MILITARY SPECIFICATION

PROPULSION AND AUXILIARY CONTROL CONSOLES AND

ASSOCIATED CONTROL AND INSTRUMENTATION EQUIPMENT,

NAVAL SHIPBOARD USE, BASIC DESIGN REQUIREMENTS

1. SCOPE

1.1 This specification covers the basic general requirements applicable to the design, materials, construction, inspection, and operating conditions for automated or centralized propulsion and auxiliary control consoles together with their associated control and instrumentation equipment used for Naval shipboard service. Reference to a console herein shall mean the complete unit with all systems, subsystems and parts installed. Requirements applicable to individual propulsion and auxiliary control consoles shall be as specified in the individual console specification (see 6.5.1).

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 this specification to the extent specified herein.

SPECIFICATIONS

FEDERAL

P-F-300 - Filter, Air Conditioning: Viscous-Impingement and Dry Types, Cleanable.
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: Square, Hexagon, Cap, Slotted, Castellated, Clinch, Knurled and Welding.
QQ-A-200 - Aluminum Alloy, Bar, Rod, Shapes, Tube, and Wire, Extruded, and Structural Shapes, General Specification For.
QQ-A-200/5 - Aluminum Alloy, Bar, Rod, Shapes, Tube and Wire, Extruded, 5086.
QQ-A-200/8 - Aluminum Alloy, Bar, Rod, Shapes, Tube and Wire, Extruded, 6062.
QQ-A-250 - Aluminum Alloy Plate and Sheet; General Specification For.
QQ-A-250/2 - Aluminum Alloy 3003, Plate and Sheet.
QQ-A-250/8 - Aluminum Alloy 5052, Plate and Sheet.
QQ-A-250/11 - Aluminum Alloy 6061, Plate and Sheet.
QQ-S-698 - Steel, Sheet and Strip, Low Carbon.
QQ-S-700 - Steel, Sheet and Strip, Medium and High Carbon.
QQ-S-741 - Steel, Carbon: Structural Shapes, Plates, and Bars.
QQ-S-764 - Steel Bar, Corrosion Resisting, Free Machining.
QQ-W-343 - Wire, Electrical, (Uninsulated).

MILITARY

MIL-C-5 - Capacitors, Fixed, Mica-Dielectric, General Specification for.
MIL-I-10 - Insulating Compound, Electrical, Ceramic, Class L.
MIL-M-14 - Molding Plastics and Molded Plastic Parts, Thermosetting.
MIL-C-20 - Capacitors, Fixed, Ceramic Dielectric (Temperature Compensating) General Specification for.
MIL-R-22 - Resistors, Variable (Wirewound, Power Type).
MIL-R-26 - Resistors, Fixed, Wirewound (Power Type), General Specification.
MIL-T-27 - Transformers and Inductors (Audio, Power and High Power Pulse) General Specification for.
MIL-R-29 - Resistors, Fixed, Meter Multiplier, External (High Voltage, Ferrule Terminal Type).
MIL-W-80 - Window, Observation, Acrylic Base, Anti-Electrostatic, Transparent (For indicating Instrument).
MIL-C-81 - Capacitors, Variable, Ceramic Dielectric.
MIL-C-92 - Capacitors, Variable Air Dielectric (Trimmer) General Specification for.

MILITARY (Cont'd)

MIL-I-631 - Insulation, Electrical, Synthetic-Resin Composition, Nonrigid.
MIL-T-713 - Twine: Impregnated, Lacing and Tying.
MIL-S-901 - Shock Tests, H.I. (High-Impact); Shipboard Machinery, Equipment and Systems, Requirements for.
MIL-E-917 - Electric Power Equipment, Basic Requirements (Naval Shipboard Use).
MIL-T-981 - Transformer, Power, Voltage Regulating.
MIL-P-997 - Plastic Material, Laminated, Thermosetting, Electrical Insulation: Sheets, Glass Cloth, Silicone Resin.
MIL-D-1000 - Drawings, Engineering and Associated Lists.
MIL-D-1000/2 - Drawings, Engineering and Associated Lists.
MIL-Y-1140 - Yarn, Cord, Sleeving, Cloth, and Tape-Glass.
MIL-I-1361 - Instrument Auxiliaries, Electrical Measuring: Shunts, Resistors, and Transformers.
MIL-T-1943 - Telephone Equipment, Dial (Shipboard Use).
MIL-C-2212 - Controllers, Electric Motor, A.C. or D.C. and Associated Switching Devices, 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 Core, Fibrous-Glass.
MIL-I-3190 - Insulation Sleeving, Electrical, Flexible, Coated, General Specification For.
MIL-I-3505 - Insulation Sheet and Tape, Electrical, Coil and Slot, High Temperature.
MIL-L-3661 - Lampholders, Indicator Lights, Indicator Light Housings, and Indicator Light Lenses, General Specification For.
MIL-L-3661/50 - Lampholders, Indicator Lights, Indicator-Light Housings, and Indicator Light Lenses, Indicator Light, 2 Lamp, Display Type LHC91.
MIL-L-3661/55 - Lenses, Indicator Light, Style LC41.
MIL-L-3661/56 - Lenses, Indicator Light, Style LC42.
MIL-L-3661/57 - Lenses, Indicator Light, Style LC43.
MIL-L-3661/58 - Lenses, Indicator Light, Style LC44.
MIL-L-3661/59 - Lenses, Indicator Light, Style LC45.
MIL-L-3661/61 - Lights, Indicator (Housing), Style LH94.
MIL-L-3661/62 - Lights, Indicator (Housing), Style LH95.
MIL-L-3661/63 - Lights, Indicator (Housing), Style LH96.
MIL-L-3661/65 - Lights, Indicator (Housing), Style LH98.
MIL-S-3786/4 - Switch, Rotary, Style SR04.
MIL-G-3787 - Glass, Laminated, Flat; (Except Aircraft).
MIL-S-3950 - Switch, Toggle, General Specification for.
MIL-C-3965 - Capacitors, Fixed, Electrolytic (Nonsolid Electrolytic), Tantalum, 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 - Packing, Preformed, Petroleum Hydraulic Fluid Resistant, 160°F.
MIL-R-5757 - Relays, Electrical (for Electronic and Communication Type Equipment), General Specification for.
MIL-T-7928 - Terminals, Lug: Splices, Conductor: Crimp Style, Copper, General Specification for.
MIL-S-8660 - Silicone Compound.
MIL-S-8805 - Switches and Switch Assemblies, Sensitive and Push, (Snap Action), General Specification for.
MIL-F-8815 - Filter and Filter Elements, Fluid Pressure, Hydraulic, Line, 15 Micron Absolute, Type II Systems.
MIL-Q-9858 - Quality Program Requirements.
MIL-R-10509 - Resistors, Fixed, Film (High Stability), General Specification for.
MIL-C-11015 - Capacitors, Fixed, Ceramic Dielectric (General Purpose), General Specification for.
MIL-C-11272 - Capacitors, Fixed, Glass Dielectric.
MIL-R-11804 - Resistors, Fixed, Film (Power Type), General Specification for.
MIL-R-12934 - Resistors, Variable, Wirewound, Precision, General Specification for.
MIL-P-13949 - Plastic Sheet, Laminated, Copper Clad (for Printed Wiring).

MILITARY (Cont'd)

MIL-C-14157 - Capacitors, Fixed, Paper (Paper-Plastic) or Plastic Dielectric, DC (Hermetically Sealed in Metal Cases), Established Reliability, General Specification for.
MIL-R-14293 - Resistors, Fixed, High Megohm (Hermetically Sealed).
MIL-P-15024 - Plates, Identification - Information and Marking for Identification of Electrical, Electronic and Mechanical Equipment.
MIL-P-15037 - Plastic Sheet, Laminated, Thermosetting, Glass-Cloth, Melamine-Resin.
MIL-M-15071 - Manuals, Technical, Equipment and Systems, Content Requirements for.
MIL-R-15109 - Resistors and Rheostats, (Naval Shipboard Use.)
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 - Fuses; Instrument, Power, and Telephone.
MIL-S-15291 - Switches, Rotary, Snap Action.
MIL-A-15303 - Audible Signals: Alarms, Bells, Buzzers, Horns and Sirens.
MIL-T-15514 - Telephone Equipment, Sound Powered Handsets, Headset-Chest Sets, and Headset-Microphones, Types H-200/U, H-201/U, H-202/U, H-203/U, and H-204/U.
MIL-P-15554 - Propeller Revolution Indicating Equipment, Synchro (Naval Shipboard Use).
MIL-S-16032 - Switches, Shipboard Alarm System.
MIL-M-16034 - Meters, Electrical-Indicating (Switchboard and Portable Types).
MIL-T-16315 - Transformers, Power, Step-Down (Miscellaneous, Naval Shipboard Use).
MIL-E-16366 - Electrical Clamps, Lug Terminals and Conductor Splices - Pressure Grip.
MIL-O-16485 - Ohmmeters, Insulation - Resistance - Indicating, Portable.
MIL-B-16540 - Bronze, Phosphor, Castings.
MIL-P-16552 - Filters, Air Environmental Control System, Cleanable, Impingement (High Velocity Type).
MIL-W-16878 - Wire, Electrical, Insulated, High Temperature.
MIL-I-16923 - Insulating Compound, Electrical, Embedding.
MIL-M-17059 - Motors, 60-Cycle, Alternating-Current, Fractional H.P. (Shipboard Use).
MIL-M-17060 - Motors, 60-Cycle, Alternating-Current, Integral H.P. (Shipboard Use).
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-S-17299 - Ship Control Order and Indicating Equipment - Self-Synchronous (Naval Shipboard Use).
MIL-L-17331 - Lubricating Oil, Steam Turbine (Noncorrosive).
MIL-C-17361 - Circuit Breakers, Air, Electric, Insulated Enclosure (Shipboard Use).
MIL-I-17384 - Insulating Compound, Electrical, Quick-Drying.
MIL-M-17413 - Motors, Direct-Current, Integral H.P., Naval Shipboard.
MIL-E-17555 - Electronic and Electrical Equipment, Accessories, and Repair Parts; Packaging and Packing of.
MIL-M-17556 - Motor, Direct-Current, Fractional, HP (Shipboard Use).
MIL-C-17588 - Circuit Breaker (Automatic-ALB) and Switch, Toggle (Circuit Breaker, Non-Automatic-NLB), Air, Insulated Enclosure, 125 Volts and Below AC or DC, Naval Shipboard.
MIL-L-17672 - Lubricating Oil, Hydraulic and Light Turbine, Noncorrosive.
MIL-S-17773 - Switching Unit, Power Transfer (Bus Transfer) (Naval Shipboard Use).
MIL-B-17931 - Bearings, Ball, Annular, for Quiet Operation.
MIL-C-18312 - Capacitors, Fixed, Metallized (Paper, Paper-Plastic, or Plastic Film) Dielectric, Direct Current (Hermetically Sealed in Metal Cases), General Specification For.
MIL-F-18327 - Filters: High Pass, Low Pass, Band Pass, Band Suppression, and Dual Functioning: General Specification for.
MIL-S-18396 - Switches, Meter and Control, Naval Shipboard.
MIL-G-18586 - Gaskets, O-Ring, Shipboard Electrical Junction Box.
MIL-I-18997 - Indicator, Pressure, Panel Mounted or Case Supported, General Specification for.

MILITARY (Cont'd)

MIL-I-19166 - Insulation Tape, Electrical, High Temperature, Galss Fiber, Pressure-Sensitive.
MIL-P-19207 - Fuseholders, Extractor Post Type, Blown Fuse Indicating and Nonindicating, General Specification for.
MIL-H-19457 - Hydraulic Fluid, Fire Resistant.
MIL-R-19523 - Relays, Control, Naval Shipboard.
MIL-C-19978 - Capacitors, Fixed, Plastic (or Paper-Plastic) Dielectric, (Hermetically Sealed in Metallic, Ceramic or Glass Cases), General Specification for.
MIL-T-21038 - Transformers, Pulse, Low Power, General Specification for.
MIL-F-21346/1 - Fuse, Clip, Electrical (Styles FC21, FC22, FC23, and FC25).
MIL-S-21604 - Switches, Rotary, Multipole and Selector Type, 1 to 10 amperes.
MIL-I-22129 - Insulation Tubing, Electrical, Polytetrafluoroethylene Resin, Nonrigid.
MIL-S-22473 - Sealing, Locking, and Retaining Compounds; Single-Component.
MIL-R-22684 - Resistors, Fixed, Film, Insulated, General Specification for.
MIL-S-22710 - Switches, Rotary (Printed Circuit), (Thumbwheel, Inline, and Pushbutton), General Specification for.
MIL-S-22885 - Switch, Push Button, Illuminated, General Specification for.
MIL-I-23053 - Insulation Sleeving, Electrical, Heat Shrinkable, General Specification for.
MIL-P-23236 - Paint Coating Systems, Steel Ship Tank, Fuel and Salt Water Ballast.
MIL-C-23269 - Capacitors, Fixed, Glass Dielectric, Established Reliability, General Specification for.
MIL-R-23285 - Resistors, Variable, Nonwire-Wound, General Specification for.
MIL-T-23648 - Thermistor, (Thermally Sensitive Resistor) Insulated, General Specification for.
MIL-P-24212 - Pressure Transducer Equipment (Electrical) (Naval Shipboard Use).
MIL-D-24304 - Differential Pressure Transducer Equipment (Electrical) (Naval Shipboard Use).
MIL-M-24359 - Meters, Milliammeters, Direct Current Panel Mounting (Edgewise Types).
MIL-T-24387 - Temperature Measurement Equipment, Signal Conditioner and Power Supply (Naval Shipboard Use).
MIL-T-24388 - Thermocouples and Resistance Temperature Elements (Naval Shipboard Use).
MIL-I-24391 - Insulation Tape, Electrical, Plastic, Pressure-Sensitive.
MIL-L-24407 - Liquid Level Transducer Equipment (Electrical) (Naval Shipboard Use).
MIL-C-39001 - Capacitors, Fixed, Mica Dielectric, Established Reliability, General Specification for.
MIL-R-39002 - Resistors, Variable, Wirewound, Semi-Precision, General Specification for.
MIL-C-39003 - Capacitors, Fixed, Electrolytic, Tantalum, Solid-Electrolyte, Established Reliability, General Specification for.
MIL-R-39005 - Resistors, Fixed, Wirewound (Accurate), Established Reliability, General Specification for.
MIL-C-39006 - Capacitors, Fixed, Electrolytic (Nonsolid Electrolyte), Tantalum, Established Reliability.
MIL-R-39007 - Resistors, Fixed, Wirewound (Power Type), Established Reliability, General Specification for.
MIL-C-39014 - Capacitors, Fixed, Ceramic Dielectric (General Purpose), Established Reliability, General Specification for.
MIL-R-39015 - Resistors, Variable, Wirewound (Lead Screw Actuated), Established Reliability, General Specification for.
MIL-R-39017 - Resistors, Fixed, Film (Insulated), Established Reliability, General Specification for.
MIL-C-39022 - Capacitors, Fixed, Metallized-Paper (or Polyester Film), Dielectric, Direct-Current, (Hermetically Sealed in Metal Cases), Established Reliability, General Specification for.
MIL-C-39024 - Connectors, Electrical, Test Point Type, Panel and Printed Wiring; General Specification for.
MIL-C-39027 - Readouts, Incandescent Type, General Specification for.
MIL-T-43435 - Tape: Impregnated, Lacing and Tying.
MIL-T-55164 - Terminal Boards, Molded, Barrier, Screw and Stud Types and Associated Accessories, General Specification for.
MIL-R-55182 - Resistor, Fixed, Film, Established Reliability, General Specification for.

STANDARDS

MILITARY

MIL-STD-100 - Engineering Drawing Practices.
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-198 - Capacitors, Selection and Use of.
MIL-STD-199 - Resistors, Selection and Use of.
MIL-STD-202 - Test Methods for Electronic and Electrical Component Parts.
MIL-STD-242 - Electronic Equipment Parts, (Selected Standards).
MIL-STD-275 - Printed Wiring for Electronic Equipment.
MIL-STD-438 - Schedule of Piping, Valves, Fittings and Associated Piping Components for Submarine Service.
MIL-STD-454 - Standard General Requirements for Electronic Equipment.
MIL-STD-740 - Airborne and Structureborne Noise Measurements and Acceptance Criteria of Shipboard Equipment.
MIL-STD-749 - Preparation and Submission of Data for Approval of Nonstandard Electronic Parts.
MIL-STD-761 - Electric Power, A.C. for Shipboard Use, Characterization and Utilization of.
MIL-STD-777 - Schedule of Piping, Valves, Fittings and Associated Piping Components for Surface Ships.
MIL-STD-806 - Graphic Symbols for Logic Diagrams.
MIL-STD-883 - Test Methods and Procedures for Microelectronics.
MS15612 - Lamp, Incandescent, T-1-3/4, Midget Screw.
MS25237 - Lamp, Incandescent, Single Contact, Midget Flanged Base (T-1-3/4 Bulb).

DRAWINGS

MILITARY

810-1385850 - Piping, Gage, for All Service.
5000-S8700-841569 - Ring, Steel for Flush-mounted Plastic Case, Gages and Thermometers.

PUBLICATION

MILITARY

NAVSHIPS 0969-019-7000 - Electronic Test Equipment Application Guide.

HANDBOOKS

DEPARTMENT OF DEFENSE

H6-2 - Federal Item Identification Guide for Supply Cataloging.

MILITARY

MIL-HBK-225 - Synchro Description and Operation.

(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.

UNIFORM CLASSIFICATION COMMITTEE

Uniform Freight Classification Rules.

(Application for copies should be addressed to the Uniform Classification Committee, 202 Union Station, 516 West Jackson Boulevard, Chicago, Illinois 60606).

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

A-131 - Structural Steel for Ships.
A-415 - Hot Rolled Carbon Steel Sheets.

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

INSTRUMENT SOCIETY OF AMERICA (ISA)

S5.1 - Instrumentation Symbols and Identification.

(Application for copies should be addressed to the Instrument Society of America, 530 William Penn Place, Pittsburgh, Pa. 15219.)

AMERICAN NATIONAL STANDARDS INSTITUTE, INC. (ANSI)
Y32.2 - Electrical and Electronics Diagrams, Graphic Symbols For.
Y32.16 - Reference Designations for Electrical and Electronics Parts and Equipments.

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

(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 Sample for first article inspection. Prior to beginning production, a prototype model (see 6.5.12) shall be tested as specified in 4.3 (see 6.6) unless otherwise specified in the individual console specification.

3.2 Design objectives. The basic design objectives are that the consoles shall meet the functional requirements of the individual console specification and otherwise reflect attainable trade-offs of simplicity, reliability, maintainability, minimum size and weight, and minimum life cycle cost.

3.2.1 Fail safe design. The console shall be designed such that failure of any part (see 6.5.2) or subassembly (see 6.5.3) will not result in unsafe operating conditions. Specific performance requirements for fail safe operation, where required for particular applications, shall be as specified in the individual console specification.

3.2.2 Standardization. The supplier shall design the console such that subassemblies and assemblies which perform similar functions will be standardized and interchangeable.

3.2.3 Life. The console shall be designed for an expected life of 160,000 hours of operation. The console shall be designed for 10,000 hours mean-time-between-failure.

3.3 Safety. Personnel safety requirements shall be in accordance with requirement 1 of MIL-STD-454.

3.4 General requirements.

3.4.1 Order of precedence. When there is any difference in requirements among specifications, the order of precedence shall be as follows:

(a) Contract or order.
(b) Individual console specification.
(c) This specification.
(d) Parts specifications (see 3.13).

3.4.2 Approvals. Where approval by the procuring activity is required by this specification or the individual console specification, such approval shall be obtained by the procuring activity from the Naval Ship Engineering Center (NAVSEC) in writing.

3.5 Basic console characteristics.

3.5.1 Compatibility. Compatibility of materials and parts shall conform to MIL-E-917.

3.5.2 Accessibility. All parts and subassemblies which may require servicing, repair or replacement during the life of the console shall be readily accessible for repair or replacement. Access to these parts and subassemblies shall be from the front or back of the console.

3.5.3 Interchangeability. All parts and replaceable assemblies and subassemblies (see 6.5.7) which are removable from the console shall be physically and electrically interchangeable with corresponding items from identical consoles, from stock or from production

without the necessity for reforming (for example, drilling, bending, filing) or the use of undue force. When such parts, subassemblies and assemblies are substituted from stock or production, the equipment shall perform as specified. However, it may be necessary to make adjustments for calibration, compensation or alignment.

3.5.4 Ease of operation. Ease of operation and direction of movement for controls shall be as specified in MIL-E-917. In addition, in applications where lever type propulsion controllers are used, the arrangement shall be such that movement of the lever away from the operator shall increase the ship's speed in the forward direction and movement of the lever toward the operator shall increase the ship's astern speed. This shall apply regardless of the location and arrangement of the console.

3.5.5 Modular construction. Internal assemblies shall use modular subassembly construction. Modular construction is the grouping of circuits into convenient functional subassemblies or assemblies whose shape and size are equal to, or multiples of, one basic shape and size.

3.6 General environmental requirements.

3.6.1 Ambient temperature. The console shall be designed for continuous operation, without mechanical or electrical damage, in any compartment ambient temperature between the limits of 0°C. and 50°C. The console shall be capable of meeting a nonoperating temperature range between the limits of -20°C. and 65°C. without mechanical or electrical damage. Inside the console, the actual temperatures, to which parts will be exposed, shall be used in the design of equipment; however, a minimum temperature of 65°C. shall be assumed as the part ambient temperature inside the console. Hot spot temperatures shall not exceed the maximum temperature dictated by the affected insulation.

3.6.2 Sensor fluid temperature. Sensor fluid temperature is the temperature of the fluid with which the sensor (see 6.5.10) is in contact. The individual console specification shall specify the design temperature range and the normal operating temperature of the fluid in contact with the sensor.

3.6.3 Humidity conditions. The console shall be designed to operate with relative humidities ranging up to 95 percent by both intermittent and continuous periods, including conditions wherein condensation takes place in and on the console in the form of both water and frost.

3.6.4 Sensor fluid pressure. Sensor fluid pressure is the pressure of the fluid with which the sensor is in contact. The individual console specification shall specify the design pressure range and the normal operating pressure of the fluid in contact with the sensor.

3.6.5 Vibration. The console shall be designed and constructed to withstand the type I vibration test as specified in MIL-STD-167 and as modified by the test specified in 4.6.20. Resilient mounts shall not be used in the design of the console.

3.6.6 Shock. The console shall be designed to be grade A, class I, type A, high-impact shock in accordance with MIL-S-901 and as modified by the test specified in 4.6.21.

3.6.7 Inclination. The console shall not be damaged or malfunction when permanently inclined at any angle up to 15 degrees from the vertical in any direction (that is, forward, backward, port or starboard) for surface ship consoles and at any angle up to 30 degrees from the vertical in any direction for submarine consoles. No favorable orientation may be used.

3.6.8 Pitch and roll. The console shall not be damaged or malfunction when exposed to pitch and roll at any angle up to 45 degrees from the vertical for surface ship consoles and at any angle up to 60 degrees from the vertical for submarine consoles. No favorable orientation may be used.

3.7 Electrical features.

3.7.1 Primary power supply. The console shall be designed to operate and deliver rated performance from the type I power supply characteristics as specified in MIL-STD-761 when operating under the allowable power supply variations specified therein. The nominal power supply voltage rating for the utilization console shall be selected from the type I power of MIL-STD-761. All consoles operating from an alternating current (a.c.) supply shall be rated for nominal frequency of 60 hertz (Hz). The console shall not affect the type I power supply by distorting any of the characteristics.

3.7.1.1 Transients. The console shall meet all the requirements of the individual console specification, except that indication accuracy (see 6.5.8) requirements need not be met, during the period of the voltage and frequency transients specified in MIL-STD-761 for type I power, however, the transients shall not cause failure of any part or prevent resumption of normal operation, or require the equipment to recycle when the transients have ceased, or require any recalibration, resetting or adjustment to assure proper operation of the console after these transients.

3.7.1.2 Overvoltage. The console shall be capable of being continuously energized for a period of 12 hours from a 60 Hz source with the voltage of 130 percent of the nominal voltage rating, as selected in 3.7.1, with the console at the maximum ambient temperature and without failure of any parts. During this period the console is not required to meet the performance accuracies specified in the individual console specification, however, after the nominal voltage has been restored, these accuracy requirements shall be met.

3.7.1.3 Power continuity. The console shall be provided with a no-break a.c. bus to furnish power for instrument and control circuits, logic circuits, loggers, alarms and any other devices requiring uninterrupted electrical power. The equipment for the no-break a.c. power supply shall not be mounted in the console and will be furnished by others. When instrument and control equipment requires special low voltage direct current (d.c.) power supplies in the console, these d.c. power supplies shall be furnished in pairs for parallel operation to assure continuity of power. Each d.c. power supply shall be capable of supplying the full load required by the console.

3.7.1.4 Interaction of voltage and frequency. When equipment is supplied from 2 a.c. power sources, the performance requirements of the individual console specification shall be met under all combinations of the voltage and frequency steady state tolerances specified in MIL-STD-761 for type I power.

3.7.2 Warm-up time. The console shall be operable as soon as it is energized and shall operate within the performance accuracies specified in the individual console specification within 30 minutes from the time the console is energized.

3.7.3 Electron tubes, vibrators and choppers. Electron tubes, vibrators and choppers shall not be used.

3.7.4 Electromagnetic interference emission and susceptibility. The console shall conform to requirement 61 of MIL-STD-454 for electromagnetic interference emission and susceptibility requirements.

3.7.5 Printed wiring and printed wiring boards. Printed wiring and printed wiring boards may be used in the design of the console. When used, the printed wiring and printed wiring boards shall be in accordance with requirement 17 of MIL-STD-454 and the following:

(a) The printed wiring board shall be manufactured from laminated plastic material, types GF or GH, in accordance with MIL-P-13949. The board shall be of sufficient thickness to prevent damage during insertion or withdrawal. The nominal minimum printed wiring board thickness shall be 0.063 inches.
(b) A conformal coating shall be applied in accordance with MIL-STD-275.
(c) Printed wiring boards shall be plug-in and shall include a keying provision such that it is impossible to insert a board into the wrong location. A track shall be provided to guide the printed wiring board into its place to assist installation.
(d) Printed wiring boards shall be restrained in their mounting to minimize flexing. Only captive mounting hardware shall be used. No special tools shall be required to install or remove the printed wiring boards.
(e) All test jacks and adjustments shall be accessible without removing the printed wiring board or adjacent printed wiring board or part from the chassis (see 6.5.9). These jacks shall be provided in sufficient quantity to determine board performance without removing the board from the chassis.
(f) Test jacks for printed wiring boards shall be in accordance with MIL-C-39024. They shall be selected for use with a 0.080 inch diameter probe.
(g) An extender board shall be provided to assist in troubleshooting to detect a failed printed wiring board. Test points may be provided on the extended board.
(h) Solderability tests for the printed wiring boards shall be included.

3.7.6 Wiring methods.

3.7.6.1 Harnessing. All wiring shall be neatly formed into groups which shall be laced (see 3.13.39), strapped (see 3.13.42) or secured by sleeving (see 3.13.40). The groups shall be supported or clamped in such a manner as to prevent chafing of the wire insulation. There shall be no splices in the wires. All connections shall be made at the terminals of parts, connectors or at terminal boards.

