METRIC

MIL-STD-2036
18 June 1991

SUPERSEDING
MIL-E-16400H (NAVY)
13 July 1987

MILITARY STANDARD

GENERAL REQUIREMENTS FOR ELECTRONIC EQUIPMENT SPECIFICATIONS

AMSC N/A

AREA GDRQ

DISTRIBUTION STATEMENT A. Approved for public release; distribution is unlimited.

FOREWORD

1. This military standard is approved for use by all Departments and Agencies, of the Department of Defense.

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

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1. SCOPE

1.1 Scope. This standard covers the policy guidance and general requirements for the preparation of specifications for electronic equipment for shipboard applications, including submarines. Requirements previously contained in MIL-E-16400 are hereby superseded. This document provides guidance for the use of commercial off the shelf (COTS) and ruggedized equipment in addition to militarized equipment. Requirements are to be based on the installation and intended use of the equipment.

1.1.1 Usage. The requirements of this document shall be tailored for all shipboard applications. The development of detail requirements for airborne, space, mobile and land based applications is in process. Requirements for airborne, space, mobile and land based applications will be promulgated as revisions to this document.

1.2 Use. **This standard shall not be invoked on a blanket basis in end-time specifications.** Rather, each requirement contained herein shall be tailored to the specific requirements for the equipment being acquired.

1.3 Classification. Electronic equipment acquisition options available to the program manager include COTS, ruggedized and militarized. The selection of the appropriate acquisition option is the responsibility of the program manager, and should be dependent upon the expectations for the equipment, availability of commercial equipment, functional requirements for the equipment and cost-benefit tradeoffs. The acceptable ranges for each option is illustrated in Figure 1 and is determined by specifying the service requirements for the equipment. Service requirements vary from what is considered minimally acceptable for installation in light duty applications, to fully hardened requirements which are typically required for mission critical equipment (see 4.1.4.3). In general, non-mission critical equipment, including most Command, control, communications, computer and intelligence (C^4I) equipment, does not have to meet the fully hardened requirements and may shut down or go into a standby mode when the specified operating limits are exceeded. However, so long as the support services and other interfaces remain within their specified limits, the equipment must not be damaged by such excursions. **The specific requirements for each acquisition are the responsibility of the program manager, and shall be tailored within the range of acceptable limits provided herein.**

1.3.1 Specification type. The end item specification may be a design specification, a performance specification, or a hybrid of performance and design specifications. If the

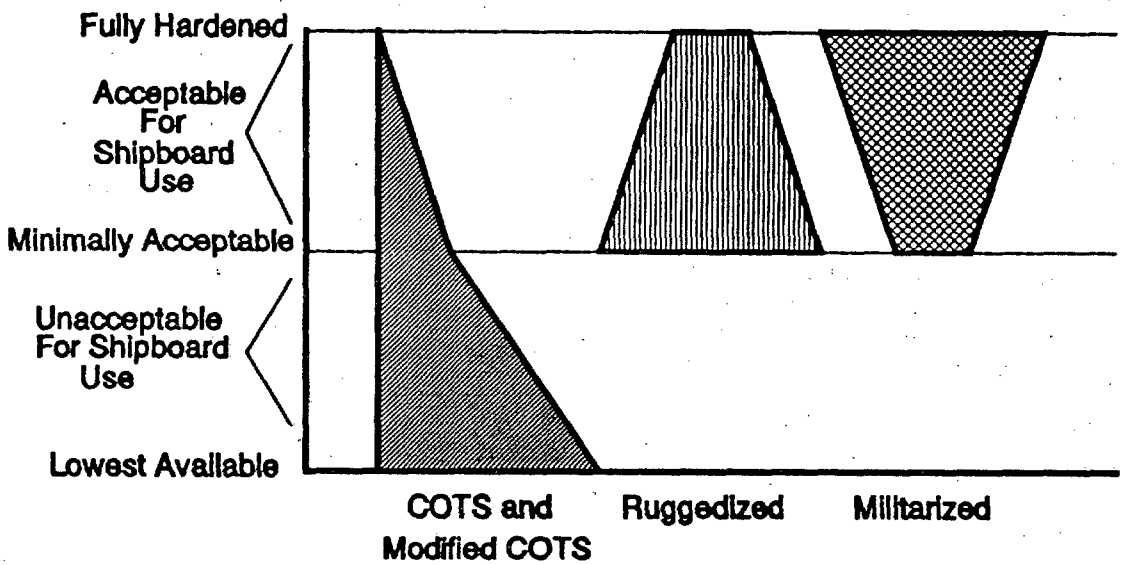

Figure 1. Procurement Options.

acquisition strategy is to be COTS, the specification type shall be performance. If the acquisition strategy is to be ruggedized, then the specification type may be either performance or a hybrid of performance and design. If the acquisition strategy is to be militarized, then the specification type may be performance, design, or a hybrid of performance and design. **The decision regarding the specification type is incumbent upon the program manager acquiring the equipment and is not to be left to the discretion of a contractor.**

1.3.1.1 Performance specification. A performance specification is a specification in which the equipment is treated as a black box, and the interfaces to the equipment are specified, as shown in Figure 2. Figure 2 is intended as an example, and does not include all service interfaces (see 5.1.1, 5.1.2 and 5.1.3). The interfaces described herein include environmental conditions, support services, human factors, safety, operational constraints, and suitability requirements such as reliability, maintainability, test interfaces, supportability, operability or produceability. These elements of performance shall be responsive to the individual acquisition program needs. The foregoing interfaces are

separate from those required for functional requirements, such as input/output (I/O) and target tracking. The performance specification permits the manufacturer to perform the hardware and software design, and places a great responsibility upon the specifier to ensure that all relevant characteristics are incorporated and that the equipment is adequately tested to demonstrate that it will be suitable for the application.

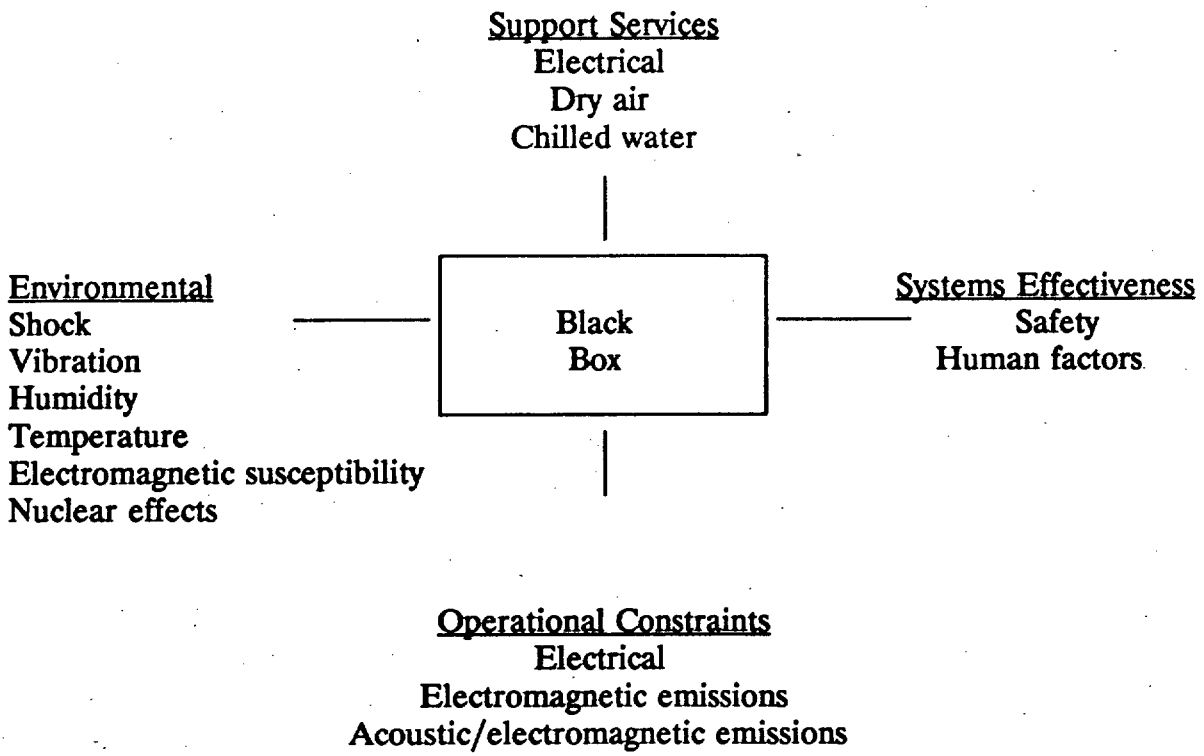

Figure 2. Services Interfaces.

1.3.1.2 Design specification. A design specification is an end item specification in which the hardware and software are specified to the component level. The contracting activity controls the product design and production methods. It is the responsibility of the contracting activity to ensure the equipment meets all relevant performance characteristics.

2. APPLICABLE DOCUMENTS.

2.1 Government documents.

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

SPECIFICATIONS

FEDERAL

QQ-A-200	Aluminum Alloy, Bar, Rod, Shapes, Structural Shapes, Tube and Wire, Extruded; General Specification for.
QQ-A-200/1	Aluminum Alloy 3003, Bar, Rod, Shapes, Tube and Wire, Extruded.
QQ-A-200/4	Aluminum Alloy 5083, Bar, Rod, Shapes, Structural Shapes, Tube and Wire, Extruded.
QQ-A-200/8	Aluminum Alloy 6061, Bar, Rod, Shapes, Tube and Wire, Extruded.
QQ-A-225	Aluminum and Aluminum Alloy Bar, Rod, Wire, or Special Shapes; Rolled, Drawn, or Cold Finished; General Specification for.
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 Gold Finished.
QQ-A-225/8	Aluminum Alloy 6061, Bar, Rod, Wire and Special Shapes; Rolled, Drawn or Cold Finished.
QQ-A-250	Aluminum and Aluminum Alloy Plate and Sheet: General Specification for.
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	Aluminum Alloy Die Castings.
QQ-A-596	Aluminum Alloy Permanent and Semipermanent Mold Castings.

QQ-B-639	Brass, Naval: Flat Products (Plate, Bar, Sheet, and Strip).
QQ-B-654	Brazing Alloys, Silver.
QQ-C-320	Chromium Plating (Electrodeposited).
TT-C-490	Cleaning Methods for Ferrous Surfaces and Pretreatments for Organic Coatings.
QQ-C-502	Copper Rods and Shapes; and Flat Products With Finished Edges (Flat Wire, Strips and Bars).
TT-E-490	Enamel, Silicone Alkyd Copolymer, Semigloss (for Exterior and Interior Non-W-F-406 Fittings for Cable, Power, Electrical and Conduit, Metal, Flexible.
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-290	Nickel Plating (Electrodeposited).
TT-P-664	Primer Coating, Alkyd, Corrosion-Inhibiting, Lead and Chromate Free, VOC-Compliant.
TT-P-1757	Primer Coating, Zinc Chromate, Low-Moisture-Sensitivity.
QQ-S-365	Silver Plating, Electrodeposited: General Requirements for.
WW-T-700	Tube, Aluminum and Aluminum Alloy, Drawn, Seamless, General Specification for.
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.
J-W-1177	Wire, Magnet, Electrical General Specification.

MILITARY

MIL-C-17	Cables, Radio Frequency, Flexible and Semirigid, General Specification for.
MIL-T-27	Transformers and Inductors (Audio, Power, and High-Power Pulse), General Specification for.
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-S-1222	Studs, Bolts, Hex Cap Screws, Socket Head Cap Screws, and Nuts.
MIL-E-2036	Enclosures for Electric and Electronic Equipment.

MIL-C-2212	Contactors and Controllers, Electric Motor AC or DC, 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-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-M-7793	Meter, Time Totalizing.
MIL-A-8625	Anodic Coatings, for Aluminum and Aluminum Alloys.
MIL-S-8660	Silicone Compound, NATO Code Number S-736.
MIL-Q-9858	Quality Program Requirements.
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, Sheet, Plate, Strip, Bar, Rod and Wire.
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-C-17112	Copper-Nickel-Zinc Alloy (Nickel-Silver): Castings.
MIL-I-17214	Indicator, Permeability; Low-Mu (Go-No Go).
MIL-B-17931	Bearings, Ball, Annular, for Quiet Operation.

MIL-N-18307	Nomenclature and Identification for Aeronautical Systems Including Joint Electronic Type Designated Systems and Associated Support Systems.
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 C96200 and C96400).
MIL-A-21180	Aluminum-Alloy Castings, High Strength.
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, Chemical and Solvent Resistent.
MIL-C-24231	Connectors, Plugs, Receptacles, Adapters, Hull Inserts, and Hull Insert Plugs, Pressure-Proof, General Specification for.
MIL-P-24441/1	Paint, Epoxy-Polyamide, Green Primer, Formula 150, Type I.
MIL-P-24441/3	Paint, Epoxy-Polyamide, Topcoat, White, Formula 152, Type I.
MIL-P-24441/6	Paint, Epoxy-Polyamide, Exterior Topcoat, Dark Gray, Formula 155-Ro = 6, Type I.
MIL-C-24640	Cable, Electrical, Lightweight for Shipboard Use, General Specification for.
MIL-C-24643	Cable and Cord, Electrical, Low Smoke, for Shipboard Use General Specification for.
MIL-C-24733	Controller Interface Unit, Fiber Optic (METRIC), General Specification for.
MIL-C-24758	Conduit, Flexible, Weatherproof and Associated Fittings, 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.
MIL-D-28000	Digital Representation for Communication of Product Data: IGES Application Subsets.
MIL-D-28001	Markup Requirements and Generic Style Specification for Electronic Printed Output and Exchange of Text.
MIL-R-28002	Raster Graphic Representation in Binary Format, Requirements for.
MIL-D-28003	Digital Representation for Communication of Illustration Data: CGM Application Profile.

MIL-C-28731	Connectors, Electrical, Rectangular, Removable Contact, Formed Blade, Fork Type (for Rack and Panel and other applications), General Specification for.
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-M-28787	Modules, Standard Electronic, General Specification for.
MIL-C-28790	Circulators, Radio Frequency, General Specification for.
MIL-T-28800	Test Equipment for Use With Electrical and Electronic Equipment, General Specification for.
MIL-C-28840	Connectors, Electrical, Circular Threaded, High Density, High Shock Shipboard, Class D General Specification for.
MIL-T-31000	Technical Data Packages, 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-T-55631	Transformers; Intermediate Frequency, Radio Frequency and Discriminator, General Specification for.
MIL-C-81562	Coatings, Cadmium, Tin-Cadmium and Zinc (Mechanically Deposited.
MIL-C-83286	Coating, Urethane, Aliphatic Isocyanate, for Aerospace Applications.
MIL-P-83461	Packing, Preformed, Petroleum Hydraulic Fluid Resistant, Improved Performance at 275 ^{o}F (135 ^{o}C).
MIL-T-83721	Transformers, Variable, Power General Specification for.

STANDARDS

FEDERAL

FED-STD-H28	Screw-Thread Standards for Federal Services.

FED-STD-H28/7	Screw-Thread Standards for Federal Services Section 7 Pipe Threads, General Purpose.
FED-STD-313	Material Safety Data, Transportation Data and Disposal for Hazardous Materials Furnished to Government Activities.
FED-STD-595	Colors used in Government Procurement.

MILITARY

MIL-STD-100	Engineering Drawing Practices.
MIL-STD-108	Definitions of and Basic Requirements for Enclosures for Electric and Electronic Equipment.
MIL-STD-129	Marking for Shipment and Storage.
MIL-STD-167-1	Mechanical Vibrations of Shipboard Equipment (Type I - Environmental and Type II - Internally Excited).
MIL-STD-188-200	System Design and Engineering Standards for Tactical Communications.
MIL-STD-196	Joint Electronics Type Designation System.
MIL-STD-198	Capacitors, Selection and Use Of
MIL-STD-202	Test Methods for Electronic and Electrical Component Parts.
MIL-STD-210	Climatic Information to Determine Design and Test Requirements for Military Systems and Equipment.
MIL-STD-242	Electronic Equipment Parts Selected Standards Microcircuits and Semiconductors. (Part 5)
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-490	Specification Practices.
MIL-STD-499	Engineering Management.
MIL-STD-701	List of Standard Semi-conductor Devices.
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-756	Reliability Modeling and Prediction.
MIL-STD-785	Reliability Program for Systems and Equipment Development and Production.

MIL-STD-810	Environmental Test Methods and Engineering Guidelines.
MIL-STD-882	System Safety Program Requirement.
MIL-STD-889	Dissimilar Metals.
MIL-STD-961	Military Specifications and Associated Documents, Preparation of.
MIL-STD-965	Parts Control Program.
MIL-STD-1285	Marking of Electrical and Electronic Parts.
MIL-STD-1286	Transformers, Inductors, and Coils, Selection and Use of.
MIL-STD-1310	Shipboard Bonding, Grounding, and other Techniques for Electromagnetic Compatibility and Safety.
MIL-STD-1378	Requirements for Employing Standard Electronic Modules.
MIL-STD-1379	Military Training Programs.
MIL-STD-1388-1	Logistic Support Analysis.
MIL-STD-1390	Level of Repair.
MIL-STD-1395	Filters and Networks, Selection and Use of.
DOD-STD-1399 Section 070-Part 1	Interface Standard for Shipboard Systems DC Magnetic Field Environment (Metric).
DOD-STD-1399 Section 071	Interface Standard for Shipboard Systems Section 071 Mass/Size/Shape, Shipboard Units (Metric).
MIL-STD-1399 Section 072-Part 1	Interface Standard for Shipboard Systems Section 072-Part 1 Blast Environment, Missile Exhaust.
MIL-STD-1399 Section 072.2	Interface Standard for Shipboard Systems Section 072.2 Blast Environment, Gun Muzzle.
MIL-STD-1399 Section 102	Interface Standard for Shipboard Systems Section 102, Low Pressure Dry Air Service for Surface Ships.
MIL-STD-1399 Section 105	Interface Standard for Shipboard Systems Section 105, Sea Water Service for Surface Ships.
MIL-STD-1399 Section 106	Interface Standard for Shipboard Systems Section 106, Compressed Air Service for Surface Ships.
MIL-STD-1399 Section 300	Interface Standard for Shipboard Systems Section 300, Electric Power Alternating Current (Metric).

MIL-STD-1399 Section 301	Interface Standard for Shipboard Systems Section 301, Ship Motion and Attitude (Metric).
MIL-STD-1399 Section 390	Interface Standard for Shipboard Systems Section 390, Electric Power, Direct Current, (Other Than Ship's Battery) for Submarines (Metric).
DOD-STD-1399 Section 406	Interface Standard for Shipboard Systems Section 406, Digital Computer Grounding (Metric).
DOD-STD-1399 Section 441	Interface Standard for Shipboard Systems Section 441, Precise Time and Time Interval (PTTI).
MIL-STD-1399 Section 501	Interface Standard for Shipboard Systems Section 501 Nomenclature, Electronic and Weapons Control Functions.
MIL-STD-1399 Section 502	Interface Standard for Shipboard Systems Section 502, Electronics Systems Parameters.
DOD-STD-1399 Section 532	Interface Standard for Shipboard Systems Section 532, Cooling Water for Support of Electronic Equipment (Metric).
MIL-STD-1399 Section 702	Interface Standard for Shipboard Systems Section 702, Synchro Data Transmission.
MIL-STD-1562	Lists of Standard Microcircuits.
MIL-STD-1661	Mark and Mod Nomenclature System.
MIL-STD-1680	Installation Criteria for Shipboard Secure Electrical Information Processing Systems.
MIL-STD-1683	Connectors and Jacketed Cable, Electric, Selection Standard for Shipboard Use.
MIL-STD-1686	Electrostatic Discharge Control Program for Protection of Electrical and Electronic Parts, Assemblies and Equipment (Excluding Electrically Initiated Explosive Devices) (Metric).
MIL-STD-1839	Calibration and Measurement Requirements.

MIL-STD-1840	Automate Interchange of Technical Information.
MIL-STD-2000	Standard Requirements for Soldered Electrical and Electronic Assemblies.
DOD-STD-2003-3	Electric Plant Installation Standard Methods for Surface Ships and Submarines (Penetrations) Section 3 of 5 Sections.
DOD-STD-2143	Magnetic Silencing Requirements for the Construction of Nonmagnetic Ships and Craft (Metric).
MIL-STD-2165	Testability Program for Electronic Systems and Equipments.
DOD-STD-2167	Defense, System Software Development.
MIL-STD-2200	Requirements for Employing Standard Enclosure Systems.
MIL-STD-45662	Calibration Systems Requirements.

HANDBOOKS

MIL-HDBK-59	Department of Defense Computer-Aided Acquisition and Logistic Support (CALS) Program Implementation Guide.
MIL-HDBK-225	Synchros Description and Operation.
MIL-HDBK-235-1	Electromagnetic (Radiated) Environment Considerations for Design and Procurement of Electrical and Electronic Equipment, Subsystems and Systems, Part 1.
MIL-HDBK-237	Electromagnetic Compatibility Management Guide for Platforms, Systems and Equipment.
MIL-HDBK-246	Program Managers Guide for the Standard Electronic Modules Program.
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-700	Plastics.
MIL-HDBK-722	Glass.
DOD-HDBK-SD-2	Nondevelopmental Item Program-Buying NDI.

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

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

PUBLICATIONS

ASSISTANT SECRETARY OF THE NAVY

TAAF	The Test, Analyze, and Fix (TAAF) Process; A Technical Brief for TAAF Implementation.

