shock - shipboard and other than shipboard equipment	4.6.8.13	Method of analyzing shock resistance quality of equipment having a mass of more than 27,000 kg.

60.2.2 Airborne noise grades (see 6.1.1).

(a) Grade A3 - Grade A3 equipment is that which is to be installed in spaces where direct speech communication must be understood with minimal error and without repetition over a distance of 2 meters or less.

(b) Grade A12 - Grade A12 equipment is that which is to be installed in spaces where direct speech communication must be understood with minimal error and without repetition over a distance greater than 2 meters.

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STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

(See Instructions – Reverse Side)

1. DOCUMENT NUMBER	2. DOCUMENT TITLE
MIL-E-16400H(NAVY)	ELECTRONIC, INTERIOR COMMUNICATION AND NAVIGATION EQUIPMENT, NAVAL SHIP AND SHORE: GENERAL SPECIFICATION FOR

3a. NAME OF SUBMITTING ORGANIZATION	4. TYPE OF ORGANIZATION *(Mark one)*
	☐ VENDOR ☐ USER ☐ MANUFACTURER ☐ OTHER *(Specify)*: _____
b. ADDRESS *(Street, City, State, ZIP Code)*	

5. PROBLEM AREAS

a. Paragraph Number and Wording:

b. Recommended Wording:

c. Reason/Rationale for Recommendation:

6. REMARKS

7a. NAME OF SUBMITTER *(Last, First, MI)* – Optional	b. WORK TELEPHONE NUMBER *(Include Area Code)* – Optional
c. MAILING ADDRESS *(Street, City, State, ZIP Code)* – Optional	8. DATE OF SUBMISSION *(YYMMDD)*

DD FORM 82 MAR 1426 PREVIOUS EDITION IS OBSOLETE.

(TO DETACH THIS FORM, CUT ALONG THIS LINE.)