3.7.6.1.1 Flexible wire bundles running between hinged panels or drawout assemblies shall be designed to avoid cutting or chafing of the wires. The wire bundle shall be protected by a plastic sleeving (see 3.13.40) over the length of the cable bundle subject to chafing. Both ends of the sleeving shall be securely clamped. Wire within the sleeving shall be free to maintain flexibility. Wire groups running from hinged panels or drawout assemblies shall be formed and clamped so that sharp bends do not occur in either the open or closed position.

3.7.6.2 Slack. Slack in wiring shall conform to the requirements of MIL-E-917.

3.7.6.3 Mechanical supports. Mechanical supports for electrical connections shall conform to MIL-E-917.

3.7.6.4 Clamp contact connections. Electrical connections shall not be dependent upon wires, lugs, terminals and the like clamped between a metallic member and an insulating pliable material. Such connections shall be clamped between metal members. Semiconductors mounted in accordance with the manufacturer's recommendations may be excepted from this requirement subject to approval by the procuring activity.

3.7.6.5 External cable connections. Provision shall be made for connection of external cables to terminal boards located within the console near the cable entrance except that cable connectors may be used when specified in the individual console specification. All terminal boards or cable connectors for external connections shall be accessible from the front or back of the console. Circuitous routing of wire shall be avoided. Care should be taken in the design to allow space for the proper bending radii of conductors of external cable going between the cable entrance and the terminal boards. Grounded terminals shall be provided for grouping the shields of each pair of external cables and shall be located on or near the terminal boards.

3.7.6.6 Insulation protection. Insulation protection for wires through holes shall conform with MIL-E-917.

3.7.6.7 Shielded wire. Conductors using metallic shielding unprotected by an outer insulation shall be so secured as to prevent the shielding from coming into contact with exposed terminals or conductors. Shielding shall be terminated as close to the circuit terminal as practicable without risk of grounding the terminal. Where required by the circuit design, shielding shall be grounded and the connection to the chassis shall be by means of terminal lugs on screw type terminals or bolts.

3.7.6.8 Wire terminations.

3.7.6.8.1 Wire end connections. The ends of each wire, except for pigtail leads or parts requiring solder connections, shall be terminated by solderless crimp type lugs (see 3.13.31) for connection to screw type terminals on parts or terminal boards. Parts with solder terminals or pigtail leads may have soldered connections. No more than 3 wires, including wires from parts, shall terminate at any one stud or terminal, except on multisection turret type terminals a maximum total of 5 wires may be terminated.

3.7.6.8.2 Connectors. Instrument and control assemblies or subassemblies shall use connectors for cable connections (see 3.13.10).

3.7.6.9 Spare terminals. Terminal boards or cable connectors used for external cable connections in consoles and terminal boards or multicontact connectors used for connection of assemblies within consoles shall have at least 10 percent spare terminals. There shall be not less than two such terminals. All spare terminals in connectors shall be in the outermost row of terminals. Where connectors or terminal boards are used only for primary power connections, no spare terminals need be provided. If more than one terminal board or connector is needed at a common place only 10 percent of the total number of terminals at this place are required as spare terminals.

3.7.7 Wire identification. All internal wires of the console shall be marked for identification at both ends except for internal chassis wiring, any wire less than 12 inches in length and wires connecting studs on a single part unless such wires are laced or secured

by sleeving into a wire bundle. Wires from 3 to 12 inches in length shall be marked in the center only. Designations shall be marked on sleeve type wire markers over the wire insulation. Markings shall be applied in a permanent manner, resistant to water, oil and abrasion. Designations at each end shall consist of the part and terminal number, as assigned in the schematic diagram, for the connection at the end being marked and the part and terminal number for the connection at the other end of the wire. Adhesive strip type markers designed for wrapping around wires shall not be used. Markings shall be indicated on the console wiring diagrams. The diagrams shall show all wires marked even if a wire is not physically marked in an assembly due to short length. Marking of internal chassis wiring or color coding may be used as an aid in manufacture or maintenance. All wire markings shall be clearly visible in the assembled equipment.

3.7.8 Mounting of parts with pigtail leads. Parts provided with pigtail leads, such as small resistors and capacitors, shall be secured between solder-type terminals on part mounting boards by soldering. The clearance between the soldered connection and the body of the part shall be not less than 3/16 inch. Parts with pigtail leads shall be held in place by means of body clamps to prevent damage or lead fatigue from shock and vibration, except that parts whose weight does not exceed 1/4 ounce per lead may be secured by only their leads. The pigtail leads of transistors shall be covered by insulating sleeving unless the solder terminals are located so that the leads cannot be shorted together or to other parts. The arrangement of parts shall be such that replacement of any part is possible without the removal of or damage to adjacent parts.

3.7.8.1 The requirements of 3.7.8 do not apply to printed wiring boards where the parts are mounted in accordance with MIL-STD-454.

3.7.9 Isolation. The design of the console shall employ isolation between the various instrument outputs such that the shorting or opening of any output circuit will not produce a change in any other instrument (see 6.5.5) output in excess of the accuracy requirements specified in the individual console specification. A failure in a remote control or instrument circuit shall not cause failure or maloperation of its associated local control or instrument circuit.

3.7.10 Local meters. The instrument output to each local meter (see 6.5.15) shall be independently adjustable for calibration purposes. The range of adjustment shall be a minimum of ± 10 percent of meter full scale under the most unfavorable part tolerance conditions.

3.7.11 Remote meters. The instrument output to each remote meter (see 6.5.16) shall be independently adjustable for calibration purposes. The range of adjustment shall be a minimum of ± 10 percent of meter full scale under the most unfavorable part tolerance conditions. Signals available to other meters or loads or both shall not be affected by the switching of any meters. Calibrating resistors for remote meters shall be mounted in the individual instrument chassis. A short or open in any of the meters or leads to these meters shall not affect the settings of instrument outputs or cause the readings of other meters to exceed the instrument specification accuracies.

3.7.12 Electrical bonding. Protective finishes shall be omitted at those points where their presence would prevent proper electrical bonding as required for shielding or connections.

3.7.13 Grounding. Grounding requirements shall conform to MIL-E-917. In addition, the design of the console shall be such that grounding is not required for satisfactory operation of console circuitry. The ground connection to the chassis shall be made by means of a screw type terminal or bolt. The ship's hull, internal chassis, or console enclosure shall not be used in lieu of electric conductors in the console circuitry.

3.7.14 Electrical protection. Protective devices, such as fuses or circuit breakers, shall be provided for protection of the console from damage due to faults. Protective devices shall be provided so that a failure in one instrument will not cause maloperation, failure or interruption of power to other instruments of the console. These devices shall be included in both wires of single phase a.c. or d.c. circuits and in all 3 wires of 3 phase a.c. circuits. When space is unavailable in an instrument, only 1 wire of single phase a.c. or d.c. circuits has to be fused provided that the same side of the line is fused for all common circuits, a disconnect device is provided to deenergize both sides of the line and the circuit is isolated from the ship's power system. Protective devices shall be easily accessible for maintenance purposes.

3.7.14.1 Switches for power on-off functions and circuit locations shall be as specified in the individual console specification. When on-off switches are specified, both sides of the line shall be interrupted.

3.7.14.2 Instrument assemblies in the console shall be designed to permit opening or shorting external loads and inputs at the nominal voltage rating plus the maximum steady state tolerance without failure of any of the instrument parts. Each instrument shall be separately fused.

3.7.14.3 Parallel d.c. power supplies shall have either individual fusing for each rectifier, or blocking diodes in the output of each supply to assure that a failure in one power supply will not prevent the other power supply from providing its proper function. Blocking diode fault indication shall be required. Parallel supplies shall have a means of disconnecting each supply from the common output.

3.7.14.4 D.c. coils rated 6 watts or greater which are controlled by switch or relay contacts shall be provided with surge suppression circuits in parallel with the coil. These circuits shall be designed to minimize the magnitude of the inductive voltage transients occurring when the coil circuit is opened. Suppression circuits using diodes shall include a current limiting device to insure that a failure of the diode will not prevent operation of the coil.

3.7.15 Embedded parts. Parts shall not be embedded together except for parts used for temperature compensation which may be embedded with the parts being compensated. Parts which may require individual selection may be embedded together, if necessary, to maintain their relationship or prevent improper replacement.

3.8 Electrical insulation. The classes and definitions of insulating materials and insulation systems shall be as required by the application and shall be as specified in MIL-E-917.

3.8.1 Electrical creepage and clearance distances. Electrical creepage and clearance distances shall be as specified in MIL-E-917.

3.8.2 Insulation resistance. The insulation resistance of the completed console shall have a minimum value of 10 megohms at 25°C. (see 4.6.3).

3.8.3 Dielectric strength. The console shall be designed such that completed assemblies shall withstand without damage the dielectric test voltages as specified in 3.8.3.1 (see 4.6.2). This requirement does not apply to printed wiring boards.

3.8.3.1 Test voltage. The test voltage shall have a closely sinusoidal wave of a frequency not less than the rated frequency of the console under test. The magnitude of the test voltage shall be determined by table I.

Table I - Test voltage magnitude.

Circuit voltage of equipment tested	R. m. s. value of dielectric test voltage
Less than 60 volts	500 volts
60 to 120 volts	900 volts
Over 120 and less than 240 volts	1200 volts
240 to 480 volts	1500 volts
Above 480 volts	Twice rated voltage plus 1000 volts.

3.8.3.1.1 For cases where the circuit consists of parts conforming to a parts specification which specifies a dielectric test voltage, the test voltage shall be as specified in the applicable parts specification, except as follows:

(a) For circuits directly connected to an external power source, the test voltage shall conform to table I.
(b) The test voltage shall in no case be less than 500 volts root mean square (r.m.s.).

3.8.4 Electrical insulating procedures. The electrical insulating procedures shall conform to the requirements of MIL-E-917.

3.9 Mechanical features.

3.9.1 Construction and weight. The console structure shall be of either steel or aluminum construction and shall be of the lightest weight consistent with the general and specific design requirements herein. The console shall be of fabricated construction.

3.9.2 Size. The console shall not be over 84 inches overall height as installed.

3.9.2.1 Surface ship installation. All assemblies or subassemblies intended for installation in surface ship consoles and subject to removal, or any part of the onboard repair parts, or any auxiliary equipment, when uncrated for installation and without further disassembly, shall be capable of passage through a doorway 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 7-1/2 inch radius).

3.9.2.2 Submarine installation. All assemblies or subassemblies intended for installation in submarine consoles and subject to removal, or any part of the onboard repair parts, or any auxiliary equipment, when uncrated for installation and without further disassembly, shall be capable of passage through a doorway 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.

3.9.2.3 The requirements of 3.9.2.1 and 3.9.2.2 do not apply to the console itself or any auxiliary cabinets.

3.9.3 Enclosures (see 6.5.11). The degree of enclosure for the console shall be a minimum of dripproof (45 degrees) protected as defined in MIL-STD-108 for surface ships. The degree of enclosure for submarine consoles shall be spraytight as defined in MIL-STD-108. Enclosures of individual parts or subassemblies that are mounted within the console and have no exposed surfaces need be no better than an open type.

3.9.3.1 Temperature indication. A console high temperature alarm shall be provided to signal that the interior of the console has reached the supplier's recommended maximum operating temperature.

3.9.4 Grab rails. The console shall be provided with nonrotating horizontal grab rails located along the front of each section. Grab rails shall be made of smooth hardwood and supported with a sufficient number of brackets to provide adequate support for personnel under all operating conditions of the ship. Grab rails shall be attached in such a manner that all hinged panels can be opened without removal of the rail from the member to which it is attached. Grab rails shall be located so that they will not interfere with operation of the console equipment and shall not extend more than 9 inches from the front of the panel.

3.9.5 Cable entrance. The cable entrance shall be from the bottom of the console.

3.9.6 Ventilation. The console shall be provided with ventilation louvers. The ventilation openings shall not be located in the top or side panels of the console. Air exhaust openings shall not be located in the front of the console. Submarine consoles shall not have ventilation openings. The design of the console, placement and selection of parts shall be such that no part shall be exposed to a higher temperature than the maximum rated part temperature.

3.9.6.1 Liquid cooling. Liquid cooling shall not be used in the design of the console.

3.9.6.2 Forced air cooling. Forced air cooling may be incorporated into the design of the console. Where forced air cooling is used, air filters shall be as specified in 3.13.43. Air filters shall be located at all air intakes and shall be installed so as to be readily removable for cleaning without disassembly of the console. The filters shall, however, be located within the console enclosure. Blowers for forced air cooling shall be selected from those listed in MIL-STD-242. Power for blowers shall be supplied from a source separate from the power supply for instrument and control circuits.

3.9.6.3 Protection of parts. Internal parts which are subject to damage, change in physical characteristics, or maloperation from accumulation of dust, soot, or other contaminations shall be protected from the direct path of natural or forced air circulation by enclosures or barriers.

3.9.6.4 Heating. The use of heaters to obtain proper operation of the console under the various ambient temperatures shall not be incorporated in the design of the console. However, heaters shall be provided in the console to prevent condensation during nonoperating periods.

3.9.7 Compartmentation. Where a console section contains both hydraulic or pneumatic pressure lines or devices and electrical parts, they shall be compartmented to separate the hydraulic or pneumatic and electrical devices, or have adequate shielding provided, to give protection for the electrical parts from any hydraulic or pneumatic device leakage. Provision shall be made to carry off any leakage.

3.9.8 Console face. All instruments and controls exposed on the console shall be recess mounted with the meters, controls, and indicators as nearly flush as practicable. The forward or lower sloping section of the console shall house the controls and devices required to be within an operator's reach. The rear of upper sloping section shall be used primarily for the instrument displays and alarm indications. There shall be no equipment mounted along the front face of the console sections except the manual handwheel throttle control, if used, and sound powered telephone handsets. Handsets shall be recessed and attached to the console by spring clips or other quick-access holding devices. Handsets shall be removable by one hand operation. The controls and operating devices shall not be placed in close proximity to the front edge of the console so as to preclude the operator from accidentally tripping a control device.

3.9.9 Console construction details. An acceptable method for the construction of the console shall be in accordance with the following requirements:

3.9.9.1 Framework. Each section of the console shall have an inner frame to which the outer shell plating shall be fastened. Each section of the console shall be constructed with a rigid, self-supporting, boxlike framework for the support of the shell plating, circuitry, gages, switches and other appurtenances to be included in the various units which comprise the section. The framework shall be fabricated from angles, channels or other structural shapes, or formed members, and shall have sufficient strength and rigidity to support all parts mounted therein as well as to support the hinged panels in both the open and closed positions without sag or distortion when the console section is secured only by its mounting bolts (no top bracing). The framework for each section shall be an independent box frame bolted together to form the complete console. The framework of each section shall be stiffened to resist bending by the use of diagonal braces or welded sheets, but braces and sheets shall not be secured in such a manner as to restrict access to the front and rear of the section. Intermediate vertical supporting members shall be provided for the support of such parts as meters, gages and switches. The framework of each section shall be fabricated by welding all members except those which must be disassembled for replacement of parts which shall be bolted. Riveting shall not be used in the assembly of the sections or in the connecting of the sections to form the console. No rubber packing shall be installed between insulating parts and framework. The frame of each section shall be bolted directly to the foundation channel. Gusset plates shall be welded at the corners of the sections in both lengthwise and lateral vertical planes such that each corner shall have a strength not less than the bending strength of the weakest adjoining vertical or horizontal member.

3.9.9.2 Side sheets. The sides of each console section shall be enclosed by solid sheets, at least 1/16 inch thick, welded to the section framework. The side sheets shall be welded by intermittent welds or spot welds to all vertical and horizontal frame members. The gusset plates in the plane of the side sheet may be omitted, provided the side sheet is welded to the frame at the corners with the same length of welding that would be normally employed with a gusset plate. When gusset plates are omitted, plug welding of the side sheets at the top corners of the frame only is permitted.

3.9.9.3 Top sheets. The horizontal top of each section shall be enclosed by a solid sheet at least 1/8 inch thick. The top shall be of a suitable design to prevent dripping water from entering the console and damaging instruments on the front panels. The top sheet shall be welded to the side sheets and frame structure to form a watertight seam.

3.9.9.4 Front and rear panels. Each section of the console shall have hinged front panels to allow easy access to the equipment inside each section. Each front panel shall be hinged along one vertical edge and latched on the other vertical edge. The design and construction of the front panels shall be adequate to carry the weight of the panel complete with all items mounted thereon without sag or distortion in both the opened and closed positions. The rear of each section shall have hinged panels so as to allow access to the rear of the console. Each rear panel shall be hinged along one vertical edge and latched on the other vertical edge.

3.9.9.4.1 Positioning stops. Positive stops and means for locking all hinged panels, in both the fully open and one intermediate position, shall be provided. The fully open position shall be 130 degrees. The intermediate position shall be at the largest opening where there is no interference with adjacent closed hinged panels on the console or at the 90 degree position.

3.9.9.4.2 The hinged panels on the front and rear of the sections shall be secured by thumb screws made captive in the panel. Thumb screws shall constitute quick access to the console sections. The mechanical arrangement shall be such that the securing devices shall not bear any weight, but shall serve merely to keep the panels closed. The weight of the hinged panels shall be borne by suitable aligning pins and roller guides. The hinged panels shall be made from a solid sheet 1/8 inch thick or U. S. gage number 11. Commercial tolerances are acceptable. The panel shall be formed with bent angle or channel edges of not less than 1 inch deep. The flanges of all panels shall be welded at the corners and ground smooth. There shall be no butt joints on the panel surfaces.

3.9.9.5 Upper and lower sloping sections. The upper and lower sloping areas of each section shall be supported and stiffened as necessary to prevent them from bending when in the opened position. The upper and lower sloping sections of the console shall be hinged to permit access to the equipment mounted on the console sections. The lower sloping sections shall be hinged along their rear horizontal edge and shall open from the front of each section. The upper sloping sections shall be hinged along their upper horizontal edge and shall open out from their lower edge. The fully open position for the upper and lower sloping sections shall be 90 degrees from the normal plane of the sloping section. Suitable means shall be employed to maintain the hinged upper and lower sloping section in the fully open position while supporting these sections sufficiently to prevent bending and distortion. A hydraulic or pneumatic dampening device shall be employed to prevent these sloping sections from slamming closed from the fully open position. This device shall protect the operating personnel from injury and equipment from damage caused by failure of the latching open device or accidental closing. The hinged sloping sections shall be secured in the closed position by thumb screws made captive in the panel.

3.9.9.6 Thread locking. All nuts, bolts, studs and screws used in the fabrication of the console sections shall be secured by means of an acceptable locking device. The following are considered acceptable types of locking devices:

(a) Nut and lock nut.
(b) Self locking nut.
(c) Castellated nut with cotter pin or safety wiring.
(d) Split ring lockwasher.
(e) External toothed lockwasher may be used where the weight of the part does not exceed 2 ounces per screw. Internal tooth type lockwashers shall not be used.
(f) Nuts or screws with captive lockwashers may be used provided they are replaceable with common type screws and lockwashers or nut and lockwashers.

3.9.9.6.1 Locking devices are not required with ovalhead screws, when used with cup-type washers, and pan head screws on identification and information plates.

3.9.9.6.2 Flat head screws that are not secured by a locking device shall be secured by upsetting metal into the slot, by application of nylon insert locking pellets or by an application of sealing compound in accordance with MIL-S-22473.

3.9.9.7 Console accessibility. The design of the console 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 connectors are used. Parts which are subject to replacement or servicing under normal maintenance shall not be secured by rivets, welding, or other means which prevent ready removal.

3.9.9.7.1 An acceptable method to provide access to parts and permit withdrawal of assemblies and subassemblies toward the front or back for servicing is by channel guided sectional construction with the provision of tracks, rollers or pivots. The drawers shall be locked in the servicing position by means of automatically operated locks. Means shall be provided to release the locks for the removal of the drawer.

3.9.9.7.2 The rear of each chassis, subassembly or assembly (see 6.5.4) shall be furnished with locating pins or other means to effect proper alignment and to reduce strain when the equipment is subjected to vibration and shock.

3.9.9.7.3 Handles shall be provided for removing chassis or assemblies from the console. Suitable means shall be provided to protect parts when the chassis is removed and inverted for servicing. Each type of removable chassis or module shall have a mechanical keying provision to prevent inserting the chassis or module into the wrong location.

3.9.9.8 Console mounting. The console shall be deck mounted unless otherwise specified in the individual console specification. No bolts less than 3/4 inch in diameter shall be used in attaching the console to its foundation. Mounting bolt holes for bolts of 3/4 inch shall have a maximum diametrical clearance of 1/32 inch. Holes for bolts larger than 3/4 inch shall have a maximum diametrical clearance of 1/16 inch.

3.9.9.9 Handling. The console shall be provided with lifting eyes to facilitate its hoisting and lowering. Adjacent to these lifting eyes, the words "LIFT HERE" shall be marked.

3.9.10 Airborne and structureborne noise. When airborne and structureborne noise limits are required by the individual console specification, the console shall be in accordance with MIL-STD-740. The grade and type required and the operating conditions during the noise tests shall be specified in the individual console specification.

3.9.11 Lubricants and lubrication. Where lubricants are required, the equipment shall be so designed as to use as few different types of lubricants as practicable. The equipment lubrication design, lubrication instruction plates and charts, and the selection of lubricants shall be in accordance with MIL-L-17192. Technical manuals shall refer to lubricants by correct Navy designations as well as by trade and specification numbers.

3.9.11.1 Inclined operation. The equipment shall be capable of satisfactory operation without any spilling or leaking of the lubricant at the angles specified in 3.6.7 and 3.6.8.

3.9.12 Threaded parts and devices.

3.9.12.1 Thread projections. Bolts and screws, secured by nuts, or other retaining devices which permit projection beyond the retaining device, shall be of such length as to insure a minimum projection of at least 2 threads from the outer face of the retaining device. Bolts and screws shall not project beyond the retaining device more than 1/4 inch. These requirements shall not be construed as precluding the use of screws assembled in blind tapped holes in castings, or spaces, or where the design restrictions require that the threaded portion of the screw be flush with the retaining device.

3.9.12.1.1 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 welded or securely staked.

3.9.12.2 Thread engagement. Bolts and screws in tapped parts other than nuts shall enter and have full thread engagement for an axial distance at least equal to the diameter of the externally threaded fastener without bottoming.

3.9.12.3 Thread cutting screws. Thread cutting (self-tapping) screws shall not be used, except as permitted in 3.16.1.

3.9.12.4 Flat head screws. Flat head screws, 82 degree head, shall not be used in sheet or thin material, the thickness of which is less than one and one-half times the screw head height. Flat head screws, 100 degree head, shall not be used in sheet or thin material, unless the thickness of the material is at least equal to the screw head height. Wherever flat head screws are used, the screw head shall be completely seated in the material.

3.9.12.5 Threads in aluminum and plastics. Threads in aluminum, threads in plastic and inserts shall conform to the requirements of MIL-E-917.

3.9.13 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.

3.9.14 Drilled and tapped holes. Drilled and tapped holes shall be slightly countersunk.

3.9.15 Special tools. The design of the console shall be such that the need of special tools for tuning, adjusting, or maintenance shall be kept to a minimum. Special tools shall not be required for the installation or replacement of parts. The use of special tools shall be subject to approval by the procuring activity. Special tools, where required, shall be supplied by the supplier and shall be mounted securely in the console in

a convenient place. The mounting shall be such that the special tools will remain in place during shock, vibration and inclination tests. Special tools are defined as those tools not listed in the Federal Supply Catalog (copies of this catalog may be consulted in the office of the Defense Contract Administration Service (DCAS)).

3.10 Hydraulic and pneumatic controls.

3.10.1 General. Piping materials and piping components, such as piping, valves, fittings, and associated piping components, for hydraulic and pneumatic controls shall be in accordance with MIL-STD-777 for surface ships and MIL-STD-438 for submarines.

3.10.2 Piping connections. All console piping shall be run to terminal blocks mounted in the lower rear of the control console. The terminal block for console piping shall consist of a steel plate pad drilled with holes for the tubes. Each tube shall extend at least 6 inches beyond the pad and shall be silver brazed to the pad. When installed onboard ship the pad will be placed over a cutout in the deck. The length and width of the pad shall be such as to permit airtight bolted joints all around the cutout. Sufficient excess tubing upstream of the pad shall be allowed for flexibility of installation.

3.10.3 Hydraulic controls.

3.10.3.1 Hydraulic fluid. For surface ships, hydraulic fluid shall be of a type or grade selected from MIL-L-17672 for controls not accumulator loaded or for accumulator loaded controls with pressure less than 600 pounds per square inch (p.s.i.). Hydraulic fluid shall be of a type selected from MIL-H-19457 for accumulator loaded controls whose pressures exceed 600 p.s.i. and have operating temperature ranges from 30 to 160 degrees F. The temperature of hydraulic fluid in surface ships shall be maintained below 160 degrees F., without the use of fluid coolers, by design and choice of parts. For submarines, hydraulic fluid shall be in accordance with MIL-L-17331. The controls shall be designed to use the selected fluid with due consideration to the effects of viscosity changes within the range of operating temperatures. Design and installation of hydraulic parts shall be such that contamination of controls using hydraulic fluids will be minimized.

3.10.3.2 Pressure. Hydraulic controls shall be designed for an operating pressure not in excess of 3,000 p.s.i. and total pressures under hydraulic transient not exceeding 1-1/2 times the operating pressure. The design pressure in piping, valves and fittings in return lines shall be based on fluid supply tank pressure plus expected pressure drop between operating equipment and the fluid supply tank.

3.10.3.3 Fluid velocity. All high pressure piping shall be large enough to limit velocity of the hydraulic fluid to 16 feet per second. The fluid velocity in pump suction lines having no positive head shall be limited to about 4 feet per second.

3.10.3.4 Arrangements. The use of piping and pipe connections shall be minimized by manifolding valves with related functions. Hydraulic control piping shall have the necessary pressure gages and means for bleeding, draining, venting and replenishing. Vents and replenishing connections to control parts shall be located so as to avoid air pockets. If a stop valve is installed in the replenishing and vent line, means shall be provided wherever necessary to protect against the inadvertent application of destructive pressure when the stop valve is closed. Return piping between a part and its cutoff valve shall withstand supply pressure. If restrictions are placed in return lines, the piping unstream of the restrictors shall also withstand supply pressure. Means shall be provided for access to, and cleaning of, fluid supply tanks and for drawing off water which may be trapped in the tanks. A connection shall be fitted to permit venting air loaded supply tanks while filling. Hydraulic auxiliaries shall be provided, when necessary, with drip pans fitted with means for draining the pan. All moving parts of controls shall be fitted with covers or guards to prevent damage to equipment and injury to personnel.

3.10.3.5 Rams and hydraulic cylinders. These devices shall be designed to be consistent with the function for which they are intended. Pistons and rods that slide in and out of cylinders shall be fitted with a wiper. Drain, leakage, and air bleeder connections shall be included as necessary. Where necessary, cylinder design shall include internal buffers or dash pots as an aid in decelerating parts attached to the piston rod or ram. Seals shall be of a type which become more effective with an increase in pressure. Piston rings shall not be used as a primary seal.

3.10.3.6 Accumulators. Accumulators shall be used, where practicable, to reduce peak power requirements and to control hydraulic pump operation. Accumulators shall be of a piston, bag, or diaphragm type designed to withstand 5 times the operating pressure of the hydraulic fluid. The design shall require a pressure gage, manual unloading valve, check valves and provision to prevent extrusion of the bag or diaphragm through the fluid pressure connection.

3.10.3.7 Tanks. Pressure tanks and fluid reservoirs shall be copper, copper base alloy or welded steel construction. Steel tanks that are filled continuously to 100 percent capacity need not be coated inside. The inside of steel fluid reservoirs shall be coated with material conforming to MIL-P-23236, types 1, 3 or 4. All weld spatter and welding flux shall be removed before the coating process. When it is necessary to stress-relieve welded tanks, this heat treatment shall be done prior to cleaning.

