MIL-I-983E(SHIPS)
15 August 1966
SUPERSEDING
MIL-I-983D(SHIPS)
26 April 1965
(See 6.6)

MILITARY SPECIFICATION

INTERIOR COMMUNICATION EQUIPMENT, NAVAL SHIPBOARD; BASIC DESIGN REQUIREMENTS FOR

1. SCOPE

1.1 This specification covers the basic design requirements, test and operating conditions for interior communication equipment to be used in Naval ships. The purpose of this specification is to secure uniformity of practice, quality of materials and workmanship necessary to meet the special requirements for equipments to be installed in ships of the United States Navy.

2. APPLICABLE DOCUMENTS

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

SPECIFICATIONS

FEDERAL

J-C-175	- Cable Assembly, Power, Electrical (3-Wire, 3-Prong, Grounding Plug Connector for 125-Volt Equipment).
L-P-387	- Plastic Sheet, Laminated, Thermosetting (for Designation Plates).
L-P-504	- Plastic Sheet and Film, Cellulose Acetate.
L-P-513	- Plastic Sheet, Laminated, Thermosetting, Paper-Base, Phenolic Resin.
FF-B-171	- Bearings, Ball, Annular (General Purpose).
FF-B-185	- Bearings, Roller, Cylindrical; and Bearings, Roller, Self-Aligning.
FF-B-187	- Bearings, Roller, Tapered.
FF-N-836	- Nut, Plain: (Hexagon, Square, Cap and Welding) Nut, Slotted, and Castellated, Hexagon.
FF-S-85	- Screw Cap, Slotted and Hexagon-Head.
FF-S-86	- Screw, Cap, Socket-Head.
FF-S-92	- Screws, Machine: Slotted, Cross-Recessed, or Hexagon-Head.
FF-S-200	- Setscrews; Hexagon Socket and Spline Socket, Headless.
FF-S-210	- Setscrews; Square Head and Slotted Headless.
FF-W-84	- Washers, Lock (Spring).
FF-W-92	- Washers, Metal, Flat (Plain).
FF-W-100	- Washer, Rock, Tooth.
QQ-A-591	- Aluminum Alloy Special Shaped Section.
QQ-A-596	- Aluminum Alloy Permanent and Semi-Permanent Mold Castings.
QQ-A-601	- Aluminum-Alloy Sand Castings.
QQ-C-320	- Chromium Plating (Electrodeposited).
QQ-C-530	- Copper-Beryllium Alloy Bar, Rod, and Wire (Copper Alloy Number 172).
QQ-C-533	- Copper-Beryllium Alloy Strip (Copper Alloy Numbers 170 and 172).
QQ-C-585	- Copper-Nickel-Zinc-Alloy Plate, Sheet, Strip, and Bar (Copper Alloy Numbers 735, 745, 752, 762, 766 and 770).
QQ-C-586	- Copper-Nickel-Zinc-Alloy; Rod, Shapes, and Flat Products with Finished Edges (Flat Wire, Strip, and Bar).
QQ-N-290	- Nickel Plating (Electrodeposited).
QQ-P-416	- Plating, Cadmium (Electrodeposited).
QQ-S-365	- Silver Plating (Electrodeposited).
QQ-W-401	- Wire, Round, Copper Alloy Number 510 (Phosphor-Bronze A); Spring.
QQ-W-423	- Wire, Steel, Corrosion-Resisting.
QQ-W-470	- Wire, Steel, High Carbon, Spring, Bright, Music.
QQ-Z-325	- Zinc Coating, Electrodeposited, Requirements for.

FEDERAL (Cont'd.)

TT-C-490 - Cleaning Methods and Pretreatment of Ferrous Surfaces for Organic Coatings.
TT-P-465 - Pigment, Zinc-Yellow (Zinc Chromate), Dry.
TT-P-664 - Primer Coating, Synthetic, Rust-Inhibiting, Lacquer-Resisting.
VV-P-236 - Petrolatum, Technical.

MILITARY

MIL-E-1 - Electron Tubes, General Specification for.
MIL-I-10 - Insulating Materials, Electrical, Ceramic, Class L.
MIL-M-14 - Molding Plastics and Molded Plastic Parts, Thermosetting.
MIL-R-19 - Resistors, Variable, Wirewound (Low Operating Temperature), General Specification for.
MIL-R-22 - Resistors, Variable (Wirewound, Power-Type), General Specification for.
MIL-C-25 - Capacitors, Fixed, Paper-Dielectric, Direct Current (Hermetically Sealed in Metallic Cases), General Specification for.
MIL-P-79 - Plastic Rods and Tubes, Thermosetting, Laminated.
MIL-P-80 - Plastic Sheet, Acrylic Base, Antielectrostatic, Transparent (for Indicating-Instrument Windows).
MIL-R-94 - Resistors, Variable, Composition, General Specification for.
MIL-W-583 - Wire, Magnet, Electrical.
MIL-I-631 - Insulation, Electrical, Synthetic-Resin Composition, Nonrigid.
MIL-T-713 - Twine, Impregnated, Lacing and Typing (for Use in Electrical and Electronic Equipment).
MIL-B-857 - Bolts, Nuts and Studs.
MIL-S-867 - Steel Castings, Corrosion Resisting, Austenitic.
MIL-S-901 - Shock Tests, H.I. (High-Impact); Shipboard Machinery, Equipment and Systems, Requirements for.
MIL-D-963 - Drawings, Electrical, Hull and Mechanical Equipment for Naval Shipboard Use.
MIL-R-978 - Reports: Research and Development (for Electronic Equipment).
MIL-P-997 - Plastic-Material, Laminated, Thermosetting, Electrical-Insulating: Sheets, Glass Cloth, Silicone Resin.
MIL-R-2033 - Relays for Naval Shipboard Electrical Service.
MIL-C-2194 - Cables, Power, Electrical, Reduced Diameter Type, Naval Shipboard.
MIL-R-2765 - Rubber Sheet, Strip, Extruded, and Molded Shapes, Synthetic, Oil Resistant.
MIL-I-3158 - Insulation Tape, Electrical Glass-Fiber (Resin-Filled): and Cord, Fibrous-Glass.
MIL-I-3190 - Insulation Sleeving, Electrical, Flexible, Treated.
MIL-G-3278 - Grease, Aircraft and Instrument (for Low and High Temperatures).
MIL-G-3545 - Grease, Aircraft, High Temperature.
MIL-L-3661 - Lampholders and Lights, Indicator, Bayonet Base, Miniature and Candelabra.
MIL-S-3786 - Switches, Rotary (Circuit Selector, Low-Current Capacity), General Specification for.
MIL-L-3918 - Lubricating Oil, Instrument, Jewel Bearing, Nonspreading, Low Temperature
MIL-S-3950 - Switches, Toggle.
MIL-C-3965 - Capacitors, Fixed, Nonsolid Electrolytic (Tantalum, Foil and Sintered-Slug), General Specification for.
MIL-C-5015 - Connectors, Electric, "AN" Type.
MIL-E-5272 - Environmental Testing, Aeronautical and Associated Equipment, General Specification for.
MIL-B-5423 - Boots, Dust and Water Seal (for Toggle and Push-Button Switches and Rotary Actuated Parts), General Specification for.
MIL-P-5425 - Plastic, Sheet, Acrylic, Heat Resistant.
MIL-P-5514 - Packings; Installation and Gland Design, Hydraulic, General Requirements for.
MIL-P-5516 - Packings and Gaskets, Preformed, Petroleum Hydraulic Fluid Resistant.
MIL-C-5541 - Chemical Films and Chemical Film Materials for Aluminum and Aluminum Alloys.
MIL-R-5757 - Relays (Electrical (Excluding Thermal), for Electronic and Communication-Type Equipment), General Specification for.
MIL-L-6085 - Lubricating Oil, Aircraft Instrument, Low Volatility.
MIL-G-7421 - Grease, Aircraft and Instrument, Extreme Low Temperature
MIL-I-7798 - Insulation Tape, Electrical, Pressure-Sensitive Adhesive, Plastic.

MILITARY (Cont'd.)

MIL-T-7928 - Terminals; Lug and Splice; Crimp Style, Copper.
MIL-P-8585 - Primer Coating, Zinc Chromate, Low-Moisture-Sensitivity.
MIL-A-8625 - Anodic Coatings, for Aluminum and Aluminum Alloys.
MIL-S-8660 - Silicone Compound.
MIL-S-8805 - Switches and Switch Assemblies, Sensitive and Push (Snap Action), General Specification for.
MIL-M-10578 - Metal Conditioner and Rust Remover (Phosphoric Acid Base).
MIL-P-10971 - Pins, Spring, Tubular (Coiled and Slotted).
MIL-S-12883 - Sockets, for Plug-in Electronic Components; and Accessories, General Specification for.
MIL-L-15016 - Lubricating Oil, General Purpose.
MIL-P-15024 - Plates, Identification - Information and Marking for Identification of Electrical, Electronic and Mechanical Equipment.
MIL-P-15035 - Plastic Sheet: Laminated, Thermosetting, Cotton-Fabric-Base, Phenolic-Resin.
MIL-P-15037 - Plastic Sheet, Laminated, Thermosetting, Glass-Cloth, Melamine-Resin.
MIL-P-15047 - Plastic-Material, Laminated, Thermosetting, Sheets, Nylon Fabric Base, Phenolic-Resin.
MIL-M-15071 - Manuals, Equipment and Systems.
MIL-E-15090 - Enamel, Equipment, Light-Gray (Formula No. 11).
MIL-I-15126 - Insulation Tape, Electrical, Pressure Sensitive Adhesive and Pressure Sensitive Thermosetting Adhesive.
MIL-P-15137 - Provisioning Technical Documentation for Repair Parts for Electrical and Mechanical Equipment (Naval Shipboard Use).
MIL-F-15160/30 - Fuses, Style F03.
MIL-S-15291 - Switches, Rotary, Snap Action.
MIL-P-15328 - Primer, Pretreatment (Formula No. 117 for Metals).
MIL-R-15324 - Rubber Sheets; and Cut, Molded and Extruded Special Shaped Sections - Synthetic, Medium Soft, Shipboard Gasket Use; Except Low Temperature Application.
MIL-T-15659 - Terminal, Lug: Solder Type, Copper.
MIL-L-15719 - Lubricating Grease (High-Temperature, Electric Motor, Ball and Roller Bearings).
MIL-S-15743 - Switches, Enclosed, Rotary, Snap Action.
MIL-B-16246 - Bill of Materials (for Ships and Ships Components).
MIL-E-16366 - Electrical Clamps, Lug Terminals and Conductor Splices-Pressure Grip.
MIL-T-16784 - Terminal Boards.
MIL-W-16878 - Wire, Electrical, Insulated, High Temperature.
MIL-I-16910 - Interference Measurement, Electromagnetic, Methods and Limits.
MIL-I-16923 - Insulating Compound, Electrical, Embedding.
MIL-L-17192 - Lubrication Design, Lubricants, and Lubrication Information for Electronic Equipment; General Specification.
MIL-I-17205 - Insulation Cloth and Tape, Electrical, Glass Fiber, Varnished.
MIL-E-17362 - Electronic Repair Parts Requirements, Procedures for Provisioning Technical Documentation and Stock Numbering.
MIL-B-17931 - Bearings, Ball, Annular, for Quiet Operation.
MIL-I-18057 - Insulation Sleeving, Electrical, Flexible, Glass Fiber, Silicone Rubber Treated.
MIL-P-18177 - Plastic Sheet, Laminated, Thermosetting, Glass Fiber Base, Epoxy-Resin.
MIL-G-18586 - Gaskets, O-Ring, Shipboard Electrical Junction Box.
MIL-G-18709 - Grease, Ball and Roller Bearing.
MIL-F-19207/1 - Fuseholders, Type FHL 10U
MIL-F-19207/2 - Fuseholders, Type FHL11U.
MIL-S-19622 - Stuffing Tubes, Nylon.
MIL-S-20708 - Synchros, 60 and 400 Cycle, General Specification.
MIL-A-21180 - Aluminum - Alloy Castings, High Strength.
MIL-F-21346 - Fuseholders, Block and Plug Type, and Associated Electrical Clips, General Specifications for.

MILITARY (Cont'd.)

MIL-M-21556 - Molding Plastic and Molded Plastic Parts, Asbestos-Fiber Filled, Arc- and Flame-Resistant Phenolic Resin.
MIL-S-21604 - Switches, Rotary, Multipole and Selector Type, 1 to 10 Ampere.
MIL-E-21981 - Electronic Type Designations, Identification Plates and Markings; Requirements for.
MIL-M-22106 - Markers, Identification, Electrical Wire, Pressure Sensitive Adhesive.
MIL-T-22361 - Thread Compound, Antiseize, Zinc Dust-Petrolatum.
MIL-S-22432 - Servo Motors, General Specification.
MIL-G-23827 - Grease, Aircraft and Instrument, Gear and Actuator Screw.
MIL-I-24092 - Insulating Varnish, Electrical, Impregnating.
MIL-S-46093 - Steel Bars, Carbon and Alloy, Round, Square, and Flat (for Springs).

STANDARDS

MILITARY

MIL-STD-108 - Definitions of and Basic Requirements for Enclosures for Electric and Electronic Equipment.
MIL-STD-167 - Mechanical Vibrations of Shipboard Equipment.
MIL-STD-200 - Electron Tubes, Selection and Use of.
MIL-STD-242 - Electronic Equipment Parts (Selected Standards).
MIL-STD-276 - Impregnation of Porous Nonferrous Metal Castings.
MIL-STD-454 - Standard General Requirements for Electronic Equipment.
MIL-STD-681 - Identification Coding and Application of Hookup Wire.
MIL-STD-701 - Preferred and Guidance Lists of Semiconductor Devices.
MIL-STD-740 - Airborne and Structureborne Noise Measurements and Acceptance Criteria of Shipboard Equipment.
MS15571 - Lamps, Incandescent, T-3-1/4, Miniature Bayonet; Single Contact.
MS15572 - Lamp, Incandescent G-4-1/2, Miniature Bayonet, Single Contact.
MS15573 - Lamp, Incandescent, G-3-1/2, Miniature Bayonet, Single Contact.
MS17039 - Stuffing Tube, NPT, Nylon, Size 1.
MS17040 - Stuffing Tube, NPT, Nylon, Size 2.
MS17041 - Stuffing Tube, NPT, Nylon, Size 4T.
MS17042 - Stuffing Tube, NPT, Nylon, Size 5.
MS17043 - Stuffing Tube, NPT, Nylon, Size 6.
MS17044 - Stuffing Tube, NPT, Nylon, Size 7.
MS17045 - Stuffing Tube, NPT, Nylon, Size 8.
MS17046 - Stuffing Tube, NPT, Nylon, Size 9.
MS17143 - Terminal, Lug, Crimp Style, Copper, Insulated.
MS35333 - Washer, Lock, Flat-Internal Tooth.
MS35335 - Washer, Lock, Flat-External Tooth.
MS35337 - Washer, Lock, Split, Helical, Light Series.
MS35338 - Washer, Lock, Split, Helical, Medium Series.
MS35339 - Washer, Lock, Split, Helical, Heavy Series.
MS35340 - Washer, Lock, Split, Helical, Extra Heavy Series.

DRAWINGS

NAVAL SHIP ENGINEERING CENTER (NAVSEC)

9-S-4725-L - Inserts for Aluminum Castings.
9000-S6202-73075 - Switch, Rotary, Multipole Panel Mounted, 10 Amp., 120V., AC, Single Pole Blades, Type S-LJR.
9000-S6202-73193 - Switch, Multipole, Rotary, Spring Return, Positive Detent Action, Panel Mounting System 2642, 2643 (Interior Units for Enclosures).
9000-S6505-73214 - Terminal Boards.
9000-S6202-73295 - Switch, Rotary, Multipole, Type 4JR, Panel Mounted, 10 Amp., 120 V., AC, Rotary Action Cutout.
9000-S6503-73436 - Switch, Rotary, Selector 16 Position, for Sound Powered Telephones, Panel Mounted, Types JA-2C(16), JA-6C(16) and JA-10C(16).
9000-S6503-73437 - Switch, Rotary, Telephone Selector, 10 Amp., 120 V., 125 V., AC Panel Mounting, No Enclosure, 2 Sect. 30 Position Type JA2C(30).

DRAWINGS (Cont'd.)

NAVAL SHIP ENGINEERING CENTER (NAVSEC)
9000-S6505-73687 - Dial Markings for IC Telegraph and Indicating Systems.
9000-S6202-73724 - Salt Spraying Machine.
9000-S6202-73826 - Switch, Rotary, Multipole, Panel Mounted, 10 Amp., 120 V., AC Double Pole Blades, Type S-2JR.
9000-S6202-73827 - Switch, Rotary, Multipole, Panel Mounted, 10 Amp., 120 V., AC, Common Rotor Blades, Type S-3JR.
9000-S6202-73907 - Light, Indicator, Switchboard, 2 Lamp-DPF, Types S-27A through S-27G.
9000-S6202-74225 - Switch, Rotary Selector, Types S-1JF, S-2JF, S-2JFM, 3 Amp., 120 V., AC, Panel Mounted, No Enclosure.
9000-S6202-74307 - Light, Indicator, Switchboard, 2 Lamp-DC Ckts.
9000-S6202-74422 - Switch, Rotary Selector, Class S-JL, 3 Amp., 120 V., AC, Panel Mounted, No Enclosure, Assemblies.

PUBLICATIONS

NAVAL AIR SYSTEMS COMMAND
OP-1303 - U.S. Navy Synchros; Description and Operation.

DEPARTMENT OF DEFENSE
Handbook H6-1 - Federal Item Identification Guides for Supply Cataloging - Part 1.

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

2.2 Other publications.- The following documents form a part of this specification to the extent specified herein. Unless otherwise indicated, the issue in effect on date of invitation for bids or request for proposal shall apply.

NATIONAL BUREAU OF STANDARDS
Handbook H28 - Screw Thread Standards for Federal Services.

(Application for copies should be addressed to the Superintendent of Documents, Government Printing Office, Washington, D.C. 20402.)

ENGINEERING EXPERIMENT STATION REPORT
No. 060025 - Proposed Specifications for the Illumination of Interior Communication Instruments and Other Visual Display Systems.

(Application for copies should be addressed to the U.S. Navy Marine Engineering Laboratory, Annapolis, Md. 21402.)

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)
A153 - Zinc Coating (Hot Dip) on Iron and Steel Hardware.

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

AMERICAN STANDARDS ASSOCIATION (ASA)
B27.1 - Lock Washers.
Y32.16 - Electrical and Electronic Reference Designations.

(Application for copies should be addressed to the American Standards Association, Inc., 10 East 40th Street, New York, N.Y. 10016.)

(Technical society and technical association specifications and standards are generally available for reference from libraries. They are also distributed among technical groups and using Federal agencies.)

3. REQUIREMENTS

3.1 Qualification. - Qualification, if required, will be in accordance with the individual equipment specification.

3.2 General requirements. -

3.2.1 The detailed requirements for the individual equipment shall be specified in the individual equipment specification which shall list the particular requirements outlined hereinafter applying to the individual equipment (see 6.3). In case of discrepancies between this specification and the individual equipment specification, the individual equipment specification shall govern.

3.2.2 Primary requirements. - All the usual desirable characteristics of commercial equipment are equally important from the Naval point of view. Some of these, however, are of exceptional importance in Naval practice. Certain additional characteristics not normally incorporated in the design of commercial equipment are extremely important on Naval ships. The primary requirements which are the basis for the selection of all Naval equipment are:

(a) Maximum reliability for operation under shipboard conditions of extreme heat, salt spray, moisture, vibration, shock and inclination as described herein.
(b) Material and design to be lightweight and compact consistent with reliable shipboard operation.
(c) Maximum accessibility for maintainability, inspection, and repair.
(d) Maximum simplicity of design consistent with other requirements described herein.
(e) Maximum resistance to corrosive action, in particular that of moist sea air and ultra violet radiation.
(f) Maximum operating and maintenance economy.
(g) Maximum interchangeability of parts.
(h) Minimum number of necessary maintenance parts.
(i) Satisfactory identification of all equipment and parts for ease in accurate requisitioning.
(j) Satisfactory drawings with full and concise manufacturing and operating instructions.
(k) Maximum ease of repair by Naval personnel and with the facilities ordinarily found onboard ships of the Navy.
(l) Maximum protection for operating and maintenance personnel.
(m) Maximum ease of installation.

3.2.3 NAVSEC approval. -

3.2.3.1 Normally, specific NAVSEC approval of design and materials proposed for use in a given equipment is obtained by the submission of working drawings to NAVSEC via the Government inspector. This action is required prior to commencing work (see 3.9.3). Such approval will be given in writing by NAVSEC or the NAVSEC authorized agent by endorsement of drawings or purchase orders.

3.2.3.2 In the development of a design, if a contractor considers it necessary or desirable to change, depart from, or modify the requirements of controlling specifications and drawings, he shall consult with the Government inspector concerning such departures or modifications and after consultation, if still considered desirable, the matter shall be referred to NAVSEC for decision. To avoid delay, it is essential that this be done, if possible, prior to the completion and submission of working drawings. When submitted to NAVSEC for decision, the reason for such changes, modifications and departures from the specifications together with a justification for any change in contract price shall be clearly stated in the contractors letter and the Government inspector shall comment fully thereon in his letter of transmittal to NAVSEC. This procedure is important and it is essential that it be followed strictly to avoid delay.