(Application for copies should be addressed to The Office of the Assistant Secretary of the Navy (Research, Development, and Acquisition), Product Integrity, Washington, DC 20360-5000)

DEPARTMENT OF COMMERCE

NTIA Manual of Regulation	Manual of Regulations and Procedures for Federal Radio Frequency Management.

(Application for copies should be addressed to United States Department of Commerce, National Telecommunications and Information Administration, Washington, DC 20230)

DEPARTMENT OF DEFENSE (DOD)

DOD 4120.3-M	Defense Standardization and Specification Program Policies, Procedures and Instructions.
DOD Directive 4245.4	Acquisition of Nuclear Series Cable Systems.
DOD Directive 5000.1	Defense Acquisition.
DOD Instruction 5000.2	Defense Acquisition Management Policies/Procedures.
DOD Manual 5000.2-M	Defense Acquisition Management Documentation/Reports.

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

FEDERAL REGULATIONS

29 CFR 1910	Code of Federal Regulations, Title 29, Part 1910.

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

GENERAL SERVICES ADMINISTRATION

FPMR 101-29	Federal Standardization.

(Application for copies should be addressed to the Superintendent of Documents, US Government Printing Office, Washington, DC 20402)

CHIEF OF NAVAL OPERATIONS

SECNAVINST 200.32/ OPNAVINST 5200.28	Life Cycle Management of Mission Critical Computer. Resources (MCCR) For Navy Systems Managed Under the Research, Development, and Acquisition (RDA) Process.
SECNAVINST 4490.2	Transition From Development to Production.
SECNAVINST 5231.1B	Life Cycle Management (LCM) Policy and Approval Requirements for Information System (IS) Projects.
SECNAVINST 5239.2	Department of the Navy Automated Information System (AIS) Security Program.
OPNAVINST 1500.2	Responsibilities and Procedures for Establishment and Coordination of Contractor - Developed Training For Military and Civilian Personnel.
OPNAVINST 1500.8	Navy Training Planning Process.
OPNAVINST 1500.44	Responsibilities for Development of Personnel Training Requirements and Related Plans.
OPNAVINST 3000.12	Operational Availability of Equipment and Weapons Systems.
OPNAVINST C5510.93	Navy Implementation of National Policy on Control of Compromising Emanations (limited distribution).

(Application for copies should be addressed to Naval Publications and Forms Center, 5801 Tabor Avenue, Philadelphia, PA 19120-5099)

NAVAL SEA SYSTEMS COMMAND

S9407-AB-ATM-010	Nuclear Powered Submarine Atmosphere Control Manual.
TE000-AB-GTP-020	Environmental Stress Screening Requirements and Applications Manual for Navy Electronic Equipment.
TE000-AB-GTP-010	Parts Derating Requirements and Application Manual for Navy Electronic Equipment.

(Application for copies should be addressed to the Commander, Naval Sea Systems Command, Naval Sea Systems Command Headquarters, Washington, DC 20362-5101)

NAVSEA Instruction C3401.1	Nuclear Survivability Design Standards for Surface Ships of the U. S. Navy. (limited distribution)

(Application for copies should be addressed to the Commander (Code 09P21), Naval Sea Systems Command, Naval Sea Systems Command Headquarters, Washington, DC 20362-5101)

SPACE AND NAVAL WARFARE SYSTEMS COMMAND

NAVELEX 0967-LP-624-6010	Electromagnetic Radiation Hazards.

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

NAVAL SURFACE WARFARE CENTER

NSWC TR 87-192	Suggested Electronic Equipment Standards for Nuclear Weapons Environments.
NSWC TR 90-22	Basic Nuclear Survivability Concepts for Navy Computational Electronics.

(Application for copies should be addressed to the Naval Surface Warfare Center, Dahlgren, VA 22448-5000)

NAVAL WEAPONS SUPPORT CENTER

NAVSEA SE 010-AA-SPN-010	Standard Power Supply Program, General Specification for Power Supplies.

(Application for copies should be addressed to the Naval Weapons Support Center, Code 6023, Bldg. 2917, Crane, IN 47522-5060)

NAVMAT P 4855-1A (NAVSO P-3641)	Quality Assurance Policy For the Naval Material Command.

(Application for copies should be addressed to the Naval Publications and Forms Center, 5801 Tabor Ave., Philadelphia, PA 19120-5099)

SHARP TP-001	Standard Battery Systems - "Preferred Standard Battery List".

(Application for copies should be addressed to the Naval Weapons Support Center, Code 602, Bldg. 2940, Crane, IN 47522-5060)

TM S3910-AQ-SAF-010	Technical Manual for Batteries, Navy Lithium Safety Program Responsibilities and Procedures.

(Application for copies should be addressed to the Naval Weapons Support Center, Code 3057, Bldg. 36, Crane, IN 47522-5060)

DRAWINGS

DEFENSE ELECTRONICS SUPPLY CENTER (DESC)

87060	Circuit Breakers, Magnetic, Panel Seal, Shock Enhanced, Trip-Free, Series Trip, Single Pole (0.2 to 30 Amperes).
87061	Circuit Breakers, Magnetic, Panel Seal, Shock Enhanced, Trip-Free, Series Trip, Two Pole (0.2 to 30 Amperes).
87062	Circuit Breakers, Magnetic, Panel Seal, Shock Balanced, Trip Free, Series Trip, Three Pole (0.2 to 30 Amperes).

(Application for copies should be addressed to the Defense Electronics Supply Center, Attn: SESC-ES, 1507 Wilmington Pike, Dayton, OH 45444)

2.2 Non-Government publications. The following documents form a part of this document to the extent specified herein. Unless otherwise specified, the issues of the documents which are DOD adopted are those listed in the issue of the DODISS cited in the solicitation. Unless otherwise specified, the issues of documents not listed in the DODISS are the issues of the documents cited in the solicitation.

AMERICAN CONFERENCE OF GOVERNMENT AND INDUSTRIAL HYGIENISTS (ACGIH)

ISBN 0-936-712-39-2	Threshold Limit Values (TLVs) for Chemical Substances and Physical Agents in the Work Environment.

(Application for copies can be obtained through any commercial bookstore.)

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI C95.1	Safety levels with respect to human exposure to radio frequency electromagnetic fields, 300 Hz to 100 Ghz.
ANSI C95.2	Radio frequency radiation hazard warning symbol.
ANSI C95.3	Techniques and Instrumentation for the Measurement of Potentially Hazardous Electromagnetic Radiation at Microwave Frequencies.
ANSI Z53.1	Safety Color Code for Marking Physical Hazards.
ANSI N2.1	American National Standard for Warning symbols-Radiation symbol.
ANSI X3.131	Small Computer System Interface (SCSI).
ANSI X3T9.5	Fiber Distribution Data Interface (FDDI) Station Management (SMT).

(Applications for copies should be addressed to the American National Standards Institute, 1430 Broadway, New York, NY 10018.)

AMERICAN SOCIETY OF HEATING AND AIR CONDITIONING ENGINEERS (ASHRAE)

ASHRAE Handbook	HVAC Systems and Applications.

(Application for copies should be addressed to the American Society of Heating and Air Conditioning Engineers, 1791 Tullie Circle, NE, Atlanta, GA 30329)

AMERICAN SOCIETY FOR TESTING AND MATERIALS

ASTM A 153	Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
ASTM A 4944	Standard Specification for Castings, Nickel and Nickel Alloy.
ASTM B 16	Rod, Bar and Shapes for Use in Screw Machines, Free Cutting Brass.
ASTM B 21	Rod, Naval Brass, Bar and Shapes (METRIC).
ASTM B 26	Aluminum-alloy Sand Castings.
ASTM B 36	Brass Plate & Sheet, Strip and Rolled Bar.
ASTM B 121	Plate, Leaded Brass, Sheet, Strip and Rolled Bar.
ASTM B 122	Plate, Sheet, Strip, and Rolled Bar, Copper Nickel Tin Alloy, Copper Nickel Zinc Alloy, (Nickel Silver) and Copper Nickel Alloy.
ASTM B 124	Copper and Copper Alloy Forging Rod Bar and Shapes.
ASTM B 138	Manganese Bronze Rod, Bar and Shapes.
ASTM B 139	Phosphor Bronze Rod, Bar, and Shapes, General Specification for.
ASTM B 151	Rod and Bar, Copper-Nickel-Zinc Alloy (Nickel Silver) Wire and Copper-Nickel Alloy Wire.
ASTM B 194	Copper-Beryllium Alloy Plate, Sheet, Strip and Rolled Bar.
ASTM B 196	Copper-Beryllium Alloy Rod and Bar.
ASTM B 197	Copper-Beryllium Alloy Wire.
ASTM B 206	Copper-Nickel-Zinc Alloy (Nickel & Silver) Wire and Copper-Nickel Alloy Wire.
ASTM B 545	Standard Specification for Electrodeposited Coatings of Tin.
ASTM B 633	Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel. (DOD Adopted)
ASTM D 1868	Standard Method for Detection and Measurement of Partial Discharge (Corona) Pulses in Evaluation of Insulation System.
ASTM D 3951	Standard Practices for Commercial Packing.
ASTM D 4169	Performance Testing of Shipping Containers and Systems, Practice of.
ASTM F 104	Standard Classification System for Nonmetallic Gasket Materials.
ASTM F 1166	Standard Practices for Human Engineering Design for Marine Systems, Equipment and Facilities.

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

ELECTRONIC INDUSTRIES ASSOCIATION (RIA)

RS-232	Interface Between Terminal Equipment and Data Circuit-Terminating Equipment Employing Serial Binary Data Interchange.
RS-310	Racks, Panels, and Associated Equipment. (DOD Adopted)
RS-422	Electrical Characteristics of Balanced Voltage Digital Interface Circuit.

(Application for copies should be addressed to the Electronic Industries Association, 2001 Pennsylvania Avenue, NW, Washington, DC 20006.)

THE INSTITUTE FOR INTERCONNECTING AND PACKAGING ELECTRONIC CIRCUITS (IPC)

D-330	CIU Documents.

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

INTERNATIONAL ELECTROTECHNICAL COMMISSION (IEC)

68-2-11Ka	Basic Environmental Testing Procedures, Part 2: Tests, Test Ka: Salt Mist.
68-2-13	Basic Environmental Testing Procedures, Part 2: Tests, Test M: Low Air Pressure.
68-2-30Db	Basic Environmental Testing Procedures, Part 2: Tests, Test Db and Guidance: Damp Heat, Cyclic (12 + 12 hour cycle)
68-2-3Ca	Basic Environmental Testing Procedures, Part 2: Tests, Test Ca: Damp Heat, Steady State.

(Application for copies should be addressed to the American National Standards Institute, 1430 Broadway, New York , NY 10018)

INSTITUTE OF ELECTRICAL AND ELECTRONIC ENGINEERS (IEEE)

IEEE 100	IEEE Standard Dictionary of Electrical and Electronic Terms.
IEEE 200	Reference Designations for Electrical and Electronics Parts and Equipments (ANSI Y32.16, DOD adopted)
IEEE 260	IEEE Standard Letter Symbols for Units of Measurement (SI Units, Customary Inch-Pound Units, and Certain Other Units).
IEEE 268	Standard Metric Practice (DOD adopted)
IEEE 280	Standard Letter Symbols for Quantities Used in Electrical Science and Electrical Engineering (DOD adopted)
IEEE 315	Graphic Symbols for Electrical and Electronics Diagrams (Including Reference Designation Class Designation Letters) (ANSI Y32.2)
IEEE 315A	Supplement to Graphic Symbols for Electrical and Electronics Diagrams (DOD adopted)
IEEE 488.1	IEEE Standard Digital Interface for Programmable Instrumentation.
IEEE 696	IEEE Standard 696 Interface Devices
IEEE 802.3	Information Processing Systems - Local Area Networks - Part 3: Carrier Sense Multiple Access with Collision Detection (CSMA/CD) Access Method and Physical Layer Specification
IEEE 802.5	Token Ring Access Method and Physical Layer Specifications.
IEEE 896.1	IEEE Standard Backplane Bus Specification for Multiprocessor Architectures: Futurebus
IEEE 961	Standard for an 8-Bit Microcomputer Bus System: STD Bus
IEEE 1014	Standard for a Versatile Backplane Bus: VMEbus
IEEE 1196	Standard for a Simple 32-Bit Backplane Bus: NuBus
IEEE 1296	Standard for a High-Performance Synchronous 32-Bit Bus: MULTIBUS II

(Applications for copies should be addressed to the Institute of Electrical and Electronics Engineers Inc, 345 East 47th Street, New York, NY 10017.)

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)
NFPA 70 National Electrical Code (NEC)

(Application for copies should be addressed to the National Fire Protection Association, One Batterymarch Park, P. O. Box 9101, Quincy, MA 02269-9101.)

UNDERWRITERS LABORATORIES, INC.
UL-478 Information-Processing and Business Equipment.
UL-1012 Power Supplies.

(Application for copies should be addressed to the Underwriters Laboratories, Inc., 333 Pfingsten Road, Northbrook, IL 60062.)

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

3. DEFINITIONS

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

3.1.1 Battleshort. Battleshort is a function which disables equipment protection and personnel safety interlocks in order to keep the equipment on-line during high readiness states. It maintains the maximum available mission readiness and system availability by avoiding interlock caused shutdowns and prolonged start-ups.

3.1.2 C^4I. Command, control, communications, computer and intelligence.

3.1.3 Catastrophic fault. Faults which destroy the system or subsystem and its function almost immediately.

3.1.4 CLIPS. Classified information processing system. Any equipment, device or system which is electrically powered and processes, converts, reproduces, or otherwise manipulates any form of classified information.

3.1.5 Compromising emanations. Unintentional intelligence-bearing signals which, if intercepted and analyzed, disclose the national security information transmitted, received, handled or otherwise processed by any classified information processing system.

3.1.6 Continuously degrading faults. Faults which permit continued use of the equipment for a limited time. However, if operation continues for protracted times the system will transition into a catastrophic fault.

3.1.7 COTS. Commercial off the shelf. Items or equipment which can be purchased through commercial retail or wholesale distributors as is (for example, equipment that is available as a cataloged item).

3.1.7.1 FDDI. Fiber Distribution Data Interface.

3.1.8 EISA. Extended industry standard architecture.

3.1.9 EMCON. Emission control. A shipboard operational condition in which acoustic, electromagnetic, and optical emitters such as radars and communications equipment are inhibited or limited.

3.1.10 EMI. Electromagnetic interference. Any electromagnetic disturbance that interrupts, obstructs, or otherwise degrades or limits the effective performance of electronics or electrical equipment. It can be induced intentionally, as in some forms of electronic warfare, or unintentionally, as a result of spurious emissions and responses, intermodulation products, and the like.

3.1.11 EMP. Electromagnetic pulse. An electromagnetic traveling wave resulting from a nuclear event.

3.1.12 Enclaving. A synergistic zoning of the combat system, Hull, Mechanical, and Electrical (HM&E) systems, and damage control systems into regions which, if necessary, can function independently to provide a subset of the ship's mission capabilities.

3.1.13 Failure. See IEEE 100. Several definitions exist, dependent upon the application/type equipment to which it applies.

3.1.14 Faults. See IEEE 100. Several definitions exist, dependent upon the application/type equipment to which it applies.

3.1.15 Fully hardened. The most stringent performance requirements for service and combat conditions.

3.1.16 Functional requirements. Parameters related to the ability of the equipment to perform its intended mission. Examples are frequency, bandwidth, and so forth. Functional requirements shall be delineated in the end item specification. Specification guidance for functional requirements is not provided in this document.

3.1.17 GFB. Government Furnished Baseline.

3.1.18 GIDEP. Government/Industry Data Exchange Program. GIDEP may be contacted at: GIDEP Operations Center, Corona, CA, 91720-5000.

3.1.19 GPIB. General purpose interface bus.

3.1.20 Greenwater loading. Mechanical loading due to wave slap.

3.1.21 LAN. Local area network.

3.1.22 Leakage current. All currents, including capacitively coupled currents, that conduct between exposed conductive surfaces of a unit and ground or other exposed surfaces of the unit.

3.1.23 MCCR. Mission critical computer resources. Computer resources acquired for use as integral parts of weapons; command and control; communications; intelligence; and other tactical or strategic systems aboard ships, aircraft, and shore facilities and their support systems. The term also includes all computer resources associated with specific program developmental test and evaluation, operational test and evaluation, and post-deployment software support including weapon system trainer devices, automatic test equipment, land-based test sites, and system integration and test environments. (Tactical Digital Standard (TADSTAND) A, Space and Naval War Systems Command (COMSPAWARSYSCOM).

3.1.24 Militarized. Those items which are specified and manufactured to military specifications and shall withstand all environmental conditions which may be encountered during wartime service.

3.1.25 Minimal acceptance. The least strict performance criteria which shall be met for equipment to be used in the application area for which the requirement is specified. Minimal acceptance is typically applied to COTS equipment for light duty (non-mission critical) applications.

3.1.26 Mission critical. Equipment that contributes significantly to the platform's safety, maneuverability and continued combat capability. To be considered "mission critical", the equipment shall be specifically identified as such by the platform sponsor.

3.1.27 Modified COTS. COTS equipment that has been customized to meet functional requirements. Within this document, all references to COTS equipment performance shall be construed to include modified COTS items unless otherwise indicated. Ruggedized is COTS or modified COTS equipment that is modified to meet specified service requirements.

3.1.28 Modularizing. The ability to remove and replace all components supporting a common function in a single operation.

3.1.29 MTBF. MTBF shall be defined as mean time between failure.

3.1.30 MTTR. MTTR shall be defined as mean time to repair.

3.1.31 MTTF. MTTF shall be defined as mean time to failure.

3.1.32 NDI. Nondevelopmental item. NDI equipment can be COTS, ruggedized or militarized. NDI shall be defined as any of the following:

(a). Item of supply that is available in the commercial marketplace.

(b). Previously developed item of supply that is in use by a department or agency of the United States, a state or local Government, or a foreign Government with which the United States has a mutual defense cooperation agreement.

(c). Item described above that requires only minor modification to meet the procuring agency's requirements.

(d). Item currently being produced that does not meet the above requirements solely because it is not yet in use, or not yet available in the commercial marketplace (section 907 of the Defense Acquisition Improvement Act of 1986).

3.1.33.1 NPT. National Pipe Threads.

3.1.33.2 NTDS. Navy Technical Data Systems.

3.1.33 NWSCC. Naval Weapons Support Center Crane.

3.1.34 Operational constraint. Limits (parameters) which define the operational characteristics and/or environment of a component, unit, assembly or system.

3.1.35 Operational availability. The expected percentage of time that a weapon system or individual equipment will be ready to perform satisfactorily in an operating environment when called for at any random point in time.

3.1.36 OSA. Open systems architecture. OSA shall be defined as design approach whereby hardware/software are designed to non-proprietary standards to allow the interfacing of components and systems manufactured by multiple vendors.

3.1.37 Plain text. Intelligible text or signals which have meaning and which can be read or acted upon without the application of any decryption (see 3.1.4).

3.1.38 Power density. The power density shall be defined as output power supply envelope volume, including cooling components/fins and EMI filtering where required.

3.1.39 Program manager. Shall be understood to refer to the Government program manager.

3.1.40 Reengineering. Examination and alteration of an existing system to reconstitute it in a new form and the subsequent implementation of the new form.

3.1.41 Ruggedized. COTS or modified COTS equipment that is modified to meet specified service requirements. Modified COTS involves modifications to meet functional requirements; Ruggedized incorporates modifications to meet service requirements. This may be in the form of added parts, such as shields and shock mounts, power conditioners, and so forth, or in the form of direct modification to COTS equipment.

3.1.42 SBS. Standard Battery System (see 4.1.2.1).

3.1.43 SCSI. Small computer systems interface.

3.1.44 SEM. Standard Electronic Module (see 4.1.2.1).

3.1.45 Service requirements. Parameters related to the ability of an equipment to perform in its intended environment. The principle categories of service requirements and their relationship to a piece of equipment are presented in FIGURE 2. The specification of service requirements is discussed in detail in sections 4 and 5.

3.1.46 SES. Standard Enclosure System (see 4.1.2.1).

3.1.47 SHARP. Standard Hardware Acquisition Reliability Program. A coordinated program, residing at the NWSCC, for providing standard hardware for improved acquisition and reliability. This program includes the SES, SBS, SEM and SPS.

3.1.48 Stable degraded faults. Faults which will permit indefinite continued use of the equipment at a reduced capability.

3.1.49 Sheltered. Installations that are protected from the external environment. This includes both controlled and uncontrolled internal climates.

3.1.50 TADSTAND. Tactical Digital Standard.

3.1.51 TEMPEST. A short name referring to investigations and studies of compromising emanations. It is sometimes used synonymously for the term compromising emanations.

3.1.52 TREE. Transient radiation effects on electronics, resulting from a nuclear event. In sensitive semiconductors, the energy absorbed in electronics may be sufficient to toggle a p-n junction to the conducting state, and if maintained, the device may fail catastrophically. Also, radiation may sufficiently alter the design characteristics of semiconductors that the equipment will not function properly.

3.1.53 Unsheltered. Installations that are not protected from the external environments.

4. GENERAL REQUIREMENTS.

4.1 Policy guidance. **The specifier shall tailor performance and design criteria to meet the applications and operating conditions for which the equipment is intended to be used.** The requirements specified herein apply to Shipboard applications; they may also be applied to other application areas at the discretion of the program sponsor. This document implements the acquisition policies of the Department of Defense and the Navy Department as they relate to electronic equipment purchases.