3.10.3.7.1 Reservoirs shall be capable of withstanding, without leakage, an internal pressure of 8 p.s.i. Capacity of reservoirs shall be limited to 125 percent of the total fluid volume contained in the whole system. Reservoirs shall be so designed and constructed as to prevent the entrance of any foreign matter. Filling and breathing pipes on reservoirs shall be arranged to prevent fluid spillage under roll and pitch conditions. Breathing pipes shall be terminated near exhaust ventilation terminals if practicable. Reservoirs shall be provided with reliable means for determining the fluid level, arrangements for cleaning and draining, and with baffle plates to minimize aeration and cavitation.

3.10.3.8 Filters. Filters shall be provided for hydraulic controls and shall be readily accessible. All filter elements shall be removable for service and inspection without disconnecting the attached pipe or dismounting the filter housing. Frequency of servicing shall be indicated on a label plate attached to the filter. Filters employing earths or clays shall not be used. Filter elements shall comply with MIL-F-8815 and shall be capable of removing all particles 15 microns or greater in size. Filler pipes for tanks and liquid reservoirs shall include a removable filter screen of 180 mesh or finer. Breather pipe caps shall have removable air filter screens.

3.10.3.8.1 Closed loop type controls. A full flow filter shall be installed in the discharge line and a strainer in the suction line of each replenishment pump. Filter cases shall have built-in by-pass valves, set to open when the pressure drop across the filter element reaches the value recommended by the manufacturer of the filter element to be used. These by-pass valves shall be capable of handling the entire replenishing pump capacity.

3.10.3.8.2 Other than closed loop controls. A filter shall be installed in the discharge line and a strainer in the suction line of each pump. Filters shall be full flow where the volume of flow allows a reasonable size filter, but where an excessively large filter would be required, a partial flow type may be used. Provision shall be made to allow full flow by-pass of the filters when the pressure drop across the filter elements becomes 3 to 4 percent of operating pressure.

3.10.3.9 Valves. Directional and volume control, check, pilot, and servo valves shall be designed for minimum resistance to flow when in the operating position. All plungers, balls, pistons, and other moving parts shall be accurately guided to prevent cocking and jamming. Large valves shall be pilot operated to maintain operating devices, such as solenoids, cams, and levers at a minimum size. Adjustable valves shall be locked at service adjustment to prevent tampering. No valve shall operate improperly because of back pressure or surges. Valve operation shall be such as to prevent detrimental surges in the hydraulic controls. All valves shall be permanently marked to indicate proper connection and directional arrows shall be used as appropriate. The force to manually operate control valves shall not exceed 15 pounds applied to the rim of the operating wheel or the end of the operating lever. All valves shall be adequately supported. Valves shall be mounted using cap screws or bolts extending through or into the valve body. Lug mounting of valves shall not be used.

3.10.3.9.1 By-pass or unloading valves shall be designed to operate without exceeding 25 p.s.i. pressure drop across the valve. Throttling shall be minimized.

3.10.3.9.2 Pressure control valves (including relief, unloading, back pressure, and sequence valves) and check valves shall be damped to eliminate hydraulic squeal and chatter at all rates of flow up to the maximum design rate. Relief valves shall be accurate within 9 percent of setting and shall reseat at not less than 85 percent of setting. Relief valves shall be adjustable. Relief valves shall be designed and located to limit the maximum pressure to 110 percent of the working pressure.

3.10.3.9.3 High pressure valves on the air side of accumulators shall be of a slow opening type capable of preventing a shock wave from being produced when rapidly opened.

3.10.4 Pneumatic controls.

3.10.4.1 General. Pneumatic controls shall consist of an air compressor, actuators, motors, valves, piping and accessories, as necessary, to provide control air at the required pressure. An air dryer shall be installed at the compressor discharge downstream of the

moisture separator. A by-pass shall be provided around the dryer. The dryer shall be located in an area where the ambient temperature will not, under the worst conditions, exceed the maximum allowed by the dryer manufacturer. Means shall be provided in the delivery from the compressor to assure clean and oil free air to the pneumatic controls. The air pressure to the pneumatic controls shall be automatically maintained at the level required for the operation of the installation.

3.11 Processes and treatments.

3.11.1 Welding. Welding and allied processes shall conform with the requirements of MIL-E-917.

3.11.2 Soldering. Soldering of electrical wiring shall be in accordance with requirement 5 of MIL-STD-454 except that on turret type terminals, solid wires and leads shall be given a wrap of at least one full turn with a short wire end protruding to aid removal with pliers. When stray circuit capacitance or other effects may be introduced or when it is impractical due to space considerations, the protrusion may be shortened or eliminated. Soft solder alone shall not be depended upon for mechanical strength.

3.11.3 Brazing. Brazing alloys for electrical connections shall conform to the requirements of MIL-E-917.

3.11.4 Treatment and processing of metals for corrosion-resistance. The treatment and processing of metals for corrosion-resistance shall conform to the requirements of MIL-E-917.

3.11.5 Painting. The exterior and interior surfaces of the console and equipment enclosures shall be painted and shall conform to the requirements of MIL-E-917.

3.12 Materials.

3.12.1 General. General material requirements shall conform to MIL-E-917.

3.12.2 Prohibited materials. Prohibited materials shall conform to the requirements of MIL-E-917, except as specified in 3.12.2.1 through 3.12.2.3.

3.12.2.1 Glass. Glass shall not be used, except where included in completed parts or materials and the use of such parts or materials is acceptable to the procuring activity. All glass for use in equipment for protection of instruments, meters and for viewing dials and indicators shall be clear, presenting no evidence of distortion when viewed from any angle. Consideration shall be given to the use of glareproof glass when the equipment to be viewed will be illuminated from an outside light source. All glass, when used, shall be of the shatterproof type and conform to class I, type A of MIL-G-3787.

3.12.2.2 Fungus-inert materials. Materials which provide a nutrient medium for fungus and insects shall not be used in the manufacture of any equipment covered by this specification. Fungus-inert materials shall be in accordance with requirement 4 of MIL-STD-454.

3.12.2.3 Wood. Wood shall not be used except for grab rails on the console.

3.12.3 Arc-resistant materials. Arc-resistant materials shall conform to requirement 26 of MIL-STD-454.

3.12.4 Metals. Metals, including dissimilar metals and corrosion-resisting metals, shall conform to the requirements of MIL-E-917 and as specified in 3.12.4.1 through 3.12.4.4. Government inspection at source is not required for "commercial standard" material.

3.12.4.1 Steel. When used, steel conforming to QQ-S-741 or ASTM A-131 shall be utilized in the fabrication of the console structures. Steel conforming to QQ-S-698, QQ-S-700 or ASTM A-415 shall be used for plates and sheets.

3.12.4.2 Aluminum. When the use of lightweight metal is desired, aluminum alloy shall be used. Aluminum alloy conforming to alloy 5086, temper H111 of QQ-A-200/5, or alloy 6062, temper T6 of QQ-A-200/8 shall be used for console structural pieces. Aluminum alloy conforming to alloy 5052 temper H32 or H34 of QQ-A-250/8, or alloy 6061, temper T6 of QQ-A-250/11 shall be used for plates and sheets. Aluminum alloy conforming to alloy 3003, temper H22 or H24 of QQ-A-250/2 may be used for nonstructural applications. Aluminum alloy conforming to alloy 5086, temper O of QQ-A-200/5 shall be used for structural pieces which are bent into shape.

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

3.12.4.4 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.

3.12.5 Plastics. Plastic materials shall conform to the requirements of MIL-P-917 and as specified in 3.12.5.1 through 3.12.5.4.

3.12.5.1 Plastic parts shall retain the original smooth or polished surface unless objectionable glare makes a dull surface necessary. All surfaces that have been sawed, cut or otherwise machined shall be smooth.

3.12.5.2 Thermoplastic materials shall not be used.

3.12.5.3 Where a specific color is required by the application, this color shall be obtained by adding coloring matter to the base material, provided electrical or mechanical properties are not adversely affected. If for any reason the procurement of colored base material is not feasible, color may be obtained by painting with insulating lacquer, subject to approval of the procuring activity. The insulating lacquer shall conform to type G of MIL-I-17384.

3.12.5.4 Dials and transparent and translucent parts. Plastic for dials and other transparent and translucent applications shall be in accordance with MIL-W-80. Material conforming to MIL-P-5425 may be used, provided it is treated with an antielectrostatic coating.

3.12.6 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 as specified in MIL-STD-242. Prior to the use of ceramics for insulation, the supplier shall specifically call its use to the attention of the procuring activity and obtain approval.

3.12.7 Impregnating, embedding and encapsulating compounds. Materials used for impregnating, embedding or encapsulating electrical 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 or crack at temperatures encountered during the temperature operating tests, unless contained in such a manner that the compound will not flow from the container and the parts therein are not dislodged by high impact shock. Rigid materials used for encapsulating or embedding parts in subassemblies shall be in accordance with MIL-I-16923 and as specified in 3.12.7.1 through 3.12.7.3.

3.12.7.1 Selection of type. Type B or C compounds of MIL-I-16923 shall be used, except where the ambient temperature for the assembly may exceed 130°C., in which case type D shall be used.

3.12.7.2 Selection of material. Unless otherwise specified in MIL-I-16923, or specifically approved by the procuring activity, the conditions under which these materials are applied and used shall in all respects conform to the manufacturer's recommendations. 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.

3.12.7.3 General characteristics. These materials can be used 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.

3.13 Parts. The design and construction of the console shall use only those parts specified herein. These parts are defined as standard parts. The use of standard parts in the console, as required herein, does not relieve the supplier of the responsibility for conforming with all performance requirements specified in the individual console specification for the particular console.

3.13.1 Selection of standard parts. The selection of standard parts shall be in accordance with the following order:

(a) Standards, specifications and requirements listed herein
(b) Other standards, specifications and requirements listed in MIL-STD-242.

3.13.1.1 Nonstandard parts . When a supplier has determined that the console requirements cannot be met by using a standard part, the supplier shall determine the nonstandard part which will be suitable for the application and request written approval from the procuring activity. The requirements for the approval of nonstandard parts shall be in accordance with MIL-STD-749. Approval will not be granted for the use of parts of special or novel design where parts specified herein are suitable and available. Submittal of data in accordance with MIL-STD-749 is not required when the individual console specification requires a specific part not covered herein. Certification of first article tests or acceptance for delivery shall not be made by the cognizant Government representative for any console using unapproved nonstandard parts without the written approval of the procuring activity.

3.13.1.2 Nonstandard part replacement. When the use of a nonstandard part has been approved because of delivery schedules, the supplier shall provide for mechanical replacement by a standard part by allowing mounting space and providing mounting holes for the standard part.

3.13.2 Design application. In the application of parts, the parts selected shall be applied at their nominal rated values and environmental capabilities (e.g., any ambient or hot spot temperatures, voltage, current or power dissipation) only when these nominal ratings are based on the life specified in 3.2.3 and on application and environmental conditions equal to or more severe than those which apply for the worst combination of range of steady state voltage and frequency and temperature conditions. When these nominal ratings are not so based, the parts shall be derated to meet the life specified in 3.2.3 to assure the required console reliability within the specified operating conditions. Parameter values, such as ambient temperature, voltage, current, to be used as a basis for determining application limits, shall be taken from the following sources listed in their order of precedence:

(a) Applicable Military specifications and standards.
(b) Limits set as a result of Government laboratory tests establishing specific suitability for Naval service.
(c) Test data from supplier tests. (If this source is used, test data shall be submitted to the procuring activity for review).

3.13.2.1 Individual selection. The console shall be designed such that the performance of the console shall not be dependent on the selection of individual parts for characteristics which have tolerances closer than those specified by the applicable part specification or Military standard. (For example, selecting a resistor with a ± 1 percent tolerance to meet the required accuracy, when the specification for this resistor specifies a ± 5 percent tolerance.) Where matched parts are needed for the proper operation of the console, the matched parts shall be treated as nonstandard parts.

3.13.2.2 Tolerances. In the selection of parts, other than those listed in MIL-STD-242 or otherwise specified herein, the widest tolerances permitted by the individual part specification shall be used in the design of the console commensurate with the particular long term stable circuit application requirement. However, in the fabrication of the console, parts of closer tolerances may be substituted as long as interchangeability is not affected.

3.13.2.3 Plug-in parts. Where plug-in parts are used, they shall be securely retained in their sockets in their proper position by means of positive holding devices to meet the vibration and shock requirements of 3.6.5 and 3.6.6. These parts shall comply with the creepage and clearance requirements of 3.8.1.

3.13.3 Audible alarm signals. Audible alarm signals (bells, buzzers, horns, or sirens) shall be in accordance with MIL-A-15303.

3.13.4 Telephone equipment. Sound powered telephone handsets shall be in accordance with MIL-T-15514. Dial telephone handsets shall be in accordance with MIL-T-1943.

3.13.5 Engine order and propeller revolution indicating equipment. Engine order and indicating equipment shall be in accordance with MIL-S-17299. Electrical propeller revolution indicating equipment shall be in accordance with MIL-P-15554.

3.13.6 Batteries. Batteries shall be in accordance with requirement 27 of MIL-STD-454.

3.13.7 Cable and wire.

3.13.7.1 Internal hookup wire. Extra flexible stranded wire with special stranding for increased flexibility shall be used for wires and cables which are normally flexed in use and servicing of the equipment, such as wires and cables attached to the movable half of detachable connectors and hinging cables attached to removable or movable doors and panels.

3.13.7.1.1 Insulated hookup wire. Insulated hookup wire shall be in accordance with table II.

Table II - Insulated hoodup wire.

Temperature limit (maximum hot spot) 1/	Voltage rating volts a.c.	Type	Specification
(Degrees C.)			
105	600	B	2/ MIL-W-16878
105	1,000	C	3/ MIL-W-16878
105	3,000	D	3/ MIL-W-16878
200	600	E	4/ MIL-W-16878
200	1,000	EE	4/ MIL-W-16878
200	600	F	MIL-W-16878
200	1,000	FF	MIL-W-16878

1/ Total wire temperature is the ambient temperature plus the temperature rise resulting from current flow through the conductor.

2/ Type B shall have a braid or an extruded polyamide cover over the insulation in accordance with MIL-W-16878.

3/ Types C and D shall have a braid or an extruded polyamide cover over the insulation in accordance with MIL-W-16878 when bound into a harness or tight assembly which operates near the the permissible temperature limit. (For other applications, the use of the cover shall be at the option of the supplier).

4/ For high density wiring terminated by soldering, type E or EE wire may be used.

3.13.7.1.2 Bare hookup wire. Bare hookup wire shall not be used unless insulated wire is impractical because of circuit characteristics or shortness of wire run. Such wiring shall be straight line and the wire length between adjacent terminals shall not exceed one inch. Bare hookup wire shall be type S, coated, and shall conform to QQ-W-343.

3.13.7.2 External interconnecting cables. External interconnecting cables shall not furnished by the supplier, unless special cables are required to meet the performance requirements of the equipment.

3.13.7.3 Signal shielding. Wiring within the console carrying low level control or instrumentation signals, such as between signal conditioners and remotely located sensors, shall use shielded cable to provide electromagnetic interference immunity.

3.13.8 Capacitors. Only the capacitors in 3.13.8.1 through 3.13.8.13 shall be used in the design of the console. Application, styles and values shall be selected from MIL-STD-198.

3.13.8.1 Fixed ceramic dielectric (general purpose). Fixed ceramic dielectric general purpose capacitors shall conform to MIL-C-11015 or MIL-C-39014. General purpose ceramic capacitors are suitable for use as bypass, filter, and noncritical coupling elements in high frequency circuits where appreciable changes in capacitance, caused by temperature variations, can be tolerated.

3.13.8.2 Fixed ceramic dielectric (temperature compensating). Fixed ceramic dielectric temperature compensating capacitors shall conform to MIL-C-20. These capacitors are designed for use primarily in circuits where compensation is needed to counteract reactive changes, caused by temperature variations, in other circuit components and in bypass, coupling and filtering applications. The widest possible capacitance tolerance and the least stringent temperature coefficient commensurate with the requirements of the circuit application shall be used.

3.13.8.3 Fixed glass dielectric. Fixed glass dielectric capacitors shall conform to MIL-C-11272 or MIL-C-23269. These capacitors are intended for use in blocking, bypass, coupling and tuning applications.

3.13.8.4 Fixed mica-dielectric (molded case, molded case potted and ceramic case potted). Fixed mica-dielectric capacitors (molded case, molded case potted and ceramic case potted) shall be in accordance with MIL-C-5 or MIL-C-39001. These capacitors are intended for use in circuits requiring precise high frequency filtering, bypassing and coupling. They are also ful in blocking and tuning applications.

3.13.8.5 Fixed metallized paper (or polyester film) dielectric d.c. Fixed metallized paper (or polyester film) dielectric capacitors, hermetically sealed in metal cases, shall conform to MIL-C-18312 or MIL-C-39022. These capacitors are primarily intended for use in power supply filter circuits, bypass applications and other applications where the a.c. component of voltage is small with respect to the d.c. voltage rating, where high values of insulation resistance are not essential, and where occasional momentary breakdowns can be tolerated.

3.13.8.6 Fixed plastic (or paper-plastic) dielectric. Fixed plastic (or paper-plastic) dielectric capacitors, hermetically sealed in metal cases, shall conform to MIL-C-19978. These capacitors are intended for use in circuit applications requiring high insulation resistance, low dielectric absorption, or low loss factor over wide temperature ranges, and where the a.c. component of the impressed voltage is small with respect to the d.c. voltage rating.

3.13.8.7 Fixed paper (paper-plastic) or plastic dielectric, d.c. Fixed paper (paper-plastic) or plastic dielectric capacitors, hermetically sealed in metal cases, shall conform to MIL-C-14157. These capacitors are intended primarily for filter, bypass and blocking applications where the a.c. component of the impressed voltage is small with respect to the d.c. voltage rating.

3.13.8.8 Fixed tantalum (solid electrolytic). Fixed tantalum solid electrolytic capacitors shall be in accordance with MIL-C-39003. These capacitors are intended for use where low-frequency pulsating d.c. components are to be bypassed or filtered out and for other uses where large capacitance values are required and where space is limited. These capacitors are mainly designed for filter, bypass, coupling, blocking, energy storage and other low voltage d.c. applications where stability, size, weight and shelf life are important factors.

3.13.8.9 Fixed tantalum (nonsolid electrolytic). Fixed tantalum (foil) nonsolid electrolytic capacitors shall be in accordance with MIL-C-3965 or MIL-C-39006. Sintered slug, wet electrolyte tantalum capacitors shall not be used. The foil type capacitors can be either polarized or nonpolarized. The polarized types are intended for applications where low-frequency pulsating d.c. components are to be bypassed or filtered out and for other uses were large capacitance values are required and comparatively wide capacitance tolerances can be tolerated. The nonpolarized types are primarily suitable for a.c. applications or where d.c. voltage reversals occur.

3.13.8.10 Variable ceramic dielectric. Variable ceramic dielectric capacitors shall be in accordance with MIL-C-81. These capacitors are intended for use where fine tuning adjustments are periodically required during the life of the equipment.

3.13.8.11 Variable air dielectric (trimmer). Variable air dielectric (trimmer) capacitors shall be in accordance with MIL-C-92. These capacitors are intended for use where relatively few fine tuning adjustments are required during the life of the equipment.

3.13.8.12 Variable air dielectric (tuning). All variable air dielectric (tuning) capacitors, except capacitors in accordance with 3.13.8.11, shall conform to requirement 2 of MIL-STD-454.

3.13.8.13 Variable compression type. Variable compression (spring plate) type capacitors shall not be used.

3.13.9 Circuit breakers. Circuit breakers shall conform to requirement 37 of MIL-STD-454, except that circuit breakers in accordance with MIL-C-17361 and MIL-C-17588 shall only be used.

3.13.10 Connectors. Electrical connectors shall be in accordance with requirement 10 of MIL-STD-454. Connectors shall be selected to be in accordance with 3.8.1.

3.13.10.1 Connectors, general. The mating connectors shall be furnished with all receptacles or plugs. All external mounted connector receptacles shall be provided with a suitable protective cap to prevent damage to the connector when the mating connector is not installed. The protective cap shall be affixed adjacent to the connector receptacle. The backend accessory hardware necessary to provide the moisture seal to single jacketed cable shall be furnished with each mating external connector plug.

3.13.10.2 Connectors, removable contact, crimp type. Environmental connectors shall have the full complement of contacts installed. Nonenvironmental type connectors need only have the necessary contacts required by the equipment design, plus the spare terminations required by requirement 10 of MIL-STD-454.

3.13.10.3 Connector mounting. Connectors shall be secured only by bolts (machine screws); shall be capable of ready removal and replacement; and shall be mounted in the position that will best facilitate the testing of the equipment.

3.13.11 Contactors, motor starters and controllers. Contactors, motor starters and controllers shall be in accordance with MIL-C-2212.

3.13.12 Filters, electrical. High pass, low pass, band pass, band suppression and dual functioning electrical filters shall be in accordance with class R, S or V, life expectancy X of MIL-F-18327.

3.13.13 Fuses. Fuses shall conform to MIL-F-15160 and shall have silver plated ferrules. Fuses shall be selected from the following styles:

(a) Style F02, characteristic A (for fuses rated less than 1 ampere only).
(b) Style F03, characteristic A.
(c) Style F09, characteristic A.
(d) Style F60, characteristic C.
(e) Style F62, characteristic C.

3.13.13.1 Electrical circuits supplied directly from the ship's power system shall be fused with characteristic C fuses, except fuses rated 5 amperes or less may be characteristic A. Electrical circuits supplied from internal power supplies may be fused with characteristic A or C fuses.

3.13.13.2 Fuses are not intended to perform the function of thermal overload relays or circuit breaker devices. Fuses in the equipment shall be not less than the next higher standard rating above 125 percent of the rated load current for transformer and noninductive loads and above 300 percent of the rated load current for transient producing loads, except that fuses of less than one-fourth ampere rating shall not be used. All fuses shall be easily replaceable.

3.13.14 Fuseholders. Fuseholders shall be in accordance with MIL-F-19207 and shall be selected from the following types:

(a) Types FHL10U, FHL11U, FHL12U or FHL14G for use with style F02, F03, F09, F60 and F62 fuses when the circuit voltage is 90 volts or more.
(b) Types FHL29G or FHL30G for use with style F02 and F03 fuses when the circuit voltage is less than 90 volts. These fuseholders are incandescent lamp indicators.
(c) Type FHN28WB (nonindicating type) shall be used where types FHL29G or FHL30G will not indicate properly or circuit functions would be adversely affected by their use.

3.13.14.1 All indicating type fuseholders shall be installed so that the indicators are visible from outside the console at all times. All indicating type fuseholders shall be installed so that the test prod hole(s) is located in the downward direction. Connections to the nonindicating type fuseholder posts shall be such that the metal structure which terminates the test prod hole is connected to the load side of the fuse.

3.13.14.2 Information plates shall be provided adjacent to the fuseholders for each set of fuses and shall indicate the fuse type designation and the circuit (e.g., F09A250V8AS, 115 vac). The letters shall be at least 3/64 inch high.

3.13.14.3 For applications requiring other than panel mounting, copper clad steel fuse clips in accordance with MIL-F-21346/1 shall be used.

3.13.15 Indicator lights. Indicator lights shall be style LH94 or LH98 (transformer type) in accordance with MIL-L-3661/61 or MIL-L-3661/65 for standard a.c. voltage and frequency applications. Indicator lights shall be style LH95 or LH96 (for use with resistors) in accordance with MIL-L-3661/62 or MIL-L-3661/63 for nonstandard a.c. voltages and frequencies and d.c. applications. Indicator lights shall be style LHC91 in accordance with MIL-L-3661/50 for applications where space requirements do not permit the use of the indicator lights specified above.

3.13.15.1 Lamps for use with the style LH94 and LH98 indicators shall be type MS15612-3 (Industry No. 1769). Lamps for use with the style LH95 and LH96 indicators shall be type MS15612-5 (Industry No. 342). Lamps for use with the style LHC91 indicator shall be type MS15237-328 (Industry No. 328). The industry number shall be marked on the indicator.

3.13.15.2 All indicator lights shall be provided with flush mounting type lenses. Information plates shall not be furnished for identification of indicator lights unless the necessary information cannot be engraved on the indicator light lens. Style LH94, LH95, LH96 and LH98 indicator lights shall use lenses in accordance with style LC41 through LC45 of MIL-L-3661/55 through MIL-L-3661/59. Style LC44 and LC45 lenses shall be engraved with appropriate information.

3.13.15.3 Colors. Indicator light lens colors shall be selected in accordance with the following:

(a) Red - dangerous or emergency condition requiring immediate attention or corrective action.
(b) Amber - abnormal but not immediately dangerous condition or cirucit under test.
(c) Green - normal condition.
(d) Blue - closed (shut).
(e) White - power on or power available.
(f) Clear - ground detection.

3.13.15.3.1 For an auxiliary or parameter where both "operating" and "not operating" may be a normal condition, depending on the service, the green designation shall be used for both cases.

3.13.15.3.2 Indicator light lenses used for valve position indication shall be ring and bar type (style LC41, LC42, or LC43) to indicate open or shut conditions. The color used shall be red, amber or green in accordance with 3.13.15.3. For a valve where both open and shut may be normal depending on the service condition, the green designation shall be used for both cases.

3.13.15.3.3 Circuit breakers that perform the function of a controller shall use the color designation green, amber or red as dictated by the condition when the equipment is in service. The blue closed indication specified in 3.13.15.3 shall be used for power distribution circuit breakers only.

3.13.16 Indicators.

3.13.16.1 Electrical indicating meters. Electrical indicating meters shall be 4-1/2 inch, 250 degree scale, in accordance with MIL-M-16034 for electrical parameter applications (e.g., voltage and current). Electrical indicating meters for machinery plant parameter applications (e.g., pressure, temperature, level, flow) shall be vertical edgewise type, 5 inch case, in accordance with MIL-M-24359.

3.13.16.1.1 The scale color scheme shall have a white scale background with black markings. Radium dials shall not be used.

3.13.16.1.2 All electrical indicating meters shall have a full scale range of 0 to 1 milliampere d.c., unless otherwise specified in the individual console specification.

3.13.16.2 Digital indicators. Digital readout indicators shall be style RP01, class A, or RP02, class A, in accordance with MIL-R-39027. The height of the indicator characters shall be a minimum of 0.45 inches. Display colors shall be selected in accordance with 3.13.15.3.

3.13.16.2.1 Digital readout circuitry. The need for digital indicators may require that some circuitry be mounted with the digital indicators to reduce the number of connections necessary between the equipment and the digital indicators. Any such circuitry must be approved by the procuring activity.

3.13.16.2.1.1 Digital requirements for digital readout circuitry. Any circuitry that is to be mounted with the digital indicators shall be designed according to the following guides with the order of importance being the same as the order of the design guides:

(a) Minimize the complexity of the indicator component.
(b) Minimize susceptibility.
(c) Minimize the number of connections between the equipment and the digital indicators.

3.13.16.2.2 Digital indicator flicker. The digital indicators that display the parameter measurements in engineering units shall be designed to reduce flickering of the readout equipment. The least significant digit will inherently change from one digit to another at the transfer point. Every effort shall be made to reduce objectionable flicker in the least significant digit.

3.13.16.2.3 Isolation shall be used among the various instrument outputs such that shorting or opening any digital output circuit will not produce a change in any other output in excess of the specified accuracy requirements.