3.2.3.3 Approval of drawings of equipment for Naval use is, in all cases, secondary to satisfactory operation under service conditions; by approval of drawings NAVSEC thereby assumes the responsibility to the Government for the purchases of the material represented but in no way assumes any part of the contractors responsibility as to the design or the satisfactory performance thereof for the purpose intended. If for any reason, an equipment fails to meet service requirements during the guarantee period, although its use has been tentatively sanctioned by NAVSEC approval of drawings, such fact does not relieve the contractor from the responsibility of correcting defects and making such changes as may be necessary to meet the service requirements without additional cost to the Government for the necessary labor and materials. When drawings have been approved by NAVSEC subject to specific modifications and the contractor has no

objections to such modifications, the contractor may proceed if so directed with the work in accordance with the drawings as modified on the assumption that revised drawings may be submitted in due course for file and to record the fact that the specified modifications have actually been made in the drawings and followed in the work.

3.2.4 Completeness of equipment. - It is the intent of the equipment specifications to obtain equipment complete in every way ready for operation and service, unless specific exception is made in the specification stating that certain parts are to be supplied by the Government or from other sources.

3.2.5 Omissions, mistakes, and discrepancies. -

3.2.5.1 The misplacement, inclusion, or omission of any word, letter or punctuation mark shall in no way be considered to alter the manifest intent or meaning of this specification or of any individual equipment specification which references this specification.

3.2.5.2 Any part of an equipment or any component essential to the specific performance characteristics thereof which is not described in full or at all in the specifications or drawings pertaining thereto but which is necessary for the proper performance of the equipment in accordance with the specification requirements, shall be supplied by the contractor without an increase in the contract price.

3.2.5.3 Mistakes in descriptions of equipment details which, if not corrected, would interfere with the specified performance characteristics of the equipment involved, shall not relieve the contractor of the responsibility for meeting the performance requirements of the specifications or for producing satisfactory results. Such mistakes shall be corrected without an increase in the contract price.

3.2.5.4 In any case of discrepancy or lack of clarity in this specification or in an individual equipment specification which references this specification, the contractor shall promptly request clarification from the contracting officer. Neither such request nor the time reasonably necessary to resolve the discrepancy or provide clarification shall relieve the contractor of his responsibility for timely delivery of equipment meeting the performance characteristics of the specifications. Work performed based on such discrepancy or lack of clarity shall be at the contractor's own risk.

3.2.6 Changes and developments. -

3.2.6.1 Contractors shall make no changes in any approved drawing without obtaining the approval of NAVSEC through the Government inspector. Authorized changes comprise items beyond the original intent of the contract. Estimates of increased or decreased cost of changes shall be submitted to and approved by NAVSEC before any work is undertaken in connection therewith. Developments include all modifications necessary to comply with the original intent of the contract and the proper and satisfactory completion thereof.

3.3 Definitions. - For purposes of this specification, definitions specified in 6.4 shall apply.

3.4 Materials. -

3.4.1 General. - The equipment shall be sturdily constructed of a grade of material adequate for each specific application (see 2.1).

3.4.2 Substitution of (equal or superior) materials or parts. - The specifications, standards, drawings and publications in 2.1 have been listed to show materials of known quality which will provide for good design to meet the rigorous needs of the Naval service. The bidder or manufacturer may consider the listed materials or substitute any material of equivalent grade in lieu of the specified materials provided all other requirements of the individual equipment specifications are fulfilled. Before such substitutions are made, approval for each application shall be obtained in writing from the command or agency concerned (see 6.5). If the contractor desires to make substitution for a specified material after the design has been approved he shall submit a statement to the command or agency concerned describing the proposed substitution, together with evidence to substantiate his claim that such substitution is desirable and will not affect reliability. At the discretion of the command or agency concerned, test samples may be required to prove the suitability of the proposed substitute.

3.4.3 Fungus-inert materials. - Fungus-inert materials shall be in accordance with requirement 4 of MIL-STD-454.

3.4.4 Flammable materials. - Flammable materials shall be in accordance with requirement 3 of MIL-STD-454.

3.4.5 Arc-resistant materials. - Materials used for insulation of electrical power circuits, where arcing is possible, shall conform to the following:

Material	Specification	Types
Ceramic	MIL-I-10	All
Plastic, laminated thermosetting rods and tubes	MIL-P-79	GMG
Plastic Sheets, laminated thermosetting, glasscloth, melamine-resin	MIL-P-15037	GME
Plastic material, laminated thermosetting, sheets, glasscloth, silicone resin	MIL-P-997	GSG
Plastic, molding plastic and molded plastic parts	MIL-M-14	GMG CMI-5 MME MMI-30 MAG MAI-60 MDG
Molding plastic, silicone resin, thermosetting	MIL-M-14	MSG MSI-30

3.4.6 Toxic materials. - Materials which may produce harmful toxic vapors under conditions encountered in Naval service shall not be used. Mercury and radium shall not be used on submarines. Radioisotopes shall not be used without specific approval from the command or agency concerned (see 6.5).

3.4.7 Wood. - Wood shall not be used, unless specifically permitted in an individual equipment specification.

3.4.8 Metals. - Metal parts shall be of a corrosion-resisting material or of a material given a corrosion-resistant treatment or coating. Except as otherwise specified, the following shall apply.

3.4.8.1 Aluminum. - Where the use of lightweight metal is desired, aluminum alloy shall be used insofar as practicable. Aluminum alloys, except castings, shall conform to ASTM standards. Aluminum alloy casting shall conform to QQ-A-591, QQ-A-596, or alloy 43, temper F or alloy 356 of QQ-A-601. Where aluminum alloy castings for high strength and high quality applications are required, they shall conform to MIL-A-21180.

3.4.8.2 Magnesium. - The use of magnesium shall require specific approval of the command or agency concerned for each application (see 6.5).

3.4.8.3 Ferrous alloys. - Ferrous alloys shall be in accordance with requirement 15 of MIL-STD-454. Where enclosures, cases, frames, panels, brackets and miscellaneous hardware are fabricated of steel, such materials shall be treated to prevent corrosion in accordance with requirement 15 of MIL-STD-454. Corrosion resisting steel castings shall conform to MIL-S-867.

3.4.8.4 Nonferrous material (except aluminum). - Nonferrous materials, except aluminum, shall conform to commercial standards.

3.4.8.5 Zinc.- Zinc shall not be used where the increased electrical resistance of the surface, due to the protective treatment, has a deleterious effect on electrical performance.

3.4.8.6 Springs (material).- The type and grade of material used for and the processing of springs shall be entirely suitable for the intended purpose. Spring material shall conform to the following specifications, as applicable:

Specification	Subject
QQ-C-585	- Copper-Nickel-Zinc-Alloy-Plate, Sheet, Strip and Bar, Copper Alloy Numbers 735, 745, 752, 762, 766 and 770.
QQ-V-586	- Copper-Nickel-Zinc-Alloy-Rod, Shapes and Flat Products with Finished Edges (Flag Wire, Strip and Bar).
QQ-C-530	- Copper-Beryllium Alloy Bars, Rods, and Wire.
QQ-C-533	- Copper-Beryllium Alloy Strip, Copper Alloy Numbers 170 and 172.
QQ-W-401	- Wire, Round, Copper Alloy Number 51A (Phosphor Bronze A) Spring.
QQ-W-423	- Wire, Steel, Corrosion-Resisting.
QQ-W-470	- Wire, Steel, High Carbon, Spring, Bright, Music.
QQ-W-777	- Steel, Carbon, Strip, Cold-Rolled, Untempered, Spring.
MIL-S-7947	- Steel, Sheet and Strip (1095) Aircraft Quality.
MIL-S-46033	- Steel Bars, Carbon and Alloy, Round, Square, and Flat (for Springs).
MIL-S-46049	- Steel, Carbon, Strip, Cold Rolled, Hardened and Tempered Spring Quality.

3.4.8.7 Other metals.- Gold, silver, nickel, chromium, rhodium, tin, and lead-tin alloys, if used, shall be of suitable quality to meet the requirements of this specification and the individual equipment specification.

3.4.9 Plastics.- In any plastic considered for use in interior communication equipment, the properties of fire resistance (see 3.4.4), arc resistance (see 3.4.5) and low toxicity (see 3.4.6) are important. In addition, good mechanical and electrical properties are necessary. Laminated plastics in the form of sheets, rods, tubes, and special shapes (channels, and so forth) are generally used where a rigid material, having dielectric properties, and capable of being readily machined or fabricated is needed.* Cut or machined surfaces of glass base laminates need not be treated with lacquer. Similar surfaces of other base laminates shall be coated with a clear lacquer. Molded plastics are generally used where a rigid dielectric is needed and where the form or shape is such that fabrication out of sheet stock is too costly or time-consuming or where the part is too complex in design. The molding compound used to produce the parts shall also have good moldability in a great variety of molds; most of these molds being already in existence.

3.4.9.1 Mechanical parts.- Whenever plastic materials are contemplated for mechanical applications as replacements or substitutes for metal parts, due consideration shall be given to the fire hazard (see 3.4.4) that such usage may incur. Tables I and II summarize the characteristics of the various plastics for use in selecting material for mechanical applications.

3.4.9.2 Electrical insulating parts.- Plastics used for electrical insulating parts shall be of the type specified hereinafter for the various classes of electrical insulation (see 3.8.14).

3.4.9.2.1 Laminated thermosetting plastics.-

3.4.9.2.1.1 Classes A and B insulated equipment.- Sheet laminates shall conform to type GME or MIL-P-15037. Rods and tubes shall conform to type GMG of MIL-P-79. Special shapes shall be of a suitable laminated fibrous glass and melamine resin combination.

3.4.9.2.1.2 Class H insulated equipment.- Sheet laminates shall conform to type GSG or MIL-P-997. Rods, tubes, and special shapes shall be of a suitable laminated fibrous glass and silicone resin combination.

3.4.9.2.2 Molded thermosetting plastics. -

3.4.9.2.2.1 Classes A and B insulated equipment. - Molded parts shall conform to type MAI-60 or MMI-30 of MIL-M-14. In those cases involving small-mass parts and where the design is such that a lower impact grade can be tolerated, type MME of MIL-M-14 may be used.

3.4.9.2.2.2 Class H insulated equipment. - Molded parts shall conform to type MSG or MSI-30 of MIL-M-14.

3.4.9.3 Thermoplastic materials. - Plastics which melt or soften under test conditions imposed by equipment specifications shall not be used.

3.4.9.4 Painted plastics. - Plastic materials shall normally be furnished in the natural color. Where a specific color is required by the application, this color may be obtained by adding coloring matter to the base material, providing electrical or mechanical properties are not adversely affected. If for any reason satisfactory to the command or agency concerned, the procurement of colored base material is not feasible, color may be obtained by painting with insulating lacquer or other materials approved by the command or agency concerned (see 6.5). The insulating lacquer shall conform to type G of MIL-I-17384.

Table I - Comparator chart.

Relative rating of molded thermosetting plastics.

Specification	Type	Resin	Filler	Heat resistance	Arc resistance	Electrical properties after moisture exposure	Dielectric strength	Dielectric loss	Impact and shock resistance	Moldability	Approximate specific gravity
MIL-M-14	CFG[1/]	Phenolic	Wood flour (cellulose)	F	P	F	G	F	P	E	1.37
MIL-M-14	CFI-5[1/]	Phenolic	Cotton (cellulose)	F	P	F	F	F	F	VG	1.37
MIL-M-14	CFI-10[1/]	Phenolic	Cotton (cellulose)	F	P	F	F	F	G	VG	1.39
MIL-M-14	CFI-20[1/]	Phenolic	Cotton (cellulose)	F	P	F	F	F	VG	G	1.40
MIL-M-14	CFI-40[1/]	Phenolic	Cotton (cellulose)	F	P	F	F	F	VG	F	1.40
MIL-M-14	MFE	Phenolic	Mica (mineral)	G	P	G	E	E	P	G	1.90
MIL-M-14	MFG	Phenolic	Asbestos (mineral)	G	F	F	F	F	F	G	1.90
MIL-M-14	MFH	Phenolic	Asbestos (mineral)	G	F	F	G	F	F	G	1.67
MIL-M-14	MFI-10	Phenolic	Asbestos (mineral)	G	P	F	F	F	G	G	1.65
MIL-M-14	MFI-20	Phenolic	Asbestos (mineral)	G	P	F	F	F	VG	G	1.65
MIL-M-14	CMG	Melamine	Cellulose	G	G	F	G	G	P	G	1.45
MIL-M-14	CMI-5	Melamine	Cotton (cellulose)	G	G	F	F	G	F	G	1.50
MIL-M-14	MME	Melamine	Asbestos (mineral)	VG	VG	F	E	VG	P	G	1.78
MIL-M-14	MMI-30	Melamine	Glass (mineral)	E	E	F	G	VG	VG	F	2.00
MIL-M-14	MAG	Alkyd	Clay-asbestos (mineral)	VG	VG	F	F	VG	P	E	2.23
MIL-M-14	MAI-60	Alkyd	Glass (mineral)	VG	G	F	G	VG	VG	G	2.00
MIL-M-14	MDG	Diallyl-phthalate	Asbestos (mineral)	G	G	E	E	G	P	E	1.65
MIL-M-14	MSG	Silicone	Mineral	E	E	E	E	E	P	G	1.80
MIL-M-14	MSI-30	Silicone	Glass (mineral)	E	VG	E	E	E	VG	F	2.00

Ratings: E - excellent, VG = very good, G = good, F = fair, P = poor

1/ Cotton or wood flour filled molding compounds shall not be used, unless specifically approved by the command or agency concerned (see 6.5).

Table I - Comparator chart (Continued).

Specification	Type	Resin	Filler	Heat resistance	Arc resistance	Electrical properties after moisture exposure	Dielectric strength	Dielectric loss	Impact and shock resistance	Moldability	Approximate specific gravity
MIL-M-14	SDG	Diallyl-phthalate	Glass	G	F	VG	E	E	P	E	1.59
MIL-M-14	SDI-5	Diallyl-phthalate	Acrylic polymer	F	F	E	E	E	F	E	1.30
MIL-M-14	SDI-30	Diallyl-phthalate	Polyethylene terephthalate	G	F	E	E	E	VG	E	1.30
MIL-M-21556	MFA-30	Phenolic	Asbestos-Glass	G	VG	F	G	F	VG	VG	1.90
MIL-M-14	MAI-30	Alkyd	Asbestos-Glass	VG	VG	F	F	E	VG	VG	2.30

Ratings: E = excellent, VG = very good, G = good, F = fair, P = poor

3.4.9.5 Plastic identification plates. - When plastic materials are used for identification plates, instruction plates or wiring diagrams (see 3.8.10), the materials shall be in accordance with L-P-387.

3.4.9.6 Dials and transparent or translucent parts. - Plastic for dials and other transparent or translucent applications shall be in accordance with MIL-P-80, L-P-504 or MIL-P-5425. In general, polystyrene, methacrylates, allyls; cellulose acetate butyrate, vinyl chloride-acetates and melamine are acceptable materials for dials and related translucent or transparent parts.

Table II - Comparator chart.

Relative rating of laminated thermosetting plastic sheets.

Specification	Specification type	Dielectric loss dry	Insulation resistance	Mechanical strength		Voltage rating	Effect of moisture on electrical properties	Fungus resistance	Heat resistance	Ease of fabrication	Dimensional stability	Cost	Weight
				Flexural strength	Impact strength								
MIL-P-997	GSG	E	G	G	E	F	G	E	VH	P	G	VH	H
MIL-P-15047	NPG	G	E	P	G	G	G	G	L	F	P	VH	L
MIL-P-15037	GME	G	E	E	E	E	E	G	H	P	G	H	H
L-P-513	PBE-P	F	G	F	P	E	G	G	M	G	F	M	M
L-P-513	PBE	P	P	F	P	G	F	F	M	G	F	L	M
L-P-513	PBG	P	P	F	P	G	G	F	M	G	F	L	M
1/ MIL-P-15035	FBI	P	P	G	F	P	P	P	M	G	P	M	M
1/ MIL-P-15035	FBE	P	P	G	F	F	P	P	M	G	P	M	M
1/ MIL-P-15035	FBG	P	P	G	F	F	P	P	M	F	P	M	M
1/ MIL-P-15035	FBM	P	P	G	G	P	P	P	M	F	P	M	M

Ratings: E = excellent, G = good, F = fair, P = poor, VH = very high, H = high, M = medium, L = low

1/ Cotton fabric base laminates shall be used only where high-impact resistance for gears, cams or similar parts is required and each application shall be specifically approved by the command or agency concerned (see 6.5).

Table II - Comparator chart (Continued).

Specification	Specification type	Dielectric loss dry	Insulation resistance	Mechanical strength		Voltage rating	Effect of moisture on electrical properties	Fungus resistance	Heat resistance	Ease of fabrication	Dimensional stability	Cost	Weight
				Flexural strength	Impact strength								
MIL-P-18177	GEE	G	E	E	E	E	G	G	M	P	G	VH	H
MIL-P-18177	GEB	G	E	E	E	E	G	G	H	P	G	H	H

Ratings: E = excellent, G = good, F = fair, P = poor, VH = very high, H = high, M = medium, L = low

3.4.10 Ceramics. - Ceramics used for purposes of insulation shall be in accordance with MIL-I-10. All surfaces of ceramic parts shall be glazed or, if glazing is impracticable, the surfaces shall be treated with a silicone varnish (Dow Corning DC 200, or equivalent) acceptable to the command or agency concerned (see 6.5). Prior to the use of ceramics for insulation, the contractor shall specifically call its use to the attention of the command or agency concerned and obtain approval.

3.4.11 Impregnating, embedding and encapsulating compounds. - Materials used for impregnating, embedding or encapsulating electronic parts shall not, either in the state of their original application or as the result of aging, have any injurious effect on the insulation materials to which they are applied and shall not cause corrosion or deterioration of any adjacent parts. The compound selected shall not flow at temperatures below 85°C. nor crack at temperatures down to minus 54°C. Rigid materials used for encapsulating or embedding parts in subassemblies shall be in accordance with MIL-I-16923 and the following: Enclosures shall be avoided wherever possible. Filling or potting is not approved.

3.4.11.1 Selection of type. - Unless otherwise specified in the individual equipment specification, type A, B, or C compounds shall be selected to provide optimum performance of the assembly. In general, type B materials are to be preferred, except where critical electrical characteristics are required or where the ambient temperature for the assembly may exceed 105°C.

3.4.11.2 Selection of material. - Unless otherwise specified in MIL-I-16923, or specifically approved by the command or agency concerned (see 6.5), the conditions under which these materials are applied and used shall in all respects conform to the manufacturers recommendations. However, the selection of a particular compound shall be such that neither the material itself nor the process by which it is applied shall have a deleterious effect on the operation of the assembly or the overall equipment.

3.4.11.3 General performance characteristics. - These materials are particularly useful where it is required to have a rugged compact assembly sealed against moisture and rigidly supported internally so that the effects of shock and vibration are minimized.

3.4.12 Glass. - All glass for use in units for protection of meters, cathode ray tubes, and for viewing dials and indicators shall be clear, presenting no evidence of distortion when viewed from any angle.

3.4.13 Lubricants and lubrication. - Lubricants shall be selected from the applicable specifications listed in table III. Service manuals shall refer to lubricants by correct Navy designations as well as by trade and specification numbers. When the manufacturer is unable to determine the applicable lubricant, complete information on the specific application shall be forwarded to the command or agency concerned, with a request for assistance. Equipment shall be so designed as to use as few different types of lubricants as practicable. It shall be possible to quickly and conveniently lubricate the equipment, due consideration being given to access, probable installed location, number of tools and accessories required, and so forth. All points requiring periodic lubrication shall be conveniently accessible (preferably from the front of the unit) to permit lubrication without major disassembly. In general, the required bearing and gear parts shall be consolidated into the minimum number of grease or oil tight cases with only the operating shafts protruding through adequate seals. Cases too small for inspection covers shall be so placed that their removal for bench inspection would not necessitate the disturbance of any wiring except that fastened to that case.

Table III - Characteristics and applications of lubricants.

Specification	Material	Characteristics and applications
MIL-G-3545	Grease, aircraft, high temperature	0° to 300°F. Soda soap and petroleum oil, long retention and water resistant. Used for high speed anti-friction bearings, engine accessories.
MIL-G-3278	Grease; aircraft and instrument (for low and high temperatures)	Synthetic oil grease (-65° to 250°F. and 300°F. for short periods of time; 1,000 hours at 250° F. and 10,000 r.p.m.). Bleeding 5 percent. Used in ball, roller, and needle bearings, gears, and on sliding and rolling surfaces of such equipment as instruments, cameras, and electronic gear.
MIL-G-7421	Grease, extreme low temperature	Low starting torque (-100°F.) (650 hours at 250°F. and 10,000 r.p.m.) lithium base diester oil. For use in low torque application where starts at -70°F. or lower may be required.
MIL-L-15719	Lubricating grease (high temperature, electric motor, ball and roller bearings)	0° to 300°F. silicon-lithium soap grease for use on ball and roller bearings only of electric motors, class H insulated. This grease is not to be used for action involving metal sliding on metal, journals.
MIL-L-6085	Lubricating oil, gear, petroleum base	Diester oil, reduction of galvanic corrosion a basic requirement. Used for electronic equipment where a low evaporation oil is required for both high and low temperature applications.
MIL-G-23827	Grease, aircraft and instrument	Minus 65° to 250°F. range - reduced evaporation; rust prevention and oxidation stability. For use on lightly loaded bearings of fire control equipment and instruments and related components such as synchros, gyros, gears, bearings, sliding parts, and small instruments.
MIL-G-18709	Grease, ball and roller bearing	For use on rotating, sliding or roller bearing, surfaces at medium speeds with temperature range of 125° to 200°F. and intermittent use at 225°F.
MIL-L-15016	Lubricating oil, general purpose	For general purpose use.
MIL-L-3918	Lubricating oil, instrument, non-spreading, low temperature	For jewel bearings.