4.1.1 Applicability. COTS and ruggedized equipment are acceptable for all applications, including mission critical systems, provided they meet service requirements and functional requirements. The principal justification for the use of COTS and ruggedized equipment is rapid introduction of new technologies into military applications. In some instances, cost savings may also be possible (see 4.3.3).

4.1.2 Acquisition Preference. The order of preference for the consideration of equipment design and selection shall be NDI (which includes COTS), ruggedized, and militarized (which may also be NDI).

4.1.2.1 NDI. The use of NDI is encouraged. Guidelines are provided in DOD-HDBK-SD-2. Examples of such items are Standard Electronic Modules (SEM) in accordance with MIL-STD-1378, MIL-HDBK-246, and certified in accordance with MIL-M-28787; Standard Battery Systems (SBS); Standard Enclosure Systems (SES) in accordance with MIL-STD-2200; and Standard Power Supplies (SPS) in accordance with NAVSEA SE 010-AA-SPN-010. To prevent large numbers of SEM A and B modules, the specifier shall specify SEM D modules and larger for new developments, where appropriate.

4.1.2.2 Modified COTS. Where a functional parameter must be modified to meet operational requirements, the use of modified COTS equipment is the preferred acquisition option, provided cost and logistic considerations are favorable.

4.1.2.3 Ruggedized equipment. Where COTS and modified COTS equipment is not available to meet functional requirements, ruggedization is the preferred strategy to meet the service requirements of the military environment, provided cost and logistic considerations are favorable.

4.1.3 Specification selection. Where available, end item specifications shall use or cite commercial consensus standards of U.S. industry as a first preference, international consensus standards as a second preference, and military/federal specifications and standards as a third preference. The cited specifications shall be suitable for the specified environment and service conditions (see 5.1.1, 5.1.2, and 5.1.3).

4.1.3.1 Specification guidance. Specifications shall follow the general guidelines of MIL-STD-961 or MIL-STD-490 for format. Commercial item descriptions (CIDs) shall follow the guidance of DOD 4120.3-M and the format and instructions for the preparation of CIDs in accordance with FPMR 101-29.

4.1.3.2 Computer-aided Acquisition and Logistics Support (CALS). The end item logistics specification shall be delivered in the CALS format following the guidelines set forth in MIL-STD-1840, MIL-D-28000, MIL-M-28001, MIL-R-28002, MIL-D-28003 and MIL-HDBK-59 for data interchange. The technical package shall be specified and delivered in accordance with requirements tailored from MIL-T-31000.

4.1.4 Tailoring of requirements. Applications vary both in terms of severity and criticality. Two factors of significant importance in the military environment that are not common in the commercial environment are survivability and combat system integration. The purpose of the platform is to carry out its mission in wartime conditions, which may include exposure to such hazards as shock, fire, and heat. Furthermore, the specifier must understand constraints and limitations of supporting systems which must operate under the same conditions, and accommodate the direction of future system designs, such as integrated combat systems. The requirements contained in sections 5.1.1 through 5.1.3 apply to all acquisitions including COTS and ruggedized. The requirements specified in sections 5.1.4 through 5.1.9 apply to militarized acquisitions; those requirements may also be selectively applied to COTS and ruggedized acquisitions when it is deemed appropriate by the program sponsor.

4.1.4.1 Unique Applications. Unique requirements, such as arctic operations, shall be carefully addressed so that the tailoring does not drive up the performance criteria and costs unnecessarily for all equipment when the unique requirement applies to either a small fraction of the units being acquired or has a very low probability of occurrence. A separate, less expensive solution shall be considered, such as modification of individual units and the development of field kits/add-ons to prepare for the unique application.

4.1.4.2 Commonality. Where similar functions are performed by different equipment, consideration shall be given to incorporating all required capabilities into one piece of

hardware. Also, the end item specification shall be non-proprietary so that any qualified manufacturer may provide the equipment, rather than being a sole-source item.

4.1.4.3 Mission critical equipment. Unless required to meet forecast design conditions, fully hardened requirements shall be specified for mission critical equipment only, and then only to the extent applicable. C^4I equipment is not intrinsically treated as mission critical. To be considered mission critical, equipment shall be specifically identified as such by the platform sponsor.

4.1.4.4 Equipment specification. The specifier is cautioned in the tailoring of equipment requirements, that the specification requirements are driven by the application rather than existing equipment capabilities.

4.1.5 Open system architecture. Where possible, an open system architecture shall be used.

4.2 Mission critical system level requirements. The following requirements apply to all mission critical equipment. Additionally, these requirements shall be reviewed for applicability to non-mission critical equipment and tailored into the equipment specifications as appropriate.

4.2.1 Survivability. Survivability shall be a major design criteria for all mission critical equipment. Survivability features include the ability to withstand battle damage (graceful degradation), to be maintained at maximum readiness during an engagement (reconfiguration), and to permit rapid repairs following any casualties (modularity).

4.2.1.1 Battleshort. Interlock bypass circuits shall be provided to override personnel safety and maintenance interlocks. Interlocks provided for protection against catastrophic faults shall not be bypassed. Interlock bypass circuits shall be provided to override equipment interlocks used to protect against continuously degrading faults and stable degraded faults. Interlock bypass circuits shall latch so that loss of power does not disable the battleshort mode. The use of battleshort accepts the potential damage to equipment as a trade-off for its operation during battle.

4.2.1.1.1 Battleshort indication. Visual indication shall be provided when the equipment is in the battleshort mode. Indicator lights shall be located in a position clearly visible to personnel, and on the chassis of the equipment that is in the battleshort mode. An audible alarm shall be provided to indicate when personnel hazards exist while in the battleshort mode. Consideration shall be given to providing a means for manually

disabling the audible alarm. The means for manually disabling the audible alarm shall be such that the audible alarm will be re-enabled when the alarm signal has been removed. Means shall also be provided for remote indication of the battleshort mode at supervisory stations.

4.2.1.1.2 Activation of battleshort. The equipment shall be provided with means for remote activation of the battleshort mode. The remote feature shall be so that spurious signals do not disable the battleshort mode. The equipment shall also be provided with a maintenance switch for disabling of the battleshort feature, and means for remote indication of the switch position. Where applicable, the battleshort feature shall be disabled when equipment is in the training mode. Where equipment has both manual and automatic restart modes, the equipment shall go into the automatic restart mode when battleshort has been enabled.

4.2.1.1.3 Catastrophic fault indication. Interlocks for protection against catastrophic faults shall include provisions to indicate the cause of equipment shutdown when in the battleshort mode. The indication circuitry shall be so that status indication will be maintained through power interruptions of up to 8 hours. The intent of this requirement is to identify cause of shutdown following ship shock trials, or under casualty conditions, when inadvertent loss of power has occurred. Circuitry used during ship shock trials to meet the foregoing requirements consisted of a voltage detector which trigger a silicone controlled thyristor (SCR). This SCR was series connected with a capacitor, resistor, and light emitting diode (LED). The SCR, when triggered, latches to the "on" state, and the capacitor discharges through the LED, providing an indication that the voltage detector has operated.

4.2.1.2 Smart loadshed. Equipment rated 5 kilowatt (kW) or more shall be provided with a means for being placed in a low power mode when loadshed has been activated from a remote location. This may include reduced capability, standby, or turn-off. The low power mode shall be so that the equipment will automatically resume full specified performance when loadshed has been de-activated. As an alternative, units may be provided with an un-interruptable power supply (UPS).

4.2.1.3 Systems monitoring and control. Systems and equipment shall be designed for supervisory monitoring and control from a central location, for implementation of a total ship mission readiness assessment and reporting system. To ensure adequate capabilities, the following information shall be available: Equipment operational status, battleshort indication, EMCON condition, interface operations, and capability level. Control capabilities include the ability to perform smart loadshed, central setting of

battleshort, EMCON, and combat system reconfiguration control. For equipment that does not have a local area network (LAN) interface and requires low volume communications, the monitoring and control capabilities may be incorporated using a North Atlantic Treaty Organization (NATO) Low Level Serial interface in accordance with MIL-STD-1397. Specifications for equipment level communications devices are provided in the appendix of MIL-STD-1397. For submarine applications, specific guidance shall be provided by OP-02 in conjunction with Naval Sea Systems Command (NAVSEASYSCOM)(SEA-08).

4.2.1.4 Redundancy and enclaving. Redundancy criteria shall be determined from the operating requirements and includes multiple independent signal paths, parallel processing, auxiliary/standby components, and backup controls to eliminate single points of failure. Modularizing and enclaving shall be utilized to improve the equipment survivability and to reduce MTTR. Modularizing should incorporate the use of SEM, SPS, SBS, and SES (see 4.1.2.1).

4.2.1.5 Special considerations. Although the combatant's mission priority may be simultaneous engagement of multiple threats and other tactical offensive capabilities, the equipment designer shall also consider soft kills that may be inflicted by lightly armed adversaries, for example gunboats. The concern is secondary damage (fragmentation, water and heat) resulting from otherwise inconsequential hostile fire. Also, a higher level of survivability is needed for point defense and maneuverability subsystems for a damaged combatant to safely withdraw and effect repairs.

4.2.2 Power interface.

4.2.2.1 Surface ship electrical power. Mission critical equipment shall remain fully operational through momentary power interruptions of 100 milliseconds or less, operate through line voltage variations of plus 35 percent to minus 20 percent, limit line current harmonics to 3 percent of the fundamental, be suitable for continuous operation from 50 to 67 hertz (Hz), and shall immediately (within 1 second) restart following short term power interruptions of less than 5 minutes duration. Computers that require longer than 1 second to "re-boot" shall be modified to retain volatile memory during short term power interruptions. To meet this requirement, commercially available battery backup cards can be used that plug into expansion slots. High power transmitters shall inhibit pulses but otherwise remain fully operational until external power has been restored. The above requirements are to provide for continued combat capability under the casualty and emergency conditions expected to be encountered aboard ship.

4.2.2.1.1 Navy Standard Electronic Power System. To achieve the foregoing requirements, the Navy Standard Electronic Power System (described in Appendix A) may be implemented. Implementation may be either completely internal to the equipment or as a stand alone unit supplying a group of low powered, functionally compatible equipment.

4.2.2.1.2 Circuit breaker protection. The circuit breaker protection for the equipment, and the interface to the electrical power system, shall coordinated to ensure that the circuit breaker closest to the cause of an overcurrent or fault current condition will trip first. This requirement is to prevent inadvertent shutdown of adjacent equipment connected to a common source.

4.2.2.2 Advanced electrical distribution systems. New combat systems, for example, high energy weapons, will put a strain upon electrical power resources and impose significant transients on the electrical system. Specifications for new electronic equipment shall incorporate the anticipated electrical system characteristics and isolate the equipment as much as possible, for example, through the use of the Navy Standard Electronic Power System.

4.2.3 Computer applications. Equipment shall have non-proprietary intra-computer and inter-computer interfaces which support an open architecture. Computer programming languages shall be higher order whenever possible. For equipment which is not NDI, ADA (a computer language) is the preferred language. All computer resources will comply with the computer security requirements of SECNAVINST 5239.2. Equipment shall be capable of accepting upgrades in computer technology and be capable of interfacing with all system architectures envisioned during its service life.

4.2.3.1 MCCR. MCCR shall be in accordance with SECNAVINST 200.32 and OPNAVINST 5200.28.

4.2.3.2 Automated data processing (ADP) equipment. ADP equipment shall be in accordance with SECNAVINST 5231.1B.

4.2.3.3 Data buses. The preferred method for data transfer between system components shall be by a common data bus. Where point to point data transfer is required, a digital format shall be the preferred method in lieu of an analog format. The use of an industry accepted standard data bus format is encouraged. Tables I and II describe industry standard external interfaces and internal data busses, respectively.

Table I. Standard External Interfaces

INTERFACE	STANDARD	FORMAT
NTDS INPUT/OUTPUT	MIL-STD-1397	Digital (Parallel/Serial)
SCSI	ANSI X3.131	Digital (Parallel)
RS-232	EIA RS-232	Digital (Serial)
RS-422	EIA RS-422	Digital (Serial)
GPIB	IEEE Std 488.1	Digital (Parallel)
TOKEN RING	IEEE 802.5	Digital (Serial)
ETHERNET	IEEE 802.3	Digital (Serial)
FDDI	ANSI X3T9.5	Digital fiber optic (serial)
TACTICAL	MIL-STD-188-200	Analog
SAFENET II	(Under development)	Digital fiber optic (serial)

Table II. Standard Internal Data Busses

INTERFACE	STANDARD
Futurebus	IEEE 896.1
Multibus II	IEEE 1296
NuBus	IEEE 1196
S-100	IEEE 696
STD Bus	IEEE 961
VMEbus	IEEE 1014
PC Bus	(Under development)
EISA	(Under development)

4.2.3.4 Fiber optics. The preferred method for handling data transmission shall be fiber optics. As required, fiber optic ports shall be provided with equipment. The use of fiber optics will improve system survivability, reduce EMI/EMP and TEMPEST concerns.

4.2.3.5 Mass storage media. Media shall be removable and designed to minimize the effect of EMP and other strong magnetic and electrical fields. The media shall consist of nonvolatile memory capable of data retention for at least 10 years in an un-powered state without loss of data integrity. The preferred method for read-only mass data storage and retrieval is optical media. Magnetic media shall be limited to data with a short term retention, write many applications, or non-mission critical functions.

4.2.3.6 Distributive processing. Reliance upon central computer systems for operation and control of the combat system shall be avoided. Computing and processing functions shall be placed at the system element which these functions control to which input is provided. Utilizing distributive processing, the problem is broken down into functional modules handled by available processors. The central computer acts as a coordinator for the overall problem. Use of distributive processing improves performance, increases reliability, permits modular upgrades, and reduces vulnerability to battle damage. Care must be taken to assure problems that occur within a system can be isolated to the equipment level.

4.2.3.7 Software and firmware. All software and firmware shall be supplied in accordance with requirements tailored from DOD-STD-2167. COTS software shall be provided with documentation to meet the requirements of 4.3. Software upgrades shall meet the requirements of 4.3.3.4 to ensure that data and databases generated under past revisions can be read or converted for use into the later revision. Programmable Read-Only Memories (PROMs) shall be documented for logistic purposes; the high-level source code shall be provided for all militarized firmware.

4.3 General application. Contracting activities shall tailor the requirements of this standard to the needs of each acquisition and shall encourage contractors to submit cost effective tailoring recommendations, based on life cycle economic analysis.

4.3.1 TEMPEST. All CLIPS installed on ships shall meet the TEMPEST requirements of OPNAVINST C5510.93 and MIL-STD-1680.

4.3.2 Engineering management. The guide lines for engineering management shall be in accordance with MIL-STD-499.

4.3.3 General considerations. Design, application, safety, and quality considerations, as well as economic factors, shall govern the selection of components, materials and processes used in the design, acquisition, construction, and support of material for the DOD. Whenever acquisition documents do not explicitly specify the items or standards

and specifications to be used, selection of a suitable standard or specification for a specific design application shall be the responsibility of the contracting or design activity. In this selection process, the following considerations shall govern.

4.3.3.1 Economic considerations. When two or more items or processes will satisfy design parameters, selection shall be made in a manner that is most economical to the Government. Economic factors include, but is not limited to, consideration of life-cycle costs related to development, initial fabrication, production, reliability, operation, maintenance, supply, and replacement.

4.3.3.2 Logistic considerations. Logistic requirements shall be tailored from MIL-STD-1388-1 and as specified herein.

4.3.3.2.1 Documentation. Documentation for use, training, operation, maintenance and repair of equipment is required regardless of the acquisition option (COTS, ruggedized, or militarized). This documentation shall clearly indicate the conditions in which the equipment is designed to operate, and the specific requirements which must be observed during installation and use of the equipment. Where adequate, the use of vendor supplied documentation is encouraged. The contracting activity shall ensure that vendor supplied documentation is accurate and complete, as documentation is of utmost importance in military systems. Documentation requirements for hazardous materials are specified in 4.7.2.

4.3.3.2.1.1 Proprietary information. The program manager shall ensure that the Government's interests are protected with respect to vendor proprietary information concerning equipment. In the event an equipment is removed from production or deleted from the vendor's catalog, data rights and the right to other proprietary information shall be transferred to the Government at the time maintenance support is discontinued by the vendor.

4.3.3.2.1.2 Drawings and nomenclature. Drawings and nomenclature that is not NDI shall be as specified herein.

4.3.3.2.1.2.1 Graphic symbols. Graphic symbols for electrical and electronics diagrams shall be in accordance with IEEE 315.

4.3.3.2.1.2.2 Reference designations. Reference designations shall be in accordance with IEEE 200, IEEE 315, and IEEE 315A.

4.3.3.2.1.2.3 Standard Symbols. Standard letters and symbols representing quantities of measurement shall be in accordance with IEEE 260 and IEEE 280.

4.3.3.2.1.2.4 Metric practice. Standard metric practice shall be in accordance with IEEE 268.

4.3.3.2.1.2.5 Terminology. The vocabulary and terms used to describe electronic systems shall be in accordance with IEEE 100.

4.3.3.2.2 Maintainability and reliability. Quantitative maintainability requirements in terms of MTTR shall be specified. Quantitative reliability requirements in terms of basic reliability and mission reliability shall be specified. Guidance on maintainability program requirements is provided in SECNAVINST 4490.2. Guidance on reliability program requirements is provided in MIL-STD-785. The determination of quantitative maintainability and reliability requirements for COTS and ruggedized equipment shall be the responsibility of the program manager. Analytical, field experience or test data shall be required as evidence of achievement of reliability.

4.3.3.2.3 Operational availability. Requirements shall be specified for operational availability in the end item specification. Guidance is provided in OPNAVINST 3000.12.

4.3.3.2.4 Testability. Testability shall be as specified herein.

4.3.3.2.4.1 Test provisions. Test provisions shall be provided for monitoring performance, calibration, and fault isolation in accordance with requirement 32 of MIL-STD-454. The test provisions of the equipment shall provide the capability for a straight forward, logical, step-by-step testing sequence, as well as providing for an end-to-end performance check. The specific test capability and class of test provisions shall be as specified in the end item specification.

4.3.3.2.4.2 Test equipment and built in test devices. Test equipment and built in test devices required for calibration, operation, and maintenance shall be tailored from MIL-T-28800. Design for testability shall be tailored from MIL-STD-2165. Test equipment calibration requirements shall be tailored from MIL-STD-1839 and MIL-STD-45662.

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

4.3.3.2.4.4 External test points. Protection shall be provided in the test point circuitry to prevent equipment damage caused by the external grounding of test points.

4.3.3.2.4.5 Special tools. Special tools shall kept to a minimum and 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 Management Area Operations (DCMAO)).

4.3.3.2.5 Level of repair analysis. Level of repair guidance is provided in MIL-STD-1390.

4.3.3.2.6 Training. Training requirements shall be determined for the proper and safe use, operation, maintenance, and repair of the system equipment and software. Consideration shall be given to on-line and built-in training helps, aids, tutorials, and other instructional media. The use of vendor and/or crew developed training is encouraged. Vendor developed training shall be used in accordance with OPNAVINST 1500.2 and MIL-STD-1379, when appropriate. Vendor developed training shall be integrated in Chief of Naval Education and Training (CNET) curricula in accordance with OPNAVINST 1500.8 and OPNAVINST 1500.44.

4.3.3.3 Reengineering. Reengineering shall be considered for upgrading existing systems in lieu of beginning new development efforts, and for developing software documentation.

4.3.3.4 Interchangeability. Interchangeability shall be in accordance with MIL-STD-454, requirement 7. Interface performance specifications shall be provided for interchangeable items as part of the item documentation specified in 4.3.3.2.1. System software shall be "reusable" in accordance with DOD-STD-2167 in the same sense as interchangeability is applied to hardware items. Re-engineered items shall be backward compatible as a minimum. Items, other than maintenance parts, from different sources of supply may be designated as "fully interchangeable."

4.4 Environmental design guidance. Environmental design guidance shall be provided by the contracting activity.

4.4.1 Environmental plans. It is necessary to give proper consideration to environments throughout the development process in order to obtain a quality product. To assure such consideration, environmental management plans shall be formulated that require the following engineering tasks: determination of life cycle environmental conditions;

establishment of environmental design and test requirements, including a test plan; the collection and analysis of field data for verification of environmental design and test criteria. Proper attention to each of these tasks ensures that the correct environments are identified for test, that engineering development as well as qualification tests are phased properly into the item's acquisition program, that environmental test conditions are traceable to life cycle conditions realistically encountered, and that testing is appropriate for the item application. The following plans, tasks, and documentation are established to facilitate the tailoring process. Each will be prepared directly by the contracting activity or by the contractor as directed by the contracting activity. Limited information on environmental conditions is provided in MIL-STD-810 and MIL-STD-210. Information on electromagnetic environmental management guides is provided in MIL-HDBK-237 and MIL-STD-210.

4.4.1.1 Environmental design criteria and test plan. This plan shall be in accordance with MIL-STD-810. This plan shall define the specific environmental design and test requirements and include an environmental test plan. Results obtained under provisions of above shall be utilized, along with the individual environmental test methods listed in MIL-STD-202 and MIL-STD-810. Consideration shall be given to the following:

(a). Probability of environmental occurrence, alone or in combination. Note: Mission critical equipment shall be suitable for operation in any condition that is to be encountered, regardless of the probability.