3.13.17 Indicator accessories.

3.13.17.1 Resistors. External indicator resistors shall be in accordance with MIL-R-29.

3.13.17.2 Shunts. External indicator shunts shall be in accordance with MIL-I-1361.

3.13.17.3 Instrument transformers. Current and potential instrument transformers shall be in accordance with MIL-I-1361.

3.13.18 Jacks, tip (test point jacks). Tip jacks shall be selected from MIL-STD-242. Banana plugs shall not be used as test points.

3.13.19 Motors. A.c. motors shall be in accordance with service A of MIL-M-17059 or MIL-M-17060. D.c. motors shall be in accordance with service A of MIL-M-17413 or MIL-M-17556.

3.13.19.1 Motor rotation. All motors used shall be marked in a permanent manner to show direction of rotation where applicable to the function of the equipment.

3.13.20 Servo motors. Servo motors shall be in accordance with requirement 56 of MIL-STD-454.

3.13.21 Relays. Relays shall be in accordance with MIL-R-19523 except as specified in 3.13.21.1 and 3.13.21.2. The individual console specification shall include the ordering data required by MIL-R-19523 for all relays specified to be furnished.

2.13.21.1 Time delay and overload relays shall be in accordance with MIL-C-2212 for a.c. and d.c. applications.

3.13.21.2 Relays which require extremely high insulation resistance, a minimum of contact resistance and special coil sensitivity, or any of these, such that they cannot be supplied under MIL-R-19523, shall be selected in accordance with the general requirements of MIL-R-5757.

3.13.22 Resistors and variable resistors. Only the resistors and variable resistors specified in 3.13.22.1 through 3.13.22.5 shall be used in the design of the console. Application, styles and values shall be selected from MIL-STD-199, except for those resistors and variable resistors specified in 3.13.22.3 through 3.13.22.5.

3.13.22.1 Fixed resistors. Fixed resistors, for rated wattage of less than 15 watts, shall be in accordance with MIL-R-26, MIL-R-10509, MIL-R-11804, MIL-R-22684, MIL-R-39005, MIL-R-39007, MIL-R-39017, or MIL-R-55182.

3.13.22.2 Variable resistors. Variable resistors, for rated wattage of less than 15 watts, shall be in accordance with MIL-R-22, MIL-R-12934, MIL-R-39002, or MIL-R-39015.

3.13.22.3 Resistors over 15 watts. Resistors and variable resistors, for rated wattage of 15 watts or more, shall be in accordance with MIL-R-15109.

3.13.22.4 Fixed resistors (high megohm). High megohm fixed resistors shall be in accordance with MIL-R-14293.

3.13.22.5 Variable resistors (cermet). Metal film (cermet) variable resistors shall be in accordance with MIL-R-23285.

3.13.22.6 Resistor and variable resistor application. Resistor and variable resistor power dissipation shall not exceed 50 percent of the rated value after ambient temperature derating factors have been applied in accordance with the part specification or MIL-STD-199, as applicable, except that in the case of resistors and variable resistors which operate on a short-time or intermittent basis, this power dissipation limitation need not be applied.

3.13.22.7 Locking devices. Variable resistors shall have positive locking devices. Locking devices on miniature potentiometers are not required provided the stability requirements of requirement 28 of MIL-STD-454 are met.

3.13.23 Semiconductor devices. Silicon diodes, rectifiers, voltage regulator diodes, voltage reference diodes, silicon controlled rectifiers and transistors shall be in accordance with requirement 30 of MIL-STD-454.

3.13.24 Semiconductor integrated circuits (SIC). SIC's may be used in the console. When used, the SIC's shall have adequate noise immunity to prevent errors in indication and control functions. Hermetically packaged SIC's are preferred and shall be used unless the required function cannot be achieved by other than plastic packaged devices. SIC's shall be selected such that second sources are available. Each SIC shall be in accordance with a SIC detail specification, to be provided by the manufacturer of the console, which complies with 3.13.24.1.

3.13.24.1 SIC detailed specification. All physical and performance features and requirements necessary to define the SIC and assure its adequacy and acceptable quality for the intended application shall be included in the SIC detail specification. The specification shall be in the form of a drawing which shall be devoid of any restriction which would limit its use by the Government, or by others in the interest of the Government. The detail and completeness of the specification shall be sufficient to enable direct Government procurement from any device manufacturer who has the production capacity and willingness to comply with the specification. Test methods, procedures and conditions which are pertinent in MIL-STD-883 shall be specified in the specification. SIC reliability assurance shall be as specified in 4.6.25. The test report for the tests specified in 4.6.25.1 and 4.6.25.2 shall be submitted by the supplier prior to installation in the console.

3.13.25 Analog-to-digital converter (ADC). The type of ADC (see 6.5.13 and 6.5.14) used in the console shall be chosen by the supplier subject to the approval of the procuring activity.

3.13.26 Solenoid actuators. Solenoid actuators shall conform to the requirements specified in this specification.

3.13.27 Surge voltage suppressors. Surge voltage suppressors shall be of the selenium type, the voltage sensitive nonlinear resistance type, or another type specifically authorized and approved in writing by the procuring activity for the particular application. (Other kinds of devices such as voltage regulator diodes, controlled avalanche rectifier diodes and capacitors may be used to function as suppressors but requirements applicable to these are contained in 3.13.8 and 3.13.23.) Surge voltage suppressors of the types identified above may be used when selected and applied in accordance with the following:

(a) Each suppressor certified for the application by the console manufacturer shall be of a type which is covered by a published technical data bulletin, or equivalent, issued by the suppressor manufacturer and which shows suppressor rating, derating and application criteria. A copy of each applicable bulletin shall be forwarded with the nonstandard part data sheet required by MIL-STD-749.

(b) The suppressor assembly shall comply with the material, design and construction requirements of this specification and shall have a protective coating for use in moist salt-laden atmosphere (manufacturer's finish coating designated for military or commercial marine service).

(c) The maximum cell temperature shall not exceed the maximum operating temperature recommended by the suppressor manufacturer minus 20°C. or the operating temperatures corresponding to 40,000 hours life expectancy for 95 percent probability of survival, whichever is smaller.

3.13.28 Switches. Switches shall be in accordance with 3.13.28.1 through 3.13.28.9.3.

3.13.28.1 Toggle switches. Toggle switches shall be in accordance with MIL-S-3950. These switches shall be used only in alarm and test circuits.

3.13.28.2 Sensitive switches. Sensitive switches shall be in accordance with MIL-S-8805. These switches shall not be used for applications above 125 volts or 50 volt-amperes. Maximum contact gap shall be used.

3.13.28.3 Push button switches. Push button switches shall be in accordance with MIL-C-2212 or MIL-S-8805.

3.13.28.4 Push button, lighted. Lighted push button switches shall be in accordance with MIL-S-22885. Lamps for use with these switches shall be type MS25237-328 (Industry No. 328).

3.13.28.5 Mercury switches. Mercury switches shall not be used.

3.13.28.6 Pressure, level and thermostatic switches. Pressure, level and thermostatic switches shall be in accordance with MIL-C-2212 or MIL-S-16032.

3.13.28.7 Printed circuit switches. Printed circuit switches shall be in accordance with MIL-S-22710.

3.13.28.8 Automatic bus transfer switches. Automatic bus transfer switches shall be in accordance with MIL-S-17773.

3.13.28.9 Rotary switches.

3.13.28.9.1 Control and power circuits. Switches for control and power circuit applications shall be in accordance with MIL-S-15291. Class SRN switches shall be used in all applications up to and including 30 amperes. Class SR switches shall be used in all applications over 30 amperes. Where more than four positions are required, switches shall be in accordance with MIL-S-18396 or style JM or JR of MIL-S-21604.

3.13.28.9.2 Instrument, metering, test and alarm circuits. Switches for instrumentation equipment and for metering, test and alarm circuitry used in control equipment shall be in accordance with the following:

(a) For voltages of 125 volts or less, switches shall be class SRN of MIL-S-15291, MIL-S-21604 or style SR04 of MIL-S-3786/4.
(b) For voltages above 125 volts, switches shall be in accordance with MIL-S-15291 or MIL-S-18396.

3.13.28.9.2.1 Rotary switches rated less than one ampere may be used where space limitations require the use of switches other than those specified above, provided that test data is presented that shows they meet the requirements of MIL-S-21604 except for the "Detail requirements of the individual styles".

3.13.28.9.3 Stops shall be provided to limit rotation of rotary switches to the minimum number of positions necessary for the application in the equipment. However, four-position switches having identical alternate positions need not be required to have stops when only two positions are needed.

3.13.29 Synchros. Synchros shall be in accordance with requirement 56 of MIL-STD-454. Installation requirements shall be in accordance with MIL-HBK-225.

3.13.29.1 Resolvers. Electrical resolvers shall be in accordance with requirement 56 of MIL-STD-454.

3.13.30 Terminal boards. Terminal boards shall be in accordance with MIL-T-55164, except that lockwashers are not required under the terminal nuts. Terminal boards shall be double row, linked, front connected, class 8TB, 17TB and 26TB, or single row feed-through connected, class 5TB, 7TB, 11TB and 27TB. The maximum number of lugs to be connected to any one terminal or stud on a terminal board shall be three lugs, except where class 8TB and 26TB with stud connector are used, only two lugs shall be connected to any one stud.

3.13.30.1 Mounting. Terminal boards shall be secured only by bolts (machine screws) and shall be capable of ready removal and replacement. They shall be mounted in the position that will best facilitate the testing of the console.

3.13.31 Terminal lugs. On all applications of 5 amperes or less, the terminal lugs shall be type II in accordance with MIL-T-7928. On all applications of more than 5 amperes, the terminal lugs shall be in accordance with MIL-T-7928 or MIL-E-16366. Where uninsulated terminal lugs are used, the barrel shall be covered with an insulating sleeve. Where the conductor temperature may exceed 100°C., an uninsulated terminal lug shall be used with an insulating sleeve which is suitable for the maximum temperature of the conductor. The terminal lugs and type of wire shall be selected so that the inside diameter of the lug barrel in which the bare wire is to be inserted shall be smaller than the overall outside diameter of the wire plus the insulation on the wire.

3.13.31.1 Only one wire shall be crimped to a terminal lug.

3.13.32 Terminals, stud and feedthrough. Stud and feedthrough terminals shall be in accordance with requirement 19 of MIL-STD-454.

3.13.32.1 Mounting. Adequate spacing shall be employed between adjacent stud or feedthrough terminals to prevent corona discharge, breakdown and low leakage resistance under specified environmental conditions, such as high humidity, including condensation, for the particular application. Terminals shall not turn or loosen or deteriorate when the equipment is subjected to specified service conditions, such a shock and vibration. Terminals mounted on boards shall not cause cracking or delamination of the board.

3.13.33 Transducers.

3.13.33.1 Differential pressure. Differential pressure transducers shall conform to MIL-D-24304.

3.13.33.2 Pressure. Pressure transducers shall conform to MIL-P-24212.

3.13.33.3 Temperature. Temperature transducers shall conform to MIL-T-24387 and MIL-T-24388.

3.13.33.4 Level. Liquid level transducers shall conform to MIL-L-24407.

3.13.34 Thermistors. Temperature compensating thermistors shall be in accordance with MIL-T-23648.

3.13.35 Transformers, reactors and inductors. Transformers shall have electrically isolated windings (primary and secondary). Neither auto-transformers nor open-delta connected transformers shall be used.

3.13.35.1 All transformers, reactors and inductors of less than 150 volt-ampere rating shall conform to grade 4 or 5, class R, S, T, U or V of MIL-T-27 and the following:

(a) Shall be designed for life expectancy X of MIL-T-27.
(b) Shall meet the requirements for dielectric test as specified in MIL-T-27, except that in no case shall the dielectric test voltage be less than that specified in 3.8.3.1.
(c) Shall meet method II shock test of MIL-T-27.
(d) Wire size finer than AWG number 42 shall not be used.

3.13.35.2 Power transformers shall have electro-static shields. For metal cased transformers, the nonstandard case sizes and mountings designated as "YY" shall not be used. The class of the transformer, reactor or inductor shall be such that the maximum operating temperature, for that class, as given in MIL-T-27, will not be exceeded when the equipment is subjected to the specified ambient conditions.

3.13.35.3 Standard transformers in accordance with MIL-STD-242 shall be used to the maximum extent possible. Where transformers, reactors and inductors are not listed on the Qualified Products List of MIL-T-27 and the number of identical units per contract or order is less than 100, it will not be necessary to obtain qualification approval for these items. The procedures specified in 3.13.35.3.1 through 3.13.35.3.3 will be accepted as sufficient quality assurance in lieu of qualification approval. The data required by 3.17.4.2(h)(1) shall be submitted with a request for approval under any of the procedures specified in 3.13.35.3.1 through 3.13.35.3.3. This data shall be submitted prior to or with the production drawings.

3.13.35.3.1 Procedure 1. Transformers, reactors and inductors shall be procured from a source appearing on the Qualified Products List of MIL-T-27 which has been approved for the same or similar units. Similar units are defined as follows:

(a) Same grade; same class of operation; same or higher nominal ambient temperature; and same or higher nominal operating temperature.
(b) Same external and internal mountings; similar shape; same case construction; nominal wall thickness within 25 percent when a case is used; linear case dimensions not greater than 150 percent nor less than 90 percent of the corresponding dimensions; total volume of case not greater than 250 percent. (For encapsulated units, the envelope dimensions shall be considered as the case dimensions.)
(c) Same terminal construction and material, including insulating and gasketing parts; same or greater terminal-strength requirement for the same size of terminals; same or greater dielectric-strength requirement for

the same size of terminals; same or greater current rating for corresponding terminals; same or lesser spacing between corresponding terminals; and between corresponding terminals and the case wall or other grounded surfaces.
(d) Same or smaller wire size and same coating material for corresponding winding.
(e) Same processing and material for case, finish, marking, potting, insulation and impregnating.

3.13.35.3.2 Procedure 2. If there is no similar acceptable design for the source desired, a design can be established as acceptable by conducting all of the tests shown in the table for "Qualification inspection for mechanical design and construction only" of MIL-T-27, with the following exceptions:

(a) Dielectric strength test voltage shall in no case be less than that specified in 3.8.3.1.
(b) Vibration test shall have a maximum frequency of 33 Hz.
(c) Shock shall be method II of MIL-T-27.
(d) The number of test samples shall be two typical units of the same design from each group of similar units from the same manufacturer. The definition of similar is as defined in procedure 1. Prior to testing, approval shall be obtained from the procuring activity for the proposed grouping and the units selected as typical. The test data shall be submitted to the procuring activity for approval.

3.13.35.3.3 Procedure 3. Acceptability of transformers, reactors and inductors based upon similarity to units approved under procedure 2. A given design may be established without testing the units, when the procuring activity is satisfied that the unit compares with a single unit, which was tested and approved for mechanical design characteristics under procedure 2, in accordance with procedure 1.

3.13.35.4 All transformers, reactors and inductors which are approved under the procedures of 3.13.35.3.1 through 3.13.35.3.3 shall be subjected to the group A inspection of MIL-T-27 with the following exception:

(a) Dielectric strength test voltage shall in no case be less than that specified in 3.8.3.1.

3.13.35.5 Pulse transformers, low power. Low power pulse transformers shall be in accordance with grade 4 or 5, class R, S, T, U or V of MIL-T-21038 and the following:

(a) Shall be designed for life expectancy X of MIL-T-21038.
(b) Shall meet the requirements for dielectric test as specified in MIL-T-21038, except that in no case shall the dielectric test voltage be less than that specified in 3.8.3.1.
(c) Shall meet method II shock test of MIL-T-21038.
(d) Wire size finer than AWG number 42 shall not be used.

3.13.35.5.1 Where low power pulse transformers are not listed on the Qualified Products List of MIL-T-21038, it will not be necessary to obtain qualification approval for these items. The procedures specified in 3.13.35.3.1 through 3.13.35.3.3 will be accepted as sufficient quality assurance in lieu of qualification approval, except that MIL-T-21038 shall be substituted for MIL-T-27.

3.13.35.5.2 All pulse transformers which are approved under 3.13.35.5.1 shall be subjected to the group A inspection of MIL-T-21038, with the following exception:

(a) Dielectric strength test voltage shall in no case be less than that specified in 3.8.3.1.

3.13.35.6 All transformers, reactors and inductors rated 150 volt-amperes and above shall be in accordance with type CC, PR or SA of MIL-T-16315. In addition, sample units of each type shall pass the vibration test specified in MIL-STD-167 and shall meet the minimum material requirements of table III. Type PR transformers shall meet the shock tests of MIL-S-901.

Table III - Material for transformers, reactors and inductors.

Item	Electrical insulation material
Magnet wire	As required by MIL-E-917
Lead wire	Type C, D, E, EE, F or FF of MIL-W-16878
Ground	As required by MIL-E-917
Layer	As required by MIL-E-917
Tape	(a) Type GPT or MFT of MIL-I-15126 (b) Silicone glass adhesive of MIL-I-19166 (c) Glass fiber of MIL-Y-1140
Sleeving	As required by MIL-E-917
Tying cord	(a) Neoprene treated glass cord of MIL-Y-1140 (b) Silicone treated glass cord of MIL-Y-1140
Cable support	(a) Glass melamine of MIL-P-15037 (b) Glass silicone of MIL-P-997
Coil spacer	(a) Glass melamine of MIL-P-15037 (b) Glass silicone of MIL-P-997
Varnish for treating and impregnating	Material and treating methods as required by MIL-E-917
Terminal boards	The following shall apply where the current rating exceeds those available under MIL-T-55164 or where the terminal board is designed to conform to the shape or construction of the unit:
(a) Molded	Type MMI-5, MMI-30, MAI-30 or MAI-60 of MIL-M-14
(b) Machined	Glass melamine of MIL-P-15037 or glass silicone of MIL-P-997
Encapsulating compound (if used)	Type A, B, C or D of MIL-I-16923.

3.13.36 Voltage regulating transformers. Voltage regulating transformers shall conform to MIL-T-981.

3.13.37 Miscellaneous inductive devices. Miscellaneous inductive devices not falling strictly under the requirements of 3.13.35, for example, differential transformers, shall meet the requirements of type SA of MIL-T-16315. In addition, sample units shall pass the vibration test specified in MIL-STD-167 and shall meet the minimum material requirements of table III. Wire finer than AWG number 42 shall not be used.

3.13.38 Electrical tapes. Electrical tapes shall be in accordance with MIL-I-631, MIL-Y-1140, MIL-I-3505, or MIL-I-17205. Electrical pressure-sensitive adhesive tape shall be in accordance with MIL-I-24391, types AFT, EF-9, EF-20 or GFT of MIL-I-15126, or MIL-I-19166. Fabric or texture pressure-sensitive (adhesive or friction) tape shall not be used.

3.13.39 Lacing cord and tape. Lacing cord and tape shall be in accordance with table IV.

Table IV - Lacing cord and tape.

Temperatures (Degrees C.)	Material	Applicable document
Up to 105	Type P, unwaxed nylon cord Type SR-4.5, glass fiber cord Type I or V, polyamide tape, with finishes C or E	MIL-T-713 MIL-I-3158 MIL-T-43435
Up to 130	Neoprene treated glass cord	MIL-Y-1140
Up to 200	Silicone treated glass cord Type III, tetrafluorocarbon tape with finishes D or F Type IV, glass tape with finishes D or F	MIL-Y-1140 MIL-T-43435 MIL-T-43435

3.13.40 Sleeving. Sleeving shall be synthetic resin type A or F, class I, category 1, in accordance with MIL-I-631, where total temperature does not exceed 80°C; any of the types in accordance with MIL-I-3190, or polytetrafluoroethylene in accordance with MIL-I-22129. Heat shrinkable type sleeving shall be in accordance with MIL-I-23053.

3.13.41 Bearings. The selection and application of bearings shall be in accordance with requirement 6 of MIL-STD-454 and as modified in 3.13.41.1 through 3.13.41.4.

3.13.41.1 Ball bearings. Ball bearings shall be applied and installed in accordance with FF-B-171. Grade 00 ball bearings shall be used wherever possible.

3.13.41.2 Roller bearings. Roller bearings shall be applied and installed in accordance with FF-B-185 or FF-B-187.

3.13.41.3 Sleeve-type bearings. Sleeve-type bearings shall not be used.

3.13.41.4 Noise tested bearings. Where required, noise tested ball bearings shall be in accordance with MIL-B-17931.

3.13.42 Cable clamps and straps. Cable clamps and straps for securing or tying wires shall be selected from MIL-STD-242. Cable clamps need not be marked with the part number as specified therein.

3.13.43 Air filters. Air filters for air conditioning and ventilating systems of consoles shall be of the cleanable type.

3.13.43.1 High velocity. For air velocities of 400 feet per minute and over, the air filters shall be in accordance with MIL-P-16552.

3.13.43.2 Low velocity. For air velocities of below 400 feet per minute, the air filters shall be in accordance with F-F-300.

3.13.44 Gage piping and gages (indicators). Gage piping shall be in accordance with Drawing 810-1385850. Gages (indicators) on all main gage boards, panels and piping systems shall conform to MIL-I-18997. Gages on all main gage boards and panels shall be flush mounted in accordance with Drawing 5000-S8700-841569.

3.13.45 Gaskets, O-rings and seals. Gasketed surfaces shall have metal-to-metal contact, wherever practicable, so that the amount of gasket compression can be accurately controlled. The inside radius of gaskets at corners of square or rectangular enclosures shall be the maximum value that will not restrict access or inhibit design. The minimum radius shall be consistent with the gasket material. Gaskets, O-rings and seals when purchased to the specifications listed in 3.13.45.1 and 3.13.45.2 shall be in accordance with these specifications except that lot testing is not required. General examination in accordance with 4.5 herein is required. Gasket requirements shall be in accordance with 3.13.45.1 through 3.13.45.3.

3.13.45.1 Nonoil resistant applications. Gasket and O-ring material for nonoil resistant applications for static seals (between unit case and cover), for reciprocating motion seals (push button shafts) and for rotary motion seals (rheostat shafts or operating knob shafts where the rotational speed is less than 10 revolutions per minute (r.p.m.)) shall conform to MIL-P-5516 or class 2 of MIL-G-18586. The 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 for other than static seals. 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.

3.13.45.2 Oil-resistant applications. Gasket materials for oil-resistant applications shall be in accordance with MIL-R-2765.

3.13.45.3 For dial windows. All gaskets for dial windows shall be 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 in such a manner as to protect the window from mechanical shock, and also maintain the integrity of the enclosure in which the window is mounted.

3.13.46 Gears. The design, construction, and assembly of gears shall be such as to provide smooth, continuous tooth contact without interference, tight spots, loose spots, or other irregularities. Every precaution shall be taken to reduce tooth pressures and backlash to a minimum. All gears fitted on shafts shall be secured thereto by means which will effectively prevent relative motion between the gear and the shaft.

3.13.46.1 Spur and bevel gears. Spur and bevel gears for heavy duty drives shall be made of corrosion-resistant steel conforming to class 416 of QQ-S-764 or of bronze conforming to MIL-B-16540. Fibre gears shall not be used. Aluminum alloys and nylon may be used for spur and bevel gears for light duty drive only.

3.13.46.2 Worm gears. Worm gears transmitting an appreciable amount of torque shall be made of bronze conforming to MIL-B-16540. The use of aluminum alloys is considered satisfactory for worm gears transmitting very low torque, such as drives for dials in synchro transmission systems. Worms shall be made of corrosion-resistant steel conforming to class 416, or better of QQ-S-764.

3.13.46.3 Planetary and epicyclic gears. Planetary or epicyclic gears are preferred to worm gears where friction is a critical consideration.

3.13.47 Handles and control knobs. Handles and control knobs shall conform to the requirements for the parts specification. When a part specification does not include the requirements for handles or knobs, they shall be selected from MIL-STD-242. Handles and control knobs shall be firmly secured to the control shafts by the use of setscrews.

3.13.48 Miscellaneous hardware. All miscellaneous hardware, such as cotter pins and rivets, shall conform to commercial standards.

3.13.49 Inserts and pins, metallic. Metallic inserts shall be staked in position, or secured by knurling or other methods, to preclude their rotation. Inserts shall be of such design that tightening of the screws or studs, which they are intended to secure, will not result in the loosening or movement of the inserts.

3.13.49.1 Pins. Pins or slotted tubular spring pins and inserts shall be of austenitic corrosion-resistant steel, nickel-copper alloy, or other corrosion-resistant metal so that corrosion does not occur and affect disassembly. When a nonmagnetic material is required, austenitic corrosion-resistant steel shall be used.

3.13.49.2 Dowel pins. Dowel pins for securing aluminum or aluminum alloy parts together shall be of aluminum alloy. Dowel pins for securing materials other than, or in combination with, aluminum or aluminum alloy shall be brass protected against corrosion, except where required for reasons of strength, in which case austenitic corrosion-resistant steel shall be used. Pins shall be adequately secured to prevent dislodging under shock and vibration.

3.13.50 Threaded fastening devices. Threaded fastening devices (nuts, bolts, screws, washers and so forth) shall be of corrosion-resisting material (see 3.12.4) or treated to resist corrosion without paint (see 3.11.4). Spring type locking devices such as lockwashers and retaining rings, when made of precipitation hardened semi-austenitic corrosion-resisting steel, do not require additional protection against corrosion. Fasteners shall be of the same materials as the parts or assemblies in which they are used, where practicable and within the limitations specified herein. When locking devices are used, the material of the locking device shall be the same as or similar to the material of the fastener. Aluminum and aluminum alloys shall not be used. Screw thread standards for all threaded fastening devices shall be as specified in MIL-E-917. 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. Only those shapes and sizes of threaded devices specified herein shall be used in the console.

3.13.50.1 Machine screws. Machine screws shall be as specified in MIL-E-917. Styles shall be the pan head, flat countersunk head and drilled fillister head. Oval head screws may be used with cup type washers.

3.13.50.2 Cap screws. Cap screws shall be as specified in MIL-E-917.

3.13.50.3 Set screws. Set screws shall be as specified in MIL-E-917.

3.13.50.4 Bolts and nuts. Bolts and nuts shall conform to FF-N-836 or as specified in MIL-E-917. Square nuts and square or round head bolts shall not be incorporated into the design of the console.

3.13.50.5 Washers. Lockwashers and flat washers shall be as specified in requirement 12 of MIL-STD-454.

3.13.50.6 Source inspection. Source inspection of threaded fasteners in accordance with the applicable specifications will not be required.

3.13.51 Springs. Springs shall be in accordance with requirement 41 of MIL-STD-454.

3.13.52 Bell and data loggers. The requirements for the bell and data loggers shall be as specified in the individual console specification. The printout devices shall have fixed carriages. The power supply for the loggers shall be provided from the no-break a.c. bus in the console.

3.13.53 Digital clock. The digital clock for the bell and data loggers shall have an accuracy of within plus or minus 15 seconds per month. In addition to time control of the bell and data loggers, the digital clock shall display hours (2 digits), minutes (2 digits) and tenths of a minute (1 digit). The clock shall be resettable from the front of the bell and data logger console. The supply shall provide the precision frequency, if required, for the digital clock.

3.13.54 Throttle control equipment. The requirements for the throttle control equipment shall be as specified in the individual console specification.

3.13.55 Alarm annunciators. The alarm annunciator system shall be designed for continuous duty. The alarm annunciators shall consist of lamp and lens assemblies and circuitry to perform the required functions specified in the individual console specification. All parts used in the alarm annunciator system shall be as specified in this specification. The alarms to be monitored shall be specified in the individual console specification.