Wherever possible, prelubricated, sealed-for-life bearings shall be used. Where the use of sealed-for-life bearings is not practicable, single shield or open type bearings may be used, as applicable. Grease lubricated ball bearings shall be lubricated by means of compression grease cups and grease drain plugs, wherever practicable. A lubrication chart in accordance with the applicable requirements of MIL-L-17192 may be supplied by the manufacturer.

3.4.14 Painting. - Sheet metal and cast enclosures shall be completely painted in accordance with the requirements outlined hereinafter. Plastic enclosures normally will not be painted (see 3.4.9.4).

3.4.14.1 Cleaning. - After all machining, welding, and brazing operations are completed, the exterior and interior surfaces of all metal enclosures shall have all rust or other visible corrosion products removed; (rust removal from ferrous metal surfaces shall be in accordance with MIL-M-10578, and shall be thoroughly cleaned of all grease, oil, and dirt by solvent wiping, vapor degreasing, or caustic washing and rinsing.

3.4.14.2 Undercoats. - Either of the following undercoats shall be applied:

(a) One coat of primer pretreatment coating in accordance with MIL-P-15328 shall be applied as a continuous film 0.0002 to 0.0005 inch thick.
(b) A hot diptank phosphate or chromate-phosphate treatment conforming to type I of TT-C-490 followed by one coat of primer, conforming to TT-P-664 or MIL-P-8585 and applied as a continuous film 0.0002 to 0.001 inch thick.

3.4.14.3 Finish coats. - Gray enamel, conforming to MIL-E-15090, shall be applied in sufficient thickness over the undercoat to provide protection of the equipment and to provide a satisfactory appearance.

3.4.15 Protection against corrosion. - In order to prevent corrosion, all metal parts shall be of suitable corrosion resisting materials or other materials treated in a satisfactory manner (see 3.4.15.2) to render them adequately resistant to corrosion. Internal parts fabricated of nonferrous materials contained in a watertight or submersible enclosure need not be given a corrosion resistant treatment in accordance with 3.4.15.2.

3.4.15.1 Corrosion resisting materials. - The following are satisfactory corrosion resisting materials:

(a) Silver
(b) Brass.
(c) Bronze.
(d) Copper.
(e) Copper-nickel alloy.
(f) Nickel-copper alloy.
(g) Austenitic corrosion resistant steel.

3.4.15.2 Corrosion resisting treatments. - The corrosion resisting treatments listed hereinafter are satisfactory. They shall be applied after all fabricating operations such as welding, machining, drilling and tapping have been completed. Unless otherwise specified in the contract or order, corrosion resisting treatments shall not be applied to surfaces which are in functional contact where gouging or binding may be a factor or where the treatment might interfere with normal functioning or where electrical grounding through the surface is required. Other corrosion resisting treatments, including combination coatings such as an electro deposited nickel, shall be approved by the command or agency concerned prior to their use (see 6.5).

(a) Zinc coating (hot dip galvanizing) conforming to ASTM A153, for parts other than threaded fasteners, unless part specifications contain other requirements.
(b) Electroplating of zinc conforming to class 2, type II of QQ-Z-325, for surfaces not to be painted except that class 3 thickness may be used for externally threaded parts, bolts, studs and washers. Class 2, type I plating may be used on parts which are continuously exposed to temperatures in excess of 150° F. or are intermittently exposed for short periods to temperatures of approximately 300° F. Either class 2, type II, or class 2, type III coatings shall be used on surfaces that are to be painted.
(c) Electroplating of cadmium conforming to type II, class 1 of QQ-P-416, for surfaces not to be painted. Type I, class 1 may be used on parts which are continuously exposed to temperatures in excess of 150 F. or intermittently exposed for short periods to temperatures of approximately 300 F. Either type II, class 1 or type III, class 1 coatings shall be used on surfaces that are to be painted. Electroplating of cadmium shall not be used internally in any instrument or equipment or for applications as follows:
  (1) Where plated parts are in grease or oil chambers.
  (2) Lock washers.
  (3) Threaded parts.
(d) Electroplating of chromium conforming to QQ-C-320
(e) Electroplating of nickel conforming to QQ-N-290.
(f) Electroplating of silver conforming to QQ-S-365.
(g) Electroplating of gold to a thickness that is adequate to pass the salt spray test of 4.4.12.
(h) Anodic treatment of aluminum conforming to MIL-A-8625 for surfaces not to be painted. For surfaces to be painted, either the method of MIL-A-8625 or chemical treatment in accordance with MIL-C-5541 may be used.
(i) Platinum sheathing, when used, shall be at least 0.003 inch thick to withstand continuous immersion in salt water.

3.4.15.3 Selection of metals. - In order to minimize corrosion attack due to electrolytic action between dissimilar metals when used in contact with each other, the selection of metals shall be limited to those having a small difference of electrical potential in the electrochemical series. The same principle applies in the selection of a corrosion resisting treatment (see 3.4.15.2). In addition, metallic coatings that are anodic to the basic metal will afford galvanic protection to the basic metal and so are not required to be completely free from pores. Metallic coatings that are cathodic to the basic metal are required to be free from pores so that accelerated corrosion of the basic metal at pores will not take place. When selecting metals, the manufacturer should consult table IV covering to probable action of combinations of metals in sea water. Where contact is required, for structural reasons, between dissimilar metals having large differences of electrolytic potentials in the electrochemical series, the contact surfaces shall be isolated with at least two coats of varnish (or other suitable means) at the time of assembly.

Table IV - Sea water corrosion of galvanic couples.

Since sea water is a good electrolytic conductor, and since it is common practice to combine dissimilar metals and alloys in structures exposed to sea water attack, galvanic corrosion is encountered quite frequently.

Galvanic action in sea water follows the general laws of galvanic corrosion. However, the calcium, magnesium and strontium present in sea water tend to precipitate as carbonates on cathodic surface. The effect of such precipitated deposits, plus heavy growths of marine organisms, is to stifle the galvanic effect and to distribute the galvanic protection over larger areas of cathodic surfaces than would be the case in their absence. Marine growths also tend to distribute galvanic action over the anodic surfaces by interposing a common resistance which reduces the relative importance of the initial resistance of the electrolyte.

On the basis of practical experience and experimental observations, the table has been constructed as a qualitative guide to what may be expected when different metals and alloys are combined with different area relationships in sea water exposure. The common materials have been arranged in a galvanic series with respect to sea water. In the case of active-passive materials, like the corrosion resisting steels, it has been assumed in the table that these alloys may suffer accelerated corrosion when in contact with all materials more noble than their active state and that they may accelerate corrosion of all materials less noble than their passive state. In other words, the table tends to err in the safe direction.

TABLE IV -(Cont'd.)

SEA WATER CORROSION OF GALVANIC COUPLES

Legend

- □ The corrosion of the metal under consideration will be reduced considerably in the vicinity of the contact.
- ○ The corrosion of the metal under consideration will be reduced slightly.
- △ The galvanic effect will be slight with the direction uncertain.
- ⌂ The corrosion of the metal under consideration will be increased slightly.
- ▲ The corrosion of the metal under consideration will be increased moderately.
- ● The corrosion of the metal under consideration will be increased considerably.

S Exposed area of the metal under consideration is small compared with the area of the metal with which it is coupled

E Exposed area of the metal under consideration is approximately equal to that of the metal with which it is coupled.

L Exposed area of the metal under consideration is large compared to that of the metal with which it is coupled.

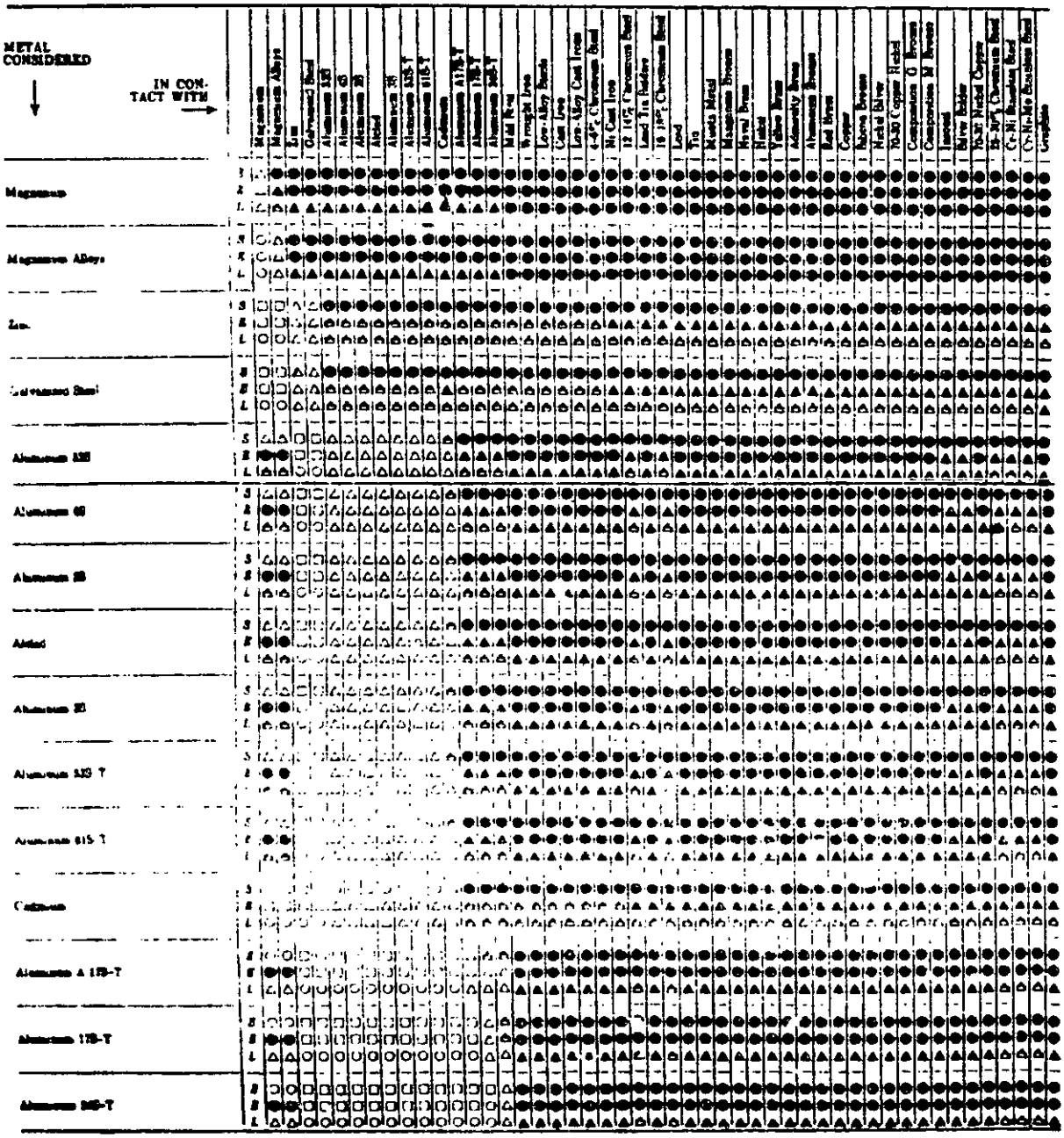

TABLE IV—(Cont'd.)

SEA WATER CORROSION OF GALVANIC COUPLES — Continued

Legend

- ☐ The corrosion of the metal under consideration will be reduced considerably in the vicinity of the contact.
- ○ The corrosion of the metal under consideration will be reduced slightly.
- △ The galvanic effect will be slight with the corrosion uncertain.
- ⚠ The corrosion of the metal under consideration will be increased slightly.
- ▲ The corrosion of the metal under consideration will be increased moderately
- ● The corrosion of the metal under consideration will be increased considerably.

S Exposed area of the metal under consideration is small compared with the area of the metal with which it is coupled.

E Exposed area of the metal under consideration is approximately equal to that of the metal with which it is coupled.

L Exposed area of the metal under consideration is large compared to that of the metal with which it is coupled.

METAL CONSIDERED ↓ / IN CONTACT WITH →		Magnesium	Magnesium Alloys	Zinc	Galvanized Steel	Aluminum 52S	Aluminum 61S	Aluminum 53S	Alclad	Aluminum 2S	Aluminum 356-T	Aluminum 618-T	Aluminum 4S	Cadmium	Aluminum A132-T	Aluminum 138-T	Aluminum 195-T	Mild Steel	Wrought Iron	Low-Alloy Steels	Cast Iron	Low-Alloy Cast Irons	4-6% Chromium Steel	Ni Cast Iron	11-13% Chromium Steel	Lead-Tin Solders	14-18% Chromium Steel	Lead	Tin	Monel Metal	Manganese Bronze	Naval Brass	Nickel	Yellow Brass	Admiralty Brass	Aluminum Bronze	Red Brass	Copper	Silicon Bronzes	Nickel Silver	70-30 Copper Nickel	Composition G Bronze	Composition M Bronzes	Inconel	Silver Solder	70-30 Nickel Copper	25-20% Chromium Steel	Cr-Ni Stainless Steel	Cr-Ni-Mo Stainless Steel	Graphite
Mild Steel	S	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	▲	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	▲
	E	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	△	△	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
	L	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△
Wrought Iron	S	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	△	△	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
	E	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	△	△	△	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
	L	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△
Low-Alloy Steels	S	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	△	△	▲	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
	E	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	○	△	△	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
	L	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△
Cast Iron	S	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	△	△	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
	E	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	○	△	△	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
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Low-Alloy Cast Irons	S	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	△	△	▲	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
	E	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	○	△	△	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
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4-6% Cr Steel	S	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	△	△	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
	E	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	○	△	△	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
	L	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△
Ni Cast Iron	S	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	△	△	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
	E	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	○	△	△	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
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12-14% Chromium Steel	S	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	△	△	▲	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
	E	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	○	△	△	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
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Lead-Tin Solders	S	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△
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16-18% Chromium Steel	S	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	△	△	▲	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
	E	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	○	△	△	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲
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25-30% Chromium Steel	S	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	△	△	▲	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	△	●
	E	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	○	△	△	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	●
	L	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△
Austenitic Cr-Ni Stainless Steel	S	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	△	△	▲	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	△	●
	E	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	○	△	△	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	●
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Austenitic Cr-Ni-Mo Stainless Steel	S	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	△	△	▲	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	△	●
	E	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	○	△	△	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	○	●
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Lead	S	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	●
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Tin	S	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	●
	E	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	○	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	▲
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TABLE IV - (Cont'd.)

SEA WATER CORROSION OF GALVANIC COUPLES — Continued

Legend

- ☐ The corrosion of the metal under consideration will be reduced considerably in the vicinity of the contact.
- ○ The corrosion of the metal under consideration will be reduced slightly.
- △ The galvanic effect will be slight with the direction uncertain.
- ◬ The corrosion of the metal under consideration will be increased slightly.
- ▲ The corrosion of the metal under consideration will be increased moderately.
- ● The corrosion of the metal under consideration will be increased considerably.

S Exposed area of the metal under consideration is small compared with the area of the metal with which it is coupled.

E Exposed area of the metal under consideration is approximately equal to that of the metal with which it is coupled.

L Exposed area of the metal under consideration is large compared to that of the metal with which it is coupled.

METAL CONSIDERED ↓ / IN CONTACT WITH →		Magnesium	Magnesium Alloys	Zinc	Galvanized Steel	Aluminum 52S	Aluminum 61S	Aluminum 53S	Aluminum 56S	Aluminum 56	Aluminum 52S-T	Aluminum 61S-T	Aluminum 53S-T	Aluminum 56S-T	Aluminum 17S-T	Aluminum 24S-T	Aluminum 24S-T Alclad	Mild Steel	Wrought Iron	Low-Alloy Steels	Cast Iron	Low-Alloy Cast Irons	4-6% Chromium Steel	Ni-Cast Iron	12-14% Chromium Steel	Lead-Tin Solders	16-18% Chromium Steel	Lead	Tin	Monel Metal	Manganese Bronze	Naval Brass	Nickel	Yellow Brass	Admiralty Brass	Aluminum Brass	Red Brass	Copper	Silicon Bronzes	Nickel Silver	75-25 Copper-Nickel	90-10 Copper-Nickel	Composition G Bronze	Composition M Bronze	Inconel	Silver Solder	70-30 Nickel-Copper	25-20% Chromium Steel	17-4% Ni-Cu Stainless Steel	17-4% Ni-Mo Stainless Steel	Graphite
Aurus Metal	S	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	▲	▲	●	△	▲	△	▲	△	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
	E	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△
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Manganese Bronze	S	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	▲	▲	●	△	▲	△	▲	△	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
	E	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△
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Naval Brass	S	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	▲	▲	●	△	▲	△	▲	△	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
	E	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	▲
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Nickel	S	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	△	△	△	☐	△	☐	△	☐	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
	E	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	△	△	△	○	△	○	△	○	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	▲
	L	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	△	△	△	○	△	○	△	○	△	△	△	△	△	△	△	△	△	△	△	△	△	△	△	▲
Inconel (15% Cr, 6.5% Fe, Bal. Ni)	S	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	△	△	△	☐	△	☐	△	☐	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
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75-20 Copper Nickel	S	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	△	△	△	☐	△	☐	△	☐	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
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Composition G Bronze (88% Cu, 2% Zn 10% Sn)	S	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	△	△	△	☐	△	☐	△	☐	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
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Composition M Bronze (88% Cu, 3% Zn, 6.5% Sn, 1.5% Pb)	S	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	△	△	△	☐	△	☐	△	☐	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
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TABLE IV-(Cont'd.)

SEA WATER CORROSION OF GALVANIC COUPLES — *Continued*

Legend

- ☐ The corrosion of the metal under consideration will be reduced considerably in the vicinity of the contact.
- ○ The corrosion of the metal under consideration will be reduced slightly.
- △ The galvanic effect will be slight with the direction uncertain.
- ◬ The corrosion of the metal under consideration will be increased slightly.
- ▲ The corrosion of the metal under consideration will be increased moderately.
- ● The corrosion of the metal under consideration will be increased considerably.

S Exposed area of the metal under consideration is small compared with the area of the metal with which it is coupled.

E Exposed area of the metal under consideration is approximately equal to that of the metal with which it is coupled.

L Exposed area of the metal under consideration is large compared to that of the metal with which it is coupled.

METAL CONSIDERED ↓ / IN CONTACT WITH →		Magnesium	Magnesium Alloys	Zinc	Galvanized Steel	Aluminum 52S	Aluminum 53S	Aluminum 61S	Aluminum 62S-T	Aluminum 63S-T	Aluminum 61S-T	Aluminum 17S-T	Aluminum 24S-T	Aluminum 245-T	Nickel Steel	Wrought Iron	Low-Alloy Steels	Cast Iron	Low-Alloy Cast Irons	4-6% Chromium Steel	Ni Cast Irons	12-14% Chromium Steel	Lead-Tin Soldiers	16-18% Chromium Steel	Lead	Tin	Monel Metal	Manganese Bronze	Naval Brass	Nickel	Yellow Brass	Aluminum Bronze	Admiralty Brass	Red Brass	Copper	Silicon Bronze	Nickel Silver	90-10 Copper-Nickel	80-20 Copper-Nickel	Composition G Bronze	Composition M Bronze	Lead	Silver Solder	70-30 Nickel-Copper	25-30% Chromium Steel	C-Ni-Mo Stainless Steel	C-Ni-Mo Stainless Steel	Graphite
Silver Solder	S	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	○	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	△	△	△	△	△	△	△	△	●
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70-30 Nickel-Copper	S	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	○	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	△	△	△	△	△	△	△	△	●
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3.4.16 Bolts, machine screws, studs and nuts. - Bolts, machine screws, studs, and nuts shall conform to FF-N-836, FF-S-85, FF-S-86, FF-S-92, FF-S-200, FF-S-210 or MIL-B-857, as applicable, in accordance with 3.7.11 and 3.4.16.1.

3.4.16.1 Materials. - *All bolts, screws, or nuts used on the outside of watertight (or better) enclosures* shall be of nickel-copper or brass. All other bolts, screws, or nuts may be of steel (when treated as specified in 3.4.15.2(b), (c), or (e)) brass, bronze or nickel-copper alloy.