(b). Expected effects and failure modes.

(c). Effect on hardware performance and mission success.

(d). Likelihood of problem disclosure by the test methods.

(e). Occurrence of similar environmental stress in more than one life profile phase.

(f). Experience gained from other equipment similarly deployed.

4.4.1.2 Environmental management plan. The environmental management plan shall be in accordance with MIL-STD-810. The overall purpose of this plan is to develop a viable and cost effective program to assure that military equipment will be designed and tested for all pertinent environmental conditions to which it will be subjected during its life cycle. The overall management of the environmental program shall include consideration of manpower requirements, scheduling, life cycle, environmental

conditions, test tailoring, test performance, analysis of results, corrective actions, and collection of data about, and analysis of, actual field environments. Plans for monitoring, assessing, reporting, and implementing the entire environmental program shall be addressed.

4.4.1.3 Life cycle environmental profile. The life cycle environment profile shall be in accordance with MIL-STD-810. A life cycle history of events and associated environmental conditions for an item from its release from manufacturing to its retirement from use shall be determined. The life cycle shall include the various phases an item will encounter in its life, such as: handling, shipping, or storage prior to use; phases between missions, such as stand-by, storage, or transfer to and from repair sites; geographical locations of expected deployment; and platform environments. The environments and combination of environments the equipment will encounter at each phase shall be determined. All potential deployment scenarios shall be described. The following factors shall also be taken into account:

(a). Configuration of the hardware.

(b). Environment that is encountered.

(c). Platform with which the hardware interfaces.

(d). Interfaces with other equipment.

(e). Absolute and relative duration of exposure phase.

(f). Number of times phase will occur; intermittency of phase.

(g). Probability of occurrence of environmental conditions.

(h). Geographical location.

(i). Any other information which will help identify any environmental conditions which may act upon the item.

4.5 Human engineering. Human engineering design criteria shall be considered. Guidance for Militarized equipment shall be in accordance with MIL-H-46855 and ASTM F 1166.

4.5.1 Accessibility. Consideration shall be given to maintaining equipment accessibility by maintenance personnel in the equipment's installed configuration.

4.6 Serial numbers. Serial numbers shall be unique to each unit of equipment. Serial numbers shall be furnished by the vendor for COTS and ruggedized equipment. Serial numbers may be furnished by the Government or vendor for militarized equipment.

4.7 Marking requirements. Marking of Militarized equipment and items thereof shall be as specified herein and shall be in accordance with requirement 67 of MIL-STD-454. Identification plates shall be designed for normal service conditions in accordance with MIL-P-15024 and MIL-P-15024/5.

4.7.1 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.

4.7.2 Hazardous materials. The contracting activity shall be provided a material safety data sheet (MSDS) at time of submittal of bid for each hazardous material (see 5.1.3.10). The MSDS shall contain as a minimum all the data required by OSHA form 174 which is contained in FED-STD-313. The MSDS shall be included with each shipment of the material covered by the end item specification. In order to obtain the MSDS, Federal Acquisition Regulation (FAR) clause 52.223-3 must be incorporated into the contract. Hazardous material containers shall be labelled in accordance with 29 CFR Part 1910.1200, MIL-STD-129 and the appropriate Environmental Protection Agency and Department of Transportation requirements. Parts containing hazardous material, such as beryllium oxide insulators, shall also be labelled with the appropriate hazard warning.

4.7.3 Marking of electrostatic discharge (ESD) components. Enclosures, assemblies, and subassemblies containing ESD sensitive components, MIL-STD-1686, class I or II parts or assemblies, shall be marked in accordance with MIL-STD-129, DOD-STD-100, or MIL-STD-1285. Also, an ESD warning plate conforming to Figure 3 shall be readily visible to personnel prior to gaining access to class 1 and class 2 parts or assemblies.

4.7.4 Electrostatic discharge. Electrostatic discharge control shall be in accordance with MIL-STD-1686 using the guidance of MIL-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.

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

Figure 3. Electrostatic Discharge Warning Plate.

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. Electrostatic discharge tests shall be in accordance with MIL-STD-1686.

4.7.5 Marking (lubrication points). Lubrication points shall be marked as LUBRICATION POINT.

4.7.6 Nomenclature (item name and type designation). Nomenclature (item name and type designation) for the equipment shall be established in accordance with MIL-STD-196, MIL-N-18307, and MIL-STD-1399, section 501. When specified in the end item equipment specification, nomenclature shall be established in accordance with MIL-STD-1661. The assignment of type designations does not constitute approval of equipment or the use of a particular item in a specific set and does not waive any requirements of the contract involved, nor does the approval of the equipment constitute approval of the type designation assignment.

4.7.7 Battery circuit identification. Components designed to operate from internal batteries shall be marked with the following in a convenient form for use by operating and maintenance personnel:

(a). Battery type number.

(b). Battery location and position.

(c). Polarity.

(d). Nominal voltage.

(e). Interconnection between batteries.

4.7.8 Electrical power source plates. Information plates conforming to 29 CFR 1910 and Figure 4 shall be provided on each unit of the equipment that is powered from multiple electrical power sources.

DANGER
SHOCK HAZARD
THIS UNIT ENERGIZED FORM MULTIPLE SOURCES, ENSURE THE FOLLOWING SWITCHES ARE IN THE OFF POSITION AND TAGGED-OUT BEFORE ATTEMPTING MAINTENANCE.

CIRCUIT	VOLTAGE	LOCATION	SWITCH ID
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____

Figure 4. Electrical Power Source Information Plate.

4.8 Packaging. Packaging shall be in accordance with ASTM D 3951 and tested in accordance with ASTM D 4169.

4.9 Quality assurance. Emphasis will be placed upon developing manufacturing processes whose variability around target product critical attributes is minimized rather than on simply being within the product tolerance. MIL-Q-9858 provides further guidance on the elements of an effective quality program. For COTS and ruggedized equipment, the program manager is responsible for the continued monitoring and evaluation of the quality program of his vendors (see Appendix B).

4.10 Safety. Safety shall be a principal concern in all acquisitions. Guidance for the System Safety Engineering program is provided in MIL-STD-882. Specification Safety requirements are provided in section 5.1.3.11. Specifiers shall tailor safety requirements and incorporate them into their end-item specifications.

5. DETAILED REQUIREMENTS

5.1 Shipboard equipment. The constraints inherent in Naval ships and the shipboard environment pose unique requirements on the design of electronic equipment. The following sections provide detailed criteria that establish the boundaries of the requirements which are applicable to both shipboard and submarine platforms. Sections 5.1.1 through 5.1.3 provide specific requirements applicable to COTS, ruggedized and militarized equipment, while sections 5.1.4 through 5.1.9 are design requirements applicable to militarized equipment. These requirements may be adopted for ruggedized and COTS equipment (see Appendix C). All equipment shall meet the minimal acceptance limits for all shipboard environmental conditions to which the equipment will be subjected; mission critical equipment shall be "fully hardened" so that it will operate under the full range of applicable environment conditions. The program manager shall tailor requirements to the specific application in a cost effective manner; for example, greenwater loading is not be applicable to equipment installed in a controlled environment. A table of features for militarized equipment that may be appropriate for COTS and ruggedized equipment is provided in Appendix C.

5.1.1 Auxiliary support services. The equipment shall be compatible with the services to which they are connected, as specified herein.

5.1.1.1 Alternating current (ac) power. Equipment shall be suitable for installation under the conditions specified for type I electrical power in MIL-STD-1399, section 300 and the additional requirements specified herein. Electrical tests shall be as specified in MIL-STD-1399, section 300 and Appendix D.

5.1.1.1.1 Additional requirements. The duration for the emergency line voltage conditions of plus 35 percent specified in MIL-STD-1399, section 300 shall be changed from "2 minutes" to "indefinitely". The emergency condition of minus 100 percent (frequency or voltage) will be treated as a power interruption. Momentary power interruptions will be limited in duration to 100 milliseconds. Short term power interruptions will be limited in duration to 5 minutes.

5.1.1.1.2 Fully hardened. Equipment shall remain fully operational through the conditions specified for 440 Volt (V), type I power in accordance with MIL-STD-1399, section 300 and as modified by 5.1.1.1.1; equipment shall remain operational through

momentary power interruptions, and rapidly (within 1 second) restart following short term power interruptions.

5.1.1.1.3 Minimal acceptance. Equipment shall be fully operational within the normal tolerance limits specified for type I power in MIL-STD-1399, section 300. The preferred equipment service is 440 V, 60 Hz then 115 V, 60 Hz. Equipment may shutdown or go into a standby condition, but not be damaged, when operating outside these limits.

5.1.1.1.4 Ruggedization techniques. The ship's electrical power system is significantly different from commercial standards. For example, fault current of public utilities will typically be limited to 65,000 Amperes (A) at 13,000 V, where shipboard fault current is limited to 100,000 A at 450 V (with two of three generators paralleled). With proper care, COTS equipment can be ruggedized to be powered from the ship's electrical service. The primary considerations for ruggedization are as follows:

(a). MIL-STD-1399, section 300 specifies a harmonic current limit of 3 percent of the fundamental for equipment rated 1 kilovolt-ampere (kVA) or more. The typical approach has been to get a waiver, which is unsatisfactory. The shipboard electrical system has a lower reactance/resistance ratio than the commercial world, and harmonic currents have a higher impact on voltage distortion. Studies that have been performed by Naval Sea Systems Command (NAVSEA) indicate that harmonic current limits should be lowered below present standards.

(b). The voltage variations specified in MIL-STD-1399, section 300 are more severe than those seen in the commercial environment. The peak value may be as high as 220 V for up to 2 minutes for 115 V equipment. This may be sufficient to damage commercial equipment. Voltage spikes are particularly severe, specified at 1000 V for 115 Vac equipment where commercial equipment is typically rated for 600 V.

(c). The line and return leads on the 115-V, 60-Hz service are both "hot", that is, both line and return spade connectors on convenience outlets have a potential to the ground, and the ground (safety) spade connector is grounded to the ship's hull. Commercial equipment will connect the return lead to ground at a power panel, and the return lead on commercial equipment may not be fully insulated. If the return lead is not disconnected when the equipment is shut-off, the equipment will remain energized presenting a safety hazard when assumed to be shut-off.

(d). Equipment which is permanently located and is energized more than 50 percent of the working day, such as copiers, personal computers and peripherals, soda machines,

and money machines, are not to be connected to the ship's isolated receptacle circuits. Convenience outlet services are rated 15A, and present a fire hazard when overloaded. Equipment of this type are to be connected to a separate dedicated, hard wired circuit supplied by the lighting distribution system.

(e). To ruggedize for the forgoing conditions, equipment may adopt the approach indicated in Appendix A. In effect, a power conditioner is placed between the equipment and the electrical system. Since harmonic currents are minimized, such types of power conditioners are referred to as "unity power factor power supplies". Navy Standard Power Supplies do not meet the 3 percent current harmonic limits in accordance with MIL-STD-1399, section 300. Appendix A recommends a polyphase transformer since transformer technologies are mature, and transformers are both reliable and robust. Solid state unity power factor power supplies are being developed; however, the specifier should be aware that this technology is not mature and the risk of failing to meet specified performance and reliability criteria is greater.

(f). An alternative for 115-V equipment rated at less than 1 kVA is to use a double-pole switch to disconnect both power and return lines. The equipment shall be tested to verify that the equipment return is fully insulated from the equipment case. Voltage arrestors shall be applied to protect against voltage spikes; voltage arrestors that conduct at less than 220 V shall be removed and replaced with voltage arrestors of a higher rating. The equipment shall be tested for operation at plus 35 percent voltage, or over voltage protection applied to remove the equipment from the line under such conditions.

(g). An Electrical Power Interface Compatibility (EPIC) mobile test facility is available for testing equipment under the electrical power conditions specified in MIL-STD-1399, section 300. Further information on this facility may be obtained from NAVSEA, Code 56Z14.

5.1.1.2 Submarine direct current (dc) power. Equipment shall be suitable for installation under the conditions specified in MIL-STD-1399, Section 390.

5.1.1.2.1 Fully hardened. Equipment shall be fully operational through the conditions specified in MIL-STD-1399, Section 390.

5.1.1.2.2 Minimal acceptance. Equipment shall be fully operational within normal tolerance limits specified in MIL-STD-1399, Section 390. Equipment may shutdown or go into a standby condition, but not be damaged, when operating outside these limits.

5.1.1.3 Seawater. This requirement applies to open shipboard cooling systems which use ocean water. All equipment shall be suitable for installation under the conditions specified in MIL-STD-1399, section 105.

5.1.1.3.1 Fully hardened and minimal acceptance. Equipment shall be fully operational through the conditions specified in MIL-STD-1399, section 105.

5.1.1.4 Cooling water. This requirement applies to closed shipboard cooling systems which use fresh water. All equipment shall be suitable for installation under the conditions specified in DOD-STD-1399, section 532.

5.1.1.4.1 Fully hardened and minimal acceptance. Equipment shall be fully operational through the conditions specified in DOD-STD-1399, section 532.

5.1.1.5 Compressed air. Equipment shall be suitable for installation under the conditions specified in MIL-STD-1399, section 106.

5.1.1.5.1 Fully hardened and minimal acceptance. Equipment shall be fully operational through the conditions specified in MIL-STD-1399, section 106.

5.1.1.6 Dry air. This section is applicable to equipment requiring high quality (non-conductive) gas under pressure, such as waveguides, and other equipment requiring compressed air of greater purity than is available from the ship service low pressure air system specified in 5.1.1.5. Equipment shall be suitable for installation under the conditions specified in MIL-STD-1399, section 102.

5.1.1.6.1 Fully hardened and minimal acceptance. Equipment shall be fully operational through the conditions specified in MIL-STD-1399, section 102.

5.1.2 Environmental conditions. Guidelines for specifying environmental conditions are specified herein. Separate requirements shall be specified for shipment, installation and operation. All equipment shall be suitable for the environmental conditions under which it will be installed. Environmental conditions under which the equipment is to be fully operational shall be tailored to the specific application and use of the equipment, and from the environmental conditions specified herein. The equipment shall not require alignment or adjustment when fully operational. Many MIL-STD-810 tests have equivalent IEC standards. The International Electrotechnical Commission (IEC) standards noted herein are accepted in lieu of MIL-STD-810 methods. Other IEC standards may be approved on a case-by-case basis for an individual acquisition. COTS

and ruggedized equipment which have been design qualified against MIL-STD-810 (or equivalent) are acceptable if the design qualification meets or exceeds the requirements tailored from this document.

5.1.2.1 Altitude, non-operating. Equipment with hermetic seals, and so forth, shall be designed so that it will not be damaged when under transit in an un-pressurized cargo bay of an aircraft at 4.6 km (15,000 feet). It is to the discretion of the program manager if the equipment is to be fully functional following an explosive decompression test. In general, the rate of altitude change shall not exceed 10 meters per second (2,000 feet/minute). Further guidance may be obtained from MIL-STD-810, method 500. Altitude tests shall be in accordance with IEC 68-2-13 or MIL-STD-810, method 500.

5.1.2.2 DC magnetic field environment. Requirements for magnetic fields shall be as specified herein.

5.1.2.2.1 Fully hardened. Equipment shall operate in the magnetic field values in accordance with DOD-STD-1399, section 070, part 1.

5.1.2.2.2 Minimal acceptance. Equipment designated for installation on ships which contain degaussing or mine neutralization equipment shall have requirements which are tailored to meet DOD-STD-1399, section 070.

5.1.2.3 Electromagnetic susceptibility. Equipment electromagnetic radiated and conducted susceptibility requirements shall be as specified herein (see 5.1.3.5).

5.1.2.3.1 Fully hardened. Equipment susceptibility requirements shall be in accordance with MIL-STD-461. Tailoring guidance for electromagnetic susceptibility is provided in MIL-STD-461. Tests shall be in accordance with MIL-STD-462.

5.1.2.3.2 Minimal acceptance. Equipment shall be capable of operating in the presence of the expected conducted and radiated electromagnetic environment (EME) in accordance with MIL-HDBK-235.

5.1.2.4 Dust and sand. Requirements for dust and sand shall be as specified herein.

5.1.2.4.1 Fully hardened. Equipment shall withstand dust and sand. Dust and sand tests shall be in accordance with MIL-STD-810, method 510.

5.1.2.4.2 Minimal acceptance. Generally, requirements for dust and sand are not applicable. Requirements for equipment operation in dust and sand conditions shall be specified only for those installations determined by the specifier to have excessive dust and sand conditions.

5.1.2.5 Greenwater loading. Requirements for greenwater loading shall be as specified herein.

5.1.2.5.1 Fully hardened. Equipment parts exposed to greenwater loading shall show no mechanical or electrical damage when the mean greenwater load is 42 kilopascals (kPa) for surface ships, and 62 kPa for submarines.

5.1.2.5.2 Minimal acceptance. Generally, requirements for green water loading are not applicable. Requirements for equipment operation under greenwater loading shall be specified only for those installations determined by the specifier to be subject to greenwater loading.

5.1.2.6 Gun muzzle. Requirements for gun muzzle effects shall be as specified herein.

5.1.2.6.1 Fully hardened. The equipment shall meet the interface requirements in accordance with MIL-STD-1399, section 072, Part 2.

5.1.2.6.2 Minimal acceptance. Generally, requirements for gun muzzle effects are not applicable. Requirements for equipment operation under gun muzzle effects shall be specified only for those installations determined by the specifier to be subject to gun muzzle effects.

5.1.2.7 Humidity. Requirements for humidity shall be as specified herein. The specified criteria for equipment installed in controlled spaces shall take into account failure of the environmental control system for up to 8 hours duration.

5.1.2.7.1 Fully hardened. Equipment shall be tested for condensing humidity conditions in accordance with IEC 68-2-30Db or MIL-STD-810, Method 507, to simulate shipping and storage conditions, and where applicable, installation in an uncontrolled environment. The temperature range in IEC 68-2-30Db shall be changed to "25 Centigrade (°C) to 55°C". Equipment not subjected to testing in accordance with IEC 68-2-30Db or MIL-STD-810 shall withstand 95 percent humidity (non-condensing) and tested in accordance with IEC 68-2-3Ca. IEC 68-2-3Ca shall be modified to require 21 days testing.

5.1.2.7.2 Minimal acceptance. Equipment shall be capable of operation in an environment conforming to the full range of requirements for data processing spaces of the ASHRAE Handbook, and specifically, the Heating, Ventilation, and Air Conditioning (HVAC) Systems and Application Volume of the handbook.

5.1.2.8 Hydrostatic pressure. Requirements for hydrostatic pressure shall be as specified herein.

5.1.2.8.1 Fully hardened. Parts of the equipment that will be immersed in seawater shall withstand the hydrostatic pressure without physical or electrical damage and without leakage. Leakage immersion tests shall be in accordance with MIL-STD-810, method 512.

5.1.2.8.2 Minimal acceptance. Generally, requirements for hydrostatic pressure are not applicable. Requirements for equipment operation under hydrostatic pressure shall be specified only for those installations determined by the specifier to be subjected to immersion in seawater.

5.1.2.9 Icing. Requirements for icing shall be as specified herein.

5.1.2.9.1 Fully hardened. Exposed equipment shall withstand an icing load of 20 kilograms per square meter. Icing tests shall be in accordance with MIL-STD-810, method 521.

5.1.2.9.2 Minimal acceptance. Generally, requirements for icing are not applicable. Requirements for equipment operation under icing loads shall be specified only for those installations determined by the specifier to be subject to icing.

5.1.2.10 Missile exhaust. Requirements for missile exhaust effects shall be as specified herein.

5.1.2.10.1 Fully hardened. The equipment shall meet the interface requirements of MIL-STD-1399, section 072, part 1.

5.1.2.10.2 Minimal acceptance. Generally, requirements for missile exhaust are not applicable. Requirements for equipment operation under missile exhaust effects shall be specified only for those installations determined by the specifier to be subject to missile exhaust.

5.1.2.11 Nuclear hardening. Requirements for nuclear hardening shall be as specified herein.

5.1.2.11.1 Fully hardened. Levels of nuclear survivability shall be tailored from NAVSEA Instruction C3401.1. Requirements for air blast, thermal radiation, and free field EMP shall be tailored from NSWC TR 87-192 for exposed equipment and cables; modified to limit conducted current levels to 10A on cables that penetrate the ship's hull. Requirements for air blast induced shock, transient radiation effects on electronics (TREE), and conducted EMP shall be tailored from NSWC TR 87-192 for all equipment. EMP tests shall be tailored in accordance with the RS05 and CS10 requirements of MIL-STD-461 (see 5.1.2.3).

5.1.2.11.2 Minimal acceptance. It is the responsibility of the specifier to determine if the equipment requires nuclear hardening, and the degree of nuclear hardening. DOD Directive 4245.4 provides further guidance. Installation in a sheltered, controlled environment does not protect the equipment from all effects of a nuclear event.

5.1.2.11.3 Ruggedization techniques. With proper care, COTS equipment can be ruggedized to meet the nuclear environment. The specifier may consult NSWC TR 90-22 for techniques to harden equipment to the nuclear environment. Suggested guidelines for hardening are provided below.

(a). Air blast and thermal radiation: Appropriate shielding and insulation may be applied to protect exposed equipment.

(b). Air blast induced shock: To meet this requirement and the underwater shock requirements of MIL-S-901, equipment may be shock mounted (see 5.1.2.14).