3.13.55.1 Light flashing rate. The flashing rate of the alarm annunciator lights shall be approximately 80 cycles per minute. The on and off time of the light shall be approximately equal when the light is flashing.

3.13.55.2 Loss of alarms. The alarm annunciator system shall be monitored in such a manner that the loss of the alarm system will be indicated by an alarm on the console.

3.14 Controls, indicators, and panel layout.

3.14.1 Controls. General criteria for characteristics of controls shall be in accordance with requirement 28 of MIL-STD-454, except that coupling between or to shafts shall be accomplished by means of rigid metallic or insulated couplings secured with pins. Direction of movement shall be as specified in 3.5.4.

3.14.1.1 Tactile forms. Tactile forms for control knobs shall be as specified in MIL-STD-242 when required by the individual console specification.

3.14.2 Dial, indicator and vernier marking. Where verniers are employed to subdivide dial divisions, the marking and numbering shall be such as to provide continuity throughout the dial range. All dials, indicators and verniers shall be marked in evenly spaced divisions, if practicable, according to the degree of precision required, except where nonlinear scales are required. The space between any two adjacent markings shall be not less than 0.05 inch. The width of any single calibration mark shall not exceed 20 percent of the space between it and the adjacent mark. The marking and mounting of all dials and scales shall be such that at least three identifying figures will be visible at all times. The design shall be such that the values of settings or other indications shall increase numerically or alphabetically with increase of the final controlled effect.

3.14.2.1 In the marking of dials, indicators and verniers, the following principles shall be followed:

(a) The zero or start position shall be uniform.
(b) Numerals and letters shall be orientated in a horizontal direction.
(c) Scales and dials shall begin and end with a numbered mark.
(d) The measurement units shall be as simple and uniform as feasible.
(e) The number of units per marked scale division shall be uniform and follow a decimal system. The best numbers of units per scale division are 1, 0.1, 0.01, etc., and 10, 100, etc. Corresponding numbers based upon 2 and 5 instead of 1 are acceptable, but numbers based upon 3, 4, 6, 7, 8 and 9 shall not be used.
(f) The number of marked scale divisions between numbered divisions shall be uniform and follow the rule stated in 3.14.2.1(e).
(g) Where nonlinear scales are required, the spacing of marked scale divisions between numbered divisions need not be uniform provided the value of each scale division is immediately evident.
(h) Markings may be used to indicate operating values, maximum and minimum values, operating ranges and the like. These markings should be clearly visible and remain distinct from the scale and numerals of the indicator.

(i) All indicators should be clearly identified and labeled to show the measured variable and the measurement unit used.

3.14.3 Windows. Where operating controls are so arranged as to require the reading of dials or scales through windows in the panels or enclosures, the window shall be provided with safety glass or plastic secured to the panels or enclosures by means of clips or other devices. The use of cement alone for securing the glass or plastic window is not acceptable. Where operating conditions may result in condensation on windows, means for the absorption of this condensation shall be provided.

3.14.4 Panel layouts and operating controls arrangement. Panel layouts and operating controls arrangement shall be subject to the approval of the procuring activity. The supplier shall make available to the procuring activity preliminary sketches, photographs, mock-ups or other descriptive material adequate to permit detailed analysis to insure optimum functional performance combined with ease of operation. This material shall be provided at a stage of the contract which will allow the analysis specified herein to be completed before final design is started.

3.14.5 General. All adjustment and control ranges shall be sufficient to compensate for differences among parts within their specified tolerances. Adjustments and controls shall provide at least 20 percent of mechanical adjustment in either direction after proper alignment. A complete description and instructions for the adjustment of all the controls shall be included in the technical manual. All devices required for trip point and calibration check, such as potentiometers, pin jacks and test devices, shall be mounted on the front of the panel or behind access doors and shall be operable without withdrawing the respective drawer.

3.14.6 Function identification. The function of each control and indicator on the console shall be indicated by means of information plates mounted adjacent to the control or indicator. These plates shall be placed so they can be read from left to right. Abbreviations shall be avoided. The function of each internal adjustment, connector, and test point shall be identified. Symbols and abbreviations are acceptable. The markings shall be located adjacent to the adjustment, connector, and test point.

3.15 Maintenance design.

3.15.1 General. For servicing and maintenance purposes, the console shall be so designed as to be capable of full operation with drawers withdrawn and access doors open. Accessory cables shall not be used to meet this requirement.

3.15.2 Test points and test facilities. Built-in test devices and test points shall be provided in the console to aid in installation, maintenance, operation, calibration, alignment and repair.

3.15.2.1 Test points shall be provided for routine maintenance, repair, alignment and calibration of the console. For example: Checking significant voltages, currents and waveforms and the injection of test signals. Protection shall be provided in the test point circuitry to prevent console failure which could result from external grounding of test points. Where currents are to be measured across test points, provision shall be made to provide shunt impedance across the test points.

3.15.2.2 Built-in devices shall be provided when any of the following conditions apply:

(a) Where the use of portable equipment will not give consistent reproducible results for operations necessary in maintenance.
(b) When periodic observations are necessary, (as example: every watch or every day).
(c) When the maintenance of complex systems or equipment can be facilitated by fault location test devices (as example: panel meter with selector switches to show voltages at various essential points).
(d) Where measurements which are dangerous to life must be made (see 3.15.3).

3.15.2.2.1 Built-in test devices shall maintain their accuracy under all the operating conditions required of the console. The test devices shall be designed to provide connections or access for calibration or operational checkout of the test devices.

3.15.2.3 Indicator lights shall be provided on the front panel to show that a circuit or instrument is under test, except that a light need not be provided where the circuit or instrument is placed in the test position and the test performed by means of a single spring return to normal switch.

3.15.3 High voltage equipment. When the maintenance or operation of equipment employing potentials in excess of 1000 volts requires that these voltages be measured, the equipment shall be provided with test points such that all these high voltages may be measured at potential levels of less than 1000 volts relative to ground. This may be accomplished through the application of voltage dividers or other techniques such as the use of safety type panel meters and multipliers. Full detail as to the method used in the equipment to obtain the voltage at the test points shall be forwarded to the procuring activity for approval. The above voltages shall be construed as applying to d.c., a.c., and d.c. plus a.c. voltages.

3.15.4 Portable test equipment. Where built-in test devices are not provided, the console shall be so designed as to be capable of being calibrated, aligned, maintained and repaired with the aid of portable test equipment selected from table V.

Table V - List of portable test equipment

Item	Type number	Federal stock number
(a) Multimeter	AN/PSM-4 ( )	1/
(b) Multimeter	AN/USM-123	1N6625-684-3082
(c) Oscilloscope	AN/USM-117	F6625-787-0304
(d) Vacuum tube voltmeter	AN/USM-116	F6625-783-6235
(e) Vacuum tube voltmeter	Me-6 ( )/U	1/
(f) Milliammeter, d.c.	Weston Model 901-4903001, or equivalent	N6625-713-8571
(g) Ohmmeter, insulation resistance	AN/PSM-1A	2N6625-284-0265
(h) Temperature bridge	Leeds & Northrup, Model 8064A, or equivalent	2N6625-867-6629
(i) Millivolt potentiometer	Leeds & Northrup, Model 8693, or equivalent	N6685-711-0616
(j) Millivoltmeter, d.c.	G.E. Model DP-11, or equivalent	N6625-713-8572
(k) Decade resistance box	Shallcross type 817B, or equivalent	N6625-893-2212
(l) Hydraulic comparator	Mansfield & Green type T-3A, or equivalent	1H-6685-821-0791
(m) Vacuum gage	Allen Electric & Equipment Co. Model E-345, or equivalent	1H6685-821-0793

1/ Federal stock numbers for test equipment with Military type numbers having more than one model (for example, AN/PSM-4 ( )) are not listed since each model has a different stock number.

3.15.4.1 Selection of test equipment other than listed in table V shall be submitted to the procuring activity with justification as to why the console cannot be designed to use the preferred test equipment, prior to the start of manufacture of the console.

3.15.4.2 When manufacturing release is requested, the supplier shall submit to the procuring activity for approval a list of the test equipment and quantities of each equipment considered necessary for maintenance of the instrumentation and control equipment. This list shall include the complete identification data and description for any special test equipment which is necessary but is not covered by table V.

3.15.4.3 Test equipment required for maintenance of the console, which is not covered by table V, by the Portable Test Equipment List for Electric Plant, or by NAVSHIPS 0969-019-7000, shall be furnished by the supplier with the console.

3.15.5 Technical manual test data. Test data from recommended maintenance tests is to be included in the technical manual and this data shall be taken with the test equipment specified in 3.15.4. The supplier shall provide the test equipment for developing this test data, except when the specific models of such test equipment are not available commercially, in which case, either the necessary test equipment will be made available to the supplier for a limited time, through the Government representative, or the procuring activity will designate a substitute.

3.16 Identification and information plates.

3.16.1 General. Identification and information plates shall be attached by means of screws in tapped holes, screws held by captive nuts, self-tapping screws, or screws held by nuts welded to the opposite side of the panel or chassis. The mounting and location of the plates shall not adversely affect the strength of the item on which the plates are mounted or impair the integrity of the enclosure. Aluminum plates shall be attached by corrosion-resisting screws and not by aluminum screws (see 3.13.50). Plastic information plates shall be mounted by corrosion-resisting screws and shall be gray in color with lettering in black.

3.16.2 Identification plates for consoles and major assemblies. Identification plates shall be metallic and in accordance with types A, B, C or H of MIL-P-15024. The following minimum information shall be provided and may appear on two identification plates, one of which may be the manufacturer's usual identification plate. However, all identification plates shall conform to MIL-P-15024 except for size.

(a) Manufacturer's name and serial No.
(b) Name of unit.
(c) Rating and range of unit.
(d) Prime contract number, as specified in the contract or order.
(e) Federal stock number, if available.
(f) Technical manual number, if available.
(g) Space for inspector's stamp.

3.16.3 Information plates. Information plates shall be in accordance with types A, B, C or H (metallic only) of MIL-P-15024 and shall show the function of each control or indicator on a panel front, including those behind access doors and protective covers and in other locations where they are subject to wear.

3.16.3.1 Miscellaneous information. Where information plates are used to show component names, wiring and schematic diagrams, calibration charts, operating instructions, safety notices, list of tools, and similar information, the plates shall conform to types A, B, C, E, F or H of MIL-P-15024.

3.16.3.2 Warning and caution plates. Information plates showing safety notices or operating instructions which, if not observed, would result in material damage or personal injury, shall have the word "WARNING" or "CAUTION" in double sized letters filled with red paint. The use of warning and caution plates shall be limited to the following conditions:

(a) "Warning" - Where nonobservance would result in personal injury, loss of life or damage to the equipment.
(b) "Caution" - Where nonobservance would result in damage to, or destruction of equipment or inadvertent shutdown of the propulsion plant.

3.16.4 Identification of parts by reference designations. To facilitate maintenance, each part shall be identified by its reference designation as assigned in the schematic diagram (see 3.17.4.2(i)(2)).

3.16.4.1 Reference designations location. Reference designations shall be located adjacent to each part and shall be marked on the chassis, back of front panel, partitions, insulator strips, etc. Designations shall not be marked on parts which are subject to replacement. Designations shall be marked in such a position as to physically locate the parts and still be readily visible for purposes of maintenance without removal of other parts. On those printed wiring boards where space does not permit the reference designations to be printed on the board, the designations shall be located on a surface adjacent to the board, or the information shall be included in chart form in the technical manual.

3.16.4.2 Enclosed parts. Reference designations for parts enclosed in separate and removable shields or compartments may be marked on the shields or supporting structures for such parts, provided that the replacement of such parts does not require destruction of the original shields or supporting structures and provided that such shields or structures are not interchangeable with other shields or structures within the console.

3.16.4.3 Identification of part leads. For each polarized part, such as electrolytic capacitors and rectifiers, the polarity identification shall be marked on the part mounting surface in order to insure proper replacement of the part. For multiple lead parts such as transistors where proper circuit operation is dependent on a specific lead hookup, appropriate lead identification should be marked on the part mounting board to insure proper replacement of the part.

3.16.4.4 Method of marking. Markings shall be permanent and legible. The markings on plastic or metallic materials shall be made by stamping, engraving, stenciling or rubber stamping with smudgeproof ink covered with a coat of clear lacquer, or silk screening. Decalcomanias or paper labels shall not be used.

3.17 Drawings.

3.17.1 General requirements. Drawings shall conform to categories A, B, D, G and H, form 1 of MIL-D-1000 and to type II or III of MIL-D-1000/2 as specified herein, and to the detail requirements specified herein.

3.17.2 Drawing approval. All installation and production drawings and certification data sheets shall require approval by the procuring activity. Any work, including procurement of material or fabrication of any parts, done by the supplier in advance of written approval of production drawings shall be at the supplier's own risk. When drawings are approved subject to specific modifications or comments and no specific limitations are imposed, the supplier may proceed with the manufacture of the console incorporating the modifications or comments, with the understanding that revised drawings shall be submitted as confirmation that the specified modifications or comments actually have been made. After approval has been given, the supplier shall make no changes in drawings to be used in the manufacture of the console without obtaining the approval of the procuring activity.

3.17.3 Drawings to be furnished.

3.17.3.1 Installation drawings. Installation drawings for the consoles, to be installed by the shipbuilder, shall be furnished when required by the individual console specification. Installation drawings shall be type II of MIL-D-1000/2 and in addition shall contain the information specified in 3.17.4.1.

3.17.3.2 Equipment production drawings. Equipment production drawings shall be furnished for all equipment and shall be type II of MIL-D-1000/2. The drawing content shall be as specified in 3.17.4.2.

3.17.3.2.1 Equipment drawings shall not be entitled as to the particular ship project, contract or purchase order.

3.17.3.2.2 For drawing purposes, the equipment may be divided as follows:

(a) When several control or instrument assemblies are mounted in a single console, separate drawings may be prepared for each control or instrument assembly and for the console.
(b) When a console or drawer contains multiple use assemblies, separate drawings may be prepared to cover the assemblies.
(c) When control or instrument equipment consists of two or more assemblies which are installed in different locations and these assemblies are likely to have repeated applications apart from the original equipment with which used, separate drawings may be prepared to cover one or more of the assemblies.

3.17.3.2.3 All information required in 3.17.4.2 shall be shown on one drawing, whenever practical. When this is not practical, information may be shown on three drawings as follows:

(a) An assembly drawing showing all the information specified in 3.17.4.2(a) through 3.17.4.2(h). (Reference shall be made on this drawing to the drawings of 3.17.3.2.3(b) and (c)).
(b) A schematic diagram, for electrical, hydraulic, pneumatic, or mechanical equipment, as applicable, showing all the information specified in 3.17.4.2(i). (Reference shall be made on this drawing to the drawings of 3.17.3.2.3(a) and (c)).
(c) A wiring diagram showing all the information specified in 3.17.4.2(j). (Reference shall be made on this drawing to the drawings of 3.17.3.2.3(a) and (b)).

3.17.3.2.4 If the drawings furnished under 3.17.3.2.2 are such that a complete control or instrument equipment schematic is not provided, a single overall schematic diagram for each control or instrument equipment shall be provided. Parts may be shown in phantom on one of the schematics to complete the control or instrument equipment in order to meet this requirement. A system schematic diagram shall be furnished even though partial schematics are furnished.

3.17.3.2.5 The schematic diagram of a console shall show the console wiring or piping schematically, including the schematic representation of the electrical parts which are considered to be part of the console (such as line filters) and the connectors or terminal boards of the control or instrument assemblies. The connection wiring diagram of consoles shall show the console wiring including parts which are considered to be part of the console and the connectors or terminal boards of the control or instrument assemblies.

3.17.3.2.6 If only one sheet is required to show all of the information specified in 3.17.4.2(a) through 3.17.4.2(j), drawings shall be size A, B, C, D, F or H as specified in MIL-STD-100. If separate assembly, schematic and wiring diagram drawings are provided to show the information specified in 3.17.3.2.3, drawings shall be size D, F or H as specified in MIL-STD-100. Size H sheets shall be limited to a maximum of 144 inches, except for schematic diagrams which are required to be on a single sheet. Multi-sheet drawings shall only be size H sheets. When multi-sheet drawings are provided, each sheet shall show the same drawing number, the sheet number, and the total number of sheets. All size B and larger drawings shall be zoned. Zone widths shall be as specified in MIL-STD-100.

3.17.3.2.7 Production drawings shall be prepared such that the clarity, legibility and arrangements will be suitable for micro-filming as specified in MIL-D-1000/2 and may be satisfactorily reduced in size to about 11 inches in height for insertion in technical manuals.

3.17.3.2.8 Revised drawings. Revisions to drawings shall be accomplished as specified in MIL-STD-100.

3.17.3.3 Certification data sheets. Certification data sheets shall be furnished on each contract or order. The data sheets shall be type III in accordance with MIL-D-1000/2.

3.17.3.4 Block diagrams. A functional block diagram shall be furnished for control equipment and instrument sets (see 6.5.6) when specified in the individual console specification. Block diagrams shall be type II in accordance with MIL-D-1000/2 and the contents shall be as specified in the individual console specification.

3.17.3.5 Logic diagram. A basic or detail logic diagram using distinctive shape symbols as defined in MIL-STD-806 shall be provided when specified in the individual console specification. Logic diagrams shall be in accordance with MIL-STD-100 and the contents shall be as specified in the individual console specification.

3.17.4 Drawing contents.

3.17.4.1 Installation drawings. Installation drawings shall show the following information as applicable:

(a) Front and plan views plus sufficient additional views showing the overall and principal dimensions in sufficient detail to establish the limits of space in all directions required for installation, operation and servicing, not counting the space required for personnel. The amount of clearance required to permit the opening of doors and any other operations necessary to obtain access to the equipment shall be included. Also, the amount of clearance for the withdrawal or removal of parts or assemblies, cable access and ventilation shall be included.
(b) Equipment breakdown to the smallest dimensions necessary for permitting entrance through access hatches or doors.
(c) Information necessary for preparation of foundation plans, including mounting plate details and drilling plans, showing dimensions and tolerances, and any information as to optional mounting methods. For all equipments weighing in excess of 200 pounds, the center of gravity shall be shown.
(d) Uncrated weight of each separately mounted equipment. Estimated crated weight, overall dimensions and cubical contents of each equipment. If furnished, the numbers, weight and overall dimensions of both crated and uncrated repair boxes.
(e) Location, type and dimensions of cable entrances, access plates, holes, and terminal tubes with any optional entrance indicated. Location, type, and dimensions of internal terminal blocks, boards or electrical connectors to which external (ship's) cables are connected.
(f) Special instructions, if any, for hoisting, alignment, initial lubrication, preservation, painting, installation, or assembly as necessary.
(g) A list of reference drawings.
(h) Maximum heat dissipation.
(i) Installation drawings shall contain the nominal frequency and voltage and maximum input power consumption requirements of the console.

3.17.4.2 Equipment production drawings. Equipment production drawings shall include the following minimum information as applicable:

(a) Equipment descriptive data:
(1) Degree of enclosure (see 3.9.3).
(2) Design ambient temperatures outside and inside enclosures or consoles.
(3) Vibration and shock classification.
(4) Range or ratings, including accuracies, as applicable.
(5) Maximum heat dissipation.
(6) Power requirements, including voltages, phase, frequency, watts or volt-amperes, power factor, allowable variations in frequency and voltage.
(7) Mounting.

(b) A list of reference drawings.

(c) A note that the equipment is built in accordance with the individual console specification, listing same, or this specification if there is no individual console specification. A list of the exceptions to this specification and referenced specifications shall be included.

(d) A list of parts and material presenting the following data in tabular form. This list of parts and material shall be on the same sheet as the assembly views required in 3.17.4.2(g). All parts and material shall be shown (for example, wire, lacing cord, terminal lugs, wire markers, bolts, screws and solder.)
(1) Piece number.
(2) Name of part or material (for example, transformer, diode, solder, and other similar parts).
(3) Reference designation for parts as assigned in the schematic diagram of 3.17.4.2(i)(2) (for example, diode CR-1, resistor R-2, transistor Q-5, and other similar designations).
(4) Quantity of each part required per assembly.
(5) Military or Federal specification number or NAVSEC drawing number, if any.
(6) Material or type, class, grade, size, Military part number or other classification of any referenced specification.
(7) Part number and drawing number assigned by supplier, if any.
(8) Name of manufacturer of part.
(9) Part number or identification assigned by part manufacturer.
(10) Rating of part from Military specification or from part manufacturer's catalog if not covered in the Military specification (for example, resistor 10 ohm 25 watt; diode - 200 PRV, 750 milliamps and similar ratings).
(11) Remarks column.

(e) A table of revisions in accordance with MIL-STD-100.

(f) Complete identification of first article inspection reports.

(g) Plan, elevation and section assembly views as required to show clearly the details of the mechanical design, construction and assembly of the equipment and to identify each part and its location. All parts shall be identified by their piece numbers or by their schematic reference designations, as shown in the lists of materials. The following minimum data shall be included on the assembly views:
(1) Overall dimensions, mounting dimensions, and size of mounting holes.
(2) Weight of complete assembly.
(3) A front view showing all visible parts and markings and drawn to scale.
(4) A full scale view of each indicator face.
(5) Markings on all identification and information plates and indicator light lenses.
(6) The location and method of marking of reference designations and polarity identification of parts (see 3.16.4).
(7) Sectional views or notes as necessary to show or explain special mounting provisions or installation procedures required for the proper operation of the parts.
(8) Flexible wire bundle arrangement and construction details for each separate assembly (wire bundle between hinged panel and console, console chassis and console).

(h) Part information and application data required. Information on parts and subassemblies shall include the data specified below. The data required shall be presented in tabular form whenever practical. Each part shall be identified by its reference designation. Application data required are actual circuit values as used in the equipment. Where equipment includes multiple-use subassemblies, such as plug-in modules or part mounting boards, with different circuit conditions for different applications, the application data required shall be presented for each application.

(1) Transformer, reactor and inductor data:
a. Core data:
1. Lamination form - EI, toroid, etc.
2. Lamination material and gage.
3. Stack and interleave dimensions.
4. Construction - open, tape wound, cut core, and other construction.
5. Core box, if any.
6. Ground insulation.
b. Winding data:
1. Insulation class - class 130, 180, etc.
2. Winding identification - same terminal designation as given in schematic and connection diagrams.
3. Wire size and insulation type, for example, AWG 10, type B2, etc.
4. Number of turns and taps.
5. Nominal voltage between terminals.
6. D.c. resistance at 25°C. between terminals.
7. Material of insulation used between winding layers and between windings.
c. Varnish impregnation:
1. Varnish type and specification.
2. Varnish manufacturer and material identification.
3. Impregnation procedure - preheating temperature and time, number of dips and bakes, temperature and time of bakes, etc.
d. Volt-ampere ratings for potential transformers and current ratios for current transformers.
e. Details of miscellaneous items, such as terminal boards, grommets, leads, etc.
f. The above data in a. through e. may be submitted, if desired, on a separate drawing showing various construction methods used by the manufacturer. The production drawing may then refer to the applicable details on this separate drawing.

(2) Semiconductor device data. Semiconductor data shall include the rating and complete identification for ordering from original supplier (JEDEC number is adequate), and the following:
a. Rectifiers using silicon diodes:
1. Circuit symbol and piece number.
2. Maximum reverse voltage peak and r.m.s. (complete rectifier circuit).
3. Maximum load current d.c. amperes (complete circuit).
4. Maximum diode case temperature at design ambient (use for diodes rated against case temperature).
5. Maximum ambient temperature directly adjacent to diodes (use for diodes rated against ambient temperature - no cooling plates).
6. Cooling plate size, thickness and material, where so mounted.
7. Duty cycle.
8. Description of insulation hardware if insulated from a cooling plate.
b. Voltage regulator diodes:
1. Circuit symbol and piece number.
2. Range of actual voltage levels which circuit will accept (with or without circuit adjustment) from regulator diodes and still give required equipment performance.
3. Regulation (including temperature error) permitted in an installed regulator diode under all conditions of operation (assume equipment is initially adjusted for optimum performance).
4. Maximum level of steady-state average reverse current through regulator diode (steady-state shall be considered any time in excess of 30 seconds).
5. Maximum transient reverse current under any operating condition.
6. Maximum ambient temperature at diode (no cooling plate).
7. Maximum case temperature of diode (use for diodes rated against case temperature).
8. Cooling plate size, thickness and material, where used.
9. Duty cycle.
10. Description of insulation hardware if insulated from a cooling plate.
c. Voltage reference diodes (see regulator diodes also):
1. Circuit symbol and piece number.

2. Range of reference voltage levels which circuit will accept (with or without circuit adjustment) from the voltage reference diodes.
3. Error permitted in an installed voltage reference diode under all conditions of operation.
4. Circuit design current through voltage reference.
   a. Nominal or average value.
   b. Regulation about nominal value.
5. Maximum ambient temperature (include internal heat rise above outside design ambient).
6. Duty cycle.

d. Transistors:
1. Circuit symbol and piece number.
2. Maximum collector to emitter voltage.
3. Maximum collector to base voltage.
4. Maximum collector current.
5. Maximum base current.
6. Maximum collector power dissipation.
7. Maximum ambient temperature (include internal heat rise at transistor at 50°C., design ambient).
8. Maximum case temperature of transistor at 50°C., equipment design ambient and any condition of required equipment operation (where rating is based on case temperature).
9. Cooling plate size, thickness and material, where so mounted.
10. Description of insulating hardware if insulated from a cooling plate.
11. Duty cycle.

e. Silicon controlled rectifiers:
1. Circuit symbol and piece number.
2. Nominal working peak forward and reverse voltages.
3. Repetitive peak forward and reverse voltages (maximum).
4. Nonrepetitive peak forward and reverse voltages (maximum).
5. False firing, or self-firing, restrictions.
6. Repetitive peak forward current (nominal and maximum values).
7. Surge current (peak for nonrepetitive value occurring within the conduction portion of a single cycle but after turn-on has occurred, effective amplitude and cycles duration for multi-cycle surges, or amplitude and duration for sub-cycle pulse duration).
8. Peak current and maximum rate of current rise during turn-on.
9. Minimum time from the instant of voltage reversal to the instant when voltage is reapplied in the forward direction.
10. Peak forward gate current (minimum and maximum, per device).
11. Peak forward gate voltage (minimum and maximum, per device).
12. Peak reverse gate voltage (maximum, per device).
13. Maximum gate power dissipation (average and peak, per device).
14. Maximum device case temperature at design ambient.
15. Cooling plate size, thickness and material, where so mounted.
16. Insulation hardware if insulated from a cooling plate.

f. Selenium surge suppressors:
1. Identify the suppressor manufacturer's technical data bulletin applicable to each product certified for the application. For each application indicate which product is installed in the equipment and which is the alternate product that may be used for replacement purposes.
2. Provide the following product rating data:
   a. Stack r.m.s. voltage (steady-state).
   b. Stack clamping voltages (new and aged).
   c. Peak discharge current (corresponding to clamping voltage).
   d. Polarization (polarized or nonpolarized).
   e. Maximum energy (watt-seconds) at rated clamping voltage (aged) for single pulse (nonrepetitive) current.
   f. Maximum pulse duration (micro-seconds) for repetitive pulses at supply frequency (specify Hertz) and amplitude equal to clamping voltage (aged).
   g. Maximum ambient temperature at which rated values in 2.a. through 2.e. apply.
   h. Maximum operating temperature.

g. Integrated circuits:
1. The manufacturer and manufacturer's type number shall be given.