3.5 Parts - mechanical. -

3.5.1 Gaskets. - Gaskets shall be in accordance with 3.5.1.1 through 3.5.1.4.

3.5.1.1 For static seals (between unit case and cover) gaskets, "O" ring, in accordance with MIL-P-5516 or class 2 of MIL-G-18586 shall be used. For square or rectangular enclosures, the inside radius of the "O" ring at the corners of the enclosure shall be 1/2 inch minimum. The gaskets shall be lubricated with a compound in accordance with MIL-S-8660.

3.5.1.2 For reciprocating motion *seals (push button shafts) and for rotary motion seals (illumination* rheostat shafts or operating knob shafts where the rotational speed is less than 10 r.p.m.) gaskets, "O" ring, in accordance with MIL-P-5516 or class 2 of MIL-G-18586 shall be used. Gaskets shall be lubricated with a compound in accordance with MIL-S-8660. Clearances and other installation data as specified in MIL-P-5514 shall be used. The "O" ring retaining groove shall be cut in the shaft. Where lubrication in service is required, it shall be provided as specified for pneumatic seals in MIL-P-5514.

3.5.1.3 Where the use of "O" rings is not practicable, gasket materials shall be in accordance with MIL-R-2765 (oil resistant) or class 1 of MIL-R-15624 for other than low temperature (minus 20°F. minimum) applications.

3.5.1.4 For round dial windows. - All gaskets for round dial windows shall be of a continuous band of a circumference less than the glass and shall be so arranged that when stretched over the glass the material will form over the edge and the faces of the glass to form a "U" shaped gasket.

3.5.2 Dials and pointers. - Dials shall be of plastic materials as specified in 3.4.9.6, except where this is not practical and indicated in the individual equipment specified. Pointers shall be of plastic materials as specified in 3.4.9.6 for illuminated units and of aluminum as specified in 3.4.8.1 for non-illuminated units. The face of the dial with the markings, lettering and graduations shall be placed as close as practicable to the dial window. The dial faces, markings, lettering, lettering, graduations and pointers shall have a matte finish. For non-illuminated instruments metal dials may be used.

3.5.2.1 Nominal diameters of dial markings shall be 4 inches, 6 inches and 8 inches measured across the outermost item of marking, lettering or graduation on the dial (see 3.5.3). Dial markings and pointers shall be in accordance with 9000-S6505-73687. The markings shall be free from distortion with clear and sharp edges. The width of the pointer tip shall be the same width as the dial graduations. The pointer shall not cover the graduations to which it refers but shall extend only to the nearer edge of the graduations. For other dial sizes specific approval shall be obtained from NAVSEC.

3.5.2.2 Dials and pointers for units having self-contained red illumination in accordance with 3.8.13 shall have dark faces with white numerals, graduations and lettering when viewed under high level ambient illumination and shall present red numerals, graduations and lettering when the internal illumination is energized and viewed under low level ambient illumination. In units having a single indication, the pointer shall have a white border. In units having two concentric indications, distinctive numerals and shapes in addition to a white border as specified in the individual equipment specification shall be used to identify each pointer (see 6.3).

3.5.2.3 Dials for units not having self-contained illumination shall have white faces with black numerals graduations and lettering. In units having a single indication, the pointer shall be black. In units having two concentric indications, distinctive colors and numerals as specified in the individual equipment specification shall be used to identify each pointer (see 6.3).

3.5.3 Dial sizes. - The size of dial markings, dial window openings, and dial windows shall be as follows:

Maximum diameter dial markings	Approximate diameter of window opening	Diameter of window glass	Thickness of window glass
Inches	Inches	Inches	Inches
4	4-1/2	5	1/4
6	6-3/4	7-1/2	1/4
8	9	9-3/4	1/4

Dial windows for submersible units shall comply with the requirements of the individual equipment specification.

3.5.4 Locking devices.

3.5.4.1 Shaft locking devices. - Positive locking devices shall be used to secure collars, gears and similar parts to their associated shafts. Acceptable methods of attachment are keys, splines, spring pins (see MIL-P-10971) and suitable flats or rectangular shapes which shall be provided on both of the connecting parts. Taper pins shall not be used. Setscrews shall not be used unless specifically approved by NAVSEC.

3.5.4.2 Lock washers. - Lock washers, or other means shall be provided for securing threaded connections. Lock washers shall be of corrosion resistant material (see 3.4.15.1) and shall conform to the following:

Type	Specification	MS sheet number
External tooth	FF-W-100	MS35335
Spring	FF-W-84	MS35337 through MS35340 as applicable
Internal tooth	FF-W-100	MS35333

Internal tooth type lock washers shall be used only where specifically approved. Lock washers shall be used with bolts or machine screws and nuts in all cases, including those used to secure electrical connections except on standard Navy terminal boards (see 3.8.11.1). The use of self-locking nuts shall not required additional locking by means of lock washers. Where lock washers are used externally for securing to an aluminum part, an additional flat washer shall be provided to prevent marring the applied protective coating.

3.5.5 Washers. - The sizes of washers shall be in accordance with FF-W-92, or ASA B27.1.

3.5.6 Bearings. - Bearings shall be in accordance with requirement 6 of MIL-STD-454 and as specified in 3.5.6.1 through 3.5.6.4.

3.5.6.1 Bearings, ball. - Ball bearings shall be in accordance with FF-B-171. They shall be applied and installed in accordance with the recommendations of that specification. Grade 00 ball bearings shall be used wherever possible. When ball bearings of the metric series are required, they shall be in accordance with the individual equipment specification (see 6.3).

3.5.6.2 Bearings, roller. - Roller bearings shall be in accordance with FF-B-185 or FF-B-187 and shall be applied and installed in accordance with the recommendations of these specifications.

3.5.6.3 Bearings, sleeve-type. - Sleeve-type bearings shall not be used unless approved by the command or agency concerned. When used, they shall be constructed of oil-impregnated phosphor bronze. Means for replenishing oil reserves as required by the intended service shall be provided in accordance with the bearing manufacturers' recommendations.

3.5.6.4 Bearings, noise tested. - Where required, noise tested bearings shall conform to MIL-B-17931.

3.6 Parts, electrical. -

3.6.1 General. - Resistors and capacitors shall be selected from the types listed in MIL-STD-242, as modified by 3.6.4 and 3.6.5.

3.6.1.1 Use of nonstandard parts. - When a contractor has determined that circuit applications cannot be met by using parts selected from either those specified in this specification, or those specified in MIL-STD-242, the contractor shall inform the command or agency concerned of the following:

(a) If size and weight are the reasons for rejection of the standard part, give details as to physical requirements in equipment which makes necessary the use of the nonstandard part.
(b) If electrical characteristics are the reason for rejection of the standard part, give detailed circuit analysis as to operation when standard part is used as against when nonstandard part is used.
(c) If undue delay in production of equipment is threatened by not being able to procure standard parts, give delivery dates of both standard and nonstandard parts.

If the command or agency concerned authorizes a nonstandard part to be used in place of a standard part, the nonstandard part shall be replaceable by a standard part. Mechanical replacement shall be provided for by allowing mounting space, providing mounting holes, and other measures such as may be necessary in the equipment to permit replacement in the field with a standard part. In such cases, the contractor shall inform the command or agency concerned of the type designation (including nominal values and tolerances) of the standard part for which the nonstandard part is being substituted.

3.6.2 Requirements for semi-conductor devices. - All semi-conductor devices to be used shall be in accordance with the provisions of MIL-STD-701.

3.6.2.1 Device characteristics. - Equipment performance shall depend only on semi-conductor device characteristics defined by the Military specifications.

3.6.2.2 Ratings. - Semi-conductor device maximum ratings shall be followed during the equipment design. Selection of the type of device to be used shall be based on the conditions specified in 3.6.2.3 through 3.6.2.11.

3.6.2.3 High voltage. - Maximum applied voltage shall not exceed the maximum voltage rating of the device under any environmental or operating condition.

3.6.2.4 High current. - The maximum current rating shall not be exceeded under any environmental or operating condition.

3.6.2.5 Power dissipation (audio applications). - For audio applications the instantaneous power required to obtain the desired output power shall in no case exceed the rated maximum power dissipation of the device under any environmental or operating condition during any portion of a cycle.

3.6.2.6 Power dissipation (switching applications). For switching applications, the instantaneous power may exceed the rated maximum power dissipation only after and to the extent that an analysis will show that the peak instantaneous power and the duration and repetition rate of this peak results in an average power below the rated maximum power dissipation of the semi-conductor device.

3.6.2.7 Ambient temperature. - The effect of the specified ambient temperature on the semi-conductor ratings shall be determined.

3.6.2.7.1 Junction temperature. - Maximum rated semi-conductor junction temperatures shall not be exceeded. The following points shall be considered in an equipment design.

3.6.2.8 Mounting of the semi-conductor power devices. - The semi-conductor power device shall be mounted to allow maximum heat transfer out of the device. The desired mounting is the mounting of the device directly on its heat sink or on the metal of a chassis. The equipment design shall be investigated to determine if other semi-conductor components require such mounting.

3.6.2.9 Heat sink. - Sufficient heat sink shall be provided so that the equipment performance shall be as specified at the maximum specified ambient temperature.

3.6.2.10 Cooling. - Convection cooling shall be a prime consideration during equipment design. Circuit boards shall be mounted vertically to allow maximum heat transfer to the circulating air.

3.6.2.11 Transients. - Equipment design shall be such that under any mode of operational switching of the equipment, including on and off, or with an input supply over voltage of 300 percent for a period of 1 millisecond, the output voltage of the equipment power supply(ies) shall not vary by more than 20 percent when tested as specified in 4.4.19.

3.6.3 Electron tubes. -

3.6.3.1 Preferred list. - All electron tubes shall be in accordance with MIL-E-1 and shall be selected from those types in MIL-STD-200. Tentative and final electron tube complements shall be listed on Form DD 816 and four copies of each list forwarded to NAVSEC. (Copies of Form DD 816 may be obtained from the Government inspector, except that activities of the Department of Defense should make application to the Commanding Officer, Naval Supply Depot, Philadelphia, Pennsylvania 19120.)

3.6.3.2 Electron tube or capacitor sockets. - Tube or capacitor sockets shall be of the single-unit type in accordance with MIL-S-12883. Gang type sockets are not acceptable. (This requirement is not intended to preclude the assembly of several sockets on a supporting frame providing the contact clips for any socket are on insulating material which is not continuous with that of any other socket.) Contact springs shall have positive contact and positive action. Socket contacts shall be silver plated phosphor bronze or beryllium copper.

3.6.4 Capacitors. - The use of electrolytic capacitors shall be restricted to equipment application where space and weight limitations prohibit the use of paper dielectric capacitors. Each application (employing electrolytic capacitors) shall be specifically approved by the command or agency concerned (see 6.5) if not

permitted by the individual equipment specifications (see 6.3). When approved, tantalum electrolytic capacitors conforming to MIL-C-3965 are preferred. Plug-in types are preferred and the capacitor shall be firmly secured in the socket.

3.6.4.1 Variable capacitors. -

3.6.4.1.1 Air-dielectric variable (tuning). - Air-dielectric variable capacitors shall be in accordance with requirement 2 of MIL-STD-454.

3.6.5 Variable resistors. - Variable resistors employed as illumination, volume or gain controls for vital equipment shall be of wirewound construction in accordance with MIL-R-22 (for high wattage application) and MIL-R-19 (for low wattage application) and shall provide facilities for staking to prevent turning of the body when the shaft is rotated in service. For nonvital equipment, such as sound motion picture projectors, sound recorders and reproducers, variable composition resistors in accordance with MIL-R-94 will be acceptable. All commercial type switch-resistor combinations shall be provided with mechanical stops at each end of the shaft rotation.

3.6.6 Transformers and inductors. - Transformers and inductors shall be in accordance with requirement 14 of MIL-STD-454 and as specified in 3.6.6.1. Unless otherwise specified in the individual equipment specifications (see 6.3), transformers and inductors shall be grade 5, class S, and life expectancy X.

3.6.6.1 Input transformers. - Input transformers for audio application shall be completely enclosed in a high permeability alloy shield. Primary and secondary windings shall be separated from each other by one or more electrostatic shields, the shields being grounded.

3.6.7 Relays. -

3.6.7.1 Relays shall be designed to operate directly from the normal power supply of the equipment concerned without requiring the use of resistors or transformers. Power supply tolerances shall be as specified in 3.8.3.

3.6.7.2 Relays shall conform to MIL-R-5757 or MIL-R-2033. Relays shall preferably be of the plug-in type with shockproof removable dustproof covers, firmly secured in the mounting sockets. The use of hermetically sealed relays shall be approved by NAVSEC (see 6.5).

3.6.7.3 Relays shall operate satisfactorily, shall make firm, low-resistance contact, and shall retain their setting in any position of the equipment and under any service condition. The contacts shall be noncorrosive and, where practicable, of the self cleaning type. Open type relays shall be readily accessible for inspection, cleaning, adjustment or replacement.

3.6.7.4 Relays, the contacts of which control power of 25 watts, or less, and those used for audio applications, shall be of the bifurcated contact type and shall be capable of one million operations at the rate of 120 operations per minute without exhibiting any erratic operation of the contacts in making or breaking the electric circuits and without requiring any repair or servicing. Relays, the contacts of which control power in excess of 25 watts and all ratchet type motors and other electromagnetically operated devices shall be capable of 10,000 operations at the highest rate at which they are likely to be operated in service use, but in no case at less than two operations per minute, without requiring any repair or servicing. The foregoing requirements shall be met with the relay contacts loaded as they normally would be used in the equipment Contact materials for low level relays shall be of noble metals.

3.6.7.5 When automatic sequencing or coding cycles are required, suitable precautions shall be taken in the design to prevent erratic operation under conditions of shock specified in 4.4.18.

3.6.8 Synchros. - Synchros shall be in accordance with MIL-S-20708. Installation requirements shall be in accordance with OP-1303. The sizes of synchros shall be as specified in the individual equipment specification (see 6.3).

3.6.8.1 Synchro capacitors. - Synchro capacitors shall be connected across the stator leads of all differential synchros and control transformers. Synchro capacitors shall be delta connected, and be rated at 600 volts d.c. for 60 cycle synchros and 1,000 volts for 400 cycle synchros. The capacitors in either case shall

be matched within 1 percent. Synchro capacitors shall have the following values within plus or minus 10 percent.

Synchro	Synchro capacitor (in μf units)	Synchro	Synchro capacitor in μf units)
15TDX4	0.50-0.50-0.50	15CT6	0.34-0.34-0.34
18TDX4	1.0-1.0-1.0	18CT6	0.24-0.24-0.24
23TDX4	2.1-2.1-2.1	18CDX6	0.80-0.80-0.80
15CDX4	0.21-0.21-0.21	23CT6	0.34-0.34-0.34
18CDX4	0.28-0.28-0.28	23TDX6	3.4-3.4-3.4
23CDX4	0.66-0.66-0.66	23CDX6	1.2-1.2-1.2
11CT4	0.036-0.036-0.036	31TDX6	10.0-10.0-10.0
15CT4	0.022-0.022-0.022	31TDX4	4.5-4.5-4.5
18CT4	0.014-0.014-0.014	1HCT	0.6-0.6-0.6
23CT4	0.014-0.014-0.014	1HDG	3.0-3.0-3.0
		5HDG	10.0-10.0-10.0

3.6.8.2 Synchro electrical zero and equipment mechanical zero. - In order that synchro components may work together properly in a system, it is essential that they be correctly connected and aligned with respect to each other, and to the device or parent equipment with which they are used. Electrical zero is the reference point for alignment of all synchro components. The mechanical zero or reference point for the device or parent equipment using synchro components depends upon the particular application of the equipment involved. Whenever a synchro component is used, either as a transmitter or receiver, the synchro electrical zero and the equipment mechanical zero, unless specified otherwise by the procuring activity, shall be physically positioned to the same point. All synchros shall be electrically zeroes by method prescribed in OP-1303 prior to delivery of equipment.

3.6.8.3 Servo motors. - Four hundred cycle servo motors shall conform to MIL-S-22432.

3.6.9 Electrical tapes. - Fabric or textile pressure-sensitive (adhesive or friction) tape shall not be used. One of the following types shall be used:

Description	Type	Specification
Acetate film backing	AFT	MIL-I-15126
Glass fiber, varnished	----	MIL-I-17205
Polyethylene backing (9 mils thick)	EF-9	MIL-I-15126
Polyethylene backing (20 mils thick)	EF-20	MIL-I-15126
Polyvinylchloride or its copolymers	----	MIL-I-7798

3.6.10 Batteries. - Batteries of any type shall not be used for any purpose, except where their use is specifically required in the individual equipment specification (see 6.3).

3.6.11 Dial illumination lamps. - Lamps for dial illumination shall be of the types specified in table V or as specified in the individual equipment specification. (For indicators, see 3.6.13.) The lamps shall be energized from the secondary of a transformer, and the lighting circuit shall be equipped with a rheostat, or other control device, to vary light intensity from maximum value to full extinction when all lamps, or 50 percent of the lamps, are operative. At 115 volts input to the transformer, and with all lamps operative, the lamp socket voltages shall not exceed the values (calculated for 1,000-hour life) as shown in table V.

Table V - Lamps for dial illumination.

MS sheet number	Navy type	Industry number	Maximum socket volts (r.m.s.)
15571-1	-	44	6.87
15571-2	-	47	6.87
15573-1	-	51	7.5
15572-1	TS-52	55	6.6

3.6.12 Switches. -

3.6.12.1 Toggle switches. - Toggle switches shall be in accordance with MIL-S-3950. Where moisture seal of toggle switches is required, boots in accordance with MIL-B-5423 shall be used.

3.6.12.2 Sensitive switches. - Sensitive switches shall be in accordance with MIL-S-8805.

3.6.12.3 Rotary switches. -

3.6.12.3.1 Rotary selector switches (non-enclosed). - Rotary selector switches shall comply with one of the following drawings or specifications as determined by rating and space requirements.

Drawings

9000-S6202-73075 (S-1JR)
9000-S6202-73193 (JR-304 and JRM-300)
9000-S6202-73295 (S-4JR)
9000-S6503-73436 (JA2C (16))
9000-S6503-73437 (JA2C (30))
9000-S6202-73826 (S-2JR)
9000-S6202-73827 (S-3JR)
9000-S6202-74225 (S-2JF)
9000-S6202-74422 (S-JL)

NOTE: Type JR switches shall be used only in 5, 10, 15, 20 and 25 section sizes.

Specifications

MIL-S-3786 MIL-S-21604

3.6.12.3.2 Enclosed rotary selector switches. - Enclosed type rotary selector switches shall be in accordance with MIL-S-15743.

3.6.12.3.3 Power type switches. - Power type switches shall be of the rotary design and shall be in accordance with MIL-S-15291.

3.6.12.4 Push switches. - Push switches shall be in accordance with MIL-S-8805. For watertight applications, boots as approved by the command or agency concerned (see 6.5) shall be used.

3.6.13 Indicator lights and lampholders. -

3.6.13.1 Indicator lights. - Indicator lights for high impact shockproof applications shall be in accordance with 9000-S6202-73907 (for a.c. applications) and 9000-S6202-74307 (for d.c. applications). For applications where shockproofness is not a requirement, and where space requirements do not permit the use of indicator lights as above, the indicator lights shall conform to MIL-L-3661. Indicator light globes or lenses, except for special applications or dark adapted spaces, shall be colored as follows:

Yellow . . . . . Open

Amber . . . . . Abnormal but not immediately dangerous condition

Blue . . . . . Closed (shut)

Green . . . . . Normal

Red . . . . . Dangerous or emergency condition requiring immediate attention or corrective action

White . . . . . Power on or power available

Indicators with red lenses and stencil-type marker discs, shall be used in spaces where dark adaptation of personnel is required.

3.6.13.2 Lampholders. - Lampholders shall comply with the applicable 9-S or 9000 series drawings specified in the individual equipment specification (see 6.3) or shall comply with MIL-L-3661.

3.6.14 Fuses. - Fuses shall be style F03 in accordance with MIL-F-15160/03. Glass tube fuses shall not be used.

3.6.15 Fuseholders and fuse clips.

3.6.15.1 Fuseholders. - Fuseholders shall be of the dead front, blown fuse indicating type FHLIOU or FHLIIU conforming to MIL-F-19207/1 and MIL-F-19207/2, respectively.

3.6.15.2 Fuse clips. - Fuse clips shall be in accordance with MIL-F-21346.

3.6.16 Printed wiring. - Printed wiring shall be in accordance with requirement 17 of MIL-STD-454 (see 6.5).

3.7 Features - mechanical. -

3.7.1 Enclosures - general. - Acceptable materials for enclosures are sheet or cast aluminum and sheet brass. Enclosures shall be as specified in the individual equipment specification (see 6.3). Impregnation of castings if necessary to prevent minor leaks, shall be in accordance with MIL-STD-276. Enclosure construction shall be as specified in the individual equipment specification.