(c). EMP: Appropriate electromagnetic shielding and grounding shall be used. Protection may be applied at I/O ports to prevent propagation of the EMP pulse into equipment. For small signal interfaces, terminal protection devices (TPDs) or filter pin connectors shall be used due to the fast rise time of the EMP pulse. For power circuit interfaces, metal oxide varistors (MOVs) may be applied.

(d). TREE: The ship's hull is relatively transparent to the TREE conditions. Radiation detection, power interruption and dump may be applied. With this approach, a radiation detection integrated circuit (IC) provides a signal for power supplies to momentarily turn off, and high voltage circuits and capacitors to be crow-barred (discharged to ground). A radiation detection IC is under development and will also be available as a SEM module

of the Standard Hardware Acquisition & Reliability Program (SHARP) program at NWSCC, Crane, Indiana. Using this approach, any momentary component latch-ups will not result in a sustained fault of components and subsequent failure. Power supplies of COTS equipment and capacitors used to store energy would be modified to interface with the radiation detection IC. Other methods employed include component selection and component derating. Fiber optics may be sensitive to TREE conditions. Fiber optic cables shall be selected which are insensitive to TREE.

5.1.2.12 Salt fog (spray). Requirements for salt fog (spray) shall be as specified herein.

5.1.2.12.1 Fully hardened. Equipment shall be tested in accordance with MIL-STD-810, method 509. As an alternative, equipment may be tested in accordance with IEC 68-2-11Ka, except with a duration for exposure of 48 hours.

5.1.2.12.2 Minimal acceptance. Generally, requirements for salt fog effects are not applicable. Requirements for equipment operation under salt fog effects shall be specified only for those installations determined by the specifier to be subjected to salt fog effects.

5.1.2.13 Ship motion and attitude. Requirements for ship motion and attitude shall be as specified herein.

5.1.2.13.1 Fully hardened. Equipment shall be fully operational through the ship motion and attitude conditions in accordance with DOD-STD-1399, section 301. Inclination tests shall be as specified in Appendix D.

5.1.2.13.2 Minimal acceptance. Ships motion and attitude conditions are defined in DOD-STD-1399, section 301. Under heavy weather conditions, office equipment such as duplicating machines may be permitted to shut down when the inclination exceeds a pre-specified limit.

5.1.2.14 Shock. Equipment used aboard ship is subjected to shock and vibration as a result of shipping and service conditions, as well as from hostile engagements (see 5.1.2.11.3). In all cases, equipment shall be designed to operate within the service environment to be encountered aboard ship. Shock tests and requirements for shipboard equipment are specified in the following documents:

(a). Functional shock: MIL-STD-810, method 516, procedures I and VI.

(b). Storage and transportation: MIL-STD-810, method 516, procedures II, III, IV, and VIII.

(c). Combat condition: MIL-S-901.

Requirements for shock testing shall be as specified herein.

5.1.2.14.1 Shock spectrum and transient duration. In order to perform shock tests, a shock spectrum and transient duration shall be defined which represent the extreme design conditions to be encountered. Where published data is not available, guidance shall be sought from COMNAVSEASYSCOM (Codes SEA-06K21 and SEA 55X12).

5.1.2.14.2 Shock Grades. Equipment is classified into grades in accordance with DOD-STD-1399, section 072.4, in order to determine the testing requirements for combat shock (see MIL-S-901). The shock grade, shock spectrum, and transient duration determine the tailoring requirements for testing.

5.1.2.14.3 Fully hardened. Equipment shall be classified as grade A and shall be in accordance with MIL-S-901 in addition to the applicable portions of MIL-STD-810, method 516.

5.1.2.14.4 Minimal acceptance. Equipment which is normally stowed for combat shall be classified as grade C with no testing requirements. All other equipment shall be classified as grade B and be tested in accordance with MIL-S-901. Note: MIL-S-901 does specify grade C.

5.1.2.15 Solar radiation. Requirements for solar radiation shall be as specified herein.

5.1.2.15.1 Fully hardened. Exposed equipment shall not be damaged and shall maintain specified performance when exposed to the sun at its service location. Equipment shall be tested in accordance with MIL-STD-810, method 505, procedure II.

5.1.2.15.2 Minimal acceptance. Generally, requirements for solar radiation are not applicable. Requirements for equipment operation under solar radiation shall be specified only for those installations determined by the specifier to be subject to solar radiation.

5.1.2.16 Spray tight enclosures. Requirements for equipment enclosures to withstand spray from ruptures or discharges from adjacent high pressure fittings are as follows:

5.1.2.16.1 Fully hardened. Requirements shall be tailored from MIL-STD-108. Typical applications include submarines and hazardous locations.

5.1.2.16.2 Minimal acceptance. General, requirements for spray tight enclosures is not applicable to equipment installed in controlled spaces.

5.1.2.17 Temperature ranges. Requirements for temperature shall be as specified herein. Temperature tests shall be in accordance with MIL-STD-810, methods 501 and 502, procedure I. Safety criteria shall be as specified in 5.1.3.11.9. The specified criteria for equipment installed in controlled spaces shall take into account failure of the environmental control system for up to 8 hours duration.

5.1.2.17.1 Fully hardened. Equipment temperature requirements for shipping and operating shall be tailored from Table III.

5.1.2.17.2 Minimal acceptance. Equipment temperature requirements for shipping and operating shall be tailored from Table IV. Equipment shall not be damaged when ambient conditions are outside nominal operating limits.

Environment	Operating (°C)	Non-Operating (°C)
Uncontrolled	-28 to +65	-40 to +70
Controlled	0 to +50	-40 to +70

Table III. Fully Hardened Limits.

5.1.2.18 Underwater explosion. Requirements for underwater explosion shall be as specified herein.

Environment	Operating (°C)	Non-Operating (°C)
Uncontrolled	-28 to +50	-40 to +70
Controlled	+10 to +50	-40 to +70

Table IV. Minimal Acceptable Limits.

5.1.2.18.1 Fully hardened. Equipment which is submerged and exposed to external sea pressure shall withstand the underwater explosion test in accordance with MIL-S-901 for wetted-surface type mounted items.

5.1.2.18.2 Minimal acceptance. Generally, requirements for underwater explosion are not applicable. Requirements for equipment operation under underwater explosion conditions shall be specified only for those installations determined by the specifier to be subjected to underwater explosions.

5.1.2.19 Vibration. Requirements for vibration shall be as specified herein.

5.1.2.19.1 Fully hardened and minimal acceptance. Shipboard equipment shall be in accordance with the type I vibration requirements of MIL-STD-167-1.

5.1.2.20 Wind effects. Requirements for wind effects shall be as specified herein.

5.1.2.20.1 Fully hardened. The exposed equipment, or portions thereof, shall operate within performance limits in winds having a relative velocity of 140 km/hr (75 knots) with gusts up to 250 kilometers per hour (130 knots), and shall withstand, without damage, winds having a relative velocity as great as 185 km/hr (100 knots) with gusts up to 325 km/hr (175 knots).

5.1.2.20.2 Minimal acceptance. Generally, requirements for wind effects are not applicable. Requirements for equipment operation under wind effects shall be specified only for those installations determined by the specifier to be subject to wind effects.

5.1.3 Operational constraints. Equipment shall meet the operational constraints as specified herein. Requirements specified are applicable to "full hardness" and "minimal acceptance".

5.1.3.1 Airborne noise. Equipment generated airborne noise shall be in accordance with MIL-STD-740-1. Tests are specified in MIL-STD-740-1. Tailoring guidance for the grade to be required is provided below:

Grade A3 - Equipment is that which is to be installed in spaces where direct speech communication shall be understood with minimal error and without repetition over a distance of 2m (6.5 feet) or less.

Grade A12 - Equipment is that which is to be installed in spaces where direct speech communication shall be understood with minimal error and without repetition over a distance greater than 2m (6.5 feet).

Grade B - Equipment is that which will be placed in spaces where comfort of personnel in their quarters is the principal consideration.

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.

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.

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.

5.1.3.2 Structureborne noise. Equipment generated structureborne noise shall be in accordance with type III equipment of MIL-STD-740-2. Tests are specified in MIL-STD-740-2.

5.1.3.3 Alternating current (ac) power. The equipment shall meet the operational constraints (including, but not limited to, harmonic current content, ramp loading, and so forth for type I power in accordance with MIL-STD-1399, section 300 (see 5.1.1.1).

5.1.3.4 Submarine direct current (dc) power. The equipment shall meet the operational constraints in accordance with MIL-STD-1399, section 390 (see 5.1.1.2).

5.1.3.5 Electromagnetic emissions. Equipment radiated and conducted emissions requirements shall be in accordance with MIL-STD-461 (see 5.1.2.3). Tests shall be in accordance with MIL-STD-462. Radar equipment shall also meet the requirements of the NTIA Manual. COTS equipment may be procured to Federal Communications Commission (FCC), Class A regulations and modified to meet the requirements of the shipboard installation, through application of EMI filters and shielding. FCC regulations only specify emission limits; COTS equipment may need to be shielded for susceptibility considerations.

5.1.3.6 EMCON requirements. Acoustic, electromagnetic and optical emitters, such as radars and communication systems, shall have provisions for emission control.

5.1.3.7 Dc magnetic requirements for minesweeper equipment. The equipment shall be in accordance with DOD-STD-2143. Magnetic material tests shall be in accordance with MIL-I-17214.

5.1.3.8 Fungus. The equipment shall not support fungal growth. Fungus tests shall be in accordance with MIL-STD-810, method 508.

5.1.3.9 Toxic hazards. The equipment shall not expose personnel to toxic substances in excess of the threshold limit values in accordance with ACGIH ISBN O-936-712-39-2.

5.1.3.10 Prohibited materials. The materials listed in Table V, and 29 CFR 1910.1001 to 1910.1101, shall not be used. Additional submarine atmosphere prohibited materials are specified in S9407-AB-ATM-010. Waivers for the use of prohibited materials shall be granted in accordance with current DOD acquisition directives. Waivers shall not be granted for the use of radium and its daughter products (radioactive materials). Additional material requirements for militarized equipment are specified in 5.1.7.8. The use of hazardous material (see 4.7.2) as defined in FED-STD-313 shall be approved by the contracting activity upon submission of justification to prove that:

(a). There is no safer substitute to meet specifications.

(b). The material is or is not recyclable.

(c). Non-recyclable material may be safely disposed of in such a manner as to minimize hazardous waste and the cost of alternative approaches is not practical, including life-cycle cost for use and disposal of the hazardous waste including employee training.

Flammable materials
Asbestos; asbestos compounds; and asbestos-filled molding compounds
Lithium and lithium compounds
Magnesium or magnesium alloys
Zinc or zinc alloys
Carcinogens
Radioactive material
Polychlorinated biphenyl (PCB)
Polyvinyl Chloride (PVC), except where used for component leads
Mercury or its compounds and amalgams
Cadmium, where it may be exposed to temperatures above 400°F or where it may come into contact with petroleum based products
Chlorofluorocarbons (CFC), that is, freon

Table V. Prohibited Materials.

5.1.3.10.1 Flammability. Cable flammability will meet the test requirements in accordance with MIL-C-17 and MIL-C-24643. Flammability testing of other parts and materials shall be in accordance with MIL-STD-454, requirement 3.

5.1.3.11 Safety. Safety considerations shall be addressed. Guidance for the System Safety Engineering program is provided in MIL-STD-882. Safety requirements shall be in accordance with MIL-STD-454, requirement 1, Appendix E, UL-478 and as specified herein. Waivers to safety requirements shall require the written approval of the procuring activity. Waivers shall be granted only upon demonstration that the equipment has been tested in accordance with the appropriate Underwriters Laboratory (UL),

Government, or other industry consensus tests to demonstrate its safety for use in the shipboard environment.

5.1.3.11.1 Leakage current. Equipment leakage current shall be limited to 5 milliamperes (mA or rms). Leakage current shall be determined using a solidly grounded power source. Equipment with EMI filters connected line-to-ground shall be balanced to ensure that the leakage current in the equipment ground does not exceed 5 milliamperes (see 5.1.4.5). Leakage current tests shall be as specified in Appendix F, or equivalent UL or other industry consensus standard approved by the contracting activity. The foregoing tests shall not be performed aboard ship, in that the potential of the ship's electrical system "floating neutral" to the hull will be dependent upon the operating modes of equipment, configuration of the electrical plant, physical installation location of the equipment and so forth.

5.1.3.11.1.1 Isolation transformers. On equipment whose leakage current would otherwise exceed 5 milliamperes rms, an isolation transformer shall be applied. The isolation transformer shall be part of the equipment configuration. User equipment loads shall be isolated from ac line voltages by a dc resistance greater than 200 megohm kW of connected load.

5.1.3.11.2 Protective shields. Protective shields shall be provided to protect personnel from accidental contact with parts in excess of 30 V rms or 30 Vdc.

5.1.3.11.3 Reference and signal voltages. Equipment utilizing external reference or signal voltages in excess of 30 V rms or 30 Vdc shall have the provision for interrupting the reference and signal voltages during maintenance actions.

5.1.3.11.4 Safety, electrical power. Switches for disconnecting equipment from electrical power systems shall break all power and return conductors of the circuit. The safety ground shall not be disconnected.

5.1.3.11.5 Safety ground, internal. A ground terminal shall be provided on equipment. 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.

5.1.3.11.6 Safety ground, external. When 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.

5.1.3.11.7 Safety ground, power cable assemblies. In power cable assemblies that connect to convenience outlets, a safety ground conductor shall be included in the assemblies. The safety ground conductor shall be provided by utilizing three-pin connectors and three-conductor cables. 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.

5.1.3.11.8 Safety ground, drawers. A safety ground shall be included with the power cable assembly and connector of equipment drawers, such that disconnecting of the safety ground from the drawer will result in disconnecting of the power assembly.

5.1.3.11.9 Equipment tests. Equipment when tested under conditions of maximum intended load shall not attain a temperature at any location which constitutes a risk of fire, damages any materials used in the equipment, or exceeds temperature above the ambient as allowed by UL or other consensus standards for the equipment.

5.1.3.11.10 Thermal design. Equipment handle or knob temperatures shall not exceed those limits specified by MIL-STD-454, requirement 1, UL, or other consensus standards for the type of equipment. Other accessible surfaces on which temperatures may jeopardize operator safety as specified by MIL-STD-454, UL or other consensus standards for the type of equipment shall be labelled with a temperature hazard warning.

5.1.4 Electrical design and construction. The electrical design and construction of militarized equipment shall be as specified herein. The specifier of ruggedized equipment shall review these requirements for design features that may be required for the specific application.

5.1.4.1 Environmental stress screening. Requirements for environmental stress screening (ESS) shall be tailored from TE000-AB-GTP-020.

5.1.4.2 Electrical power. The equipment shall operate from electrical power sources as specified herein.

5.1.4.2.1 Electrical power input connections. The input power connector pin assignments and conductor color code shall be as specified in Table VI.

EQUIPMENT POWER SUPPLY	CONDUCTOR ASSIGNMENT	CONNECTOR DESIGNATION	CONDUCTOR COLOR
Single-phase	115/440 Vac	A	White
	115/440 Vac	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	Red
	Negative	C	Black
	Ground	B	Green

Note: Shipboard electrical distribution systems are delta-connected with a floating neutral, precluding the use of the safety ground as a power-carrying conductor. Safety ground connections for bonding and grounding are provided for EMI and personnel safety considerations.

Table VI. Conductor Designations.

5.1.4.2.2 Color code. 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.

5.1.4.3 Electrical equipment protection. Electrical equipment shall employ electrical protection as specified herein.

5.1.4.3.1 Equipment interlocks. The number of personnel safety, maintenance, and equipment protective interlocks shall be kept to a minimum. Safety interlocks shall be

provided where personnel could be exposed to circuits powered by greater than 30V rms or 30 Vdc during operations or maintenance actions. As an alternative to safety interlocks, protective shields may be applied. These shields shall be hinged to prevent removal, shall be such that they can only be opened using tools, and shall be labeled as being a protective shield. Interlock circuits shall be provided to protect against catastrophic failure of the equipment. Particular care shall be taken in the specification of interlocks, especially coolant flow and coolant level sensors, to preclude equipment shutdown caused by transients of momentary duration.

5.1.4.3.2 Battery systems. Battery charging systems shall be provided with built-in protection to prevent damage to batteries due to overcharge or thermal runaway. SHARP Standard Battery Systems shall be used when possible. The NWSCC shall be consulted for the method of battery charging.

5.1.4.3.3 Dielectric withstanding voltage. The equipment shall prevent electrical breakdown such as corona (defined in ASTM D 1868), flash-over (surface discharge), spark-over (air discharge) or breakdown (puncture discharge) when the electrical power circuits are subjected to the dielectric test voltages shown in Table VII for 1 minute at 60 Hz.

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

Table VII. Dielectric Test Voltages.

5.1.4.3.4 Insulation resistance. Insulation resistance of the equipment shall be not less than 10 megohms at specified environmental service conditions, measured at 500 Vdc.

Each circuit shall be measured against all other circuits connected together and to the chassis.

5.1.4.3.5 Clearance and leakage distances. Clearances between solder connections or bare conductors, such as on terminal strips, stand-offs, or similar connections shall be so that no accidental contact can occur between adjacent connections when subjected to service conditions of the equipment specification. Particular attention shall be paid to case deflections due to shock. Spacing requirements for electrical clearance and leakage distances shall be tailored from articles 384 and 710 of NFPA 70.

5.1.4.3.6 Electrical overcurrent protection. The use of circuit breakers in combat system equipment shall be minimized. Circuit breakers shall be coordinated so that the circuit breaker closest to a fault will trip before other circuit breakers trip. Multi-phase 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 designed so 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. Circuit breakers used in shipboard equipment shall be in accordance with DESC 87060 through 87062, and shall be mounted in the horizontal orientation.

5.1.4.3.6.1 Fuses and circuit breakers. Fuseholders shall provide blown fuse indication. All fuses and circuit breakers shall be readily accessible from the front panel without removal of any panels. A minimum of two spare fuses shall be provided for each fuse used (that is, four fuses for each pair of fuses), mounted adjacent to the fuse holder for which it is intended. When fuses are used, they shall be electrically located on the load side of the on-off switch. If extractor post type fuse holders are used, they shall be connected so that the load is connected to the fuse terminal which terminates in the removable cap assembly.

5.1.4.4 Main power on-off. The main power on-off switch located on the equipment shall de-energize the equipment. The switch shall open all conductors except the safety ground. The main power on-off switch shall be clearly labeled as such. A green lamp shall be mounted on or near the equipment to indicate when the equipment is energized. The lamp shall be connected to the load side of the switch. Unless specifically needed for overload protection, circuit breakers shall not be used for turning equipment on and off.

5.1.4.5 Equipment capacitance and EMI filters. Where EMI filters are required, line-to-line filters are preferred to line-to-ground filters (see 5.1.3.11.1). AC line-to-ground capacitance shall be in accordance with MIL-STD-1399, section 300 and MIL-STD-461. Line-to-ground capacitance of dc input power lines shall be in accordance with MIL-STD-1399, section 390.

5.1.4.6 Equipment electrical performance. Equipment electrical performance characteristics shall be as specified herein.

5.1.4.6.1 Grounding. Under casualty conditions, and even during the day-to-day ship operations, any one of the three-phase line voltages may short to ground. The ship's power source is connected delta, with a floating neutral, specifically in order that the operations may continue with one power input line grounded. This and cathodic corrosion are the primary reasons why the ship's power source is not connected WYE. If the equipment is connected WYE, a significant voltage may exist between the neutral connection and the ship's floating neutral, creating a safety hazard and probable failure when one line voltage becomes grounded. Equipment shall be suitable for operation in each operating mode with one power input line grounded.

5.1.4.6.2 Failure tolerance. The equipment shall be designed so that failure of a component normally used for performance improvement shall not completely disable the equipment. The design shall allow continued operation at a reduction in performance; for example, if failure occurs in the automatic frequency control circuits of a receiver, the circuitry shall be designed to provide for operation from a manual position without increasing the probability of failure of the remaining units.

5.1.4.6.3 Accelerated life. Equipment shall undergo an accelerated life test. An accelerated life test is specified in Appendix D.

5.1.4.6.3.1 Test, analyze and fix (TAAF) testing. A TAAF test shall be conducted to identify design deficiencies of the equipment in the specified environment and to permit corrective action prior to a production commitment, tailored to the TAAF guidance document.

5.1.4.6.4 Equipment warm-up and restart. Equipment warm-up times shall be minimized. Mission critical equipment shall remain fully operational through power interruptions of 100 milliseconds or less, and shall immediately (within 1 second) restart following short term power interruptions of less than 5 minutes duration (see 5.1.1.1). Equipment

requiring extended restart times, such as bias supplies, heater elements, frequency standards, and so forth, may require battery backup to meet this requirement.

5.1.4.6.4.1 Proportional timer. Fixed duration restart times following momentary power interruptions and voltage variations are unacceptable during a battle engagement. To achieve an equipment restart in the shortest time possible, a proportional timer whose restart time is a function of the power interruption time, or a functional approximation thereof, shall be used in lieu of fixed duration time delay relays.

5.1.4.7 Forcing current zero. Electrical power circuits that use solid state devices for switching shall not force electrical current to zero under the operating conditions specified herein. "Forcing current zero" will cause voltage spikes on the electrical distribution system and, inevitably, failure of other equipment. New technology equipment is beginning to feature "current limiting" characteristics, where they force the current to zero under transient or fault conditions rather than ramping the current to zero in a controlled fashion. Further, electrical testing may not reveal this characteristic to be a problem unless the source impedance of the test apparatus is consistent with that expected for the ship. It is recommended that the rate of change of the load current (di/dt) be specified as not to exceed 10 times the root mean square nominal load current per millisecond for 60-Hz equipment.