2. The function of the circuit shall be given along with a diagram illustrating the relationship of the output to the input.
3. Maximum allowed currents and voltages shall be given for each terminal, as applicable.
4. Maximum applied currents and voltages shall be given for each terminal, as applicable.
5. Maximum allowed and applied power dissipation.
6. Maximum ambient temperature.
7. Maximum case temperature at 65°C., equipment design ambient, at worst case operating conditions.

(3) Resistor data. Resistor data including the type, resistance and wattage ratings, operating temperature and standard Military type number (if applicable), actual power dissipated at design operating temperature.

(4) Capacitor data. Capacitor data including the type, capacitance, voltage rating, maximum applied d.c. and a.c. voltage and frequency values (include transient), and standard Military type number (if applicable).

(5) Switch data. Switch data including the type of switch, contact arrangement, number of poles, number of positions, and voltage and current ratings of contacts, and type of handle.

(6) Magnetic amplifier data:
a. Ratings of each amplifier (overall, not each stage) including the supply voltage, frequency, number of phases, load resistance, output currents, control current, volt amperes output, and ambient temperature.
b. The d.c. resistance of each magnetic amplifier and saturable reactor control circuit at a specified temperature. If the circuit contains adjustable resistors, the nominal value and maximum and minimum values shall be given.

(7) Relay data:
a. Rating data including the coil voltage, frequency, current and power, and the contact voltage and current rating.
b. Duty.
c. Ambient temperature.
d. Endurance category, as defined in MIL-R-19523.
e. Shock classification, as defined in MIL-R-19523.
f. Number of normally open and normally closed contacts.
g. Coil winding data, including the number of turns, taps, wire size and type, insulation, method of impregnation and treatment, and d.c. resistance at a specified temperature.
h. Any special features required such as specific pickup and drop-out voltages or time delay.

(8) Meter data. Meter data including type, voltage or current rating, resistance, and calibration (voltage or current values for the major divisions).

(i) An electrical, mechanical, hydraulic, or pneumatic schematic diagram, as applicable, and as defined in MIL-STD-100, on a single sheet to clearly represent the operation of the equipment. Circuit operation shall be described by notes. Arrows with accentuated lines indicating the flow path of electrical signals or sequential flow of fluids shall be used to clarify the operation of the equipment. In electrical schematic diagrams, conventional current, as opposed to electron flow, shall be used in all descriptions of operations and when arrows are used on signal lines, they shall indicate conventional current. Hydraulic and pneumatic schematic diagrams shall include all interconnections, piping sizes and materials, types and sizes of fittings, flow, working pressures, volumes and relief valve settings.

(1) The boundaries of each assembly or subassembly which is intended for for multiple use shall be represented by a thin broken line. All the terminals with their numbers and markings shall be shown. External connection terminals shall indicate also the type of power, ground and signal as appropriate. All spare terminals shall be shown and so marked.

(2) All parts, such as relays, capacitors, resistors, diodes, transistors, valves, shall be given a reference designation consisting of a letter(s) denoting the type of part, as required by ANSI Y32.16 for electrical parts and ISA S5.1 for mechanical parts, and a number assigned consecutively. (Where an assembly is intended for multiple use, the reference designation need not be changed.) These numbers shall be assigned in a logical sequence of the current or signal flow through the circuit. Where reference designations do not exist for a part, they shall be listed on the drawing and defined.

(3) The physical location of parts in the equipment shall not influence the location of the parts in the schematic diagram, which shall be such that the signal flow through the circuit is generally from left to right. Relay coils and contacts, individual terminals of terminal boards or connectors and switch sections may be shown in separate locations for clarity. The basic part reference designation shall be retained, however.

(4) If an assembly or subassembly appears several times on a schematic, its schematic diagram need not be repeated each time. The schematic diagram can be shown for one of the assemblies or subassemblies and blocks with terminals shown and marked can be used for other identical assemblies. This simplification shall be used only if the blocks reference the location of the schematic and the operation of the equipment can be readily followed.

(5) Matched subassemblies and selected or matched parts shall be identified as such.

(6) Relay contacts shall be shown in the relay deenergized position and a note to that effect shall be included on the drawing.

(7) A contactor and relay table showing:
- a. Location, by zone in the schematic diagram, of the coil and each set of contacts.
- b. Position of each set of contacts when coil is deenergized.
- c. Conditions under which each coil is energized and deenergized.
- d. Reference designations.

(8) Operating characteristics shall be represented by graphical operational symbols and located adjacent to each demodulator, detector, saturable reactor amplifier, linear and bistable amplifiers. Operational symbols shall show qualitatively the relation between input variable and output variables. All variables shall be defined as to the parameter such as current, voltage, frequency, temperature, pressure, flow, and polarity or direction of change.

(9) All transformer terminal voltages and supply voltages shall be indicated.

(10) A switch table showing:
- a. Location, by zone in the schematic diagram, of each set of contacts.
- b. Condition of each contact for each switch position.
- c. Designation of make-before-break contact.
- d. Conditions under which each position is used, if not explained by title.
- e. Title of each switch position.
- f. Location of stops, if used.
- g. Spring return, if used.
- h. Integral jumpers or connectors, if used.
- i. Name and reference designation.

(11) Winding polarities shall be indicated for transformers and saturable reactors. Polarity markings shall be in accordance with ANSI Y32.2. A note shall be included on the drawing describing the markings.

(12) All windings, including unused windings, of reactors and transformers shall be shown and shall be located together in such a manner that the operation is readily apparent. The function of each reactor winding shall be shown.

(13) The following information shall be noted adjacent to the following parts in addition to the reference designation. When the majority of the capacitors or resistors are of the same tolerance, power rating or voltage rating, these ratings and tolerances may be indicated by a note and a statement that any exceptions are indicated adjacent to the part. When numerical values are given, a note shall designate the units used.
- a. Capacitors - Capacitance, voltage rating and tolerance. If variable, the effect on capacitance of clockwise rotation of the control shaft.
- b. Controls, adjustments and test points - The assigned name.
- c. Fuses - Type designation.
- d. Indicator lights - Assigned name, lens color, voltage rating, lamp type.
- e. Inductors - Inductance and d.c. resistance. If variable, the effect on inductance of clockwise rotation of the control shaft.
- f. Meters - Assigned name, scale (for example, 0-300 degrees), voltage or current rating and internal resistance.
- g. Resistors - Resistance, power rating and tolerance. If variable, an arrow to indicate clockwise rotation of the control shaft.
- h. Semiconductor devices - Type number.

(14) The following requirements apply to integrated circuits shown on schematic diagrams:

a. Integrated circuits shall be depicted as logical functions, linear or digital, by distinctive shape logic symbols in accordance with MIL-STD-806. All information required for detail logic diagrams by MIL-STD-806 shall be included. A combination or truth table for each type of digital logic element shall be shown below the diagram along with the voltage corresponding to each state. Operational symbols in accordance with 3.17.4.2(i)(8) shall be shown adjacent to each integrated circuit. The input-output voltage values shall be shown on the symbol.

b. The assigned name of all input signals (i.e. bias, control, etc.) and output signals shall be identified adjacent to the diagram. In addition, the integrated circuit shall be identified by circuit designation, manufacturer's type number and functional assigned name, (i.e. shift register, counter, operational amplifier, etc.). The simplified schematic of the device as depicted on the semiconductor manufacturer's data sheet shall not be incorporated on the equipment schematic.

(j) A wiring connection diagram which includes the following information:

(1) Reference designation of parts shall conform to those assigned in the schematic diagram.

(2) Wire marking and color code of all wires. Appropriate notes shall designate wire size and type.

(3) All parts in correct relation to physical location. Terminals shall be clearly shown and marked and all wiring between parts shown. The exact wiring paths and all connections shall be shown. The schematic interior of parts may be used as long as the connection points are in their proper physical position for each part involved.

3.17.4.3 Additional data. Such additional data shall be included on drawings as may be required by specifications referenced herein or in the individual console specification. Such additional information not required herein shall be furnished as necessary to adequately describe equipment with special features or characteristics.

3.18 Technical manuals. Technical manuals shall conform to type III of MIL-M-15071 and to the additional requirements and modifications specified herein.

3.18.1 Forms. The technical manuals shall be submitted for approval to the procuring activity in three forms: Preliminary, interim and final. In addition, revision sheets will be required for changes as specified in 3.18.3.

(a) Preliminary manual:

(1) The preliminary manual provides the means for the procuring activity's review for completeness, technical adequacy, accuracy, and compliance with applicable specifications and standards. The preliminary manual completes the design information on the console to which it applies since it provides information on the functional design which is impossible or difficult to determine from the drawings. Detailed information covering alignment procedures, troubleshooting, and maintenance shall be included in the preliminary manual.

(2) The preliminary manual shall be loose leaf bound with a hardback 3 hole binder for each volume. This binding is to be furnished with the submittal of the first chapter or section and shall be sized to hold all future manual submittals.

(3) The preliminary manual shall include in draft or final form all of the required artwork. All sketches and details shall be shown except for production drawings and photographs of completed equipment. The preliminary manual shall include a page in the proper place for each production drawing and photograph to be included. The page shall give the title of the drawing or photograph, the proper figure identification and a descriptive sentence that will make clear what is to be shown in the drawing or photograph.

(b) Interim manual:

(1) The interim manual provides the means for the procuring activity's review to determine that the supplier has complied with the procuring activity's comments on the preliminary manual. It is also an interim manual in the true sense of the word in that it will remain the only manual in effect for the use of the personnel to whom the supplier may deliver the console until the final manual is available.

(2) The interim manual is to be produced by typing (full page width, not double column). The interim manual shall be bound in a hardback 3 hole binder with screw type binding posts to facilitate the addition of insert sheets.

(3) The interim manual shall be complete with all artwork including reduced size production drawings and photographs. The reduced size production drawings are to be produced by photographic means.

(c) Final manual. The final manual shall not be released for printing until after the first console has been placed in service. It will thus be possible to have incorporated into it all changes found to be necessary as the result of actual operating experience onboard ship. It will also be possible to incorporate all changes which have been made to the equipment because of of changed requirements.

3.18.2 Schedule. The schedule for technical manual submittals shall be specified in the individual console specification. These submittals shall be keyed to the breadboard test reports, the submittal of the production drawings, and the first article inspection of the lead console.

(a) Preliminary manual:

(1) Advance copies of chapters or sections covering "Principles of Operation" and "Alignment Procedures", including sketches and drawings pertinent to these chapters or sections, but excluding the production drawings, shall be submitted with the breadboard test reports for information.

(2) The complete chapter of the preliminary manual associated with a particular instrument, detector or other equipment, shall be submitted for approval with the production drawings of the equipment.

(3) Since the alignment procedures of the preliminary manual must be complete in all details at the time of submittal, it is expected that the supplier, after having built a complete breadboard of the instruments of a new design, will have thoroughly tested and evaluated not only the instrument design but the practicality and validity of the alignment procedures.

(4) Chapters or sections of the manual which pertain to general theory of operation of common parts, such as amplifiers and d.c. regulators, shall be submitted prior to the submittal of the last production drawing.

(5) Chapters or sections pertaining to the overall console or cabinet assembly shall be submitted with the production drawings pertaining to the console or cabinet assemblies.

(6) The "Front Matter" described in MIL-M-15071 shall be submitted sixty days after submittal of the last production drawing.

(7) The supplier should note that the submittal of instrument technical manuals practically concurrent with instrument design is regarded as being essential not only to guarantee the timely availability of technical manuals to the ship construction program, but also to promote a more complete evaluation of the instrument design by the supplier. Review and approval of instrument designs shall be contingent upon receipt of acceptable technical manual sections.

(b) Interim manual:

(1) The supplier shall make all corrections to the preliminary manual that result from the procuring activity's review in order that a draft of the interim manual will be available for checking during the first article and quality conformance inspection of the lead console.

(2) The interim manual shall be submitted for approval thirty days following completion of the lead console first article inspection.

(3) Approval of the interim manual for final printing will be granted following successful in-service operation of the first console.

(c) Final manual:

(1) The final manual shall include all changes that have been made to the interim manual plus any changes identified prior to printing release which have been made to the console.

(2) Printing release of the final manual shall be as noted in 3.18.2(b)(3).

3.18.3 Changes. Changes shall conform to type III of MIL-M-15071 and to the following additional requirements:

(a) Following the submittal of each chapter of the preliminary manual, the supplier may determine that changes to the original instrument design are necessary. When such changes are made by the supplier, he shall submit the revised affected production drawings together with all necessary revised pages to the affected chapter of the preliminary manual.

(b) An errata sheet may be provided to define changes that involve only a number value of a parameter (for example: the change in resistance value of a resistor) or in wire marker numbers, component numbers, etc.

(c) The interim manual shall include all revisions to the preliminary manual that are necessary as a result of the following:
(1) Supplier initiated changes.
(2) Procuring activity initiated changes.
(3) Procuring activity comments on the preliminary manual sections.
(4) Changes found to be necessary during lead console first article inspection.

(d) Following the delivery of the interim manual and of the first console, changes to the console may become necessary either as a result of problems identified during installation and operation of the first console, or as a result of procuring activity desired changes in console requirements. Whether the change is supplier responsibility or procuring activity responsibility, the supplier must furnish the following:
(1) Revised prodcution drawings.
(2) Revised pages for the interim manual if it is affected (errata sheets for changes described in 3.18.3(b) may be used).

(e) Revised reduced size prints for the interim manual, or instructions for marking existing reduced prints, shall be furnished with each change. The magnitude of the drawing change shall determine which method shall be used to revise the interim manual. The procuring activity will inform the supplier at the time a change is identified which method shall be used.

(f) After the printing of the final manual, some changes may become necessary. If changes are necessary, the supplier shall furnish all of the items listed in 3.18.3(d). This includes reproduced typed pages of corrections to the final manual for procuring activity review prior to release for printing. In addition, the supplier shall furnish printed insert sheets and reduced sized drawings for the final manuals to replace pages that have been changed.

3.18.4 Contents. Technical manual contents shall conform to type III of MIL-M-15071 and to the following additional requirements:

(a) Description. In addition to conforming with MIL-M-15071, this section shall include photographs of the overall equipment and sensors.

(b) Principles of operation. This section shall include a detailed analysis of the principles of operation of the equipment schematic diagram. The role played by each part, module, and sensor shall be fully explained. Paragraphs shall be included to explain the general principles, application and method of adjustment of parts, sensors and remote equipment. This section shall be supplemented with block diagrams and simplified schematics.

(c) Installation. In addition to the requirements of MIL-M-15071, this section shall include an alignment procedures section. The following minimum information shall be included:
(1) List of test equipment.
(2) Pre-operational check. This section shall describe the procedure for checking equipment and incoming power prior to alignment of the equipment.
(3) Instrument alignment (using actual sensors). This section shall include the initial alignment procedures for the overall equipment to be used onboard ship after initial installation, major overhaul, normal preventive maintenance, if abnormal operation is suspected, and major component replacement.
(4) Instrument alignment (using built-in test devices). This section shall include step-by-step procedures for completely aligning the equipment when access to the sensors is not possible. Procedures shall include a check to determine if alignment is satisfactory. A table "Calibrate built-in test device versus local meter" shall be included.
(5) Instrument alignment check (using sensors). The step-by-step alignment check procedure shall be included to determine that the equipment is correctly aligned. Data shall be recorded when the equipment is first aligned or realigned using the sensors. The instrument alignment check procedure is to be used when:
a. The sensor becomes accessible after an alignment with the test device.
b. Instrument accuracy is not within that specified in the trip point and calibration test.
c. As specified.

The alignment check procedure shall include a table(s) containing increasing and decreasing parameters versus local and remote meter readings. Local and remote meter readings of bistable trips shall be included in a separate table. Alignment checks of bistables are to be made using the test device. Alignment check tolerances to be used as a basis for judging equipment performance shall be recommended by the supplier and approved by the procuring activity.

(6) Calibration of test device. This procedure is to be performed immediately after an alignment and alignment check has been completed. The test device settings are to be used when performing the trip point and calibration test or instrument alignment when the sensors are not accessible. Recording the test device settings shall follow alignment with the sensors. Include a step-by-step procedure for duplicating local meter calibration (alignment check) values with the test device. All remote meter readings are to be recorded. Duplication of bistable trips (alignment check values) using the test device shall be performed. Remote meter value shall be recorded.

(7) Trip point and calibration test (instrument periodic check using built-in test devices). This section shall include the step-by-step procedures for determining the calibration condition of the equipment. Tables shall be included to list the sensor amplifier, bistable and meter calibration check points. Maintenance personnel will be required to fill in the test device settings at the check points. This procedure is to be used when:

a. Performing the preventive maintenance procedures.
b. It is suspected that the instrument is not functioning properly, or within the necessary accuracy.
c. As specified.

The trip point and calibration test shall include procedures for checking the instrument's local and remote indications against the test device settings. The trip test point and calibration test tolerances to be used as a basis for judging instrument performance shall be recommended by the supplier and approved by the procuring activity.

(d) Troubleshooting. The troubleshooting section shall conform to MIL-M-15071. The test equipment needed for troubleshooting shall be tabulated in the beginning of the section.

(e) Maintenance and repair. In addition to the requirements of MIL-M-15071, this section shall list the test equipment needed to perform preventive and corrective maintenance.

(f) Parts list. The parts list section of the technical manual shall include:

(1) All circuit elements, including those in potted assemblies.
(2) All mechanical parts having maintenance significance.
(3) Mechanical parts having no maintenance significance but which are referred to frequently in the text.
(4) Contents. The parts list shall contain the following subdivisions:

a. Introduction. The introduction shall contain instructions to explain the following:

1. Any symbols used for the parts tabulation. All cross index systems employed.
2. Titles or other markings intended to segregate different models.
3. Other information as may be required to facilitate rapid and accurate use of the parts list.

b. Parts tabulation. The parts tabulation shall contain the following information. Parts shall be listed in an intelligible sequence, such as by spatial or functioning groups and by alphabetical or numberical sequence within groups.

1. Figure number. This shall denote the illustration number wherein the physical location of the part has been shown.
2. Reference designation, or piece number (index number) if no reference designation has been assigned to the part. Reference designations shall be assigned to mechanical parts only where necessary for clarity or consistency in the text or illustrations.
3. Name of part and brief description including electrical characteristics and ratings, Military type number, actual manufacturer's name, and actual manufacturer's part number. Mechanical parts having no maintenance significance shall be identified by the phrase "For reference only" in lieu of a description.

4. Function. The function shall consist of a brief statement of use, purpose, or function of the part in the equipment. This shall be so written as to assist in locating the part in the equipment.

c. Special tools. A separate table shall be provided listing all special tools furnished with the equipment. The information provided shall include quantity, unit of issue (each, pair, set, etc.), brief description, and actual manufacturer's name and identification number.

(g) Drawings. All equipment schematic, assembly and wiring master plan drawings shall be included in this section.

3.18.5 Certification of the technical correctness of the technical manual by the supplier's project engineer shall accompany the preliminary technical manual when submitted to the procuring activity for approval.

3.18.6 Technical manual requirements for integrated circuits. Since the principles of operations are developed by explaining the equipment schematic, discussion of integrated circuit devices should be primarily based upon their use in the overall circuit. The functional input-output relationship of the device should be fully explained. In addition, the application in which the component is used should be analyzed. For example, if an integrated circuit is employed as a shift register, a detailed explanation of a shift register should be given. Typical schematics and combination or truth tables for each type SIC shall be included in the technical manual. Descriptive material such as logic diagrams, operational diagrams, or combination tables should be used as applicable to supplement the discussion.

3.19 Repair parts. Repair parts required for the maintenance of the console shall be supplied as onboard repair parts when specified by the procuring activity. Onboard repair parts lists and cataloging information shall be furnished in accordance with MIL-P-15137 (see 6.4). Nomenclature of parts shall be in accordance with Handbook H6-2. Onboard repair parts, when specified by the procuring activity, shall be furnished for each console using table VI as a general guide. (This table is not necessarily all inclusive or restrictive in any way.)

Table VI - Onboard repair parts per ship.

Item	Notes	To determine the quantity of onboard repair parts to be furnished per ship, multiply the quantity of identical installed replaceable parts times the assigned multiplying factor and round the product to the nearest whole number. For numbers less than one, furnish one item.
		Multiplying factor
Blowers		.10
Capacitors, fixed:		
Ceramic and plastic		.20
Glass		.10
Mica and paper		.20
Tantalum		.15
Capacitors, variable:		
Ceramic		.20
Air		.10
Circuit breakers		.10
Clamps (for plug-in parts)		.10
Coils (contactors and solenoids)		.10
Connectors, plugs and receptacles		.05
Contacts, sets (contactors)		.15
Filters, air:		
Reusable		.10
Nonreusable		1.00
Filters, electrical		.20
Fuseholders, each size and type		.10
Fuses, each size and type		.50
Heaters		.10
Indicators		.05
Inductors:		
Up to 150VA		.10
150VA and above		.05

Table VI - Onboard repair parts per ship (cont'd.).

Item	Notes	To determine the quantity of onboard repair parts to be furnished per ship, multiply the quantity of identical installed replaceable parts times the assigned multiplying factor and round the product to the nearest whole number. For numbers less than one, furnish one item.
		Multiplying factor
Interlocks, electrical		.10
Jacks, tip		.10
Lamps		2.00
Lens, indicator light	1	.10
Lights, indicator		.05
Meters, indicating		.05
Motors (1/4 h.p. and less)		.10
Reactors, saturable up to 150VA		.10
150VA and above		.05
Relays		.10
Resistors:		
Fixed and variable		.10
Thermal and voltage sensitive		.15
Rheostats		.15
Semiconductors		.15
Servo motors		.10
Shunts, indicating meter		.05
Sockets (for plug-in parts)		.05
Subassemblies:		
Category 1	2,3	
Category 2	2	.15
Switches		.15
Synchros		.10
Terminal boards		.10
Transducers		.05
Transformers		
Power frequency (up to 150VA)		.10
Power frequency (150 and above)		.05
Bearing or bearing lining sets		.10
Bearing lubricant seals, sets		.15
Brushes, sets		.15
Brush holders, sets (with springs)		.10
Gages, pressure		.05
Gears	4	.05
Hardware, special (nuts, bolts, screws, etc.)		.10
Packing, preformed (such as "O" rings)		2.00
Springs, sets		.10

NOTES:

1. Indicator light lenses shall be furnished without engraving.
2. The subassembly categories are defined as follows:

   a. Category 1 - A subassembly which is replaceable but not readily repairable in place and which contains parts which are replaceable and which are required to be supported by repair parts. (The parts of the repair subassemblies shall not be considered in fulfilling the requirements for the individual repair parts.)
   b. Category 2 - A subassembly which is replaceable but not repairable and which contains parts which would be required to be supported by repair parts if they were replaceable.

3. The quantities of category 1 subassemblies shall be determined by the procuring activity upon receipt of the provisioning list.
4. If any gear is not readily removable from its shaft, the shaft shall also be furnished as a repair part.

3.19.1 Quantity of items in category 1 subassemblies (see note 2 of table VI) shall be determined by the procuring activity by the procedures outlined in MIL-P-15137. In the event that the console includes wearing or expendable parts not covered by table VI, the supplier shall recommend additional onboard repair parts in accordance with the procedure outlined in MIL-P-15137, except that items of standard hardware, in the Federal Supply Catalog, shall be omitted.

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

4. QUALITY ASSURANCE PROVISIONS

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

4.1.1 Quality program. The supplier shall provide and maintain a quality program acceptable to the Government for supplies and services covered by this specification. The quality program shall be in accordance with MIL-Q-9858 (see 6.4).

4.1.2 Tests, test equipment and test procedures. The proposed tests, test equipment, and test procedures shall be submitted by the supplier to the procuring activity for approval prior to setting up test equipment for first article and quality conformance inspection.

4.1.3 The console manufacturer shall prepare the detailed test procedures for each test specified in the individual console specification. To reduce testing costs, tests may be combined where this can be done without one test obscuring the results of the other tests. For example, the operating test may be combined with the warm-up test. It shall be clearly stated in the test procedure when tests are combined. The console supplier shall prepare detailed test procedures for tests required to assure proper operation of a system where system performance depends upon the compatible operation of equipment supplied by several different equipment manufacturers. The detailed test procedures shall state where the tests will be conducted, the sequence in which they will be conducted, test equipment requirements and detailed step by step method of test.

4.1.4 No adjustment, alignment or realignment of equipment shall be permitted during and after any environmental tests. No repairs shall be permitted after exposure of equipment to extreme ambient conditions before making the required measurements. No alignment, realignment, adjustments, or repairs shall be accomplished prior to completion of all tests unless approved by the procuring activity or as otherwise specified in 4.6 or the approved test procedures.

4.1.5 Procedure after a failure. When a failure or defect is detected, the cause shall be determined and corrective measures ascertained. These corrective measures shall be introduced into new production and shall also be applied to completed consoles unless allowed otherwise by the procuring activity.

4.1.6 Test conditions. Tests shall be conducted with the console operating under the following specified conditions, except for those tests where the following factors are the variables:

(a) The ambient temperature shall be 25°C. + 5°C.
(b) The relative humidity shall be between 25 and 50 percent.
(c) The supply voltage shall be the normal operating voltage.
(d) The supply frequency shall be the normal operating frequency.
(e) The control positions ot all controls shall be in the neutral or normal position.

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

(a) Firs. article inspection (see 4.3).
(b) Quality conformance inspection (see 4.4).

4.3 First article inspection.

4.3.1 Government laboratory. In cases where first article inspection is conducted at a Government laboratory, the supplier shall conduct such inspections prior to submission of the equipment as he is able to conduct in his own facilities or at a commercial laboratory. In addition, the supplier shall furnish the following with each equipment submitted for inspection:

(a) Drawings showing details of construction and a list of materials and finishes used.
(b) Interconnection, wiring and schematic diagrams.
(c) Preliminary operating instructions.
(d) Inspection data accumulated during inspection prior to submission.
(e) Adequate repair parts to insure completion of the inspection.

4.3.2 First article inspection order. First article inspection shall consist of all examination and testing necessary to determine compliance with the requirements of the individual console specification. The first article inspection required and the order of inspection shall be specified in the individual console specification and shall be selected from the following listing. In addition, the supplier shall conduct any other inspection required to determine compliance with the requirements of the individual console specification.

Examination and tests	Paragraph reference
General examination	4.5
Dimensions and weights	4.5.1
Operating test	4.6.1
Dielectric strength	4.6.2
Insulation resistance	4.6.3
Warm-up-time	4.6.4
Supply line voltage and frequency	4.6.5
Transient voltage and frequency	4.6.6
Part interchange	4.6.7
Enclosure	4.6.8
Humidity	4.6.9
Electromagnetic interference emission and susceptibility	4.6.10
Airborne and structureborne noise	4.6.11
Salt spray	4.6.12
Inclination	4.6.13
Roll and pitch	4.6.14
Full load	4.6.15
Voltage and frequency interaction	4.6.16
Accelerated life	4.6.17
Temperature rise	4.6.18
Overvoltage	4.6.19
Vibration	4.6.20
High impact shock	4.6.21
Power	4.6.22
Hydraulic controls pressure	4.6.23
Pneumatic controls pressure	4.6.24

4.3.3 First article inspection report. The supplier shall submit to the procuring activity for approval a complete report of all the first article tests conducted on the console. This report shall be submitted within 60 days of completion of the first article inspection. The console shall not be shipped prior to approval of the first article inspection report. This report shall be bound into a 9 by 11-1/2 inch binder and shall contain the following information:

(a) Front matter. The front matter of the inspection report shall include a title page and a table of contents. The title page shall include the complete identification of the console with the names of the equipment manufacturer, prime supplier, procuring activity, contract number and date. The table of contents shall list each major section or subsection of the report and each of the individual tests.
(b) Summary. The summary shall give a brief resume of the test results and shall contain a statement certifying that the console does or does not meet the applicable specification requirements. In addition, the resume shall contain a statement certifying that the tests were conducted in accordance with the approved test procedures. The resume shall contain a list of all points

where the equipment does not meet the specification requirements if failures occur. Any unusual items, adjustments, failures or repairs encountered during the various tests shall also be described. The content of the summary shall be certified by the signatures of the test engineer and console manufacturer.