3.7.2 Enclosure - accessibility. - Enclosures shall be constructed with a view toward maximum accessibility for repair and replacement of subassemblies and parts. All parts and subassemblies shall be capable of being removed from the front of the enclosure without need of access to the back of the mounting panel. If access to the back of mounting panel is required, hinged panel or subpanels shall be provided to permit removal of parts and subassemblies from the front of the enclosure. It shall not be necessary to remove any of the permanently mounted internal parts or subassemblies in order to mount the enclosures to the bulkhead. Parts and subassemblies shall be mounted to permit easy replacement, without extensive disassembly of other parts and subassemblies in the enclosure. The covers of enclosures (except switchboard or amplifier rack panel covers) shall be completely removable. Since units of one equipment are likely to be installed with their sides immediately adjacent to units of other equipments, all parts and subassemblies likely to need replacement or servicing shall be accessible from the front of the enclosure. Hinged covers of switchboard sections or amplifier panels shall be so designed that when opened for servicing, they shall not interfere with adjacent units. Cable entry requirements shall be as specified in the individual equipment specifications (see 6.3) The enclosure construction shall be such that all wiring, terminals and electrical connections shall be accessible for servicing and test purposes without requiring the removal of a part or subassembly from the enclosure in which it is mounted except where plug and jack connections are required (see 3.8.9). Items which are subject to replacement or servicing under normal maintenance shall not be secured by rivets, welding or other means which prevent ready removal.

3.7.3 Enclosure. - degree of. - The degree of enclosure as required in the individual equipment specification (see 6.3) shall be one of the following as defined in MIL-STD-108:

(a) Dripproof. - Used for shipboard announcing amplifier racks, switchboards, instruments and other similar units requiring ventilation that are to be installed in interior locations. Zero degrees shall be used in lieu of 15 degrees.

(b) Dripproof protected. - Used for shipboard electrical rotating machinery and rectifier enclosures requiring ventilation but having a larger grill opening than permitted in the "dripproof" degree of enclosure.

(c) Watertight. - Used where unit will be installed in exposed topside locations as well as interior locations.

(d) Submersible (depth or pressure requirements to comply with individual equipment specification). - Used for submarine applications that are to be installed external to pressure hull.

(e) Gunblastproof (degree 2). - Used for equipment to be installed in exposed locations subject to gunblast.

The effectiveness of the enclosure shall be determined in accordance with 4.4.11.

3.7.4 Enclosure-mounting. - Enclosures shall be designed for universal mounting, stand, panel bulkhead, console mounting or special multiple mounting as required by the individual equipment specifications (see 6.3)

(The preferred method of mounting is the universal mounting as specified in 3.7.4.1.) The special features of the various mountings shall be in accordance with 3.7.4.1 through 3.7.4.5.

3.7.4.1 Universal mounting. - This design shall provide for three point suspension for bulkhead mounting; and three or four point suspension for panel mounting. The three mounting feet for bulkhead designs shall provide two feet at the top and one foot at the bottom. The method of mounting on panels shall incorporate design features whereby the flange of the case shall be utilized as the mounting medium with the mounting bolts hidden under the front cover of the case and shall be so arranged that the entire interior subassembly can be withdrawn from its case without disturbing the panel mounting bolts.

3.7.4.2 Stand mounting. -

3.7.4.2.1 A flange shall be provided at the bottom of the unit enclosure to secure the unit to the stand. Through bolts shall be used for securing, where practicable.

3.7.4.2.2 Stands (pedestals) shall be of sheet metal, sheet metal over frame or tubular construction and shall be of sufficient height to bring the center of the top dial approximately 39 inches from the deck. A removable cover plate shall be provided approximately 18 inches from the base for access to the stuffing tube in the base.

3.7.4.2.3 The face of the units, except for engine order transmitter-indicators, shall be inclined at an angle of 45 degrees from the vertical.

3.7.4.2.4 A stuffing tube plate shall be provided between the units and stand for entrance of cables. The joints between the unit enclosure, stuffing tube plate, and stand shall be watertight.

3.7.4.3 Panel mounting. - Enclosures shall be arranged for front mounting and shall incorporate a flange for securing in a panel in a vertical position. Enclosure shall not project more than 1-1/2 inches from the face of the panel (not including operating handles). (See 3.7.4.1.)

3.7.4.4 Bulkhead mounting. - Enclosures designed for bulkhead mounting (except switchboards) shall be provided with three mounting feet to provide a three point suspension. Two of the points of suspension shall be above the center of gravity of the enclosure and the third one below (see 3.7.4.1).

3.7.4.5 Mounting feet shall be secured to the surfaces of fabricated or drawn sheet metal enclosures in a positive manner. All surfaces of the mounting feet (straps) in contact with the case shall be secured by a continuous braze. Spot or tack welds may be employed in addition to brazing for large size enclosures. Rivets, tack welds or spot welds when used alone are not considered adequate for this purpose.

3.7.5 Stiffening grooves. - Large flat sheet metal surfaces shall have grooves along the diagonals or be provided with other adequate means to lend rigidity.

3.7.6 Minimum sheet metal thickness, s (watertight enclosures). - Thickness of sheet metals used for watertight unit enclosures shall be as follows:

Enclosure material	Enclosure size	
	Long dimension, 16 inches or less	Long dimension, over 16 inches
	Inch	Inch
Brass	0.078	0.109
Aluminum	.078	.109
Steel	.062	.078

3.7.7 Through bolting. - Through bolting or threading into watertight enclosures will not be permitted, except where specifically approved by the command or agency concerned (see 6.5). Suitable bosses shall be provided for this purpose in cast enclosures. Blind tapped welded buttons shall be used in sheet metal enclosures.

3.7.8 Cable entrance. - Cable entrance into unit enclosures shall be by means of stuffing tubes. Due to variation in cable sizes entering most unit enclosures, stuffing tubes will normally be furnished by the installing activity rather than by the equipment manufacturer. However, where the cable size entering the unit enclosure will be the same for all installations, the stuffing tube shall be provided and installed by the equipment manufacturer. Stuffing tubes furnished by the equipment manufacturer shall be nylon type in accordance with MIL-S-19622. Nylon tubes are satisfactory for use on sheet metal or cast enclosures with a wall thickness of 3/16 inch or less. On cast enclosure with a wall thickness greater than 3/16 inch, bosses, drilled and tapped with the proper NPT for stuffing tubes, as applicable (see MS17039 through MS17046) shall be provided in the top or bottom of the enclosure. Plastic protective cap-plugs (CaPlugs or equal) shall be installed by the manufacturer in cable entrance holes in cast enclosures to prevent entrance of dust or moisture and provide protection during shipment and handling prior to installation. Space shall be provided inside the enclosure between the stuffing tubes and the terminal boards so that the ships wiring will not be crushed or distorted when the internal subassembly is mounted in the enclosure. Stuffing tube sizes shall be selected so as to accommodate reduced diameter cables (see MIL-C-2194) in accordance with the cable assignments shown on MIL-S-19622 and associated Military Standard Sheets.

3.7.8.1 Cable entrance plates. - Cable entrance plates shall be as specified in the individual equipment specification. Plates shall preserve the degree of enclosure specified for the equipment.

3.7.9 Ventilation. -

3.7.9.1 The unit shall be ventilated in such a manner that under the most restrictive installation conditions encountered and at the maximum ambient temperature specified (see 3.7.16), with the unit operating continuously at full power, no part or subassembly shall attain a temperature which will tend to damage or to reduce its normal useful life. The temperature of parts or subassemblies exposed to the operator shall be kept below values injurious to personnel on contact to preclude hazard to personnel. Forced air cooling through suitable standard size dust filters will be permitted where necessary to meet the requirements of this specification. Dust filters may be omitted when specified in the individual equipment specification (see 6.3).

3.7.9.2 Ventilation shall also be provided where the design of a unit involves the collection or formation of explosive gases in an enclosed space, such as with a unit using storage batteries.

3.7.10 Size. - No unit of any equipment for interior shipboard installation may be over 72 inches overall height as installed, unless otherwise specified in the individual equipment specification. Size requirements are specified in the individual equipment specifications (see 6.3).

3.7.10.1 Surface ships. - Any unit of an equipment intended for surface ship installation, any unit of the onboard repair parts, or any unit of the auxiliary equipment, when uncrated for installation and without further disassembly, shall be capable of passage through a door 26 inches wide by 45 inches high (further reduced by round corners on an 8 inch radius) and through a hatch 30 inches long by 30 inches wide (further reduced by round corners on a 4-1/2 inch radius).

3.7.10.2 Submarines. - Any unit of an equipment intended for submarine installation, any unit of the onboard repair parts, or any unit of the auxiliary equipment, when uncrated for installation and without further disassembly, shall be capable of passage through a door 20 inches wide by 38 inches high (further reduced by round corners on a 10 inch radius) and through a circular hatch 25 inches in diameter.

3.7.11 Threaded devices. -

3.7.11.1 General. - Screw threads for all threaded securing devices shall conform to Handbook H28. The threads shall be of the coarse thread series, Unified thread form, class 2A or 2L or American National thread form, class 2. Other thread series and classes, such as fine thread or 8-pitch series and class 3 or 5 fit, may be used where it is necessary to assure functional operation of the equipment.

3.7.11.2 Head styles. - The head styles of externally threaded fasteners shall be as follows:

(a) Bolts. - Plain (solid) hexagon or square for external wrenching; socket, hexagon, for internal wrenching.
(b) Cap screws. - Plain (solid) hexagon for external wrenching; socket, hexagon, for internal wrenching.

(c) Machine screws. - Pan head, cross recessed drive; flat, countersunk (80 to 82 degrees), cross recessed drive.

3.7.11.2.1 Screws used for securing covers on watertight instruments shall have hexagon heads.

3.7.11.3 Thread cutting screws. - Thread cutting (self-tapping) screws shall not be used.

3.7.11.4 Flat head screws. - Flat head screws shall not be used in material of a thickness less than one and one half times the height of the screw head. Wherever flat head screws are used, the head shall be properly and completely seated in the material.

3.7.11.5 Threads in aluminum. - Threads in aluminum alloys shall, in general, not be used. Through bolt holes shall be used wherever practicable. Inserts in aluminum need be provided only where screws or bolts must be removed for routine maintenance of the equipment or where maximum stress in the screw or bolt is required for alignment of a vital part. Inserts in aluminum need not be provided for securing identification plates, terminal boards or other items that are removed only when equipment is modified. Inserts shall be in accordance with 9-S-4725-L, or equivalent. Threaded parts (cable fittings and similar devices) shall be treated with an antiseize compound in accordance with MIL-T-22361. A satisfactory antiseize compound can be made up of equal parts of petrolatum (see VV-P-236) and zinc dust (see TT-P-465) (100 mesh fineness). Other compounds shall be approved by the command or agency concerned prior to use (see 6.5). Inserts shall be assembled using a generous coat of wet varnish to prevent corrosion. Nickel-copper alloy inserts shall be used for applications on the outside of watertight or better enclosures. Austenitic corrosion resistant steel inserts suitably plated are acceptable for use on the inside of watertight enclosures and in dripproof enclosures when required in the individual equipment specification (see 6.3). All inserts shall be staked or otherwise secured in an acceptable manner.

3.7.11.6 Thread projection. - All bolts used shall be sufficiently long to ensure that, when nuts are screwed home, there shall be at least two threads projecting clear from the outer face of the nut. The length of the threaded portion on all bolts and nut ends of studs shall be not less than 1-1/2 times the bolt or stud diameter. Studs shall engage the part into which they are set for a length equal to at least one diameter and shall be securely staked.

3.7.11.7 Threads in plastics. - Threads shall not be employed in plastic parts without the use of suitably threaded metallic inserts, except in instances where the use of the inserts would adversely affect the electrical or mechanical characteristics of the part. In the latter instance, permission shall be obtained from the command or agency concerned (see 6.5).

3.7.12 Rounded corners and edges. - All edges and corners of external surfaces, normally exposed or to be painted, shall be rounded. Sharp edges and points of any kind shall be avoided.

3.7.13 Internal subassembly protection. - Complete unit internal subassemblies shall be provided with means to prevent injury to pointers, dials and other parts when the subassembly is removed from its enclosure and rested on a work bench on either its top or bottom.

3.7.14 Drilled and tapped holes. - Drilled and tapped holes shall be slightly countersunk.

3.7.15 Structural welding. - Structural welding shall be in accordance with requirement 13 of MIL-STD-454.

3.7.16 Temperature and humidity. - All units shall operate without mechanical or electrical damage in any ambient temperature between the limits of 40° and 149°F. with relative humidity of 95 percent or more without exceeding an external enclosure or an internal air temperature of 239°F. and shall not at any temperature have a rise exceeding 90°F. from ambient. Hot spot temperatures shall not exceed the maximum temperature dictated by affected insulation as specified in 3.8.14.2. In equipment where degradation of performance is expected under varying temperature conditions, the allowable degradation shall be specified in the individual equipment specification. Where no degradation is specified, the equipment shall perform under temperature variation in full accordance with equipment specifications. The temperature and humidity tests shall be performed in accordance with 4.4.9.

3.7.16.1 Extended storage. - Equipment shall be suitable for extended storage in any ambient temperature between the limits of minus 40°F. and 167°F.

3.7.16.2 Extreme temperature for exposed location. - When specified in the individual equipment specification (see 6.3), the units shall be capable of withstanding without mechanical or electrical damage which would cause malfunctioning or inoperation, any or all of the following weather conditions:

(a) Minus 20°F. (minus 29°C.) temperature.
(b) Operation for a period of 1/2 hour after internal air temperature stabilizes at 180°F.
(c) Condensation at an ambient temperature of 75° to 80°F. (24° to 27°C.), relative humidity 100 percent.

3.7.17 Accelerated life. - When required by the individual equipment specification (see 6.3), the units shall satisfactorily withstand the accelerated life test (endurance) specified in 4.4.10.

3.7.18 Salt spray. - When required by the individual equipment specification (see 6.3), complete units shall show no appreciable corrosion or other damage when subjected to the salt spray test specified in 4.4.12.

3.7.19 Tumbling. - When specified in the individual equipment specification (see 6.3), the units shall satisfactorily withstand without mechanical or electrical damage which would cause malfunctioning or in operation, the tumbling test specified in 4.4.13.

3.7.20 Gunblast. - When specified in the individual equipment specification (see 6.3), the units shall satisfactorily withstand without mechanical or electrical damage which would cause malfunctioning or inoperation, the gunblast test specified in 4.4.14.

3.7.21 Depth charge. - When specified in the individual equipment specifications (see 6.3), the units shall satisfactorily withstand without mechanical or electrical damage, which would cause malfunctioning or inoperation, the depth charge test specified in 4.4.15.

3.7.22 Shock, vibration and inclination. - When specified in the individual equipment specification (see 6.3), the units shall satisfactorily withstand without mechanical or electrical damage type A HI shock in accordance with MIL-S-901, vibration test specified in 4.4.17 or inclination tests as specified in 4.4.16 or 4.4.10. Minor derangements which may not cause malfunction or inoperation shall be referred to the command or agency concerned for specific approval of design consideration. The individual equipment specification will designate whether "vital" or "nonvital" vibration tests are required (see 6.3). The release, during shock test of mechanically interlocked push buttons or similar features will be considered a failure unless specifically permitted in an individual equipment specification (see 6.3).

3.7.22.1 Shock and vibration mountings. - Shock and vibration mountings shall not be used in the design of equipment except where specifically permitted in the individual equipment specification (see 6.3) to protect fragile parts. When so used, shock and vibration mounts shall be secured with substantial washers of sufficient diameter to prevent nuts or bolts from pulling out in the event of failure of the shock or vibration mounting. Shock and vibration mountings incorporated externally into mounting feet or mounting brackets of unit enclosures are not acceptable unless permitted by the individual equipment specification. Where shock and vibration mounts are used with vacuum tubes, positive stops shall be provided. All tubes shall be securely held in place by type of tube locking device approved by the command or agency concerned (see 6.5).

3.7.22.1.1 For electron tubes. - Normally all electron tubes shall be mounted in a vertical position and shall be securely held in their sockets and adequately supported so as to withstand the vibration and shock tests. Mounting in a horizontal position, if necessary and properly designed, shall meet the approval of the command or agency concerned (see 6.5). Thyratron tubes shall be shielded from surrounding magnetic fields.

3.7.22.1.2 Power plugs. - Power plugs shall be securely held in place in the equipment by a locking device or other mechanical means approved by the command or agency concerned (see 6.5)

3.8 Features - electrical. -

3.8.1 Overload protection. - Overload protection shall be in accordance with class 1, requirement 8 of MIL-STD-454.

3.8.2 Primary power supply circuits. - Since adequate switching and fusing will be provided on the switchboard from which the equipment is energized, fuses shall not be provided for special functions, in any permanently installed equipment, unless specifically required in the individual equipment specification (see

6.3). The power supply switch in portable equipment shall break both sides of the circuit. The power supply cable for portable equipment (such as motion picture projectors and sound recorder reproducers) shall be in accordance with J-C-175 having three conductors (with green conductor connected to the unit enclosure). Fuses shall be provided in each side of the power supply circuit and wherever else necessary in portable equipment. The current rating of the fuse shall be marked adjacent to or in the vicinity of fuses.

3.8.3 Power supply tolerances. - The power supply to the individual equipment and requirements for satisfactory performance under the tolerances listed in table VI shall be as specified in the individual equipment specification (see 6.2 and 6.3). (A.C. voltages are r.m.s.)

Table VI - Power supply tolerances.

Normal power source	Upper limit	Lower limit
24 volts d.c.	25 volts	23 volts
115 volts d.c.	121 volts	109 volts
115 volts, 60 cycles	121 volts, 63 cycles	109 volts, 57 cycles
115 volts, 400 cycles	121 volts, 420 cycles	109 volts, 380 cycles
440 volts, 60 cycles	462 volts, 63 cycles	418 volts, 57 cycles

Other power sources may be specified in the individual equipment specification for special applications (see 6.3), and the equipment shall be capable of operation from sources within plus or minus 5 percent of the nominal values specified.

3.8.3.1 Transient regulation in percent of nominal. -

(a) Voltage. - Plus or minus 18 percent outside of steady state band. Recovery within 3 percent of steady state band in 2 seconds.
(b) Frequency. - 3 percent dip of which no more than 1 percent is outside steady state band. Recovery within steady state band in 2 seconds.

Approximately one-half of the voltage dip shall occur within the first one-half cycle after initiation of the disturbance. Minimum voltage shall occur in 0.1 to 0.3 second. After the maximum negative voltage excursion, the voltage shall overshoot to a maximum value which can be as great as the negative excursion. The total period of this transient shall not exceed a total time period greater than 2 seconds. This voltage dip is based on power consuming equipment that does not contain motor loads. Where power consuming equipment contains motor loads, these voltage transients may be increased depending on the motor size due to motor starting current.

3.8.3.2 Harmonic content. - The equipment shall perform satisfactorily when the power supply contains harmonics of the following values: total harmonic content of not more than 5 percent and maximum of any one harmonic of 2 percent.

3.8.4 Safety (personnel hazard). - Personnel safety requirements shall be in accordance with requirement 1 of MIL-STD-454.

3.8.5 Shielding and radio frequency noise reduction. -

3.8.5.1 Design. - The equipment design, construction and shielding (particularly of wiring and contacts) shall be such as to:

(a) Shield amplifier input circuits and low level contacts from the effects of stray electromagnetic and electrostatic fields.
(b) Minimize the generation and prevent the radiation or conduction (from any part of the equipment during starting, normal operation, and stopping periods) of radio-frequency energy in excess of the limits specified in MIL-I-16910, when measured as specified in 4.4.6.

3.8.5.2 Filters. - Filters shall not be used, unless their use is satisfactory to the command or agency concerned. Interference reduction devices, including filters and capacitors, shall be of a type satisfactory to the command or agency concerned (see 6.5) shall be readily removable for replacement and repair purposes, and shall be HI shockproof in accordance with 3.7.22. Capacitors shall conform to MIL-C-25.

3.8.5.3 Bonding. - Where access doors or cover plates which form a part of the shielding are required, suitable bonding shall be provided. Bonding shall be in accordance with MIL-I-16910.

3.8.6 Ground potential and grounding. - Design and construction of units shall be such that all exposed metal parts and chassis shall be at ground (ship's hull) potential at all times. If vibration or shockmounts are used to protect the chassis or items on the chassis, the chassis shall be bonded to the unit enclosure as required in MIL-I-16910. Circuit shielding shall be positively connected (bonded) to the unit enclosure or to the chassis. Amplifier power supply (B plus or B minus within equipment) shall be positively connected (bonded) to ship's hull at one (physical) point only. The ship's hull, internal chassis, or unit enclosure shall not be used in lieu of appropriate electric conductors in equipment circuitry unless specifically approved by the command or agency concerned for each application (see 6.5). No electric circuit which connects directly to ship's wiring external to the unit enclosure shall be electrically connected to the ship's hull (placed at ship's hull potential).

3.8.6.1 Portable equipment. - The leakage current of portable electrical equipment shall not exceed 5 milliamperes whether or not such equipment contains radio interference filters or capacitors.

3.8.6.2 Permanently installed equipment. - The leakage current of permanently installed equipment should preferably not exceed 5 milliamperes. On those equipments which have an unavoidable leakage current to ground in excess of 5 milliamperes, whether or not equipped with radio interference filters or capacitors, add a warning plate reading:

"Danger - Do not energize this equipment unless frame and all exposed metal parts are grounded."