5.1.4.8 Internal wiring practices. Internal wiring practices shall be in accordance with requirements 11, 69, and 71 of MIL-STD-454.

5.1.4.9 Power supply design. Power supplies shall be designed in accordance with NAVMAT P 4855-1A (NAVSO P-3641), and shall be manufactured and tested in accordance with NAVSEA SE 010-AA-SPN-010. Standard Power Supplies, as certified by the NWSCC, meet the foregoing requirements and shall be used where practical. Where Standard Power Supplies cannot be used, power supplies shall be as specified herein.

5.1.4.9.1 Power density. Power density exceeding 0.4 watts per cubic centimeter shall require the approval of the contracting activity, and shall undergo design reviews to ensure that reliability is not compromised.

5.1.4.9.2 Power supply interface. Power supplies shall be tested with the end item 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 item equipment.

5.1.4.9.3 Power supply manufacturing. Power supply manufacturing shall include random vibration and temperature cycling of every unit, under full electrical load. All low voltage regulated power supplies shall have easily removable regulator subassemblies.

5.1.4.9.4 Open and short circuit. Power supplies shall not be damaged by any load between an open circuit and a short circuit.

5.1.4.9.5 Power supply reliability requirements. Low voltage power supplies delivering up to 5 kW at 300 Vdc or less shall have a MTBF of not less than 100,000 hours, predicted in accordance with MIL-STD-756, task 201, method 2005, Navy sheltered environment, 60°C. Some equipment does not have stand-alone power supplies, where Standard Power Supplies may be built into such equipment to meet reliability requirements.

5.1.4.9.6 Power supply EMI design guidance. NAVMAT P 4855-1A (NAVSO P-3641) provides guidance which is tailorable for use in the design of power supplies.

5.1.4.10 Battery system design. Equipment shall use Navy Standard Battery Systems certified by NAVSEA 56Z21. See 5.1.7.7 (Table VIII) for additional battery requirements.

5.1.4.10.1 Battery selection. Batteries shall be selected from SHARP-TP-001. Rechargeable batteries shall be valve regulated/starved electrolyte type. The application of lithium batteries requires safety certification. The application and the safety certification process shall be in accordance with NAVSEA TM S9310-AQ-SAF-010.

5.1.4.10.2 Battery compartment. Battery compartments shall be separated from equipment electronics and be located for ease of battery replacement. The compartment shall be vented to avoid the buildup of hydrogen during the charging process. The compartment shall be sized to accommodate larger batteries if load growth/emergency dc requirements are expected to increase with equipment maturity. CAUTION: No battery is sealed, and the battery compartment shall not be hermetically sealed. Adequate ventilation shall be provided in all battery compartments.

5.1.4.10.3 Battery charging. Charging circuits shall fail low voltage only, and shall be temperature compensated. Charging circuits shall have two modes, for normal (bulk) charging of discharged batteries, for float (trickle) charging of charged batteries.

5.1.4.10.4 Battery connection. Wires leading from load equipment to the battery shall have sufficient additional length to allow two replacements of battery connectors (that is, 10 centimeters (cm) to 15 cm).

5.1.5 Electronic design and construction. The electronic design and construction of militarized equipment shall be as specified herein. The specifier of Ruggedized equipment shall review these requirements for design features that may be required for the specific application.

5.1.5.1 DC leads. Where equipment will be damaged due to a reverse bias on the dc input, the equipment shall contain reverse polarity protection for each dc input.

5.1.5.2 Electronic signal interfaces. The interface requirements for electronic signals for sending and receiving data shall be as specified herein. This shall apply to both external equipment interfaces and internal equipment interfaces such as computer bus backplanes.

5.1.5.2.1 Digital data. The equipment shall be compatible with the data format as specified in the end item equipment specification. MIL-STD-1399, section 502 shall be used as guidance for Naval interfaces.

5.1.5.2.2 Fiber optic systems. Fiber optic systems shall be tailored from MIL-STD-454, requirement 76.

5.1.5.2.3 Local area networks. LAN interfaces shall be incorporated when practical. The interface and interoperability requirements shall conform to Tactical Digital Standard (TADSTAND) B.

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

5.1.5.2.5 Synchro data. The equipment shall be in accordance with MIL-HDBK-225. Synchro capacitors shall be rated at 600 Vdc for 60-Hz synchros. 400-Hz power will be retained for avionics use only for shipboard applications. Synchro capacitors shall be rated 1000 Vdc for 400-Hz synchros.

5.1.5.2.6 Synchro data transmission systems. Synchro data transmission systems shall conform to the interface characteristics and constraints of MIL-STD-1399, section 702. MIL-HDBK-225 provides tailoring guidance for specifying electrical zeroing methods.

5.1.5.3 Printed circuits. Printed circuits and printed circuit wiring boards shall be in accordance with MIL-STD-454, requirement 17.

5.1.5.4 Digital form of documentation. Printed wiring board description in digital (numerical) form shall be in accordance with IPC D-330.

5.1.6 Mechanical design and construction. The mechanical design and construction of militarized equipment shall be as specified herein. The specifier of ruggedized equipment shall review these requirements for design features that may be required for the specific application.

5.1.6.1 Cable entrance plates, stuffing tube. The enclosure shall be provided with cable entrance plates capable of preserving the degree of enclosure specified in the end item specification. 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 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. Stuffing tubes shall be selected from MIL-S-19622 and installed in accordance with DOD-STD-2003-3. Cable entrances shall be located such that cables will not block equipment heat exhaust vents.

5.1.6.1.1 Cable entrance stuffing tube (cast enclosures). On cast enclosures with a wall thickness greater than 4.8 millimeters, bosses, drilled and tapped with type National [Standard] Pipe Threads (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.

5.1.6.1.2 Exposed cables. Where possible, the equipment connecting cables shall be routed internal to the mounting assembly to minimize the amount of cable exposed to EMP and the conduit required for connecting the equipment.

5.1.6.2 Rotating components. Motors, dynamotors, and rotating devices shall be marked to show the direction of rotation. Positive locking devices shall be used to secure gears, cams, and similar devices to shaft.

5.1.6.2.1 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 movement or loss during operational or environmental conditions specified herein.

5.1.6.3 Enclosures. Standard Enclosure Systems (SES) shall be used when possible. The equipment shall be in accordance with MIL-STD-2200. Other equipment enclosures shall be in accordance with MIL-STD-108 and MIL-E-2036. The degree of enclosure shall be watertight for equipment exposed to weather; dripproof to 15 degrees for surface ship internal installations; and dripproof to 45 degrees for submarine internal installations.

5.1.6.4 Equipment mounting. The method of equipment mounting shall be as specified in Table VIII and herein.

EQUIPMENT MOUNTING METHOD	ORDER OF PREFERENCE	MAXIMUM WEIGHT (KGS.)
Horizontal	1	No limit.
Panel	2	As specified in EIA RS-310.
Vertical	3	89
Overhead	4	23

Table VIII. Equipment Mounting.

5.1.6.4.1 Horizontal mounting. Equipment intended for horizontal 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 stable horizontal mounting.

5.1.6.4.2 Overhead mounting. Equipment enclosures intended for overhead mounting shall be limited to lightweight devices as specified in the end item specification, and shall

incorporate mounting features located to suspend the enclosure and to transmit the load to the overhead structure.

5.1.6.4.3 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 project not greater than 40 millimeters 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 practical.

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

5.1.6.4.5 Vertical mounting. Equipment intended for vertical mounting (except switchboards) shall have mounting pads on the rear surfaces of the enclosure. Not less than two pads shall be above the center of gravity of the enclosed equipment. Additional pads shall be positioned to transmit loads to the supporting structure.

5.1.6.4.6 Resilient mounts. The use of resilient mounts shall be used in accordance with the guidance of MIL-S-901. Mechanical shock mounts are preferred to resilient material because of degradation of the resiliency characteristics of the material over the equipment lifetime, and resilient material is effective in one plane of shock only. Resilient material used in the equipment shall undergo accelerated aging prior to shock testing to demonstrate that equipment meets specified shock performance at the end of the design life.

5.1.6.5 Grounding, bonding, and shielding. Provisions for cabinet grounding, bonding, and shielding shall be tailored from MIL-STD-1310. Practices for internal equipment grounding, bonding and shielding shall be tailored from MIL-STD-454, requirement 74, and MIL-STD-454, requirement 61.

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

5.1.6.6 Handling. The equipment shall incorporate the design features for efficient handling in accordance with ASTM F 1166.

5.1.6.7 Hazardous atmosphere. When specified in the end item specification, the equipment or portions thereof shall be protected against a hazardous atmosphere 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). Embedment (potted) and encapsulation are in accordance with MIL-STD-454, requirement 47.

5.1.6.8 Pockets, wells, and traps. Pockets, wells, and traps in which water or condensate could collect when the equipment is in normal position shall be avoided.

5.1.6.8.1 Moisture pockets. Where moisture pockets are unavoidable in unsealed equipment, provisions shall be made for drainage of such pockets. Desiccants or moisture-absorbent materials shall not be used within moisture pockets. Wave guides shall include a method to purge moisture from low points in the wave guide.

5.1.6.9 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 in accordance with MIL-S-1222.

5.1.6.9.1 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 enclosures.

5.1.6.10 Mounting of electric receptacles. Where practical, when receptacles are mounted on a vertical surface the largest polarizing or prime key or keyway of the receptacle shall be at the top center of the shell of the receptacle.

5.1.6.10.1 Adjacent locations. The use of identical connectors in adjacent locations shall be avoided. When the use of connectors of the same shell size in adjacent locations cannot be avoided, differences in the keying arrangement shall be used to prevent mismating.

5.1.6.10.2 Location. External connections (excluding test connections) shall not be located on the front of the equipment.

5.1.6.10.2.1 External connections. The method of external connections to equipment enclosures shall be made by the use of connectors and shall conform to applicable requirements. EMP protected equipment shall be provided with back shells that can accept MIL-C-24758 conduit end fittings to provide 360 degrees grounding of the cable shield. Terminal boards or stuffing tubes shall be used when specified in the end item specification and the applicable requirements. Terminal boards are not preferred since they may loosen under vibration conditions. External connections, excluding test connections, shall not be located on the front of the enclosures.

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

5.1.6.11 Sealed equipment. In sealed equipment or assemblies such as waveguides, the use of desiccants or other methods, such as gas purging, is permitted.

5.1.6.11.1 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.

5.1.6.12 Size and weight. The size and weight of the equipment shall be constrained as specified in the end item specification and as specified herein.

5.1.6.12.1 Weight. Equipment weight shall be within the limits specified in the end item specification. The weight of equipment exceeding 15 kilograms (kg) (35 pounds (lbs)) shall be clearly identified on 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 practical.

5.1.6.12.2 Size limitations. Equipment size limitations shall be as specified herein. Size limits may be achieved by use of separable units. Guidance for shipboard mass/size/shape shall be in accordance with DOD-STD-1399, section 071.

5.1.6.12.3 Maximum height. Equipment intended for installation within internal shipboard spaces shall be not greater than 183 cm. (72 inches) overall height, including stacked units and resilient mounts when their use is permitted.

5.1.6.12.4 Surface ship installation. Equipment intended for installation within internal surface ship spaces shall be constructed to pass through a doorway 66 cm wide by 167 cm high (reduced further by round corners on an 20 cm radius) in accordance with DOD-STD-1399, section 071 and through a hatch 152 cm long by 76 cm wide (reduced further by round corners on a 19 cm radius). Equipment that is larger may be allowed if significant design and cost advantages can be realized and special access, such as cutting/welding the ship's bulkhead, may be authorized for installation.

5.1.6.12.5 Submarine installation. Equipment intended for installation within internal submarine spaces shall be constructed to pass through the hatches and doorways specified herein. Equipment that is larger may be allowed if significant design and cost advantages can be realized and special access, such as cutting/welding the ship's bulkhead, may be authorized for installation.

5.1.6.12.5.1 Pre-SSN 688 Class. Entrance hatches are circular tubes 63 cm in diameter. Doorways are 50 cm wide by 96 cm high, reduced by corners rounded to a 25 cm radius.

5.1.6.12.5.2 SSN 688 and later. Entrance hatches are circular tubes 76 cm in diameter. Doorways are 50 cm wide by 96 cm high, reduced by corners rounded to a 25 cm radius.

5.1.6.12.5.3 Trident Class. Entrance hatches are circular tubes 182 cm in diameter. Doorways are 91 cm in diameter.

5.1.6.13 Thermal design and construction. Thermal design shall be in accordance with requirement 52 of MIL-STD-454 and the guidance of MIL-HDBK-251. Additional requirements are specified herein. Thermal tests are specified in Appendix D.

5.1.6.13.1 Cooling method. For surface ships, the order of preference for cooling is natural convection, forced air cooling, solid state "cold plates and heat pipes", and, lastly, by chilled water. The installation may be so that exhaust heat is directed to return air ducts. For submarines, cooling by chilled water is preferred to forced air cooling to reduce the acoustic signature of the ship. The method of cooling selected shall take into account available cooling systems, density, space, weight, and structureborne noise caused by fans and pumps.

5.1.6.13.2 Inlet/outlet location. The inlet air port shall be located not less than 30 cm from the floor.

5.1.7 Parts. Parts selected in accordance with the end item specification shall not relieve the contractor of his responsibility of complying with the equipment performance requirements and the other requirements of the end item equipment specification. Parts used in militarized equipment shall be as specified herein. The specifier of ruggedized equipment shall review these requirement for design features that may be required for the specific application.

5.1.7.1 Obsolescence or non-availability. The contractor's design and method of part selection shall minimize the impact of parts obsolescence or non-availability, as specified in the end item specification or contract. Standard hardware, such as SEM, SPS, SES, and SBS may be used to minimize the effects of obsolescence.

5.1.7.2 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 end item specification.

5.1.7.3 Parts derating. Parts derating shall be in accordance with NAVSEA TE000-AB-GTP-010.

5.1.7.4 Part replacement. The arrangement of parts on repairable items shall be so that replacement of any part is possible without removal of or damage to adjacent parts. Accessibility shall be in accordance with MIL-STD-454, requirement 36.

5.1.7.5 Parts tolerances. When a specification provides more than one grade, characteristic, or tolerance of a part, the selection shall be parts of the lowest grades, broadest characteristics, and widest tolerances which will enable the equipment to meet the performance and other requirements of the end item equipment specification. The tolerances of parts shall allow for the effects of long term drift to ensure adequate performance of the equipment to the end of its intended service life.

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

5.1.7.7 Parts, general requirements. Parts shall be as specified in Table IX and as specified herein.

Table IX. Parts.

Item	MIL-STD-454 requirement	Additional requirements
Batteries	27	See 5.1.4.10.
Bearings	6	Bearings for use in noise critical applications shall conform to MIL-B-17931.
Circulators		Shall conform to MIL-C-28790.
Clamp, cable entrance		Shall conform to W-F-406.
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	
Couplers, directional (coaxial and waveguide)	53	
Fastener hardware	12	
Filters, electrical		Shall conform to MIL-STD-1395.
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.

Table IX. Parts. - Continued

Item	MIL-STD-454 requirement	Additional requirements
Gyroscopes, rate integrating		Shall conform to MIL-G-81168.
Indicator lights	50	Shall conform to the color coding requirements of ASTM F 1166.
Isolators	53	
Meters, electrical indicating and accessories	51	Shall not be of the electrochemical type.
Modules, electronic	73	MIL-STD-1378
Motors, dynamotors and rotating devices	46	Shall be marked to show the direction of rotation.
Readouts	68	
Relays	57	
Servo devices	56	
Shunts	40	
Sockets and accessories	60	
Solenoids		Shall conform to MIL-S-4040.
Springs	41	
Switches	58	
Terminations	19	

Table IX. Parts. - Continued

Item	MIL-STD-454 requirement	Additional requirements
Transformers Inductors and coils	14	
Tubes, electron	29	
Vibrator power supply		Shall not be used.
Coaxial cable	65	Shall be low smoke cables in accordance with MIL-C-17
Flat cable		Shall conform to MIL-C-49055 for cables with round conductors and MIL-C-49059 for cables with flat conductors.
Interconnecting cable	71	Cables shall be selected from MIL-C-24643. Lightweight cables with conductor sizes AWG 12 or smaller shall be selected from MIL-C-24640.
Cable multiconductor (internal)	66	
Wire internal, hook-up	20	
Wire magnet		Shall conform to J-W-1177.

5.1.7.7.1 Electronic equipment parts. Electronic equipment parts shall be selected from MIL-STD-242, MIL-STD-1562 (microcircuits), MIL-STD-701 (semiconductors) and the Government Furnished Baseline (GFB) in order to facilitate effective logistic support, improve quality, and reduce costs. The GFB is intended to support the DoD Standardization and Parts Control Program outlined in MIL-STD-965 by listing preferred parts for use in military electronic and electrical systems. GFB parts lists are available from the Military Parts Control Advisory Groups (MPCAG) of the Defense Logistics Agency (DLA). MPCAGs may be contacted at the following addresses:

Commander
Defense Electronic Supply Center (DESC)
Attn: Code DESC-EPE
1507 Wilmington Pike, Dayton, OH 45444-5000

Commander
Defense General Supply Center (DGSC)
Attn: Code DGSC-SSC
South Jefferson Davis Highway
Richmond, VA 23297-5000

Commander
Defense Industrial Supply Center (DISC)
Attn: Code ESM
700 Robbins Avenue
Philadelphia, PA 19111-5096

Commander
Defense Construction Supply Center (DCSC)
Attn: Code SS
Columbus, OH 43216-5000.

5.1.7.7.1.1 Selected parts standards. Table X lists parts that are described in MIL-STD-242.

Table X. Parts Specified by MIL-STD-242.

MIL-STD-242	Description
Part 1	Synchros, blowers and acoustical parts.
Part 2	Crystals, delay lines, coils, and transformers.
Part 3	Resistors.
Part 4	Capacitors (see 5.1.7.8.5 for additional requirements).
Part 6	Relays.
Part 7	Switches.
Part 8	Connectors.
Part 9	Circuit breakers, fuses, lamps, and meters.
Part 10	Wire and Cables.
Part 11	RF components.
Part 12	Hardware.

5.1.7.7.1.2 Order of preference for parts selection. The order of preference for parts selection shall be as shown in Table XI.

Table XI. Electronic Parts Selection.

Preference
1. Part listed in GFB and meets military specification.
2. Part listed in GFB only.
3. Part not listed in GFB but meets military specification.
4. Part not listed in GFB but meets DESC drawing.
5. Part is commercial but can meet military specification.

5.1.7.7.1.3 Suitability of electronic parts. Suitability of electronic parts for an intended application shall be in accordance with TE000-AB-GTP-010, MIL-STD-454, Table IX and as specified herein.

5.1.7.7.2 Wire and cable. Aluminum wire shall not be used.

5.1.7.7.3 Air filters. Air filters shall be in accordance with MIL-F-16552.

5.1.7.7.4 Convenience power receptacles. Convenience power receptacles shall not be provided.

5.1.7.7.5 Capacitors. Capacitors shall be in accordance with MIL-STD-198, and as specified herein.

5.1.7.7.5.1 Electrolytic capacitors. Electrolytic (aluminum foil) capacitors shall not be used in alternating current ac applications.

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

5.1.7.7.5.3 Paper dielectric capacitors. Fixed paper dielectric capacitors shall not be used except as feed through radio interference capacitors, and these shall be in accordance with MIL-C-11693.

5.1.7.7.6 Connectors. Connectors shall be in accordance with MIL-STD-454, requirement 10, and as specified herein.

5.1.7.7.6.1 Connector type. Connectors shall be of the type that will not disconnect or become loose under the service conditions specified herein and during the service life of the equipment. For example, connectors with threaded shells, ring tongue terminal connectors for terminal strips, and connectors that rotate to a locking position.

5.1.7.7.6.2 Connector selection and application. MIL-C-5015 and MIL-C-28840 connectors shall be selected and applied in accordance with MIL-STD-1683. MIL-C-28731 connectors shall be selected and applied in accordance with MIL-STD-1683.

5.1.7.7.6.3 Connector contacts, energized. Connector plug or receptacle contacts which remain energized after unmating shall be inaccessible to personnel.

5.1.7.7.6.4 Connectors, crimped type. 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.

5.1.7.7.6.5 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.

5.1.7.7.6.6 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 IX without modification of either the connector or the cable, and without the use of adapters (except RF) or special tools (other than crimping tools in accordance with MIL-C-22520).

5.1.7.7.6.7 Protective caps. Protective caps shall be provided for cable entrance holes and equipment connectors to provide protection during shipment or handling prior to equipment installation.

5.1.7.7.7 Gaskets. For EMP and EMI protection, gaskets on exposed equipment shall provide grounding along the perimeter of the gasket. Additional gaskets may be required for weather protection. The following special detail requirements for gaskets shall apply as stated herein.

5.1.7.7.7.1 Flat gaskets. The use of flat gaskets shall be held to a minimum and shall be used only between smooth regular surfaces. Flat gaskets shall be in accordance with MIL-R-15624. Consideration shall be given to the degree of enclosure required and the accessibility required. Gaskets which are not penetrated by mounting screws are preferred.