(c) Equipment and test facilities. The test report shall include a list of all equipment and test facilities used during the tests. This list shall include the model numbers and manufacturer of all the equipment and test instruments used and calibration data.

(d) Test data. The test data shall be presented in the general manner specified herein, however, no special format or approval of the proposed format is required. Each test shall be prefaced by the name of the test and the applicable specification paragraph. Each final test result shall be listed adjacent to the specification requirement for that test. All data submitted shall be copies of the actual data recorded on the test floor and not retyped data. All forms used shall allow enough columns and space to identify the test instruments used, to make all necessary calculations and meter corrections. Detailed analysis of the test data is required to be an integral part of the report, including charts and graphs. All performance test data in the summary shall be in terms of the measured parameter (for example: p.s.i., inches, degrees F.) and shall be analyzed to demonstrate the ability of the console to meet the specification requirements.

4.4 Quality conformance inspection. Quality conformance inspection shall be conducted on each console prior to delivery. This inspection shall consist of the following examination and tests and any other inspection specified in the individual console specification.

Examination and tests	Paragraph reference
General examination	4.5
Operating test	4.6.1
Dielectric strength	4.6.2
Insulation resistance	4.6.3
Full load	4.6.15

4.4.1 Assembly and subassembly spares. Assembly and subassembly spares that can be operated as a unit (as an example, amplifier or instrument drawer) shall be subjected to the same inspection as the console. Inspection for other assembly and subassembly spares shall consist of general examination, dielectric strength and insulation resistance tests, and any other inspection necessary to insure proper operation when installed in the console.

4.4.2 Repair parts. Repair parts shall be inspected in accordance with the requirements of the individual parts specification.

4.5 General examination. The completed console shall be given a thorough examination for the following:

(a) Workmanship, assembly and fit.
(b) Parts, materials and finishes.
(c) Treatment for prevention of corrosion (see 3.11.4).
(d) Markings.
(e) Safety requirements.
(f) Creepage and clearance distances.
(g) Proper cable harness dress.

4.5.1 Dimensions and weights.

4.5.1.1 Uncrated. Dimensions and weights of all units comprising the complete console and all the repair parts (not crated for shipment) shall be determined.

4.5.1.2 Crated. Dimensions and weights of all units comprising the complete console and all the repair parts (crated for shipment) shall be determined. It shall be ascertained that a complete list of contents is included in each shipping container.

4.6 Tests.

4.6.1 Operating test. The console shall be energized and subjected to an operating test to insure the proper functioning of the equipment, including all operating controls and adjustments and conformance with the safety requirements. This test shall demonstrate that the approved alignment procedures, that will be included in the technical manual, are adequate

for aligning the equipment. These alignment procedures shall be submitted with the detailed test procedure. The alignment shall be done using the exact types of test equipment that were approved in accordance with 3.15.4. Reference should be made in the test procedure to the individual console specification for all operating accuracies and limits and any other operational requirements. A procedure should be included in this test to demonstrate that when each fuse is removed, the associated circuit is de-energized and that the entire circuit is protected by fuses.

4.6.2 Dielectric strength. The completed console shall be subjected to a dielectric strength test to show conformance with 3.8.3 The equipment shall withstand the test voltage specified in 3.8.3.1 for a period of not less than one minute. The frequency of the test voltage shall be not less than 60 Hz and shall approximate a true sine wave. The source of the test potential shall have a rating of at least 1 kilowatt. As an alternate test for the one minute application, the supplier may use a test voltage 20 percent higher than that specified in 3.8.3.1 for a period of not less than one second. Assemblies having circuits grounded to chassis (see 3.7.13) shall have the ground to chassis disconnected before testing. Shielding shall not be disconnected from ground. Low voltage parts, such as transistors, diodes, electrolytic capacitors and other voltage sensitive parts shall be disconnected during this test.

4.6.2.1 The test voltage shall be applied between all electrically isolated circuits and between each circuit and ground. The test voltage shall be raised gradually to the specified value and shall be held at that value for the periods specified in 4.6.2.

4.6.2.2 There shall be no evidence of arcing, corona, (audible or visible) or punctured insulation during and after the completion of this test.

4.6.3 Insulation resistance. The completed console shall be subjected to an insulation resistance test to show conformance with 3.8.2. Insulation resistance shall be measured with an insulation-resistance-indicating instrument which conforms to MIL-O-16485. The test voltage shall be applied for a period of not less than 60 seconds and shall be conducted with the equipment cold at any convenient room temperature. At the time of the test the temperature of the circuits shall be measured and recorded. The insulation resistance measurements shall be corrected to 25°C. These corrections shall be made on the basis of insulation resistance doubling for each 15°C. decrease in temperature. The relative humidity at the time of the test shall be measured and recorded. The grounds for any grounded circuits shall be disconnected and all ungrounded circuits shall be thoroughly discharged by momentarily shorting them to ground prior to testing. Shielding shall not be disconnected from ground. Low voltage parts, such as transistors, diodes, electrolytic capacitors and other voltage sensitive parts shall be disconnected during this test.

4.6.3.1 The test voltage shall be applied between all electrically isolated circuits and between each circuit and ground. All circuits may be tied together so that only one test voltage need be applied when testing between the circuits and ground, providing that the insulation resistance when tested in this manner meets the minimum value specified in 3.8.2.

4.6.4 Warm-up time. The console shall be placed in an ambient temperature environment of 25°C. ± 5°C. for a period of not less than 8 hours with the console deenergized. The console shall then be energized for a period of no more than 30 minutes (see 3.7.2). The accuracy of the output and of each set point shall be determined immediately after this period. The accuracy shall be within the performance accuracies specified in the individual console specification. The setting of all controls and adjustments shall be as specified in the approved test procedure.

4.6.5 Supply line voltage and frequency. The equipment shall be operated over the steady state range of supply line voltages and frequencies as specified in table VII until a stable operating condition has been reached. Reference measurements shall be made at nominal voltage and frequency. The equipment shall then be operated in the combinations of voltage and frequency shown in table VII and the performance characteristics, such as the accuracy of each set point and of the output, shall be determined for each condition. The settings of all controls and adjustments shall be as specified in the approved test procedure. The combinations of voltage and frequency tests shown in table VII shall be conducted at three different ambient temperatures, namely, 0°C. ± 5°C., 25°C. ± 5°C., and at the maximum continuous design ambient temperature as specified in 3.6.1.

Table VII - Supply line voltage and frequency.

Test	Voltage (percent of nominal)	Frequency (percent of nominal)
a.	100	100
b.	110	95
c.	110	105
d.	90	105
e.	90	95

4.6.6 Transient voltage and frequency. The console shall be tested to show conformance with 3.7.1.1. The approved test procedures shall state the means of generating the applied transients and the tolerance limits on these transients.

4.6.7 Part interchange. The part interchange test need be conducted on only one of each type of identical module in the console. The approved test procedure shall designate each part to be interchanged. Each of these parts shall be removed with the equipment de-energized and replaced by one of the same type chosen from stock at random. The equipment shall then be energized and the operating test (see 4.6.1) and supply line voltage and frequency test (see 4.6.5) shall be conducted. The test shall then be repeated with another set of the same parts chosen at random. The equipment may be realigned after each interchange and prior to the operating test using only the adjustment controls in the subassembly in which a part or parts were replaced or the overall controls and adjustments that are located on the console front panel.

4.6.7.1 Interchanged parts. The parts to be interchanged shall include at least the following:

(a) Each individually selected part, if any, (see 3.13.2.1).
(b) Each set of matched parts, if any, (see 3.13.2.1).
(c) Each semiconductor.
(d) Each part whose tolerance is critical with regard to circuit operation.

4.6.8 Enclosure test. The enclosure test shall be conducted as specified in MIL-STD-108. The test for effectiveness of dripproof (45 degrees) protected shall be determined by visual examination (see 3.9.3).

4.6.9 Humidity test. The equipment shall be subjected to the conditioning and tests specified in 4.6.9.1 through 4.6.9.6. The equipment shall not be energized except for the specified periods of test.

4.6.9.1 Equipment conditioning. The complete equipment shall be dried at a temperature of not less than 40°C., nor more than 50°C., and at a relative humidity of not more than 50 percent, for a period of at least 2 hours in order to establish a reference condition for the measurement of operating parameters and a valid basis for comparison of the effects of the conditioning to follow.

4.6.9.2 Reference measurements. Following the conditioning specified in 4.6.9.1 the equipment shall be energized and allowed a warm-up period to insure stable operation. The measurement of all parameters specified in the approved test procedures to indicate the satisfactory performance of the equipment shall be conducted at 25°C. ± 5°C. and 50 ± 5 percent relative humidity.

4.6.9.3 Temperature cycling. The equipment shall then be subjected to five 24-hour cycles of temperature variation consisting of approximately 16 hours at the maximum continuous design ambient temperature (+ 5°C.) as specified in 3.6.1 and approximately 8 hours at 25° ± 5°C. The relative humidity shall be maintained above a minimum of 95 percent during the steady state conditions. The transitions between temperatures shall be accomplished within the 8-hour period so that the time at the high temperature is approximately 16 hours. Each transition shall not exceed 1-1/2 hours if the equipment remains in the chamber, or 15 minutes if a two chamber method is employed. The relative humidity need not be controlled during the transition periods. Approximately 2 hours after stabilization during the high temperature and low temperature portions of the first or second cycle, a sampling of the atmosphere in the chamber shall be made to determine that the conditions of temperature and relative humidity specified above are uniform throughout the chamber.

4.6.9.4 Measurement during cycling. During the second cycle, the measurements required in 4.6.9.2 shall be performed at the maximum continuous design ambient temperature (+ 5°C.) as specified in 3.6.1, prior to the decrease of temperature to 25°C., with the equipment

remaining in the chamber. The equipment shall be energized for as brief a period of time as required to complete the measurements. A warm-up period may be permitted where previous tests indicate a definite period of time is required for the equipment to attain thermal stability.

4.6.9.4.1 The equipment shall be capable of meeting the requirements of the individual console specification without alignment or adjustment, other than the accessible controls used for operation of the equipment. No repairs shall be permitted prior to measurement. If repairs are required, the temperature cycling test specified in 4.6.9.3 shall be repeated after the necessary repairs have been made.

4.6.9.5 Measurements after temperature cycling. After the five complete cycles and within two hours, the measurements required in 4.6.9.2 shall be performed at 25° ± 5°C. and 50 ± 5 percent relative humidity. The equipment shall meet the requirements of the individual console specification with no more than minor readjustments of readily available controls. The dielectric test specified in 4.6.2 shall be conducted after completion of these measurements except that the test voltage shall be 65 percent of that specified in 3.8.3.1.

4.6.9.5.1 Upon completion of the tests and after remaining inoperative for not less than 12 nor more than 24 hours at a temperature of 25° ± 5°C. and 50 ± 5 percent relative humidity, any additional tests or measurements considered necessary by the Government shall be made to determine complete compliance with the requirements of the individual console specification.

4.6.9.6 The equipment shall be carefully examined in detail to detect evidence of physical degradation, such as corrosion of metal parts, distortion of plastic parts, and insufficient lubrication on moving parts. When it is necessary to replace parts to obtain satisfactory performance of the equipment, the failed part or parts shall be analyzed to determine the cause of the unsatisfactory operation. The results of the analyses shall be reported with the results of measurements of the equipment operating parameters. In each case, the unsatisfactory parts or materials shall be replaced by adequate substitutes.

4.6.10 Electromagnetic interference emission and susceptibility tests. Electromagnetic interference emission and susceptibility tests shall be as specified in requirement 61 of MIL-STD-454.

4.6.11 Airborne and structureborne noise. When specified in the individual console specification (see 3.9.10), the airborne and sturctureborne noise test shall be in accordance with MIL-STD-740 for the type and grade specified.

4.6.12 Salt spray test. The salt spray test shall be made in accordance with method 101 of MIL-STD-202 on selected parts and finishes. Those parts and finishes to be tested shall be identified in the approved detailed first article inspection procedures. It will not be applied to complete sets or units. Sample corner structures and any other critical section may be used for the test. The sample shall be assembled and treated in the same manner as the complete structure. Duration of the test shall be as specified in test condition A for frame and enclosure structures and in test condition B for individual parts.

4.6.13 Inclination test. The console shall be inclined for a minimum of 5 minutes in each of the following positions to show compliance with 3.6.7:

	Surface ship	Submarine
(a)	15 degrees forward	30 degrees forward
(b)	15 degrees backward	30 degrees backward
(c)	15 degrees port	30 degrees port
(d)	15 degrees starboard	30 degrees starboard

4.6.13.1 The console shall operate satisfactory without damage during this test, however, the accuracy requirements specified in the individual console specification need not be met at the angles specified in 4.6.13. On the return of the console to its normal operating position, the accuracy requirements shall be met.

4.6.14 Roll and pitch. The console shall be mounted on any device capable of performing the test. The console shall be rolled at the rate of 5 to 7 cycles per minute in one plane to angles of 45 degrees on either side of the vertical for surface ships and to angles of 60 degrees for submarines. The duration of the test shall be sufficiently long to determine the console characteristics under such motion or for a minimum of 30 minutes. The test shall be repeated with the console reoriented 90 degrees horizontally from the plane which it was originally tested.

4.6.15 Full load. The console shall be energized for 100 hours with all inputs and outputs connected to effect maximum rated loading at the nominal voltage and frequency and ambient temperature. This test shall be conducted prior to the operating test which will determine compliance with the requirements of the console specification.

4.6.16 Voltage and frequency interaction. The console shall be tested to show compliance with 3.7.1.4 at 25° ± 5°C. and at the following combinations of voltage and frequencies:

Source No. 1		Source No. 2	
Voltage (percent of nominal)	Frequency (percent of nominal)	Voltage (percent of nominal)	Frequency (percent of nominal)
100	100	100	100
110	95	90	105
110	95	90	95
110	105	90	95
90	105	110	105

4.6.17 Accelerated life tests. The equipment shall be subjected to the conditioning and tests as specified in 4.6.17.1 through 4.6.17.2.5.

4.6.17.1 Conditioning. In order to establish a reference for the measurement of operating parameters and a valid basis for comparison of test results, the complete equipment shall be subjected to the conditioning process specified in 4.6.17.1.1 and 4.6.17.1.2.

4.6.17.1.1 Normal operation. The equipment shall first be set up in a room in an ambient temperature of 25° ± 5°C. and 50 ± 5 percent relative humidity and operated under conditions of nominal power supply line voltage and frequency input, output load conditions, and operating frequency, in accordance with the requirements of the individual console specification. Following the warm-up period specified in 3.7.2, critical performance parameters as specified in the approved detailed inspection procedures, plus any specific tests deemed necessary by the Government, shall be measured and logged as "reference test data" for comparison with subsequent tests.

4.6.17.1.2 High temperature operation. The equipment shall then be set up in a chamber which shall be maintained at the maximum continuous design ambient temperature + 5°C. specified in 3.6.1. The chamber shall be maintained at a minimum of 95 percent relative humidity. The equipment shall be energized and operated under these conditions at nominal power supply line voltage and frequency input, output load conditions, and operating frequency, for a period of two hours. Near the end of this period and preferably during the last half hour, performance test data shall be taken for comparison with the reference test data (see 4.6.17.1.1). Minor adjustments of operating controls will be permitted during this two hour test run to insure optimum equipment performance.

4.6.17.2 Test cycling. Without shutting down the equipment and immediately following the two hour high temperature conditioning run, the equipment shall be subjected to a series of test cycles specified in 4.6.17.2.1 and 4.6.17.2.2, while operating at the maximum continuous design ambient temperature ± 5°C. The relative humidity shall be maintained at a minimum of 95 percent.

4.6.17.2.1 The test cycling shall be as follows: Increase input power voltage to 110 percent nominal and operate in this condition for a period of 1-1/4 hours (75 minutes); then decrease voltage to 90 percent nominal and operate in this condition for one hour; at the end of this period increase input voltage to nominal and operate for 1/2 hour (30 minutes), at the end of which time the equipment shall be de-energized for 15 minutes. During the 30 minute period of operation at nominal line input, repeat measurement of operating parameters as specified in 4.6.17.1.1. At the end of the 15 minute shutdown period, energize the equipment and immediately decrease the input voltage to 90 percent nominal; operate in this condition for one hour; increase input voltage to 110 percent nominal and operate in this condition for 1-1/4 hours (75 minutes); decrease voltage to nominal and operate for a period of 30 minutes, again repeating measurements specified in 4.6.17.1.1, followed by a 15 minute shutdown of the equipment.

4.6.17.2.2 The test cycle specified in 4.6.17.2.1 shall be repeated without interruption for a period of 15 complete days (360 hours).

4.6.17.2.3 After the measurements of the last cycle, the dielectric strength test specified in 4.6.2 shall be conducted, except that the test voltage shall be 65 percent of that specified in 3.8.3.1.

4.6.17.2.4 Procedure in case of shutdown. Should a single shutdown for more than one hour or a total shutdown of eight hours during the 15 days of continuous operation be necessary, the continuation of the test shall be for 15 full days from the time of resumption of the run.

4.6.17.2.5 Test data. Test data accumulated during the accelerated life tests, including details of all failures, shall be provided and included in the first article inspection report.

4.6.18 Temperature rise. Temperature measuring instruments shall be placed at critical points throughout the equipment, covering suspected areas of high temperature, both ambient and part temperatures. The equipment shall be energized and operated at full load at the maximum design ambient temperature, ± 5°C. (see 3.6.1), until a stable temperature condition has been reached. A stable temperature condition is achieved when during the last three temperature readings, the ambient and test point temperature have changed less than 2°C. The temperature at each point shall be determined to insure that all parts will operate within their allowable temperature limits at the maximum continuous design ambient temperature. Readings of temperature shall be taken every half hour. The log of the data obtained should clearly identify the location of the temperature instrument in the equipment, the temperatures measured, the date and time of the measurement.

4.6.18.1 When encapsulated or potted subassemblies are used, temperature sensors shall be embedded at critical points to insure that the parts will not exceed their temperature limit at the maximum continuous design ambient temperature. These embedded sensors are only required in the test sample. The subassemblies may be installed in the equipment or operated as a separate unit for this test. The location of the sensors in the subassemblies shall be indicated in the approved detailed test procedure.

4.6.19 Overvoltage. The equipment shall be energized at the overvoltage specified in 3.7.1.2 at the maximum ambient temperature specified in 3.6.1 for a period of 12 continuous hours. All modules, access doors and protective covers shall be closed during this test. Temperature measuring sensors shall be placed at critical points throughout the equipment covering suspected areas of high temperatures. All temperatures shall be recorded every three hours and at the conclusion of the test. Near the end of this test the equipment shall be demonstrated as being operable.

4.6.20 Vibration test. All consoles shall be subjected to the type I vibration tests of MIL-STD-167, except that the maximum frequency shall be 33 Hz, to show compliance with 3.6.5. Each console shall have vibration test or waiver approved by the procuring activity. The first article inspection report shall include copies of the vibration test reports and photographs as outlined in MIL-STD-167. At the conclusion of the vibration test, the dielectric strength test specified in 4.6.2 shall be conducted, except that the test voltage shall be 65 percent of that specified in 3.8.3.1.

4.6.21 High impact shock. All consoles shall be subjected to the grade A, class I, type A, high impact shock tests of MIL-S-901 to show compliance with 3.6.6. Each console shall have shock test or waiver approved by the procuring activity. The first article inspection report shall include photographs of the test set-up and any failed elements. These photographs shall show details of external bracing. At the conclusion of the shock test, the dielectric strength test specified in 4.6.2 shall be conducted, except that the test voltage shall be 65 percent of that specified in 3.8.3.1.

4.6.21.1 The console shall be energized and in operating condition during and after this test. Failure under the shock test shall be as defined in the individual console specification. Consoles which have been subjected to this shock test shall not be installed onboard ship without specific procuring activity approval. The shock test shall be made after all other tests have been concluded.

4.6.22 Power. The console shall be checked to determine the power required from the supply line and the console power factor.

4.6.23 Hydraulic controls pressure tests. All rams, cylinders, accumulators, valves, fittings, and tanks used in hydraulic controls shall be tested hydrostatically using the service fluid to 150 percent of the operating pressure to which each specific part will be subjected. All parts shall withstand these pressures without leakage.

4.6.23.1 Hydraulic fluid tanks which are not subject to pressure shall be filled with water under a pressure of 8 p.s.i.g. and proven to be tight. Necessary precautions shall be taken to insure that all water is removed from the tanks upon completion of the test.

4.6.23.2 Test pressures shall be developed by means other than the control pumps if the control pumps cannot safely develop the required pressure.

4.6.23.3 After completion of the tests, the supplier shall clean the fluid filters in the hydraulic controls and renew the filter elements.

4.6.24 Pneumatic controls pressure tests. The pneumatic controls, including air receivers, tanks, separators and accumulators, but not including compressors, instruments, air flasks, impulse flasks, and equipment which would be damaged by water, shall be subjected to a hydrostatic pressure test of 150 percent of the design working pressure of the controls. Piping which is part of an indicating system but which is external to a particular instrument, switch, or other device and requires shipboard assembly shall be hydrostatically tested to 150 percent of the design working pressure.

4.6.24.1 After the completion of the hydrostatic test, the controls, with all instruments and equipment included, shall be charged with dry air to a pressure equal to the design working pressure of the controls. The compressed air shall be allowed to stand in the controls to equalize the temperature. The pressure drop, corrected for temperature changes, shall not exceed the percentage of the test pressure given below in the given time:

Test pressure in p.s.i.	Time in hours	Pressure drop in percent of test pressure
1000 and above	24	1
Below 1000	6	5

4.6.24.1.1 At the expiration of the test period, if the pressure drop exceeds the permissible percentage drop, a soapy solution shall be applied to the joints, the controls shall be examined and leaks corrected, and the test repeated. If repairing of leaks introduces foreign matter into the controls, those portions affected shall be recleaned before repeating the test.

4.6.24.2 Upon completion of the tightness test of 4.6.24.1, all controls shall be operated with dry air at the design working pressure to determine operation of each control, and of parts such as check valves, relief valves, automatic cutout valves, reducing valves and gages, and to determine that each control satisfies the requirements.

4.6.25 SIC reliability assurance. Test procedures for the tests specified in 4.6.25.1 and 4.6.25.2 shall be submitted to the procuring activity for approval with the nonstandard part data sheets required by MIL-STD-749. Test procedures shall include end point measurements and failure criteria. Application of the device shall be limited to an actual or predicted worst case temperature not to exceed a value 25° C. below the rated maximum operating temperature for the SIC.

4.6.25.1 Life test. Twenty of each type of SIC used in the console shall be subjected to the following operating life test:

(a) Digital SIC's shall be given a dynamic operating test causing the device to switch logic states at a frequency of 100 KHz for 1000 hours at the maximum ambient temperature of the device in accordance with method 1005 of MIL-STD-883.
(b) Linear SIC's shall be operated continuously with normal biases applied for 1000 hours at the maximum ambient temperature of the device in accordance with method 1005 of MIL-STD-883.
(c) All SIC's tested above shall be given a thermal shock test in accordance with MIL-STD-883, method 1011, test condition A. After completion of this test, all SIC's shall be mechanically and electrically checked.
(d) One failure of each type shall be acceptable. Two or more failures shall be cause for rejection unless the reason for failure is determined and corrected to the satisfaction of the procuring activity.
(e) Successful units subjected to the above tests shall be supplied as repair parts with the console.

4.6.25.2 Burn-in test. Each unit used in the console shall be subjected to the following operating burn-in test. This test may be performed by the SIC manufacturer.

(a) Digital SIC's shall be operated at a frequency of 100 KHz for 168 hours in accordance with MIL-STD-883, method 1015, test condition A.
(b) Linear SIC's shall be continuously operated for 168 hours in accordance with MIL-STD-883, method 1015, test condition A.

4.7 Inspection of preparation for delivery. The preservation, packaging, packing, and marking shall be inspected for compliance with section 5 of this document.

5. PREPARATION FOR DELIVERY

(The preparation for delivery requirements specified herein apply only for direct Government procurements. For the extent of applicability of the preparation for delivery requirements of referenced documents listed in section 2, see 6.7.)

5.1 Domestic shipment and early equipment installation and for storage of onboard repair parts.

5.1.1 Consoles.

5.1.1.1 Preservation and packaging. Preservation and packaging which may be the supplier's commercial practice, shall be sufficient to afford adequate protection against corrosion, deterioration and physical damage during shipment from the supply source to the using activity and until early installation.

5.1.1.2 Packing. Packing shall be accomplished in a manner which will insure acceptance by common carrier at the lowest rate and will afford protection against physical or mechanical damage during direct shipment from the supply source to the using activity for early installation. The shipping containers or method of packing shall conform to the Uniform Freight Classification Rules or other carrier regulations, as applicable to the mode of transportation and may conform to the supplier's commercial practice.

5.1.1.3 Marking. Shipment marking information shall be provided on interior packages and exterior shipping containers in accordance with the contractor's commercial practice. The information shall include nomenclature, Federal stock number or manufacturer's part number, contract or order number, contractor's name and destination.

5.1.2 Onboard repair parts. Onboard repair parts shall be preserved and packaged by level A, packed by level A or B, and marked in accordance with MIL-E-17555.

5.2 Domestic shipment and storage or overseas shipment. The requirements, and levels of preservation, packaging, packing and marking for shipment shall be specified by the procuring activity (see 6.2).

(5.2.1 The following provides various levels of protection during domestic shipment and storage or overseas shipment, which may be required when procurement is made:

5.2.1.1 Preservation and packaging, packing and marking. Equipment and accessories, replacement devices, stock repair parts and technical publications shall be preserved and packaged by levels A or C; packed by level A or B, as specified and marked in accordance with MIL-E-17555.)

6. NOTES

6.1 Intended use. The console 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. Failure of a vital instrument or control at a critical moment may result in serious reduction in the efficiency of the ship involved.

6.2 Since this specification is general in scope and covers only the construction practices and the conditions under which consoles for Naval ships must operate, the details of performance of the console under the conditions stated herein and the ordering information must be specified elsewhere. Attention of design engineers is invited to the following items which should be covered in the individual console specification:

(a) Detail performance requirements for the particular console.
(b) Fail safe requirements (see 3.2.1).
(c) Sensor fluid temperature requirements (see 3.6.2).
(d) Sensor fluid pressure requirements (see 3.6.4).
(e) Use of cable connectors for external connections (see 3.7.6.5).
(f) Use and circuit location of power on-off switches (see 3.7.14.1).
(g) Console mounting (see 3.9.9.8).
(h) Airborne and structureborne noise required (see 3.9.10).
(i) Use of batteries (see 3.13.6).
(j) Scale range of indicating meters (see 3.13.16.1.2).
(k) Ordering data required by MIL-R-19523 (see 3.13.21).