3.8.7 Soldering. - Soldering shall be in accordance with requirement 5 of MIL-STD-454.

3.8.8 Electrical parts mounting - All small parts, such as resistors and capacitors which are mounted by their leads shall be mounted on terminal or connection boards. (Exceptions will be permitted only for high gain, low level amplifier stages.) Kinks or other slacks shall be provided in the mounting leads to permit thermal expansion of the terminal or connection board without stressing the parts. The mounting leads shall be as short as practicable and in no case shall the leads be longer than 1 inch. Large and medium large (over 1/2 inch diameter) parts shall be securely fastened by clamps. Long resistors shall be fastened at both ends. Ceramic or composition resistors which are secured by screws shall have pliable washers inserted under the screws to prevent undue stress on resistors.

3.8.9 Internal subassembly connection. -

3.8.9.1 Each internal subassembly having electrical circuits which are required by the individual equipment specification (see 6.3) to be removable from its associated enclosure, shall be provided with plug and jack connections or connectors. Means shall be provided for their proper alignment. Alignment devices shall be self centering to permit ready engagement of parts. The exposed plug contacts shall be deenergized when the connectors are separated.

3.8.9.2 When required by the individual equipment specification (see 6.3), one test cable subassembly consisting of 10 feet of cable fitted with the proper connectors to allow the removable subassembly to be electrically connected to the ship's circuit when removed from the unit enclosure shall be provided with each onboard repair parts set. A grounding conductor shall be provided with or in the test cable to insure positive grounding of the removed subassembly to its enclosure.

3.8.10 Electrical connectors. - Electrical connectors shall be in accordance with requirement 10 of MIL-STD-454. The use of AN connectors in equipments located outboard is prohibited. Where connectors conforming to MIL-C-5015 are used (for equipments located inboard), the mating parts shall be furnished with the equipment.

3.8.11 Terminal boards and terminals. -

3.8.11.1 Terminal boards. - Terminal boards shall be in accordance with MIL-T-16784. The maximum number of wires to be connected to any one terminal shall be as specified on 9000-S6505-73214. In wiring these terminal boards with the terminals specified in MIL-T-16784 or MS17143, lockwashers are not required.

3.8.11.2 Terminals. - Pressure grip terminals in accordance with MIL-E-16366 or MIL-T-7928 are preferred; however, solder type terminals in accordance with MIL-T-15659 may be used. Terminals for connection of ship's wiring shall not be provided by the equipment manufacturer.

3.8.11.2.1 Only one wire shall be crimped to a terminal lug or connector contact.

3.8.11.2.2 Braided wire cable shielding. - Grounding sheath connectors of the two piece compression type may be used to terminate braided wire cable shielding in any circuit application not exceeding 100 megacycles per second. Such connections shall be made in accordance with the connector manufacturers recommendations, shall be secure, and shall be free from any projecting shield wire ends. Solid wire leads shall not be used with these compression type connectors.

3.8.11.3 Mounting. - Terminal boards for receiving ships cable shall be secured to a fixed portion of the enclosure, not to hinged panels or other movable assemblies that may require flexing of the ship's wiring during normal operation, maintenance or servicing. Terminal boards shall be mounted so that they will not be broken or stressed by distortion of the enclosure. Terminal boards shall be secured only by bolts (machine screws) and shall be capable of ready removal or replacement.

3.8.11.4 Terminal and terminal board marking. - All terminals, terminal boards, plugs, jacks and connectors shall be marked in a clear and permanent manner so as to identify individual wires and terminals and facilitate connection or replacement of ship's wiring to the terminal board. In addition to the marking on the terminal, the use of either an engraved plastic marker strip installed under the terminal board or an adhesive marker strip installed adjacent to the terminal board is recommended. Where the circuit designations cannot be stamped on the terminal, synthetic resin tubing conforming to type F, grade A of MIL-I-631 or type V wire identification markers of MIL-M-22106 shall be used. These markings shall be clearly visible when ship's wiring is installed and connected to the terminal board. Circuit designations shall be incorporated as designated by the command or agency concerned. For certain special applications when required by the individual equipment specification (see 6.3), a transportation table may be required showing the unit terminal marking and a blank space for the associated ship's wire markings. This table shall be mounted in a plastic holder adjacent to the terminal board inside the unit enclosure. The ship's wire markings will be added by the installing activities. Circuit designations for specific applications will be provided upon request.

3.8.11.4.1 Synchro connections and markings. - Synchro transmitters shall be connected to the unit terminal board and the ship's wiring, (where either may be marked with typical ship circuit designations, terminal "MB1" to ship's wiring "MB1" and so forth) in such a manner that an increasing value (angular displacement) in the unit shaft (counterclockwise rotation) would cause a counterclockwise rotation in a standard synchro receiver connected to the ship's wiring through the unit terminal board (terminal R1 to ship's wiring "MB," R2 to "MBB," S1 to "MB1," S2 to "MB2" and S3 to "MB3"). Direction of rotation is determined while facing the emergent shaft end of the synchro. Synchro torque receivers and control transformers shall be connected to the unit terminal board in such a manner that with direct connection between the unit terminal board and the ship's wiring, counterclockwise rotation of a standard transmitter having direct connection to the ship's wiring (R1 to "MB," R2 to "MBB," S1 to "MB1," S2 to "MB2" and S3 to "MB3") shall cause counterclockwise rotation of the unit dial or pointer. For example: for a synchro that requires clockwise rotation for increasing signal, synchro terminals S1, S2 and S3 will be connected to the unit terminal board corresponding to ship's wire numbers MB3, MB2 and MB1, respectively. (See figure 1 and OP-1303 for additional connection data.)

3.8.12 Wiring. - Wires employed in the interconnection of parts of subassemblies of the complete unit shall conform to 3.8.12.1 through 3.8.12.5.1.

3.8.12.1 Hook-up wire. - All wire shall be of stranded soft annealed copper of suitable cross section to provide ample and safe current carrying capacity and mechanical strength. Only wire in accordance with MIL-W-76, or types B, C, D, E, EE or FF (all with outer covering) of MIL-W-16878 shall be used. Recommended applications of these wires and their features are shown in table VII.

Table VII - Features of hook-up wire.

Type	Primary application	Insulation type	Maximum temperature rating	Maximum voltage rating
B	GP[1/]	PVC[2/]	105°C.	600
C	GP[1/]	PVC[2/]	105°C.	1000
D	GP[1/]	PVC[2/]	105°C.	3000
E	UHF[3/]	T[4/]	200°C.	600
EE	UHF[3/]	T[4/]	200°C.	1000
FF	H[5/]	S[6/]	200°C.	1000

1/
2/GP - General purpose.
3/PVC - Polyvinyl chloride or copolymer with polyvinyl acetate.
4/UHF - Ultra high frequency.
5/T - Polytetrafluoroethylene (teflon).
6/H - For use in class H insulated equipment.
—/S - Silicone rubber.

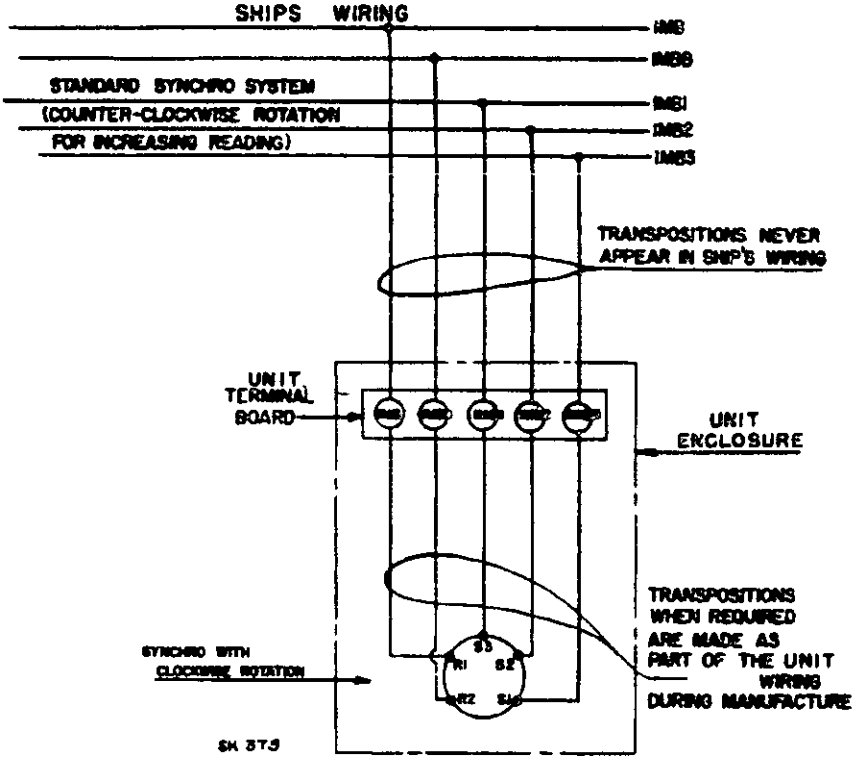

Figure 1 - Connections for clockwise rotating synchro.

3.8.12.2 Transformer and inductance wire. -

3.8.12.2.1 Leads. - Winding leads shall be protected by insulating sleeves. For coils having windings of smaller than No. 16 AWG, the coil take off wires to terminals shall be stranded and shall be joined to the coil winding by not less than three turns of the take off wire under the outside insulation.

3.8.12.2.2 Magnet wire and insulation. - Magnet wire shall be in accordance with MIL-W-583, except that types C, C2 (cotton covered), S, S2 (silk covered) and T or plain enameled wire shall not be used.

3.8.12.3 Wiring arrangement. - The wiring of the separate parts, subassemblies, or units shall conform to 3.8.12.3.1 and 3.8.12.3.2.

3.8.12.3.1 All wiring shall be arranged in a neat and workmanlike manner. The use of preformed cables and wiring harnesses is preferred to the point-to-point method of wiring.

3.8.12.3.2 Wherever practicable, wiring shall be arranged to permit bundling by one or more of the following methods:

(a) Lacing. - Twine for lacing shall be in accordance with type P (unwaxed) of MIL-T-713. Cordage shall be in accordance with type SR-4.5 of MIL-I-3158.
(b) Binding. - Tape for binding shall be as specified in 3.6.9.
(c) Sleeving insulation. - Sleeving insulation used where no bending is required shall be class A-A-1 (cotton) or class B-A-1 (glass) in accordance with MIL-I-3190. Sleeving used where bending is required shall be synthetic resin types A or F in accordance with MIL-I-631 where total temperature does not exceed 80°C, vinyl-glass class B-A-1 in accordance with MIL-I-3190, or silicone rubber-glass in accordance with MIL-I-18057.
(d) Wrapping and tying. - Various plastic devices for wrapping and tying of wires may be used provided that the material does not support combustion, nor yield toxic gases when heated. When the wire bundle is formed and secured, the device shall not loosen under vibration.

3.8.12.4 The wiring shall be protected and secured to prevent chafing, due to vibration. For securing of wiring, polyamide clamps or wrapping and tying devices (see 3.8.12.3.2(d)) with integral mounting facilities are preferred. Metal clamps if used shall be insulated and not form a complete loop around the wires.

3.8.12.5 Color coding. -

3.8.12.5.1 Circuit identification of internal wiring. - Wiring shall be identified in accordance with MIL-STD-681.

3.8.13 Dial illumination. - In those units for which dial illumination is specified, such illumination shall be satisfactory to the command or agency concerned (see 6.5) and shall be of the Duo Panel system as described in Engineering Experiment Station Report 060025.

3.8.14 Electrical insulation. - The insulation used in the equipment shall be of such a class as to meet the highest operating temperature to which the insulation may be subjected, as specified in the individual equipment specification (see 6.3). The materials used in the various classes shall be in accordance with 3.4.9 and 3.8.14.1 through 3.8.14.6.

3.8.14.1 Limitations on use of classes. - The insulation used in a given equipment need not be limited to a single class. Class B insulation may be used where class A insulation is specified but the temperature limits of class B insulation shall apply. Likewise, class C insulation may be used where class A or B insulation is specified but the temperature limits of class C insulation shall apply. Class H insulation may, if satisfactory to the command or agency concerned (see 6.5), be used where class A, B, or C insulation is specified, but the temperature limits of class H insulation shall apply. However, class A insulation shall not be used where class B, H, or C insulation is specified; class B insulation shall not be used where class H or C insulation is specified, or class C insulation shall not be used where class H insulation is specified.

3.8.14.1.1 The thickness of class A or O materials used to provide mechanical protection for class B or H insulation shall be kept to a minimum. The thickness of class A or O materials shall be not more than one-third of the total thickness of the class B insulation where the insulation being protected is class B. (Example of such application: Mica composites used for slot insulation and protected from slot damage by paper, fiber, or film.)

3.8.14.2 Highest temperature (hot spot temperature) to which classes of insulation may be subjected. - The highest temperatures (hot spot temperature) to which classes of insulation may be subjected continuously with normal life expectancy are as follows:

Insulation	Maximum temperature Degrees F.	Degrees C.
Class O	194	90
Class A	220	105
Class B	266	130
Class H	392	200
Class C	As specified (see 6.3)	

3.8.14.3 Material standards. - The performance values specified in the specifications listed in 3.4.9 for various types and classes of electrical insulation are based upon the minimum characteristics. These specifications cover certain features which, while essential from the standpoint of stocks, need not apply to the manufacturers of equipment in the utilization of the same types and classes of material. For example, such features as the thickness, length, and width of sheet or tape insulation; the dimensions of rods, tubes, and shapes of molded or pressed insulation; and the flashpoint, drying, baking time, and working viscosity, of liquid or plastic insulation are essential features when direct purchases of insulation are made, but they are not of consequence when the same materials are applied by the equipment manufacturer. Thus, in the application of the referenced specifications to manufacturers' designs, only the performance values (insulation resistance, dielectric strength, heat resistance, moisture absorption, aging, and tensile, flexural, and compressive strength) need be considered.

3.8.14.4 Insulating electrical windings. - Electrical windings shall be thoroughly treated or impregnated by a method which will ensure the evacuation of all air and water from, and the filling in of all interstices within such windings. The liquid insulation used shall have such characteristics and be so applied as to insure thorough drying, solidification, or curing throughout the innermost recesses of the windings. The material shall be compatible with the wire insulation.

3.8.14.5 Choice of varnish. -

3.8.14.5.1 Classes A and B insulated equipment. - The varnish used for treating or impregnating the windings and coils shall be in accordance with MIL-I-24092.

3.8.14.5.2 Class H insulated equipment. - The varnish used for treating the windings and coils shall be a silicone baking type.

3.8.14.5.3 Varnish restrictions. - Red pigmented alkyd type varnish, sometimes known as "glyptal," and other similar materials shall not be used on windings and coils. Solventless type varnishes shall be used only when specifically approved by the command or agency concerned (see 6.5).

3.8.14.6 Varnish treatment procedures. - The windings and coils of the units shall be clean and dry. The drying shall be accomplished by prebaking the windings so as to remove all moisture. The windings or coils shall then be allowed to cool to a temperature not below 10°C. above room temperature, then immersed in the varnish until bubbling ceases, allowed to drain, and then baked at the temperature and for the time specified by the varnish supplier. A minimum of three dips and bakes will be required. If the vacuum-pressure treating process is used, a minimum of one treatment is required and shall be followed by one dip and bake.

3.8.15 Dielectric strength and insulation resistance clearances. - Clearances between any two electrical circuits or between any electrical circuit and ground (metal enclosure or chassis) shall be such as to meet the test conditions for dielectric strength and insulation resistance as specified in 4.4.4 and 4.4.5. In general, the minimum creepage and clearance distances between electric circuits or between any electric circuit and ground specified in table VIII shall be met. Clearance distance is defined as the shortest point to point path in air between uninsulated current carrying parts or between an uninsulated current carrying part and ground. Creepage distance is defined as the shortest path along the surface of an insulating material between uninsulated current carrying parts or between an uninsulated current carrying part and ground. Cemented or butted joints do not add to the creepage path. Insulating barriers shall be used, wherever practicable, to avoid a continuous unidirectional surface creepage path. It is to be emphasized that the values

shown in table VIII represent the desired minimum acceptable limits for nonarcing rigid construction and that they take into consideration only the average degree of enclosure and service exposure. Where such uninsulated parts are arc rupturing or where there is any question of rigidity of mounting, higher voltage equipment or exceptionally severe exposure, the minimum creepage and clearance distances shall be increased as necessary, consistent with minimum space and weight requirements, to assure service reliability Insulating materials shall be as specified in table VIII.

Table VIII - Electrical creepage and clearance distances.

Voltage a.c. or d.c.	Set	Clearance	Creepage	
			Unenclosed	Enclosed (dropproof or better enclosure)
		Inch	Inches	Inches
To 150	A	1/16	1/16	1/16
	B	1/8	1/4	1/8
	C	1/4	3/4	3/8
150-300	A	1/16	1/16	1/16
	B	1/8	1/4	1/8
	C	1/4	3/4	1/2
300-600	A	1/16	1/8	1/8
	B	1/8	1/4	1/4
	C	1/4	3/4	1/2
600-1000	A	1/8	1/2	3/8
	B	1/4	1	3/4
	C	1/2	2	1-1/2

Set A - These spacings are intended for use in equipment where the effect of a short circuit is limited to the unit and where normal operating power up to 50 watts or volt amperes are involved. Any material permitted by other applicable requirements may be used.

Set B - These spacings are intended for applications where secondary short circuit protection in the form of fuses, circuit breakers, are provided and where the normal operating power does not exceed 2,000 watts or voltamperes. Material shall be as specified for set A up to 300 volts; electrical grades of fire and arc resistant materials, that is, classes B and H insulation, shall be used for higher voltages, except when otherwise approved by the command or agency concerned (see 6.5).

Set C - These spacings are intended for power applications in excess of 2,000 watts or voltamperes but still protected by secondary devices which can safely interrupt resultant short circuit currents. Electrical grades of fire and arc resistant materials, that is, classes B and H insulation, shall be used except when otherwise approved by the command or agency concerned (see 6.5).

3.8.16 Airborne noise. - Airborne noise shall comply with one of the following requirements as specified (see 6.2) when tested in accordance with 4.4.7.

3.8.16.1 For low noise applications the equipment shall comply with the requirements of MIL-STD-740. The grade of the equipment will be determined by the command or agency concerned (see 6.2) and is dependent on its location in the ship concerned.

3.8.16.2 For other than low noise applications the airborne noise (speech interference level - SIL) radiated from units to be installed in compartments in which intelligible speech communication must be maintained such as pilot house, C.I.C. or plotting rooms, shall be such that the arithmetical average of the sound pressure levels in the 300 to 600, 600 to 1200, 1200 to 2400 and 2400 to 4800 cycle per second octave bands shall not exceed 50 decibels above 0.0002 dyne per centimeter square.

3.8.17 Structureborne noise.- When specified (see 6.2), the structureborne noise shall comply with the requirements of MIL-STD-740. The grade of the equipment will be determined by the command or agency concerned (see 6.2) and is dependent on its location in the ship concerned.

3.9 Miscellaneous requirements.-

3.9.1 Drawings - general.- Drawings shall conform to MIL-D-963 and to the detail requirements specified herein. Certification data sheets shall be prepared and approved in accordance with MIL-D-963 to make detail and other drawings applicable to specific ships. The types of drawings to be furnished by the manufacturer will be as specified in the individual equipment specifications (see 6.3). The contractor's attention is invited to the requirements of 3.9.7.1.2 regarding drawings to be reproduced in the manuals. The size of the original drawings shall be such that reduced size reproductions will comply with the requirements of MIL-M-15071.

3.9.2 Drawings - preliminary.- The contractor shall submit duplicate blueprint and single reproducible (Vandyke) copies of preliminary drawings for the advance information of the shipbuilding activity or ship design agent pending the submission of working drawings. These drawings shall consist of the following:

(a) A diagram showing the cable runs required between units of an equipment, the number of active conductors per cable and the currents and voltages involved.
(b) Outline drawings of the units of the equipment showing overall dimensions, mounting dimensions, size of mounting holes, size of mounting bolts and location of gravity of units weighing over 50 pounds.

3.9.3 Drawings - working.- Duplicate blueprint and single reproducible (Vandyke) copies of all working drawings shall be submitted to the command or agency concerned for approval as soon as practicable after award of contract (see 6.5). At the same time, duplicate blueprint copies of all working drawings shall be forwarded to the Inventory Control Point for repair parts specified (see 6.2). The reproducible print is to be used for production of prints needed by installation and shipbuilding activities; therefore, this print shall be legible and of good quality. The qualities of the reproducible print will be considered in approval of the drawing. Any work (such as procurement of material or fabrication of units) done by the contractor in advance of approval of working drawings is at the contractor's own risk. Where changes are required, a similar number of copies shall be submitted for final approval. Upon approval of the working drawings, the reproducible copies shall be forwarded to the command or agency concerned. The working drawings (and features applicable to each) shall consist of a schematic diagram (see 3.9.3.3), a wiring diagram (see 3.9.3.4), a drawing list (see 3.9.3.5), and assembly drawing (see 3.9.3.6), as applicable to the equipment concerned.

3.9.3.1 Clarity and legibility.- In the preparation of working drawings, the clarity and legibility shall be such that the drawings may be satisfactorily reduced in size to approximately 11 inches in height for insertion in the manuals.

3.9.3.2 Design changes after drawing approval.- After working drawings have been approved, no changes in design or construction shall be made without the approval of the command or agency concerned (see 6.5).