5.1.7.7.7.2 O-ring gaskets. Installation of O-ring gaskets shall be in accordance with 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. O-ring gaskets in accordance with MIL-P-25732 or MIL-P-83461 shall be used for static seals (between case and cover), reciprocating motion seals (push-button shafts) and for rotary motion seals where the rotational speed is less than 10 revolutions per minute. The inside radius of corners for static seals shall be greater than 3mm.

5.1.7.7.8 Glass. Glass shall be used in accordance with MIL-HDBK-722, and shall be in accordance with class 1, type I, MIL-G-3787.

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

5.1.7.7.9 Dials and pointers for units not having self-contained illumination. Dials and pointers 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 in accordance with the end item specification.

5.1.7.7.10 Dials and pointers for interior communications, order, and indicating systems. 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.

5.1.7.7.11 Illuminated devices. 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 300 lux. Red illuminated dials and displays shall be readable in all levels of incident illumination up to 0.3 lux. Where the observation of an object or surface is critical to the operation of equipment, the illumination shall be from two or more sources.

5.1.7.7.11.1 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 5. There shall be no bright reflective surface visible to the equipment operator.

5.1.7.7.11.2 Illuminated panels. Integrally illuminated panels shall be in accordance with MIL-P-7788.

5.1.7.7.11.3 Lamps. Light emitting diodes (LEDs) are preferred to incandescent lamps for maintenance and reliability considerations. 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. The lamp socket voltage shall not exceed the rated value of the lamp under any operating condition.

5.1.7.7.11.4 Lamp/display test feature. A lamp/display test feature shall be provided. Incandescent lamps shall be replaceable from the front panel.

5.1.7.7.11.5 Dials and pointers for units having self-contained red illumination. Dials and pointers shall have dark faces and white numerals, graduations and lettering when viewed under high level ambient illumination. Dials and pointers 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 in accordance with the end item specification. Transmission cut-off characteristics shall essentially follow the curve shown on Figure 5. The transmission cut-off shall be 590 nanometers with a peak of 700 nanometers.

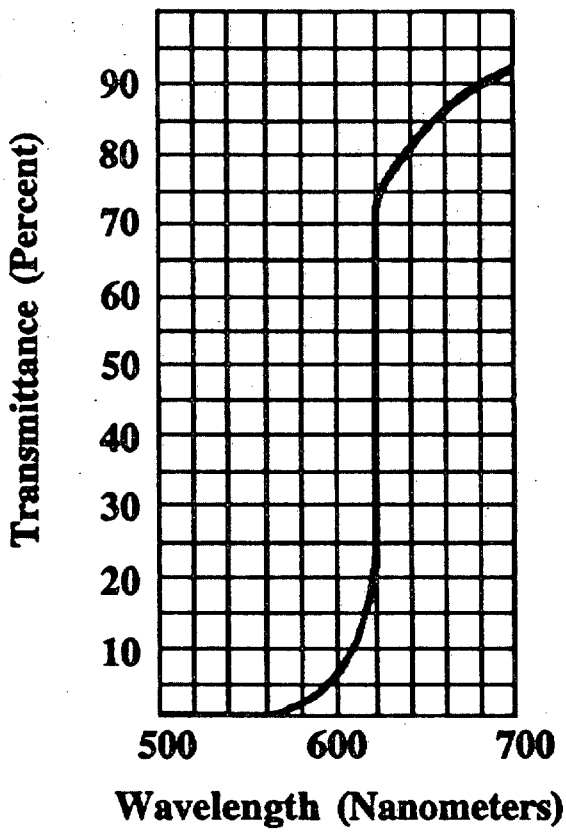

Figure 5. Curve of Light Transmission of Red Material.

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

5.1.7.7.13 Elapsed time indicators. Elapsed time indicators shall be provided to indicate the elapsed time for each equipment operating mode, and shall be of the solid state type in accordance with MIL-M-7793. Elapsed time indicators shall not be mounted on removable assemblies.

5.1.7.7.14 Transformers, inductors and coils. Selection of transformers, inductors, and coils shall be in accordance with MIL-STD-1286.

5.1.7.7.14.1 Variable transformers. Variable transformers shall be in accordance with MIL-T-83721.

5.1.7.7.14.2 Intermediate, radio frequency, and discriminator transformers. Intermediate, radio frequency, and discriminator transformers shall be in accordance with grade 1, 2, or 4 of MIL-T-55631. The use of grade 3 transformers shall be limited to hermetically sealed or encapsulated assemblies. When equipment is required to operate at an internal operating temperature of 65°C or higher, transformers and inductors shall meet the following constraints:

a. MIL-T-27 transformers and inductors shall be selected from Class S, T, U, or V.

b. MIL-T-27, grade 4 transformers and inductors shall not be potted or liquid filled.

c. Items that are selected from requirement 14 of MIL-STD-454 or any other source shall have an operating temperature of 130°C or greater.

5.1.7.7.15 Tuning dial mechanisms. Tuning dial mechanisms shall be in accordance with requirement 42 of MIL-STD-454.

5.1.7.8 Materials. Prohibited materials are specified in 5.1.3.10. Materials shall be in accordance with Table XII and as specified herein.

5.1.7.8.1 Brittle materials. Brittle materials are of concern due to performance under shock and fatiguing. General guidance is provided in the notes section of MIL-S-901 for elongation requirements. Castings for equipment mounted on the mast shall have no less than 10 percent elongation. This may be achieved with properly fabricated alloys of the ALMAG family.

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

5.1.7.8.2.1 Dissimilar metals. The selection of metals for use in electronic equipment shall be made in accordance with MIL-STD-889. When electronic design requirements preclude the insulation of incompatible metal combinations as identified in MIL-STD-889 from one another, specific attention shall be paid to isolating the combination from exterior environments.

5.1.7.8.2.2 Insulation of dissimilar metals. Where it would otherwise result in dissimilar metals being 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.

Table XII. Materials.

Item	MIL-STD-454 requirement	Additional requirements
Adhesives	23	
Aluminum alloy bars, rods,and shapes		Shall be in accordance with QQ-A-200, QQ-A-200/1, QQ-A-200/4, QQ-A-200/8, QQ-A-225, 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; ASTM B 26 or MIL-A-21180, alloys A356, A357, 359.
Aluminum alloy plates and sheet		Shall be in accordance with QQ-A-250, QQ-A-250/2, QQ-A-250/8 or QQ-A-250/11.
Aluminum alloy tubing		Shall be in accordance with WW-T-700, WW-T-700/2, WW-T-700/4, or WW-T-700/6.
Arc resistant	26	
Beryllium-beryllium		Shall be identified as containing beryllium (by labeling, and so forth). Label shall contain health hazard warning concerning dust that may arise from grinding, cutting, filing, or drilling.
Brass		Shall be in accordance with QQ-B-639, ASTM B 16, ASTM B 21, ASTM B 36, ASTM B 121, or ASTM B 124.
Bronze		Shall be in accordance with ASTM B 139 or ASTM B 138.
Copper		Shall be in accordance with QQ-C-502.

Table XII. Materials. - Continued

Item	MIL-STD-454 requirement	Additional requirements
Copper-beryllium alloy		Shall be in accordance with ASTM B 194, ASTM B 196, ASTM B 197, or MIL-C-22087.
Copper-nickel alloy		Shall be in accordance with MIL-C-15726 or MIL-C-20159.
Copper-nickel-zinc alloy		Shall be in accordance with MIL-C-17112, ASTM B 122, ASTM B 151, or ASTM B 206.
Desiccants		Shall be in accordance with MIL-D-3464.
Dial window gaskets and seals		Shall be in accordance with MIL-R-2765 for other than low temperature (-30°C minimum) applications.
Encapsulation and embedment (potting)	47	
Ferrous alloys	15	
Fungus-inert	4	
Hydraulic fluid		Shall be in accordance with MIL-F-17111 or MIL-H-19457.
Hydraulic or pneumatic packing		Shall be in accordance with MIL-G-5514 or ASTM F104.
Insulating, electrical	11	
Lubricants	43	

Table XII. Materials. - Continued

Item	MIL-STD-454 requirement	Additional requirements
Nickel-copper alloy		Shall be in accordance with QQ-N-281, QQ-N-286, ASTM A 494, or MIL-C-24733.
Plastic		Shall not be used for viewing windows. Shall be selected from MIL-HDBK-700. Shall be coated with varnish conforming to MIL-V-173, if porous.
Silver brazing alloys		Shall be in accordance with QQ-B-654.

5.1.8 Painting. The exterior and interior surfaces of metallic enclosures for militarized equipment 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. Paint system tests are specified in Appendix D. The surface preparation shall result in at least a 0.050 mm surface profile. The specifier of ruggedized equipment shall review these requirements design features that may be required for the specific application.

5.1.8.1 Adhesion and blister resistance. Paint systems shall show no blistering or adhesive failure when tested as specified herein.

5.1.8.2 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 parts shall be anodized in accordance with MIL-A-8625, primed with material conforming to TT-P-645. The topcoat shall match the surrounding structure.

(2) Exposed equipment (exterior use). For exposed equipment (exterior use), aluminum and aluminum alloys shall be coated in accordance with section 5.1.8.5.

5.1.8.3 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.

5.1.8.4 Protected equipment (interior use).

5.1.8.4.1 Primer. One coat of primer in accordance with "TT-P-645B or TFP-664". The primer shall have a dry film thickness of 0.015 millimeters (mm) to 0.020mm.

5.1.8.4.2 Enamel. Enclosures shall be painted with two continuous film coats of enamel in accordance with MIL-E-15090. Each coat shall have a minimum thickness of 0.025mm, dry film thickness. Enamel for shipboard portable equipment enclosures shall be in accordance with class 1 of MIL-E-15090. Enamel for other protected equipment enclosures shall be in accordance with class 2 of MIL-E-15090.

5.1.8.5 Exposed equipment (exterior use). Equipment or units thereof, exposed to the weather shall be finished with four coats of paint in accordance with the following:

1st coat: Epoxy-polyamide primer in accordance with MIL-P-24441 and MIL-P-24441/1 (0.075 mm to 0.100 mm dry film thickness).

2nd coat: Epoxy-polyamide top coat in accordance with MIL-P-24441/6 or MIL-P-24441/3 (0.050 mm to 0.075 mm dry film thickness).

3rd to 4th coat: Silicone alkyd enamel in accordance with DOD-E-24635, color 26270 in accordance with FED-STD-595 (0.025 mm to 0.040 mm dry film thickness). The total dry film thickness shall be 0.18 mm to 0.25 mm.

5.1.8.6 Marine Corps equipment. The following requirements apply only to equipment subjected to extreme conditions for which a urethane coating system is the only acceptable option. The primer contains chromate which is a hazardous material; the topcoat contains urethane and isocyanate which are also hazardous materials and require compliance with local air pollution control regulations. Maintenance of these coatings is considered a depot-level task. Application shall be as follows:

5.1.8.6.1 Primer. Primer in accordance with MIL-P-23377 shall be applied with a dry film thickness of 0.015 mm to 0.025 mm.

5.1.8.6.2 Topcoat. Two coats of urethane enamel in accordance with MIL-C-83286 shall be applied. Each coat shall have a minimum thickness of 0.025 mm.

5.1.8.7 Colors. Colors for the painting of equipment shall be selected in accordance with FED-STD-595.

5.1.8.8 Paint Systems. The forgoing specific guidance may not cover all possible applications, when alternative paint schemes must be specified, the treatment, prime coat and topcoat chosen shall all be compatible and shall be selected in accordance with MIL-T-704. The use of hazardous materials is to be avoided wherever possible; the use of lead- and chromate-containing coatings shall be avoided when an approved alternative exists. Consideration shall be given to the field maintenance of paint systems.

5.1.9 Processes. The specifier of ruggedized equipment shall review these requirements for design features that may be required for the specific application. Processes shall be as specified herein.

5.1.9.1 Processes, general requirements. Processes shall be as specified in Table XIII.

Table XIII. Processes.

Item	MIL-STD-454 requirement	Additional requirements
Anodizing for painted surfaces		Shall be in accordance with MIL-A-8625 or chemical treatment conforming to MIL-C-5541.
Brazing	59	
Castings	21	Zinc alloy and magnesium alloy castings shall not be used.
Chromium plating		Shall be in accordance with QQ-C-320.
Copper plating		Shall be in accordance with MIL-C-14550.
Corrosion protection	15	
Gold plating		Shall be in accordance with type II or type III of MIL-G-45204, depending on application.
Nickel plating		Electroplating shall be in accordance with QQ-N-290. Electroless shall be in accordance with MIL-C-26074.
Phosphate coating		Shall be in accordance with DOD-P-16232.
Rhodium plating		Shall be in accordance with class 3 of MIL-R-46085.

Table XIII. Processes. - Continued

Item	MIL-STD-454 requirement	Additional requirements
Silver plating		Shall be in accordance with QQ-S-365.
Soldering		Shall be tailored in accordance with MIL-STD-2000.
Tin plating		Shall be in accordance with ASTM B 545.
Aliphatic urethane plating		Shall be in accordance with MIL-C-83286.
Welds, resistance	24	
Zinc coating		Shall be in accordance with ASTM A 153 (hot dip galvanizing), ASTM B 633 (electrodeposited), or MIL-C-81562 (mechanically deposited).
Zinc plating	15	

5.1.9.2 Protective plating or coating. 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.

5.1.9.3 Welding. Welding shall be in accordance with MIL-STD-454, requirement 13. Samples representative of production and welded on production machines shall be tested to destruction to determine conformance to this requirement. Brittle materials shall not be used for castings or weldments. All weldments of equipment which is to be mounted on masts shall satisfactorily pass a non-destructive test using either radiographic or ultrasonic procedures.

6. NOTES

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

6.1 Intended use. MIL-STD-2036 is intended to assist the preparing activity with the preparation of end item equipment specifications for COTS, Modified COTS, Ruggedized, and Militarized equipment. This standard establishes the characteristics which should be selected for inclusion in an end item specification. MIL-STD-2036 provides criteria for selecting and modifying requirements from referenced standardization documents and provides equipment characteristics which are necessary for sound military operations. The preparing activity should research the requirements and documents cited herein.

6.2 Issue of DODISS. When this standard is used in acquisition, the applicable issue of the DODISS must be cited in the solicitation (see 2.1.1, and 2.2).

6.3 Forcing current zero. The requirement for forcing current zero is derived as follows:

If $i = I_m Sin(wt)$, where I_m is the peak value of current, t is time, and w is the number of radians per second, then the change in current (differential with respect to time) is $di/dt = I_m wCos(wt)$. The di/dt is maximum when wt=0, and the maximum rate of change is $I_m w$. For 60 Hz applications, $w = 2\pi 60 = 377$, and $I_m = \sqrt{2} I_{rms}$, where I_{rms} is the root-mean-square value of the current waveform, then the maximum change in current is $533 I_{rms}$. Since the inrush current may be as much as 10 times rated current (I_{rms}), then the maximum change in current expected is 5,330 I_{rms}. The specified value of 10,000 times rated current per second, or 10 I_{rms} per millisecond, is felt to be a reasonable requirement.

6.4 Applications. Requirements for shore (land based), mobile, airborne, and space applications will be promulgated as revisions to this standard.

6.5 Subject term (keyword listing).
COTS
Militarized
NDI
Ruggedized
Tailoring

CONCLUDING MATERIAL

Custodian:
NAVY - SH
ARMY - ER
AIR FORCE - 11

Review activities:
NAVY - EC, OS
ARMY - AR, AV, CR, ME, MI, TE
AIR FORCE - 17, 19, 85
COAST GUARD - CTES
DLA - ES
FAA
NASA
DESC-EPE

Preparing activity:
NAVY - SH
(Project GDRQ-0108)

Appendix A
Navy Standard Electronic Power System

10. SCOPE.

10.1 Scope. This appendix provides a description of a survivable approach for providing power to electronic equipment. This appendix is not a mandatory part of the standard. The information contained herein is intended for guidance only.

20. APPLICABLE DOCUMENTS

This section is not applicable to this appendix.

30. DESCRIPTION

30.1 Navy Standard Electronic Power System. The Navy Standard Electronic Power System places a 155 Vdc node between the electrical circuits within the combat system equipment and the ship's electrical distribution system. This node may either be internal to a single equipment or external and common to a group of functionally compatible equipment. A block diagram of the Navy Standard Electronic Power System is shown in Figure 6.

30.1.1 Rectifier conditioner. The rectifier conditioner is a polyphase transformer diode bridge, and LC filter; or another form of a unity power factor power supply. This conditioner rectifies the alternating current (ac) line to 155 Vdc while meeting the 3 percent current harmonic limit, 5 percent load current unbalance and 2500V spike voltage requirements specified in MIL-STD-1399, section 300.

30.1.2 100ms holdup module. The 100 millisecond (ms) holdup module provides ride through of momentary power interruptions of up to 100ms duration, and uses capacitors for energy storage. It is not effective to use batteries for this module due to the internal voltage drop of the batteries.

30.1.3 5min holdup module. The 5 minutes holdup module provides power to critical circuits during short term power interruptions of 5 minutes or less. The 5min holdup module uses batteries for energy storage. Because of the weight penalty associated with

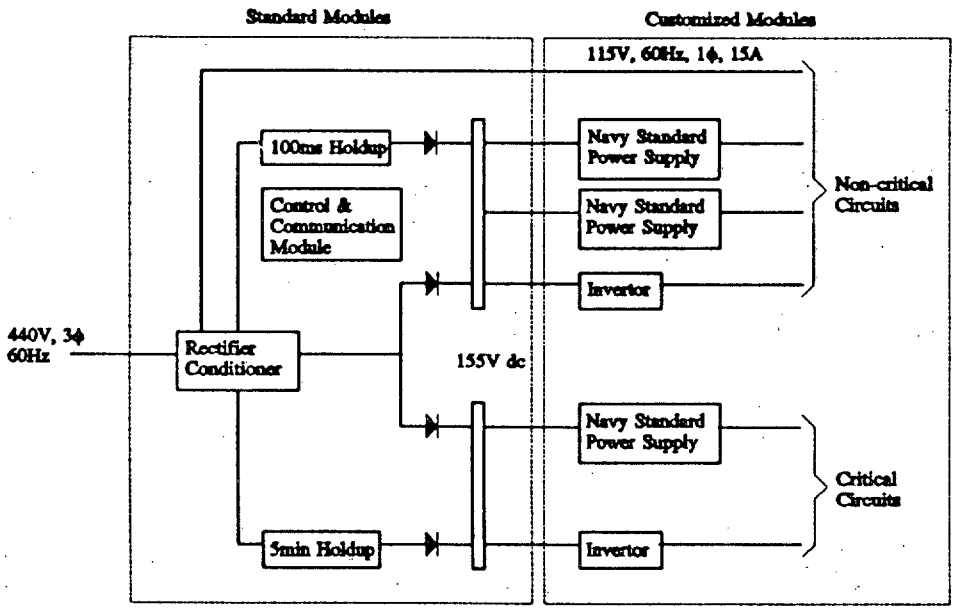

Figure 6. Navy Standard Electronic Power System.

the batteries, 5min holdup will be provided only for those critical circuits needing continuous power for rapid restart following restoration of power.

30.1.4 Navy Standard Power Supply. Conversion of the 155 Vdc node voltage to working voltages needed within the equipment shall be accomplished using Navy Standard Power Supplies (see 5.1.4.9). These units are suitable for operation from either 155 Vdc or from 115V, type I power as specified in MIL-STD-1399, section 300. Navy Standard Power Supplies provide the working voltages needed by the equipment, and enable the equipment to ride through the wide voltage variations seen on the ac line.

30.1.5 Inverters. Where special frequency power or clean 60-Hz power is required by equipment, a solid state invertor powered from the 155 Vdc node shall be used. The input power specifications for the invertor shall be the same as specified for Navy Standard Power Supplies in NAVSEA SE 010-AA-SPN-010.

Appendix B
Quality Assurance

10. SCOPE.

10.1 Scope. This appendix provides quality assurance requirements for specifying COTS and ruggedized equipment. This appendix is a mandatory part of the standard. The information contained herein is intended for compliance.

20. APPLICABLE DOCUMENTS

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

FEDERAL

MIL-STD-1556 Government/Industry Data Exchange Program (GIDEP) Contractor Participation Requirements.

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

30. PROVISIONS

30.1 Quality assurance. The quality assurance program shall be tailored in accordance with MIL-STD-961C,or an equivalent document or program approved by the Government. Provisions for quality assurance shall be as specified herein.

30.1.1 Responsibility for inspection. The contractor is responsible for the performance of all inspection requirements as specified herein. The contractor may use his own or any other facilities suitable for the performance of the inspection requirements specified herein. 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.

Appendix B
(Continued)

30.1.2 Responsibility for compliance. 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.

30.1.3 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). Alternative methods for Government inspection are as follows:

Hardware
(a) Test - Qualification through systematic exercising of the item under appropriate conditions. Performance is quantitatively measured either during or after the controlled application of either real or simulated functional or environmental stimuli. The analysis of data derived from a test is an integral part of the test and may involve automated data reduction to produce the necessary results.
(b) Demonstration - Qualification by operation, adjustment, or reconfiguration of items performing their designed functions under specific scenarios. The items may be instrumented and quantitative limits or performance monitored, but only check sheets rather than actual performance data are required to be recorded.
(c) Visual inspection - Qualification by a visual examination of the item, reviewing descriptive documentation, and comparing the appropriate characteristics with predetermined standards to determine conformance to requirements without the use of special laboratory equipment or procedures. This type of inspection requires the use of check-off lists, which indicate accept/reject criteria for each item type.