3.9.3.3 Schematic diagrams.- An electrical schematic diagram of the complete system shall be drawn to represent clearly the operation of each type of unit and the proper interconnections between typical units. The features specified in 3.9.3.3.1 through 3.9.3.3.9 shall be incorporated in this diagram.

3.9.3.3.1 A thin broken line shall be used to represent the boundaries of each unit. All terminals to which external connections are made shall be shown within these boundaries, with the appropriate numbers and markings. The normal and maximum load current shall be shown for each section of interconnecting wiring for proper sizing of ship's cables by the installing activity.

3.9.3.3.2 Relay contacts and switch sections and contacts shall be numbered and lettered to conform to the requirements of the standard system shown on figure 2. Markings of all switch positions shall be shown, and the position of each switch corresponding to that on the drawing shall be indicated.

3.9.3.3.3 Each part, such as resistors, capacitors, and relays, shall be given a unique designation consisting of a letter denoting the type of part (conforming to ASA Y32.16) and a number assigned

consecutively. The numbers shall be assigned in a logical sequence, corresponding in general to the path of the electrical current or signal flow through the circuit (as for example: from the input to the output of an audio amplifier).

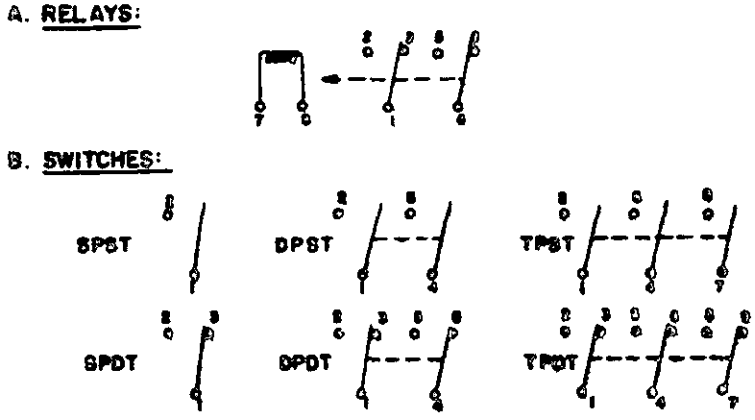

Figure 2 - Standard for designating switch and relay contacts.

3.9.3.3.4 A separate list giving electrical rating and manufacturer's name and service part number for each part shall be included with the schematic diagram.

3.9.3.3.5 Units for which a separate schematic diagram is supplied may be represented by a block with terminals shown and appropriately marked.

3.9.3.3.6 The schematic wiring of a unit which appears several times in the system need be shown only once; blocks with terminals shown and marked will suffice for the remaining identical units.

3.9.3.3.7 A system of differentiating between signal and control circuits such as one employing heavier weight lines for signal input and output circuits, shall be employed.

3.9.3.3.8 Appropriate notes shall be added to the drawing giving the following information:

Power requirements under "ready" and "standby" conditions.
Heat dissipation under "ready" and "standby" conditions.

3.9.3.3.9 In addition to the part designation, the numerical value of all electrical and electronic components shall be noted adjacent to the part. The normal and maximum load current shall be shown for each section of interconnecting wiring for proper sizing of ship's cables by the installing activity. A code shall be noted designating the units in which the numerical values are given.

3.9.3.4 Wiring diagram.- A wiring diagram shall be drawn for each unit and each major subassembly. Where practicable, the wiring diagram shall be included on the respective assembly drawings (see 3.9.3.6(d)(10)). Wiring diagrams shall include the information specified in 3.9.3.4.1 through 3.9.3.4.4.

3.9.3.4.1 All parts in correct relation as to physical location, with terminals clearly shown and marked and all wiring between parts.

3.9.3.4.2 The coding of all wires. Appropriate notes shall designate wire size and type.

3.9.3.4.3 Designations of parts shall correspond to those assigned in the schematic diagrams.

3.9.3.4.4 Voltage and resistance readings at key service points.

3.9.3.5 Drawing list.- One drawing shall list all other drawings applicable to the particular unit (contractors drawings numbers shall be listed).

3.9.3.6 Assembly drawings.- Assembly drawings shall be drawn for each unit and for each subassembly. The following information shall be included on the assembly drawings:

(a) Sufficient views in plan, elevation and cross section drawn to scale (full size if practical) to show clearly the details of mechanical design, construction and assembly of the unit and to accurately identify each part.
(b) A list of material with each part numbered, indicated and shown.
(c) Appropriate notes to cover any special methods of assembly, special treatments, use of anti-seize compounds, and use of lubricants, finishes, painting and coil treatments.
(d) The following data shall be included (as applicable):
  (1) Weight of complete unit of assembly.
  (2) Overall dimensions.
  (3) Mounting dimensions and size of mounting holes (including a template layout).
  (4) Clearances required for servicing when hinged panels or doors are employed.
  (5) Descriptive data for:
    a. Mechanical parts such as number of teeth, diametrical pitch, pitch diameter, face width and type of gears; diameter, length and thread data for all threaded parts.
    b. Electrical parts such as transformers and reactors (construction coil and core data); capacitors and resistors (type and power rating); rectifiers; relays.
  (6) Acoustical data, such as impedance and sensitivity of microphones; rated output sound pressure and corresponding power input for loudspeakers; frequency response for loudspeakers and microphones; polar distribution of sound pressure for loudspeakers.
  (7) Electrical data, such as 1,000-cycle impedance, d.c. resistance, number of turns, turns ratio of audio transformers, and size and type of wire for loudspeaker voice coils and microphone windings, operating frequency and voltage for amplifiers and signal generators.
  (8) Mechanical data for items having rotating parts (such as motor generators but excluding synchros), including speed range, center of gravity in operating condition, and radius of gyration about the three axes.
  (9) Air gap data for loudspeakers and microphones.
  (10) Electrical schematic diagrams and wiring diagrams when practicable without exceeding the size limitations of 3.9.1. (These may be supplied as separate drawings or as additional sheets of the assembly drawing at the option of the contractor.)
  (11) For equipment weighing 50 pounds or more, the weight and center of gravity of each unit.
(e) A view of each dial.
(f) The markings of all identification, designation and instruction plates.
(g) The electrical power requirements (current, voltage, power factor, frequency and number of phases) under normal, maximum demand and standby conditions for the unit. For units that require intermittent demands, the frequency and duration of the demands shall also be shown.
(h) Heat dissipation under standby and normal operating conditions.

3.9.4 Drawings - manufacturing. - When required by the individual equipment specifications (see 6.3) or in a contract or order (see 6.2), manufacturing drawings of the equipment concerned shall be furnished. These drawings shall be the manufacturer's shop drawings and need not conform to the Military standards specified herein, unless so prepared by the manufacturer. These drawings shall include a list of all drawings, bills of material and process sheets required to duplicate the equipment under procurement.

3.9.5 Bill of materials. - The requirements for the preparation of bills of materials for ships and Marine equipment shall be in accordance with MIL-B-16246.

3.9.6 Interchangeability and standardization. -

3.9.6.1 Interchangeability. - Interchangeability shall be in accordance with requirement 7 of MIL-STD-454.

3.9.6.2 Standardization. -

3.9.6.2.1 Standardization of units, subassemblies and parts shall be accomplished to as great an extent as practicable to simplify supply parts and replacement problems. Electrical and mechanical interchangeability of units, subassemblies and parts shall conform in detail to the various individual specifications.

3.9.6.2.2 Equipment standardization - Progressive standardization of complete equipments is required, at least to the extent that similar articles of different manufacture are electrically and mechanically interchangeable. In order to accomplish maximum practicable standardization, individual equipment specifications will include requirements as to mounting dimensions, limiting overall dimensions and electrical characteristics of individual items of equipment (see 6.3).

3.9.6.2.3 Standard stock parts - Standard stock parts and hardware shall be used to as great an extent as practicable (see 3.6.1). For the purpose of this specification, standard stock is defined as material listed in the Federal Supply Catalog and includes such items as bearings, grease, oil, cable, cord, wire, bolts, screws, nuts, and washers.

3.9.6.3 Proprietary parts. - Where Navy standard stock parts are not suited for the purpose intended, parts and materials shall be used which are standard, easily obtainable and produced by reliable manufacturers, as far as possible within the limits of this specification. In order to facilitate the procurement of replacement parts, the design shall not be based upon the use of parts of special manufacture where (suitable) units of standard manufacture are available. Similarly, the design shall not be based on the use of parts produced by only one manufacturer when an equivalent design available from several sources of manufacture might be employed.

3.9.7 Manuals. -

3.9.7.1 General. - Manuals shall be in accordance with MIL-M-15071, type as specified in the individual equipment specification, and as supplemented by the additional requirements specified in 3.9.7.1.1 through 3.9.7.3.5.

3.9.7.1.1 Maintenance. - For equipments employing synchros, OP-1303 shall be referenced for synchro maintenance information.

3.9.7.1.2 Drawings. - The selected final working drawings to be reproduced in the manual shall be as specified in the individual equipment specifications (see 6.3).

3.9.7.2 Preliminary manuals. - Preliminary manuals shall be submitted to the command or agency concerned for approval and assignment of identification numbers, in ample time to permit printing of finished manuals prior to the delivery date of the equipment. Except as specified hereinafter, equipment will not be accepted for delivery without finished manuals. In emergencies, and only when specifically approved by the command or agency concerned, basic instructions in typewritten or mimeographed form and blueprint copies of working drawings will be accepted as a temporary substitute for the finished manuals (see 6.5).

3.9.7.3 Manuals for developmental contracts. - Manuals for developmental contracts shall be type I in accordance with MIL-M-15071 and shall meet the minimum requirements specified in 3.9.7.3.1 through 3.9.7.3.5.

3.9.7.3.1 Manuals shall be typewritten having a single column.

3.9.7.3.2 Illustrations, drawings, sketches and photographs, shall be used freely to convey a clear picture. Illustrations included in one section may be referenced instead of being repeated in other sections.

3.9.7.3.3 High quality paper and cover stock suitable for rough handling and for the purpose intended shall be used.

3.9.7.3.4 The following topics shall be covered:

General discussion.
Theory.
Installation.
Operation.
Maintenance.
Drawings, sketches and diagrams.

3.9.7.3.5 Parts identification section shall include a column "Name of part and description" with the name of the part and the electrical ratings shown for electrical parts and the principal mechanical characteristics shown for mechanical parts. Military type numbers shall be listed, where applicable.

3.9.8 Repair parts. - Parts required for the maintenance of the parent equipment shall be supplied as "onboard" repair parts and as "stock" repair parts. Onboard repair parts shall consist of quantities of those parts, special tools (see 3.9.8.1) and test equipments required for the maintenance of the equipment by the using activity during one year's normal operation of the installed equipment. The requirements for the determination, identification and procurement of stock repair parts and for revision of the quantities of onboard repair parts shall be as specified in MIL-P-15137. Nomenclature of parts shall be in accordance with Handbook H6-1. The onboard repair parts furnished for a particular equipment shall be listed in the individual equipment specifications (see 6.3) using the list specified in table IX as a general guide (this list is not all inclusive or restrictive in any way).

Table IX - Onboard repair parts required per ship.

Item	Number equipments installed per ship						
	1	2	3	4	5	6-10	Over 10
Ball bearings (special) (each)	1	2	2	2	3	3	4
Brushes (except synchro) (each type and size) (set)	1	1	2	2	2	3	5
Contacts (set)	1	1	2	2	3	3	4
Test cables (with plugs) (each) (see 3.8.9.2)	1	1	1	1	1	1	1
Springs (the failure of which would render equipment inoperative) (each)	1	2	2	2	2	3	5
Special screws (screws not available in normal stock due to size or shape) (set)	1	1	1	1	2	2	3

3.9.8.1 Special tools. - Wherever special tools are necessary for proper service maintenance of any shipboard system, a complete set shall be furnished each ship by the contractor. The use of special tools shall be clearly justified. 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 Government inspector.)

3.9.8.2 Multiple manufacture. - Where the equipment is comprised of units procured from more than one manufacturing source, separate sets of onboard repair parts will be required from each such source covering the items associated with that source.

3.9.9 Repair parts (electronic). - Program support for the following interior communication equipments and systems (of an electronic nature) is the responsibility of the Electronic Supply Office (ESO):

(a) Shipboard announcing equipment (amplifiers and loudspeakers).
(b) Intercommunicating units.
(c) Communication consoles.
(d) Sound and data recording/reproducing equipment.
(e) Record players.
(f) Portable announcing systems and public address sets.
(g) Ships entertainment systems.
(h) Telephone amplifiers.

3.9.9.1 When specifically required in the individual equipment specifications (see 6.3), the onboard and stock repair parts for the equipments and systems listed in 3.9.9 shall be determined, identified and procured in accordance with MIL-E-17362. Nomenclature and stock numbers shall be obtained in accordance with MIL-E-21981.

3.9.10 Designation and marking. - Identification plates, wiring diagrams, instruction plates, other designation plates and markings for units, subassemblies and parts shall be in accordance with MIL-P-15024, except that reversed etched plates shall not be used. Serial numbers on identification plates will be shown only when required by the individual equipment specifications (see 6.3).

Identification plates for use on units that will be exposed to the weather shall be type A, B, C, D or I made from nickel-copper alloy, brass, or type H made from anodized aluminum. The above plates shall be in accordance with MIL-P-15024. Type E and G plates shall be used only for wiring diagrams and other plates that are housed within the equipment enclosure. Plastic type B plates shall have black inner (or record) laminations and gray cover laminations.

3.9.10.1 When specified (see 6.2), the Federal stock number shall be entered on the identification plates prior to shipment.

3.9.10.2 All diagrams or plates shall be permanently marked and securely fastened in place. Self-tapping screws shall not be used.

3.9.10.3 Designation of parts. - Where space permits, parts, such as transformers, relays, electron tubes, large capacitors and resistors, shall be identified by markings adjacent to the part on the chassis or board on which the part is mounted. The marking shall be that designation assigned in the associated schematic wiring diagram, and shall be clearly and indelibly made.

3.9.10.4 Electrical circuit diagrams of individual units shall be provided and mounted inside the enclosure so as to be usable in servicing the unit. The circuit diagrams shall be type F or H plates in accordance with MIL-P-15024.

3.9.11 Reports. - Engineering reports submitted on research and development contracts shall be type I, (interim engineering) and type II (final engineering) in accordance with MIL-R-978.

3.9.12 Item names and nomenclature. - Item names of units and parts for other than acoustic equipment and audio amplifiers shall be in accordance with Handbook H6-1. Acoustic equipment and audio amplifiers shall be assigned "AN" system nomenclature in accordance with the procedures outlined in MIL-E-21981.

\# 3.9.13 Workmanship. - The workmanship shall be in accordance with requirement 9 of MIL-STD-454. The equipment shall comply with the general examination specified in 4.4.1.

4. QUALITY ASSURANCE PROVISIONS

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

4.2 General. - The methods of sampling, inspection and test procedures to be conducted upon interior communication equipment shall be as specified hereinafter.

4.2.1 Quality conformance inspection. - Quality conformance inspection shall consist of examinations and tests necessary to insure that the equipment has been properly manufactured and assembled in accordance with the approved drawings and will operate when properly installed.

4.2.1.1 Classification of tests. - Quality conformance inspection shall be classified as follows:

(a) Group A
(b) Group B
(c) Group C

4.2.1.1.1 Group A. - Group A inspection shall be conducted on a sampling plan as specified in the individual equipment specification (see 6.3). Group A inspection will normally include simple routine examinations and tests quickly performed on large quantities of equipment and designed to reveal faulty workmanship, assembly and adjustments most likely to occur frequently in production runs.

4.2.1.1.2 Group B. - Group B tests shall be conducted on a sampling plan as specified in the individual equipment specification (see 6.3). Group B tests will normally include complicated tests designed to reveal design limitations and deficiencies and defects less likely to occur frequently in production runs.

4.2.1.1.3 Group C. - Group C tests will normally be performed on one unit and normally includes ruggedness and similar tests intended to reveal defects due to use of alternate materials, to changes in the basic design of the equipment and to determine continued compliance with the specification. Group C tests will be required only when the basic design or the material of a vital part of the equipment has been changed.

4.3 General test procedures. -

4.3.1 Test conditions. - Except for those tests where the following factors are the variables, tests shall be conducted with the equipment operating under the following conditions:

(a) The ambient temperature shall be 75° ± 5°F. (25° ± 3°C.) and the relative humidity shall be between 25 and 50 percent.
(b) The supply voltage shall be the normal operating voltage.
(c) The supply frequency shall be the normal operating frequency.
(d) The tone control(s) of audio units shall be in the neutral or normal position.

4.3.2 Repair parts. - Adequate repair parts shall be provided with each unit submitted for Government laboratory test to insure the completion of the tests.

4.3.3 Drawings. - Units submitted for laboratory test shall be accompanied by drawings showing details of construction and containing a list of the materials and finishes used, and shall include all circuit schematic wiring diagrams.

4.4 Detailed test procedures. - The specific tests required as part of qualification and quality conformance inspection and the sequence of conducting these tests shall be as listed in the individual equipment specification (see 6.3). Tests specified herein shall be conducted only when specified in the individual equipment specification. The details of the various tests are as follows:

4.4.1 General examination. - The completed unit shall be given a thorough examination to determine that it conforms to the applicable specifications and approved working drawings with respect to material, finish, workmanship, construction, assembly, dimensions, weight and marking of identification and information plates. This examination shall be limited to those examinations that may be performed without disassembling the unit in such a manner that its performance, durability or appearance would be affected. This examination shall include a check of all operating controls, circuit functions, synchro connections for compliance with 3.8.11.4.1, test facilities and adjustments, as applicable.

4.4.2 Operating test. - An operating test of the unit or complete equipment as specified in the individual equipment specification (see 6.3) shall be conducted. The power input of each unit shall be measured and recorded as a part of this test.

4.4.3 Supply line voltage and frequency variation. - Deleterious effects of changes in supply line voltage and supply line frequency shall be determined. The tolerances specified in 3.8.3 shall be used as test settings for the purpose of determining voltage and frequency variation and satisfactory performance of units.

4.4.4 Dielectric strength. - Dielectric strength between electrical circuits and between electrical circuits and ground, shall be tested with a closely sinusoidal source of 60 cycles a.c. having a capacity of at least 1 kilowatt. Root mean square (r.m.s.) values of test voltage shall be as follows:

Circuit voltage of equipment tested	R.m.s. value of dielectric test voltage
Less than 60	450
60 to 120	900
Above 120 and less than 240	1200
240 to 480	1500
Above 480	Twice rated voltage plus 1000

Equipment shall pass successfully, one high voltage test of applicable voltage specified herein. Radio interference filters having a voltage rating of less than the test voltage noted herein shall be disconnected from the equipment during this test. All synchros shall be disconnected during this test. In dielectric tests, the voltage shall be raised gradually to the specified value and shall be held at that value for the periods specified in 4.4.4.1. Dielectric tests normally shall be accomplished after the endurance test (see 4.4.10).

4.4.4.1 For the dielectric strength test conducted as part of qualification inspections the test voltage shall be held at the specified value for 1 minute plus or minus 5 seconds. For the dielectric strength test conducted as part of acceptance inspection the test voltage shall be held at the specified value for 5 seconds plus or minus 1 second.

4.4.4.2 The dielectric strength test shall not be applied to electronic/electrical circuitry which uses low voltage components such as transistors, electrolytic capacitors, diodes and other voltage sensitive components (see individual equipment specification).

4.4.5 Insulation resistance. - The insulation resistance of electrical circuits following the dielectric strength test specified in 4.4.4 shall be not less than 10 megohms at 50 volts d.c. at approximately room temperature 75°F. (25°C.) and at a relative humidity of approximately 50 percent. All synchros shall be disconnected during this test

4.4.6 Radio frequency noise interference. - Radio frequency noise interference tests when required for compliance with 3.8.5 shall be conducted in accordance with MIL-I-16910.

4.4.7 Airborne noise. - Compliance with the airborne noise requirements of 3.8.16 shall be determined in accordance with 4.4.7.1 and 4.4.7.2.

4.4.7.1 When 3.8.16.1 is applicable, the test shall be conducted as specified in MIL-STD-740 using sound power levels in one third octave bands.

4.4.7.2 When 3.8.16.2 is applicable, the test shall be conducted as follows:

(a) The unit being tested shall be mounted rigidly in its normal operation position to a 1/8 inch thick steel plate, 4 feet square stiffened with two 4-inch tee bars, with each of the stems welded to the plate 1 foot off the centerline. The plate shall be suspended vertically by rope attached at two corners.

(b) Noise levels shall be obtained with a calibrated sound level meter and octave band analyzer (filter net) conforming to Z24.3 and Z24.10, respectively. The flat, or "C", weighting network of the sound level meter shall be used during the test.

(c) The measuring microphone shall be at least 3 feet from large reflecting surfaces such as the floor and ceiling and 6 feet from the walls of the measurement room. The microphone shall be placed at a minimum of nine measuring stations, uniformly distributed on an imaginary hemispherical surface approximately 3 feet from the housing of the unit being tested. The base of

the hemisphere shall be the plane of the mounting plate. The measuring stations shall be located as follows:

(1) The "north" "east," "south," and "west" points on the base circle of the hemisphere.
(2) The "northeast," "southeast," "southwest" and "northwest" points on a circle halfway between the base circle and a point normal to the mounting plate through the geometrical center of the unit.
(3) The point normal to the mounting plate through the geometrical center of the unit.