(d) Analysis - Qualification by technical or mathematical evaluation, mathematical models or simulation, algorithms, charts, graphs, or circuit diagrams, and representative data.

Software
(a) Test - Specified values of input will be used to exercise specific segments of code. The test item and the associated requirement will then be verified by examination and comparison of obtained output and predetermined output values.
(b) Demonstration - The result of reactions of the code will be observed and recorded or logged. The examination of the data and witnessing of events will verify that the associated requirements have been met.
(c) Visual inspection - Qualification by a visual examination of the item, reviewing descriptive documentation, and comparing the appropriate characteristics with predetermined standards to determine conformance to requirements without the use of special laboratory equipment or procedures.
(c) Analysis - Qualification by technical or mathematical evaluation, mathematical models or simulation, algorithms, charts, graphs, or circuit diagrams, and representative data.

30.1.4 Failure criteria. 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) Failed to meet specification.
(b) Process out of control.
(c) Failure to test.
(d) Incorrect specification.
(e) Safety condition.
(f) Primary failed item (not failures due to secondary effects).
(g) Failure occurred within specified limits.
(h) Failure resulted from deficient:
(1). Process.
(2). Inspection.
(3). Testing.
(4). Handling and packaging.

(5). Wrong product supplied.
(6). Labeling.

30.1.5 Problem/failure reporting and corrective action. Problem/failure reporting and corrective action of any failure 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. For correction, consideration shall be paid to GIDEP data utilization in accordance with MIL-STD-1556.

30.1.6 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.

30.1.7 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 shall be subjected to examinations and tests to determine compliance with this specification and the individual equipment specification.

30.1.8 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.

30.1.9 Production quality conformance sampling inspection. Sampling for production quality conformance inspection shall be in accordance with 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.

30.1.10 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.

30.1.11 Screening of potential NDI equipment. NDI candidate equipment shall be screened against the application specifications. The screen shall include an engineering evaluation of design, production, and test specifications; inspections of visual attributes; and tests of performance, environmental, and suitability characteristics. The engineering evaluation shall determine what characteristics can be accepted from available data and what characteristics shall be verified by tests. The NDI supplier shall submit design and test data as required by the contracting activity to support the engineering evaluation. When the available data or visual inspection is insufficient to determine the ability of the equipment to meet an application requirement, a suitable test shall be conducted to assess the equipment's capability against the application requirement; application critical performance characteristics shall be tested regardless of available data. Screening tests employing combined functional and environmental performance are preferred over individual tests of attributes. The test articles shall be selected at random from production lots of NDI equipment. The NDI supplier shall normally be entitled to all test and evaluation data specific to the equipment, unless other specified in the solicitation, order, or contract. The evaluation of suitability characteristics shall take into account the acquisition strategy, including maintenance and support provisions and warranties. Note: Normally at least three test articles are required to satisfy all screening test requirements; screening tests normally require from 90 to 180 days. Mission critical equipment may require more test articles or longer test durations.

Appendix C
Ruggedized and COTS Features

10. SCOPE.

10.1 Scope. This appendix provides militarized requirements that may be specified for COTS and ruggedized equipment. This appendix is not complete, and only provides suggestions for specifiers. The specifier is encouraged to review all militarized equipment requirements (see 5.1.4 through 5.1.9) for requirements that may be suitable for the end item specification. This appendix is not a mandatory part of the standard. The information contained herein is intended for guidance only.

20. APPLICABLE DOCUMENTS

This section is not applicable to this appendix.

30. REQUIREMENTS

30.1 Customized ruggedized and COTS features. The following militarized requirements (see 5.1.4 through 5.1.9) may be adopted to ruggedized and COTS acquisition options.

Built in test.
Safety.
Electrical overcurrent protection.
Equipment warm-up and restart.
Digital computer grounding.
Connectors.
Illuminated devices.
Power interface.

Appendix D
Equipment Tests

10. SCOPE.

10.1 Scope. This Appendix provides test methods that are not adequately provided for in other standards/specifications. This Appendix is a mandatory part of the standard. The information contained herein is intended for compliance.

20. APPLICABLE DOCUMENTS

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

FEDERAL

FED-STD-141	Paint, Varnish Lacquer and Related Materials: Methods of Inspection, Sampling and Testing.

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

20.2 Non-Government publications. The following document(s) form a part of this document to the extent specified herein. Unless otherwise specified, the issues of the documents which are DoD adopted are those listed in the issue of the DODISS cited in the solicitation. Unless otherwise specified, the issues of documents not listed in the DODISS are the issues of the documents cited in the solicitation (see 6.2).

AMERICAN SOCIETY FOR TESTING AND MATERIALS

ASTM D 714	Standard Method of Evaluating Degree of Blistering of Paints.
ASTM D 1141	Standard Specification for Substitute Ocean Water. (DOD adopted)

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(Continued)

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

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

30. TEST METHODS

30.1 Thermal test. The test shall include the measurement and recording of the information specified in (a) through (d).

(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) Hotspot temperatures.
(e) 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.

30.1.1 Test conditions. The thermal test shall be performed on equipment under the conditions specified in a through d.

(a) Maximum operating temperature of the range, as specified herein.
(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. The condition under which equipment is to have achieved thermal stabilization, for example temperature does not change more than 1°C/hr, is to be tailored.
(d) Equipment cabinets closed.

Appendix D
(Continued)

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

30.2 Inclination. The equipment shall be subjected to the test limits specified herein. The equipment shall be energized and fully operating during the applicable test. 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 surface ships, 60 degrees for submarines, for a period of not less than 30 minutes. During the inclination testing, equipment with drawer slides shall be extended on its slides, to verify that the slides have sufficient lateral strength to support the equipment with inclination in all test directions. For equipment whose operation is degraded when the drawer is extended, for example due to interlocks, the tests shall also be performed with the drawer slides closed. 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 repeated. The test shall be repeated with the equipment reoriented 90 degrees to the plane in which it was originally tested.

30.3 Accelerated life tests. Accelerated life tests shall be as specified herein.

30.3.1 Initial test conditions.

(a) Equipment shall be set up in a temperature-controlled chamber at 25 ± 5°C. Maintain relative humidity of 45 to 55 percent until otherwise indicated.
(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.

Appendix D
(Continued)

(c) When equipment internal temperature has stabilized, performance parameters shall be measured and recorded as reference test data for comparison with subsequent tests.

30.3.2 Temperature conditions. Temperature conditions shall be established as follows:

(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.
(e) Maintain chamber temperature at the highest operating temperature of the range specified for 8 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.
(i) Near the end of the 2-hour period, measure and record the performance parameters.

30.3.3 Voltage and frequency cycling conditions. Voltage and frequency cycling conditions shall be established as follows:

(a) 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, at a uniform rate in not less than 6 hours. Maintain this condition for 2 hours and record performance parameters.

Appendix D
(Continued)

(g) With equipment operating at 25 ± 5°C, 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 (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 (g) with input voltage and frequency at the upper limits of the equipment voltage and frequency tolerance bands.
(j) Repeat (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) Increase chamber temperature, at a uniform rate in not less than 6 hours, to the highest operating temperature of the range specified.
(l) Record performance parameters at the end of the uniform temperature rise test of
(m) Maintain chamber temperature and frequency conditions of (k), increase input voltage to the upper limit of the equipment voltage tolerance band.
(n) Operate for 8 hours and record performance parameters.
(o) Maintain voltage, and frequency conditions of (m) and increase relative humidity to between 90 to 95 percent.
(p) Operate for 2 hours and record performance parameters.
(q) Maintain frequency and relative humidity conditions of (o), 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 of (q), 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 (o) through (t) for not less than 59 cycles.
(v) Repeat high temperature voltage and frequency cycling tests of (o) through (t) with relative humidity at 10 to 20 percent for not less than 15 cycles.

30.4 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.

Appendix D
(Continued)

30.4.1 Procedure I:

(a) Panels shall be subjected to the salt fog test in accordance with MIL-STD-810, method 509, 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.

30.4.2 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.

30.4.3 Blistering. The degree of blistering shall be determined in accordance with ASTM D 714. Blisters appearing within 0.65cm from the edge of the panel shall be disregarded.

30.4.4 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.

Appendix E
Safety

10. SCOPE.

10.1 Scope. This appendix provides safety requirements for specifying COTS and ruggedized equipment. This appendix is a mandatory part of the standard. The information contained herein is intended for compliance.

20. APPLICABLE DOCUMENTS

20.1 Government documents.

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

MILITARY STANDARD

MIL-STD-1425	Safety Design Requirements for Military Lasers and Associated Support Equipment.

HANDBOOKS

MIL-HDBK-600	Guidelines for Identification, Marking, Labeling, Storage and Transportation of Radioactive Commodities.

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

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

Appendix E
(Continued)

PUBLICATIONS

CHIEF OF NAVAL OPERATIONS
OPNAVINST 5100.19 Navy Safety Precautions for Forces Afloat.
(Application for copies should be addressed to the Chief of Naval Operations, OP-461, Washington, DC 20350)

SPACE AND NAVAL WARFARE SYSTEMS COMMAND
SPAWARINST 5100.12 Navy Laser Radiation Hazards Prevention Program.
NAVELEX 0967-LP-624-6010 Electromagnetic Radiation Hazards.

(Application for copies should be addressed to the Naval Publications and Forms Center, 5801 Tabor Avenue, Philadelphia, PA 19120)

FEDERAL REGULATIONS
10 CFR 20 Code of Federal Regulations, Title 10, Part 20.
21 CFR 1000-1050 Code of Federal Regulations, Title 21, Parts 1000-1050.

(The Code of Federal Regulations (CFR) and the Federal Register (FR) are for sale on a subscription basis by the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402.)

20.2 Non-Government publications. The following documents form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents which are DoD adopted is that listed in the issue of the DODISS cited in the solicitation. Unless otherwise specified, the issues of documents not listed in the DODISS are the issues of the documents cited in the solicitation (see 6.2).

UNDERWRITERS LABORATORIES, INC. (UL)
1012 Power Supplies.

(Application for copies should be addressed to the Underwriters Laboratories, Inc., 333 Pfingsten Road, Northbrook, IL 60062.)

Appendix E
(Continued)

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

C95.1	Safety levels with respect to human exposure to radio frequency electromagnetic fields, 300 K Hz to 100 G Hz.
C95.2	Radio frequency radiation hazard warning symbol.
C95.3	Techniques and Instrumentation for the Measurement of Potentially Hazardous Electromagnetic Radiation at Microwave Frequencies.
Z53.1	Safety color code for marking physical hazards.
N2.1	American National Standard for Warning symbols-Radiation symbol.

(Applications for copies should be addressed to the American National Standards Institute, 1430 Broadway, New York, NY 10018.)

(Non-Government standards and other publications are normally available from the organizations that prepare or distribute the documents. These documents also may e available in or through libraries or other informational services.)

30. PROVISIONS

30.1 Safety. Tailoring guidance may be obtained from the Institute of Electrical and Electronic Engineers (IEEE), National Electrical Manufacturers Association (NEMA), American National Standards Institute (ANSI), the Code of Federal Regulations (CFR), National Electrical Code (NEC), National Electrical Safety Code (NESC), National Fire Protection Agency (NFPA), Occupational Safety and Health Administration (OSHA), and Underwriters Laboratories (UL). Provisions for safety shall be as specified herein.

30.1.1 Grounding connections and internal parts bonding. Shipboard power is ungrounded. The grounding of power supplies and the grounding of their connections shall be in accordance with MIL-STD-1310.

30.1.2 Marking. Power supplies shall be marked in accordance with UL 1012, section 60.

30.1.3 Radioactive commodities. Materials that emit alpha and beta particles and gamma rays may be absorbed and deposited within the body. These particles and rays

act as damaging agents that injure or destroy blood-forming organs and other tissue. Marking and labeling requirements for identification in use, storage and transportation of radioactive commodities, their packages and shipping containers shall be in accordance with MIL-HDBK-600.

30.1.4 X-radiation and laser radiation. X-radiation tests shall be in accordance with 21 CFR 1010.2, 21 CFR 1010.3, 21 CFR 1020.10, and applicable UL or other consensus standards. Laser tests shall be in accordance with 21 CFR 1010.2, 21 CFR 1010.3, 21 CFR 1040, or Government test laboratory in accordance with MIL-STD-1425 and SPAWARINST 5100.12.

30.1.4.1 X-radiation. Radiation levels shall be limited to not greater than 2 milliroentgen(mR) in any one hour, and 100 mR in any 7 consecutive days at the operator's position or within 5 cm from the equipment (whichever is closer) in any unrestricted area accessible to personnel. In addition, these levels shall be reduced whenever necessary to ensure that exposed personnel never receive an absorbed dose to the whole body or any critical organ in excess of 125 millirem per calendar quarter or 500 millirem per year. Other exposure shall be based on application criteria and limits as required by 10 CFR 20; 29 CFR 1910.96; and 21 CFR, Chapter I, Subchapter J, Radiological Health. Equipment which, when shields, covers, and doors are removed, will allow X-radiation to exceed 2.0 mR per hour, shall be provided with nonbypassable interlocks. Shields which protect personnel from irradiation shall be labeled in accordance with 21 CFR and a warning also located when the barrier or access door is removed.

30.1.4.2 Laser radiation. Laser equipment and system design, installation, and operational and maintenance procedures shall be in accordance with 21 CFR 1040.10. Exempt military lasers or military lasers not covered by 21 CFR 1040.10 shall use the hazard classification of 21 CFR 1040 which indicates the level of control required to minimize personnel injury potential based solely on laser accessible emission levels. The safety design requirements for exempted lasers and associated support equipment shall be in accordance with MIL-STD-1425.

Appendix E
(Continued)

30.1.4.3 Color code, human exposure to RF fields in high frequencies, and RF radiation. The safety in commercial equipment and systems shall include the following:

(a) The establishment of a safety color code that will alert and inform persons to take precautionary action in the presence of hazards shall be in accordance with ANSI Z53.1.
(b) The prevention of harmful effects in human beings exposed to electromagnetic fields in the frequency range from 300 kHz to 100 gHz shall be in accordance with ANSI C95.1.
(c) The warning of biological detriment and direct and indirect cause of ignition of explosive materials or vapors from hazardous levels of nonionizing electromagnetic radiation shall be in accordance with ANSI C95.2.
(d) Techniques for measurement of potentially hazardous electromagnetic radiation at microwave frequencies shall be in accordance with ANSI C95.3.
(e) Radiation symbol shall be in accordance with ANSI N2.1.

30.1.5 Electromagnetic radiation hazards (RADHAZ). Personnel concerned with the design, installation, and operation of electronic equipment capable of producing or being susceptible to electromagnetic RADHAZ shall be in accordance with the guidance of OPNAVINST 5100.19, NAVELEX 0967-LP-624-6010 on the following aspects:

(a). Biological effects with precautionary safety measures.
(b). Safe distance and time of exposure levels of Radio Frequency (RF) for personnel on ship.
(c). Fire and personnel protection criteria.
(d). Methods and procedures for the prediction of electromagnetic radiation.
(e). Susceptibility of electro-explosive devices (EEDs) and ordnance to electromagnetic radiation.

Appendix F
Leakage Current Tests

10. SCOPE.

10.1 Scope. This Appendix provides test methods for measuring leakage current. This Appendix is a mandatory part of the standard. The information contained herein is intended for compliance.

20. APPLICABLE DOCUMENTS

This section is not applicable to this appendix.

30. TEST METHODS

30.1 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.

WARNING

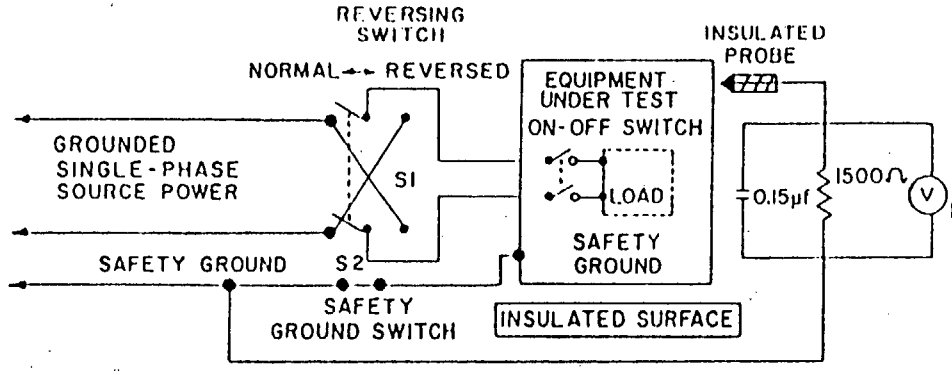
THIS TEST MAY BE HAZARDOUS DUE TO THE UNGROUNDED CONDITION OF THE EQUIPMENT DURING THE TEST. DO NOT TOUCH EXPOSED METAL SURFACES WITHOUT ADEQUATE ELECTRIC SHOCK PROTECTION.

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.

30.2 Equipment test connection. 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 and the source power shall be opened during the test. OBSERVE WARNING STATEMENT. The equipment shall be connected as

shown on Figure 7 if connected to single phase power, as shown on Figure 8 if connected to 3-phase power, and as shown on Figure 9 if connected to dc power.

30.3 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 shall be measured from each part to ground for every combination of switch positions available in the test diagram. The only safety ground conductor shall be reconnected immediately after the test is completed.



GENERAL ORDER OF TEST:

1. Source power OFF. Connect equipment per diagram.
2. ON-OFF SW OFF. S1 SW normal. S2 SW closed. Connect source power.
3. OBSERVE WARNING S2 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 SW REVERSED. ON-OFF SW ON. Repeat Step 4.
7. ON-OFF SW OFF. Repeat Step 4.
8. S2 SW CLOSED. S1 SW normal.
9. Repeat Step 3 THRU 8 for each mode of operation.
10. 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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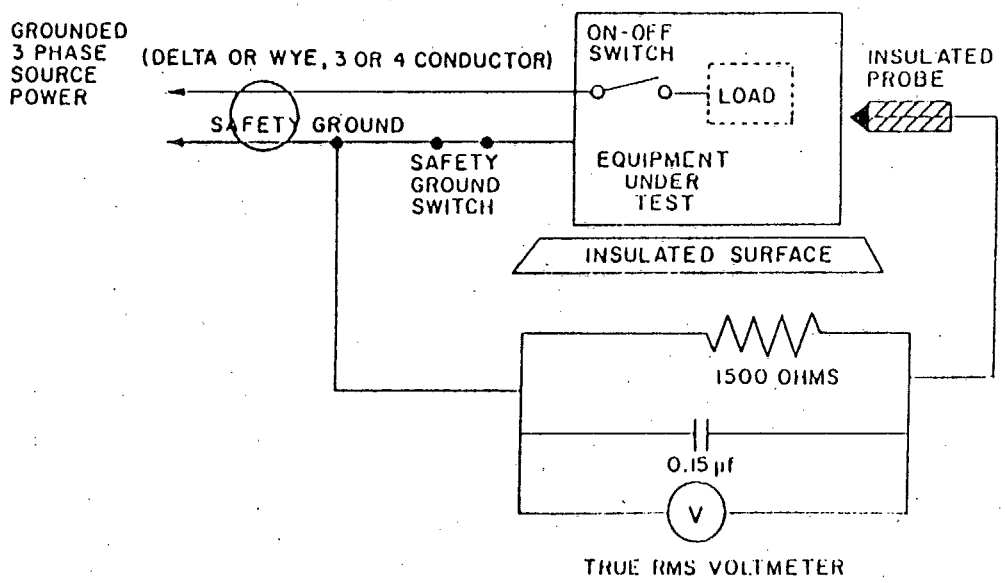
FIGURE 7. Single-phase test diagram for leakage current measurement.



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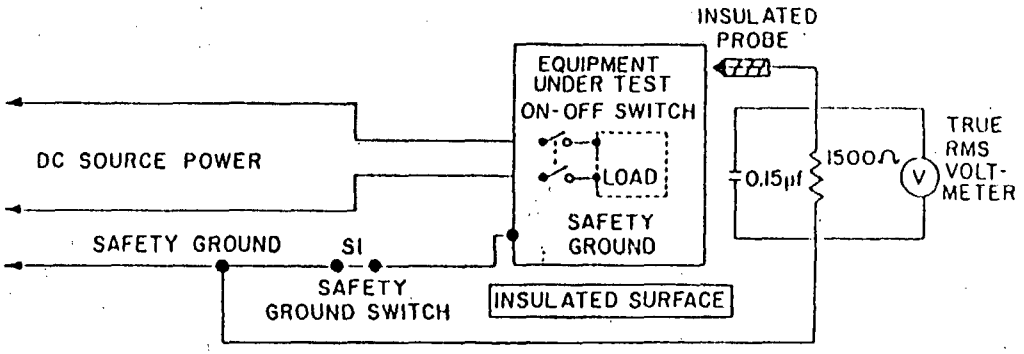
FIGURE 8. Three-phase test diagram for leakage current measurement.



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 9. DC test diagram for leakage current measurement.

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*U.S. GOVERNMENT PRINTING OFFICE: 1991--504-034/50326

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INSTRUCTIONS

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	MIL-STD-2036	18 June 1991

3. DOCUMENT TITLE
GENERAL REQUIREMENTS FOR ELECTRONIC EQUIPMENT SPECIFICATIONS

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

5. REASON FOR RECOMMENDATION

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