(d) The background, or ambient noise shall be kept as low as possible during the test and the sound pressure levels obtained shall be corrected, if necessary, for ambient noise in accordance with table X.

The following information shall be recorded:

(1) All corrected sound pressure levels, identified with the respective microphone stations. The octave band levels shall be used to determine compliance with the standard of 3.8.16.
(2) Ambient noise levels.
(3) Dimensions and materials of the walls, floor, and ceiling of the measurement room.
(4) Location in the room of unit under test.
(5) Operating conditions of unit during test.

Table X - Airborne audible noise.

Overall or octave band level with equipment operating minus ambient levels in the same band	Correction (to be subtracted from level obtained with equipment in operation)
Decibels	Decibels
9 or greater	No correction
8 to 6	1
5 to 4	2
3	3
2	4
Less than 2	Greater than 4, but indeterminate

(e) The overall sound pressure level shall be obtained at each station. In addition, an octave band analysis shall be obtained with the microphone placed at the station described in (c)(3) specified herein.
(f) All levels shall be obtained while the unit is being operated at maximum or rated speed.

4.4.8 Structureborne noise. - Compliance with the requirements of 3.8.17 for structureborne noise shall be determined in accordance with MIL-STD-740. Detailed reports shall be required.

4.4.9 Temperature and humidity tests. - The equipment shall be operated in the ambient temperatures and humidity as specified in 3.7.16 to determine conformance with that requirement.

4.4.9.1 Temperature. - Temperature test shall be conducted in the following environment:

(a) Temperature - Humidity chamber capable of providing the range of temperature and humidity specified, and having an air change rate of no more than twice per minute.
(b) Stable temperature room (75° ± 3°F.) with air change rate of no more than twice per hour.

4.4.9.1.1 Equipment installation. - Unless otherwise specified in the individual equipment specification the equipment shall be enclosed on both sides to its full height at a distance of 2 inches and in the rear to its full height at a distance of 6 inches.

4.4.9.1.2 Equipment operating mode. - The equipment shall be operated with a power supply source of normal frequency and voltage. The equipment shall be operated at full load condition and where a signal source is required to drive equipment to rated output, this shall be supplied. If this source is special, it shall be supplied by the equipment manufacturer.

4.4.9.1.3 Temperature cycle. - The equipment shall be subjected to the following temperature cycles:

Period[1/] (hours)	Temperature (± 5°F.)	Environment
6	40°F.	Chamber
6	149°F.	Chamber
6	75°F.	Stable room or chamber

[1/] Periods shall be measured from the time when the temperature is stabilized. All tests within a 6-hour period shall be continuous.

4.4.9.1.4 Temperature measurements. - During each period of the temperature cycle after equipment temperature stability has been reached, measurements shall be conducted of internal air temperature, and hot spots to determine conformance with 3.7.16.

4.4.9.1.5 Hot spot sensor location. - The number and location of hot spot sensors shall be determined by scanning the various components in the unit enclosure to determine maximum hot spot temperatures. Scanning shall be accomplished approximately 6 hours after the energized unit has been placed in the heat chamber. Not less than 3 hot spot sensors shall be attached to heat generating components in the unit enclosure.

4.4.9.1.6 Performance measurements. - Subsequent to temperature measurements at the high temperature, equipment performance tests shall be conducted.

4.4.9.1.7 Extended storage. - The equipment shall be held at each of the two temperature extremes for a period of 24 hours. Subsequent to each exposure of 24 hours the equipment shall be allowed to stabilize at room temperature for from 12 to 24 hours and appropriate measurements taken to insure compliance with 3.7.16.1.

4.4.9.2 Humidity. - The humidity test shall be conducted in accordance with the method specified in MIL-E-5272 (procedure I) for a total of 5 cycles (120 hours) to determine compliance with 3.7.16.

4.4.10 Accelerated life test. - Accelerated life test shall be conducted for a period of 500 hours. Minimum period of operation shall be 7 hours except as indicated. Conditions of operation shall be varied as specified in detail in each individual equipment specification (see 6.3). The 500-hour test shall be divided as follows:

Hours[1/]	Ambient temperature during test	Test conditions	Angle of tilt
Before starting the following tests, conduct and record an accuracy test:			
0-50	75°F. (25°C.) nominal (room temperature).	Constantly varying	Normal
After 50	Vibration test, accuracy check test, and short test runs (one-half hour each) at undervoltage and underfrequency and at overvoltage and overfrequency.		
50-175 continuous	-20°F. (-29°C.) or 40°F. (5°C.) as applicable	Constantly varying	Normal
175-300 continuous	149°F. (65°C.) at approximately 95 percent R.H. for alternate 1-hour periods. Hot spot, internal air and ambient temperatures shall be continuously recorded or points scanned. Baffels to prevent air circulation around the enclosure shall be installed in accordance with 4.4.9.1.1.	Constantly varying	Normal

Hours[1/]	Ambient temperature during test	Test conditions	Angle of tilt
300-350	75°F. (25°C.) nominal (room temperature).	Constantly varying	Incline 45° or 60°[2/] forward from vertical
350-400	75°F. (25°C.) nominal (room temperature).	Constantly varying	Incline 45° or 60°[2/] back from vertical
400-450	75°F. (25°C.) nominal (room temperature).	Constantly varying	Incline 45° or 60°[2/] right from vertical
450-500	75°F. (25°C.) nominal (room temperature).	Constantly varying	Incline 45° or 60°[2/] left from vertical

Upon completion of above tests, conduct and record an accuracy test.

[1/] Time periods may be varied to suit laboratory test schedule.
[2/] Submarine equipment only.

Immediately after the above endurance test is completed the dielectric strength test, insulation resistance tests, HI shock test and accuracy check test shall be run in the order specified. Special exceptions to the above procedure may be noted in the individual equipment specifications (see 6.3). Tumbling test, depth charge test and other special tests, if required by the individual equipment specifications, will be conducted in the order specified therein and are consequently not included in the above general outline.

4.4.11 Enclosure tests. - The enclosure shall be subjected to test conditions in MIL-STD-108 modified as shown in 4.4.11.1 and 4.4.11.2.

4.4.11.1 Watertight or submersible. - The requirement for breaking and reassembling joints sealed by gaskets prior to test applies only to cover or door openings, not indicator or observation windows.

4.4.11.2 Dripproof or dripproof protected. - In conducting this test, 10 gallons of water shall flow through the nozzle onto the top surface of the equipment. The equipment shall be set at zero degrees and its position shall not be varied. The equipment shall be energized immediately after completion of the test to check for correct operation.

4.4.12 Salt spray test. - The complete unit shall be subjected, under continuous ultra-violet light to a 20 percent hot salt spray at 131°F. (55°C.) for a period of 3 minutes, followed by a hot air blast at 131°F. (55°C.) for a period of 2 minutes. The cycle shall be repeated continuously for 100 hours. Upon completion of the test, the unit shall be washed with fresh water, dried and examined to determine conformance with 3.7.18. During test, all equipment shall be mounted in its normal installed position. Test equipment shall be equivalent to the Navy standard salt spraying machine (see 9000-S6202-73724).

4.4.13 Tumbling test. - At least two samples of the unit to be tested shall be subjected to a tumbling test of 500 revolutions in a rotary tumbler tester to determine conformance with 3.7.19.

4.4.14 Gunblast test. - Gunblast test for compliance with 3.7.20 shall be conducted as specified in 4.4.14.1 or 4.4.14.2.

4.4.14.1 Simulated gunblast test. - The unit shall be mounted on the carriage of the U.S. Navy simulated gunblast equipment. The front edge of the unit shall be positioned in the test plane, and its axis shall be coincident with that of the explosion chamber. The unit being tested shall be subjected to 30 rounds of blast at a peak pressure of 9.5 pounds per square inch. For large unit, such as superpower loudspeakers, where the loudspeaker mouth area exceeds the face area of the explosion chamber (17-1/2 inches by 17-1/2 inches or 18 inches in diameter), but which employ individual horn assemblies the area of each of which is less than the face area of the explosion chamber, the unit shall be so positioned that the axis of one of the individual horns is coincident with that of the explosion chamber.

4.4.14.2 Gunblast test at Naval Weapons Laboratory. - For large units, such as super-power loudspeakers, in which the mouth area of the unit or of any of its individual horn assemblies exceeds the face area of the explosion chamber (see 4.4.14.1), the unit shall be exposed to gunblastproof (degree 2) test in accordance with MIL-STD-108 at the Naval Weapons Laboratory, Dahlgren, Virginia.

4.4.15 Depth charge test. - Depth charge test for compliance with 3.7.21 shall be conducted as specified in 4.4.15.1 or 4.4.15.2.

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

4.4.15.2 Simulated depth charge test. - The test shall be conducted on the hydraulic shock machine at the U.S. Naval Shipyard, Portsmouth, New Hampshire. The machine shall be adjusted to requirements to be specified in the individual equipment specification.

4.4.16 Inclination. - Units shall operate satisfactorily when inclined up to 45 degrees from vertical in any direction (that is, forward, backward, left or right) for surface ships equipment and up to 60 degrees from the vertical in any direction for submarine equipment.

4.4.17 Vibration test. - Vibration tests for compliance with 3.7.22 shall be conducted as outlined for vital equipment (such as ship control order and indicating, and gyro compasses) or nonvital equipment (such as motion picture equipment or record players) with the units under test energized in the normal manner.

4.4.17.1 Vibration test for vital equipment. - The unit shall be tested in accordance with type I (environmental vibration) of MIL-STD-167, except that the variable frequency test shall be omitted.

4.4.17.2 Vibration test for nonvital equipment. - The unit shall be tested in accordance with type I (environmental vibration) of MIL-STD-167, except that the time of vibration for the endurance test shall be 1 hour and the variable frequency test shall be omitted.

4.4.18 Shock tests. - HI shock tests for compliance with 3.7.22 shall be conducted in accordance with MIL-S-901 with the unit under test energized in the normal manner. These tests shall be made after all other tests have been concluded. Units which have been subjected to this shock test shall not be installed onboard ship without specific command or agency approval (see 6.5).

4.4.19 Transients. - A one millisecond pulse of a magnitude sufficient to provide 300 percent over voltage of the peak supply voltage shall be superimposed on the supply voltage. The output of the equipments power supply(ies) shall be observed on a calibrated oscilloscope to determine conformance with 3.6.2.11. With a constant power supply input, the output of the equipment power supply shall be observed on a calibrated oscilloscope, while the equipment is switched through all operational modes to determine conformance with 3.6.2.11.

5. PREPARATION FOR DELIVERY

5.1 Preparation for delivery shall be as specified in the individual equipment specification.

6. NOTES

6.1 Intended use - The equipment covered by this specification is intended for Naval service where it is expected to withstand continuous use for long periods, under Military service conditions, without benefit of overhaul. The equipment is in each case a vital unit intended for important use by the forces concerned. Failure at a critical moment invariably results in serious reduction in the battle efficiency of the ship or shore activity involved. Emergency repairs afloat, or at distant bases, can seldom be made with sufficient celerity to avoid having equipment out of service during a critical period.

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

(a) Power supply to the individual equipment (see 3.8.3).
(b) Whether radio interference reduction requirements apply (see 3.8.5).
(c) Whether standard or low airborne noise requirements apply (see 3.8.16) and which grade of quietness is required (see 3.8.16.1).

(d) Whether low structureborne noise requirements apply and which grade of quietness is required (see 3.8.17).
(e) Whether manufacturing drawings are required (see 3.9.4).
(f) Inventory control point for repair parts (see 3.9.3, 3.9.8 or 3.9.9).
(g) If the Federal stock number is required on the identification plate (see 3.9.10.1).
(h) Level of preservation, packaging, packing and marking (see 5.1).

6.3 Information for equipment specification writers. - Since this specification is general in scope and covers only the construction practices and the conditions under which equipment for Naval ship or shore use must operate, the details of performance of the individual equipment under the conditions stated herein and the ordering information must be specified elsewhere. Attention of design engineers is invited to the items listed hereinafter which should be considered in the preparation of individual equipment specifications:

(a) Whether qualification is required (see 3.1).
(b) Requirements outlined by this specification which applies to the individual equipment specification (see 3.2.1).
(c) Use of wood (see 3.4.7).
(d) Numerals, shapes or colors for identifying pointers (see 3.5.2.2 and 3.5.2.3).
(e) Ball bearings of metric series (see 3.5.6.1).
(f) Use of electrolytic capacitors (see 3.6.4).
(g) If other than grade 5, life expectancy X transformers are required (see 3.6.6).
(h) Size of synchro transmitters and receivers (see 3.6.8).
(i) Use of batteries (see 3.6.10).
(j) Applicable drawing for lampholders (see 3.6.13.2).
(k) Enclosure material and type of construction (see 3.7.1).
(l) Cable entrance requirements (see 3.7.2).
(m) Degree of enclosure (see 3.7.3).
(n) Whether enclosures shall be designed for universal, bulkhead, pedestal, panel, console, or special multiple mounting (see 3.7.4).
(o) If dust filters may be omitted (see 3.7.9.1).
(p) Size of individual equipment (see 3.7.10).
(q) If corrosion resistant steel inserts may be used in drippproof enclosures (see 3.7.11.5).
(r) Extreme temperatures for exposed locations (see 3.7.16.2).
(s) Accelerated life requirement (see 3.7.17).
(t) Salt spray requirements (see 3.7.18).
(u) Tumbling requirements (see 3.7.19).
(v) Gunblast requirements (see 3.7.20).
(w) Depth charge requirements (see 3.7.21).
(x) Shock, vibration and inclination requirements (see 3.7.22).
(y) Release of mechanically interlocked push buttons under shock (see 3.7.22).
(z) Use of shock or vibration mounts (see 3.7.22.1).
(aa) Fuses for special functions (see 3.8.2).
(bb) Power supply for the individual equipment (see 3.8.3).
(cc) Power supply for special applications (see 3.8.3).
(dd) Application of shielding and radio interference reduction requirements (see 3.8.5).
(ee) Internal subassembly plug and jack connection required (see 3.8.9.1).
(ff) Test cable subassembly required (see 3.8.9.2).
(gg) Transportation table for wire markings (see 3.8.11.4).
(hh) Highest operating temperature for insulation (see 3.8.14).
(ii) Maximum temperature for class C insulation (see 3.8.14.2).
(jj) Type of drawings to be furnished by manufacturer (see 3.9.1).
(kk) Manufacturing drawings to be required (see 3.9.4).
(ll) Mounting dimensions, limiting overall dimensions, and electrical characteristics (see 3.9.6.2.2).
(mm) List of drawings to be included in the manuals (see 3.9.7.1.2).
(nn) List of the quantities of repair parts, special tools, and test equipments (see 3.9.8).
(oo) Whether MIL-P-15137 (see 3.9.8) or MIL-E-17362 (see 3.9.9.1) is applicable to the equipment concerned.
(pp) Whether serial numbers of units are required on identification plates (see 3.9.10).
(qq) Tests to be conducted for groups A, B and C and the sampling plans for group A and B tests (see 4.2.1 and 4.4).
(rr) Operating test to be conducted (see 4.4.2).

(ss) Temperature and humidity tests or accelerated life tests (see 4.4.9 and 4.4.10).
(tt) Operating characteristics of the equipment when temperature and humidity tests are required (see 4.4.9).
(uu) Speeds of operation of the equipment when accelerated life tests are specified (see 4.4.10).
(vv) Additional specific requirements for preparation for delivery applicable to the particular equipment (see 5.1).
(ww) Ordering data included in MIL-I-983 (see 6.2).

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

6.4.1 Individual equipment specification. - An individual equipment specification is the detailed specification covering a particular equipment.

6.4.2 Part. - A part consists of one item or two or more items so joined together that they are not subject to disassembly.

Examples: Capacitor, resistor, gear, bolt, electron tube.

6.4.3 Subassembly. - A subassembly is a grouping of two or more different parts having a common mounting, or mounted one upon the other, that can be taken apart without alteration or destruction of the parts. It cannot independently perform or fulfill a specific complete function.

Examples: Gear train
Rotor (of a synchro motor).
Rotor (of wind speed detector).
Signal generator (of shipboard announcing amplifier).
Voltage amplifier (of shipboard announcing amplifier).
Differential (of underwater log speed indicator-transmitter).

6.4.4 Unit. - A unit is a self contained grouping of parts or subassemblies, which shall be mechanically, hydraulically, or electrically connected to other unit or units in order to perform a specific function.

Examples: Loudspeaker (of shipboard announcing equipment).
Salinity cell (of salinity indicating equipment).
Indicator-transmitter (of engine order equipment).
Propeller revolution indicator (of propeller revolution indicating equipment).

6.4.5 Assembly. - An assembly is two or more parts or units of the same basic noun name (that is, two switches) having a common mounting or mounted one upon the other. They shall be separable and each part or unit shall be capable of functioning independently.

6.4.6 Equipment. - An equipment consists of two or more separate units or assemblies which shall be electrically, mechanically, or hydraulically connected or associated together to perform their intended functions.

Examples: Rudder angle indicator equipment (transmitter and indicators).
Salinity indicating equipment (panel and associated cells).

6.4.7 System. - A system is an equipment properly installed and interconnected or associated so as to be capable of performing its intended function.

6.4.8 Accessory. - An accessory is a unit, a part, or a grouping of parts or subassemblies designed for use in conjunction with another unit or an equipment, and contributes to the effectiveness thereof without extending or varying its basic function. It may be used for testing, adjusting, or calibrating.

6.4.9 Attachment. - An attachment is a unit, a part, or a grouping of parts or subassemblies designed for use in conjunction with another unit or an equipment contributing to the effectiveness thereof by extending or varying its basic function.

6.4.10 Onboard repair parts sets. - Onboard repair parts sets are those repair parts and special tools (see 3.9.8.1) which are not in standard stock but which are supplied with equipments to permit repair and maintenance of the equipment by the user for 1 year.

6.5 The attention of design engineers and contractors is invited to the items listed below which require written approval of the command or agency concerned or NAVSEC:

(a) Use of alternate materials (see 3.4.2).
(b) Radioisotopes (see 3.4.6).

(c) Use of magnesium (see 3.4.8.2).
(d) Use of material, other than insulating lacquer for painting plastics (see 3.4.9.4).
(e) Use of cotton or wood flour filled molding compounds (see table I).
(f) Use of cotton fabric base laminates (see table II).
(g) Use of ceramics (see 3.4.10).
(h) Silicone varnish used for treating ceramics (see 3.4.10).
(i) Conditions of application and use of rigid materials for encapsulating or embedding parts, if other than specified (see 3.4.11.2).
(j) Corrosion resistant treatments, if other than specified (see 3.4.15.2).
(k) Use of nonstandard parts (see 3.6.1.1).
(l) Use of electrolytic capacitors (see 3.6.4)
(m) Use of hermetically sealed relays (see 3.6.7.2).
(n) Boots used for push switches in watertight applications (see 3.6.12.4).
(o) Printed wiring (see 3.6.16).
(p) Use of through bolting in watertight enclosures (see 3.7.7).
(q) Use of special antiseize compound (see 3.7.11.5).
(r) Use of threads in plastic without inserts (see 3.7.11.7).
(s) Type of tube locking device (see 3.7.22.1).
(t) Mounting of electron tubes in horizontal position (see 3.7.22.1.1).
(u) Type of power plug locking device (see 3.7.22.1.2).
(v) Use of filters (see 3.8.5.2).
(w) Interference reduction devices (see 3.8.5.2).
(x) Use of ship's hull, chassis or enclosure for active circuit (see 3.8.6).
(y) Dial illumination (see 3.8.13).
(z) Use of class H insulation where class A, B, or C is specified (see 3.8.14.1).
(aa) Use of solventless type insulation varnish (see 3.8.14.5.3).
(bb) Use of other than classes B and H insulation for sets B and C enclosures higher than 300 volts (see 3.8.15).
(cc) Approval of working drawings (see 3.9.3).
(dd) Changes in design or construction after approval of working drawings (see 3.9.3.2).
(ee) Acceptance of basic instructions in typewritten or mimeographed form and blueprint copies of working drawings as a temporary substitute for finished manuals (see 3.9.7.2).
(ff) Use of equipment that has been subjected to HI shock test (see 4.4.18)

6.6 CHANGES FROM PREVIOUS ISSUE. THE OUTSIDE MARGINS OF THIS DOCUMENT HAVE BEEN MARKED "#" TO INDICATE WHERE CHANGES (DELETIONS, ADDITIONS, ETC.) FROM THE PREVIOUS ISSUE HAVE BEEN MADE. THIS HAS BEEN DONE AS A CONVENIENCE ONLY AND THE GOVERNMENT ASSUMES NO LIABILITY WHATSOEVER FOR ANY INACCURACIES IN THESE NOTATIONS. BIDDERS AND CONTRACTORS ARE CAUTIONED TO EVALUATE THE REQUIREMENTS OF THIS DOCUMENT BASED ON THE ENTIRE CONTENT AS WRITTEN IRRESPECTIVE OF THE MARGINAL NOTATIONS AND RELATIONSHIP TO THE LAST PREVIOUS ISSUE.

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