(l) Requirements for bell and data loggers (see 3.13.52).
(m) Requirements for throttle control equipment (see 3.13.54).
(n) Required functions and alarms for alarm annunciator (see 3.13.55).
(o) Tactile forms for control knobs (see 3.14.1.1).
(p) Requirement for installation drawings (see 3.17.3.1).
(q) Requirement for, and contents of, block diagrams (see 3.17.3.4).
(r) Requirement for, and contents of, logic diagrams (see 3.17.3.5).
(s) Additional data required on drawings (see 3.17.4.3).
(t) Schedule for technical manual submittals (see 3.18.2).
(u) Repair parts required (see 3.19).
(v) Model, tests required, and order of testing, for first article inspection (see 3.1 and 4.3.2).
(w) Additional tests required for quality conformance inspection (see 4.4).
(x) Input, output load and operating frequency for accelerated life test (see 4.6.17.1.1).
(y) Definition of failure under shock (see 4.6.21.1).
(z) Preservation and packaging, packing, and marking if other than as specified in 5.1 (see 5.2).

6.3 The attention of design engineers and suppliers is invited to the items listed below which require approval of the procuring activity (see 3.4.2):

(a) Mounting of semiconductors (see 3.7.6.4).
(b) Use of special tools (see 3.9.15).
(c) Use of glass in parts (see 3.12.2.1).
(d) Use of specific colored plastics (see 3.12.5.3).
(e) Use of ceramics for insulation (see 3.12.6).
(f) Application conditions of impregnating compounds (see 3.12.7.2).
(g) Use of nonstandard parts (see 3.13.1.1).
(h) Use of batteries (see 3.13.6).
(i) Digital readout circuitry (see 3.13.16.2.1).
(j) The detailed performance requirements for procurement under MIL-R-5757 (see 3.13.21.2).
(k) Type of analog-to-digital converter used (see 3.13.25).
(l) Other types of surge voltage suppressors (see 3.13.27).
(m) Approval of transformers (see 3.13.35.3).
(n) Panel layouts and operating controls arrangement (see 3.14.4).
(o) Method used to obtain test point voltages (see 3.15.3).
(p) List of test equipment and quantities of each equipment (see 3.15.4.1 and 3.15.4.2).
(q) Installation and production drawings (see 3.17.2 and 3.17.3.2.8).
(r) Technical manuals (see 3.18).
(s) Alignment check tolerances (see 3.18.4 (c)(5)).
(t) Trip point and calibration test tolerances (see 3.18.4 (c)(7)).
(u) Quantity of repair parts for category I subassemblies (see 3.19).
(v) Tests, test equipment and test procedures (see 4.1.2).
(w) Realignment, adjustments or repairs prior to completion of all tests (see 4.1.4).
(x) First article inspection report (see 4.3.3).
(y) Waiver of vibration test (see 4.6.20).
(z) Waiver of shock test (see 4.6.21).
(aa) Permission to install shock tested equipment (see 4.6.21.1).
(bb) Test procedures for semiconductor integrated circuits (see 4.6.25).

6.4 Management control system documents. The following management control system documents should be included on DD Form 1660:

(a) MIL-P-15137 (see 3.19).
(b) MIL-Q-9858 (see 4.1.1).

6.5 Definitions. The following definitions shall apply for the purpose of this specification:

6.5.1 Individual console specification. An individual console specification is the detailed specification covering a particular console for a ship or class of ships.

6.5.2 Part. A part consists of one item, or two or more items joined together so that they are not normally subject to disassembly without destruction. Examples are: Diode, capacitor, resistor, transformer, gear.

6.5.3 Subassembly. A subassembly consists of two or more parts having a common mounting, or mounted one upon the other, and which form a portion of an assembly, replaceable as a whole, but having a part or parts which are individually replaceable without alteration or destruction of the parts. It cannot perform independently a complete specific function. Examples are: Gear train, part mounting boards with parts mounted.

6.5.4 Assembly. An assembly consists of two or more parts or subassemblies, or any combination thereof, joined together to perform a complete specific function. Note: The distinction between an assembly and a subassembly may not always be exact, an assembly in one case may be a subassembly in another where it forms a portion of an assembly.

6.5.5 Instrument. An instrument consists of sensor(s), amplifier(s), indicator(s), and other devices considered as a whole with regard to indicating the measured parameter or producing a control signal or both. This would include the power supply and installed test devices except when they are common with other instruments.

6.5.6 Instrument set. An instrument set consists of the necessary parts, subassemblies, assemblies and instruments connected or associated together to perform their intended operational functions. Example: A pressure instrument set consists of all the related items required to make the entire pressure instrumentation equipment for one propulsion system. This includes all power supplies, installed test devices, etc.

6.5.7 Replaceable assembly or subassembly. An assembly or subassembly that is capable of being easily removed and replaced as an integral item.

6.5.8 Accuracy. Accuracy is a quantity or number defining the limit of error as the difference between the value of the observed or indicated parameter and the actual value, expressed either in percent of the instrument range, in percent of the true parameter value, or in units of the parameter.

6.5.9 Chassis. A chassis is the metallic base on which the parts of a subassembly or an assembly are mounted.

6.5.10 Sensor. A sensor is a sensing element or group of elements that responds to the quantity measured, providing an electrical output signal or other indication which is a function of that quantity. Examples are: Thermocouple, pressure transmitter.

6.5.11 Enclosure. An enclosure is a mechanical cover which wholly surrounds some item or group of items and is a part thereof. Examples of enclosures are cabinet, cubicle and console. The term "enclosure" does not apply to shipping containers or temporary storage containers.

6.5.12 Prototype model. A prototype model is a model suitable for complete evaluation of mechanical and electrical design, form and performance. It shall be of final electrical and mechanical form, employ approved parts and be completely representative of final equipment.

6.5.13 Analog. A representation of numerical quantities by means of a physically variable output such as voltage or current. The output has a continuous mathematical functional relationship to the measured quantity. Contrast with digital.

6.5.14 Digital. A representation of numerical quantities by means of a binary coded logic signal. The output is composed of a pulse train representing numbers as a binary code. Contrast with analog.

6.5.15 Local meter. A local meter is a meter mounted directly upon an instrument drawer.

6.5.16 Remote meter. A remote meter is a meter mounted separate from and located away from an instrument drawer, as a meter in a console and the instrument drawer in a separate cabinet.

6.6 First article inspection. Invitations for bids should provide that the Government reserves the right to waive the requirement for samples for first article inspection as to those bidders offering a product which has been previously procured or tested by the Government, and that bidders offering such products, who wish to rely on such production or test, must furnish evidence with the bid that prior Government approval is presently appropriate for the pending procurement.

6.7 Sub-contracted material and parts. The preparation for delivery requirements of referenced documents listed in section 2 do not apply when material and parts are procured by the supplier for incorporation into the equipment and lose their separate identity when the equipment is shipped.

Preparing activity:
Navy - SH
(Project 2030-N008)

INDEX

	Paragraph	Page
Access panels and doors	3.9.9.4 and 3.9.9.5	13 and 14
Accessibility	3.5.2. and 3.9.9.7	6 and 14
Accessibility of controls and indicators	3.14.1	33
Actuators, solenoid	3.13.26	26
Adjustments, internal	3.14.5	34
Adjustments, locking devices	3.14.1	33
Adjustments, range of	3.14.5	34
Airborne and structureborne noise	3.9.10	15
Alarm annunciators	3.13.55	33
Alarm circuit switches	3.13.28.9.2	27
Aluminum	3.12.4.2	18
Aluminum, threads in	3.9.12.5	15
Ambient temperature	3.6.1	7
Analog-to-digital converter	3.13.25	26
Applicable documents	2.	1
Application of parts	3.13.2	20
Approvals	3.4.2	6
Approval of nonstandard parts	3.13.1.1	20
Approvals required by procuring activity	6.3	60
Audible alarm signals	3.13.3	20
Axial pigtail leads	3.7.8	10
Banana plugs prohibited	3.13.18	25
Basic console characteristics	3.5	6
Batteries	3.13.6	20
Bearings	3.13.41	31
Bell and data loggers	3.13.52	33
Bevel gears	3.13.46.1	32
Block diagrams	3.17.3.4	38
Bolts and nuts	3.13.50.4	32
Bonding, electrical	3.7.12	10
Brazing	3.11.3	18
Bus transfer switches (automatic)	3.13.28.8	27
Cable and wire	3.13.7	20
Cap screws	3.13.50.2	32
Capacitors	3.13.8	21
Caution and warning information plates	3.16.3.2	36
Ceramics	3.12.6	19
Certification data sheets	3.17.3.3	38
Changes in drawings	3.17.2	37
Chassis, grounding of	3.7.13	10
Chassis wiring (marking and color coding)	3.7.7	9
Choppers, use of	3.7.3	8
Circuit breakers	3.13.9	22
Circuit, grounding of	3.7.13	10
Clamp contact connections	3.7.6.4	9
Clamps, cable	3.13.42	31
Class of insulation	3.8	11
Colors (indicator lights)	3.13.15.3	24
Compartmentation	3.9.7	13
Compatibility	3.5.1	6
Conflicts	3.4.1	6
Connection(s):		
Clamp contacts	3.7.6.4	9
External cable	3.7.6.5	9
Mechanical support	3.7.6.3	9
Soldered	3.7.6.8.1	9
Wire end	3.7.6.8.1	9
Connectors, electrical	3.7.6.8.2 and 3.13.10	9 and 22
General	3.13.10.1	22
Mounting of	3.13.10.3	23
Removable contact	3.13.10.2	22

	Paragraph	Page
Console details:		
Accessibility	3.9.9.7	14
Construction details	3.9.9	13
Face	3.9.8	13
Framework	3.9.9.1	13
Front and rear panels	3.9.9.4	13
Mounting	3.9.9.8	15
Positioning stops	3.9.9.4.1	13
Side sheets	3.9.9.2	13
Thread locking	3.9.9.6	14
Top sheets	3.9.9.3	13
Upper and lower sloping section	3.9.9.5	14
Construction	3.9.1	12
Contactors	3.13.11	23
Continuity, power	3.7.1.3	8
Control circuit switches	3.13.28.9.1	27
Control knobs and handles	3.13.47	32
Controlled rectifiers	3.13.23	26
Controllers, motor	3.13.11	23
Controls:		
Function identification	3.14.6	34
General criteria for	3.14.1	33
Indicators and panel layout	3.14	33
Operating (arrangement)	3.14.4	34
Shafts and couplings	3.14.1	33
Tactile forms for	3.14.1.1	33
Converter, analog-to-digital	3.13.25	26
Cooling, forced air	3.9.6.2	12
Cooling, liquid	3.9.6.1	12
Cords, lacing	3.13.39	30
Corrosion resistant treatments	3.11.4	18
Creepage and clearance distances	3.8.1	11
Data loggers	3.13.52	33
Definitions	6.5	60
Accuracy	6.5.8	61
Analog	6.5.13	61
Assembly	6.5.4	61
Chassis	6.5.9	61
Digital	6.5.14	61
Enclosure	6.5.11	61
Individual console specification	6.5.1	60
Instrument	6.5.5	61
Instrument set	6.5.6	61
Local meter	6.5.15	61
Part	6.5.2	60
Remote meter	6.5.16	61
Replaceable assembly or subassembly	6.5.7	61
Sensor	6.5.10	61
Subassembly	6.5.3	61
Design objectives	3.2	6
Dials, marking of	3.14.2	33
Dials, plastic	3.12.5.4	19
Dielectric strength	3.8.3	11
Dielectric test	4.6.2	53
Differential pressure transducers	3.13.33.1	28
Digital indicators	3.13.16.2	24
Digital clock	3.13.53	33
Dimensional limitations	3.9.2.1 and 3.9.2.2	12
Diodes, voltage reference	3.13.23	26
Doors, access	3.9.9.4	13
Drawings:	3.17	37
Approval	3.17.2	37
Block diagrams	3.17.3.4	38
Certification data sheets	3.17.3.3	38
Contents	3.17.4	38
Furnished	3.17.3	37

	Paragraph	Page
General	3.17.1	37
Installation	3.17.3.1	37
Logic diagrams	3.17.3.5	38
Production	3.17.3.2	37
Revision	3.17.3.2.8	38
Sizes	3.17.3.2.6	38
Drilled and tapped holes	3.9.14	15
Dry batteries	3.13.6	20
Ease of operation	3.5.4	7
Electrical:		
Bonding	3.7.12	10
Creepage and clearance distances	3.8.1	11
Design features	3.7	7
Insulation	3.8	11
Insulating procedures	3.8.4	11
Protection	3.7.14	10
Tapes	3.13.38	30
Electromagnetic interference	3.7.4	8
Electron tubes, use of	3.7.3	8
Embedded parts	3.7.15	11
Embedding compounds	3.12.7	19
Encapsulating materials	3.12.7	19
Enclosures:	3.9.3	12
Identification plates	3.16.2	36
Internal temperature indication	3.9.3.1	12
Painting of	3.11.5	18
End stops (switches)	3.13.28.9.3	27
Engine order and indicating equipment	3.13.5	20
Entrance, cable	3.9.5	12
Environmental requirements	3.6	7
Epicyclic gears	3.13.46.3	32
Examination, general	4.5	52
External cable connections	3.7.6.5	9
Fail safe design	3.2.1	6
Fastening devices for access panels and doors	3.9.9.4.2	14
Filters:		
Air	3.13.43	31
Air application	3.9.6.2	12
Electrical	3.13.12	23
Forced air cooling	3.9.6.2	12
Forming and securing wiring	3.7.6.1	9
Frequency, supply line	3.7.1	7
Frequency, transient	3.7.1.1	8
Full load test	4.6.15	56
Function identification	3.14.6	34
Fuseholders	3.13.14	23
Fuses	3.13.13	23
Fuses, application of	3.7.14 and 3.13.13.2	10 and 23
Gages and gage piping	3.13.44	31
Gaskets, O-rings and seals	3.13.45	31
Gears	3.13.46	31
Grab rails	3.9.4	12
Grease	3.9.11	15
Grounding	3.7.13	10
Handles	3.9.9.7.3	14
Handles and control knobs	3.13.47	32
Handling	3.9.9.9	15
Hardware, miscellaneous	3.13.48	32
Heaters, limitation on use	3.9.6.4	12
Height, maximum	3.9.2	12
High voltage, test facility	3.15.3	35
Hinged panels	3.9.9.4 and 3.9.9.5	13 and 14

	Paragraph	Page
Humidity conditions	3.6.3	7
Hydraulic controls	3.10.3	16
Identification plates (consoles and major assemblies)	3.16.2	36
Impregnating	3.12.7	19
Inclination	3.6.7	7
Inclined operation (lubrication)	3.9.11.1	15
Indicator lights	3.13.15	23
Indicator light colors	3.13.15.3	24
Indicator light lamps	3.13.15.1	23
Indicator light lenses	3.13.15.2	24
Indicators:	3.13.16	24
Digital	3.13.16.2	24
Electrical meters	3.13.16.1	24
Indicator accessories	3.13.17	25
Marking of	3.14.2	33
Individual console specification requirements	6.2	59
Individual selection of parts	3.13.2.1	20
Inductive devices, miscellaneous	3.13.37	30
Inductors	3.13.35	28
Information plates	3.16.3	36
Inserts, metallic	3.13.49	32
Inspection:		
First article	4.3	51
Quality conformance	4.4	52
Report (first article)	4.3.3	51
Responsibility	4.1	50
Source (threaded fastening devices)	3.13.50.6	32
Installation drawings	3.17.3.1	37
Instrument switches	3.13.28.9.2	27
Insulating:		
Electrical procedures	3.8.4	11
Materials (plastics)	3.12.5	19
Insulation:		
Electrical	3.8	11
Protection	3.7.6.6	9
Resistance	3.8.2	11
Integrated circuits, semiconductor	3.13.24 and 4.6.25	26 and 58
Intended use	6.1	59
Interaction of voltage and frequency	3.7.1.4	8
Interchangeability	3.5.3	6
Interference, electromagnetic	3.7.4	8
Internal controls and adjustments	3.14.5	34
Internal temperature	3.9.3.1	12
Internal wire	3.13.7.1	20
Isolation	3.7.9	10
Jacks, tip, test point	3.13.18	25
Lacing cords and tapes	3.13.39	30
Level switches	3.13.28.6	27
Life, basic requirements	3.2.3	6
Lights, indicator	3.13.15	23
Application	3.13.15.3.1, 3.13.15.3.2, 3.13.15.3.3	24
Liquid cooling	3.9.6.1	12
Local meters	3.7.10	10
Locking devices	3.9.9.6	14
Logic diagrams	3.17.3.5	38
Lubricants and lubrication	3.9.11	15
Lugs, terminal	3.13.31	27
Machine screws	3.13.50.1	32
Magnesium	3.12.2	18
Maintenance design	3.15	34
Manuals, technical	3.18	44

	Paragraph	Page
Marking:		
Designations, wire	3.7.7	9
Indicator	3.14.2	33
Reference designation parts	3.16.4	36
Shipping and storage	5.1.1.3	59
Materials:	3.12	18
Arc resistant	3.12.3	18
Embedding	3.12.7	19
Flammable	3.12.2	18
Fragile	3.12.2	18
Fungus inert	3.12.2.2	18
General	3.12.1	18
Glass	3.12.2.1	18
Impregnating and encapsulating	3.12.7	19
Nonferrous (except aluminum)	3.12.4.3	19
Prohibited	3.12.2	18
Radioactive	3.12.2	18
Threaded fastening devices	3.13.50	32
Toxic	3.12.2	18
Wood	3.12.2.3	18
Mechanical:		
Construction and weight	3.9.1	12
Features	3.9	12
Size	3.9.2	12
Supports	3.7.6.3	9
Mercury	3.12.2	18
Mercury switches	3.13.28.5	27
Metals	3.12.4	18
Metals, dissimilar	3.12.4	18
Meter accessories	3.13.17	25
Metering switches	3.13.28.9.2	27
Meters, electrical indicating	3.13.16.1	24
Meters, local	3.7.10	10
Meters, remote	3.7.11	10
Modular construction	3.5.5	7
Motor rotation	3.13.19.1	25
Motors	3.13.19	25
Motor starters	3.13.11	23
Motors, servo	3.13.20	25
Mounting, console	3.9.9.8	15
Mounting of parts with pigtail leads	3.7.8	10
Noise, airborne and structureborne	3.9.10	15
Nuts and bolts	3.13.50.4	32
O-rings	3.13.45	31
On-off power switches	3.7.14.1	10
Order of precedence	3.4.1	6
Overload relays	3.13.21.1	25
Overvoltage	3.7.1.2 and 4.6.19	8 and 57
Packaging and packing	5.1	59
Painting	3.11.5	18
Panel layout (operating controls)	3.14.4	34
Panels:		
Access	3.9.9.4	13
Location of ventilation openings	3.9.6	12
Parts:	3.13	19
Access to	3.5.2	6
Design application	3.13.2	20
Embedded	3.7.15	11
Identification by reference designation	3.16.4	36
Individual selection	3.13.2.1	20
Nonstandard	3.13.1.1	20
Nonstandard replacement	3.13.1.2	20
Operating temperature	3.9.6	12
Plug-in	3.13.2.3	20

	Paragraph	Page
Standard	3.13.1	19
Repair	3.19	48
Protection of	3.9.6.3	12
Tolerances	3.13.2.2	20
With pigtail leads, mounting of	3.7.8	10
Pigtail leads, soldering	3.7.8	10
Pins, metallic	3.13.49	32
Piping, gage	3.13.44	31
Piping components	3.10.1	16
Pitch and roll	3.6.8	7
Planetary gears	3.13.46.3	32
Plastics:	3.12.5	19
Color	3.12.5.3	19
Dials	3.12.5.4	19
Thermoplastic	3.12.5.2	19
Threads in	3.9.12.5	15
Translucent and transparent	3.12.5.4	19
Plug-in parts	3.13.2.3	20
Pneumatic controls	3.10.4	17
Polarity identification	3.16.4.3	36
Portable test equipment	3.15.4	35
Positioning stops for hinged panels	3.9.9.4.1	13
Power continuity	3.7.1.3	8
Power on-off switches	3.13.28.9.1	27
Power, primary supply	3.7.1	7
Preparation for delivery	5.	59
Pressure:		
Sensor fluid	3.6.4	7
Switches	3.13.28.6	27
Transducers	3.13.33.2	28
Printed circuit switches	3.13.28.7	27
Printed wiring and printed wiring boards	3.7.5	8
Processes and treatments	3.11	18
Production drawings	3.17.3.2	37
Prohibited materials	3.12.2	18
Propeller revolution indicating equipment	3.13.5	20
Protection:		
Parts	3.9.6.3	12
During servicing	3.9.9.7.3	14
Electrical	3.7.14	10
Personnel	3.3	6
Protective devices, application of	3.7.14	10
Push button switches	3.13.28.3	26
Push button, lighted, switches	3.13.28.4	27
Quality program	4.1.1	50
Reactors	3.13.35	28
Rectifiers, silicon	3.13.23	26
Reference designations, assignment of	3.17.4.2(i)(2)	40
Reference designations, identification of parts by	3.16.4	36
Relays	3.13.21	25
Remote meters	3.7.11	10
Repair parts	3.19	48
Resolvers	3.13.29.1	27
Resistor application	3.13.22.6	25
Resistors	3.13.22	25
Resistors, indicator	3.13.17.1	25
Resistors, variable	3.13.22	25
Roll and pitch	3.6.8	7
Rotary switches	3.13.28.9	27
Rounded corners and edges	3.9.13	15
Safety, personnel	3.3	6
Scope	1.	1
Screw threads	3.13.50	32

	Paragraph	Page
Screws:	3.13.50.1, 3.13.50.2, 3.13.50.3	32
Flathead	3.9.12.4	15
Thread cutting	3.9.12.3	15
Seals	3.13.45	31
Selection of nominal input rating	3.7.1	7
Semiconductor devices	3.13.23	26
Semiconductor integrated circuits	3.13.24 and 4.6.25	26 and 58
Sensitive switches	3.13.28.2	26
Servo motors	3.13.20	25
Shock	3.6.6	7
Shielded wire and cable	3.7.6.7 and 3.13.7.3	9 and 21
Shunts, indicator	3.13.17.2	25
Silicon rectifiers and diodes	3.13.23	26
Silicon transistors	3.13.23	26
Size, maximum	3.9.2	12
Sleeving	3.13.40	31
Soldering	3.11.2	18
Solenoid actuators	3.13.26	26
Spare terminals	3.7.6.9	9
Special tools	3.9.15	15
Springs	3.13.51	33
Spur and bevel gears	3.13.46.1	32
Standardization	3.2.2	6
Steel	3.12.4.1	18
Stops, panels and doors	3.9.9.4.1 and 3.9.9.5	13 and 14
Straps, cable	3.13.42	31
Supply, primary power	3.7.1	7
Suppressors, surge voltage	3.13.27	26
Susceptibility	3.7.4	8
Switches:	3.13.28	26
Bustransfer (automatic)	3.13.28.8	27
Mercury	3.13.28.5	27
Power and control	3.13.28.9.1	27
Printed circuit	3.13.28.7	27
Push button	3.13.28.3	26
Rotary	3.13.28.9	27
Sensitive	3.13.28.2	26
Toggle	3.13.28.1	26
Synchros	3.13.29	27
Tactile forms for controls	3.14.1.1	33
Tapes, electrical	3.13.38	30
Tapes, lacing	3.13.39	30
Technical manuals	3.9.11 and 3.15.5	15 and 35
Telephone equipment	3.13.4	20
Temperature:		
Ambient	3.6.1	7
Internal indication	3.9.3.1	12
Transducers	3.13.33.3	28
Sensor fluid	3.6.2	7
Terminal boards	3.7.6.5 and 3.13.30	9 and 27
Terminal:		
Lugs	3.13.31	27
Spare	3.7.6.9	9
Stud and feedthrough	3.13.32	28
Test voltage	3.8.3.1	11
Tests:		
Accelerated life	4.6.17	56
Airborne and structureborne noise	4.6.11	55
Conditions	4.1.6	50
Dielectric	4.6.2	53

	Paragraph	Page
Dimensions and weights	4.5.1	52
Electromagnetic interference emission and susceptibility	4.6.10	55
Enclosure	4.6.8	54
Full load	4.6.15	56
General examination	4.5	52
High impact shock	4.6.21	57
Humidity	4.6.9	54
Hydraulic controls	4.6.23	57
Inclination	4.6.13	55
Insulation resistance	4.6.3	53
Operating	4.6.1	52
Overvoltage	4.6.19	57
Part interchange	4.6.7	54
Pneumatic controls	4.6.24	58
Power	4.6.22	57
Roll and pitch	4.6.14	55
Salt spray	4.6.12	55
Supply line voltage and frequency	4.6.5	53
Temperature rise	4.6.18	57
Transient voltage and frequency	4.6.6	54
Vibration	4.6.20	57
Voltage and frequency interaction	4.6.16	56
Warm-up time	4.6.4	53
Test circuit switches	3.13.28.9.2	27
Test data for technical manual	3.15.5	35
Test equipment, portable	3.15.4	35
Test facility, high voltage	3.15.3	35
Test points and facilities	3.15.2	34
Test point jacks	3.13.18	25
Thermistors	3.13.34	28
Thermostatic switches	3.13.28.6	27
Thread cutting screws	3.9.12.3	15
Thread engagement	3.9.12.2	15
Thread locking	3.9.9.6	14
Thread projections	3.9.12.1	15
Threaded aluminum and plastics	3.9.12.5	15
Threaded parts and devices	3.9.12 and 3.13.50	15 and 32
Throttle control equipment	3.13.54	33
Time delay relays	3.13.21.1	25
Tip jacks	3.13.18	25
Toggle switches	3.13.28.1	26
Tools, special	3.9.15	15
Transducers:	3.13.33	28
Differential pressure	3.13.33.1	28
Level	3.13.33.4	28
Pressure	3.13.33.2	28
Temperature	3.13.33.3	28
Transformers:	3.13.35	28
Indicator and instrument	3.13.17.3	25
Pulse, low power	3.13.35.5	29
Voltage regulating	3.13.36	30
Transient:		
Frequency	3.7.1.1	8
Operating requirements	3.7.1.1	8
Voltage	3.7.1.1	8
Transistors, silicon	3.13.23	26
Treatment and processing of metals	3.11.4	18
Tubes, electron, use of	3.7.3	8
Ventilation	3.9.6	12
Ventilation, forced air	3.9.6.2	12
Ventilation openings, location of	3.9.6	12
Verniers, marking of	3.14.2	33
Vibration	3.6.5	7
Vibrators, use	3.7.3	8
Voltage:		
Frequency, interaction	3.7.1.4	8

	Paragraph	Page
Nominal rating	3.7.1	7
Reference diodes	3.13.23	26
Regulating transformers	3.13.36	30
Selection of nominal rating	3.7.1	7
Steady state tolerance	3.7.1	7
Supply	3.7.1	7
Surge suppressors	3.13.27	26
Transient	3.7.1.1	8
Warm-up time	3.7.2	8
Warning and caution information plates	3.16.3.2	36
Washers	3.13.50.5	32
Weight	3.9.1	12
Welding	3.11.1	18
Windows	3.14.3	34
Wire:		
End connections	3.7.6.8.1	9
Identification	3.7.7	9
Internal	3.13.7.1	20
Shielded	3.7.6.7 and 3.13.7.3	9 and 21
Wiring:		
Color coding	3.7.7	9
Harnessing	3.7.6.1	9
Insulation protection	3.7.6.6	9
Methods	3.7.6	9
Slack	3.7.6.2	9
Wood	3.12.2.3	18
Workmanship	3.20	50
Worm gears	3.13.46.2	32
Zinc	3.12.4.4	19

SPECIFICATION ANALYSIS SHEET

Form Approved
Budget Bureau No. 119-R004

INSTRUCTIONS

This sheet is to be filled out by personnel either Government or contractor, involved in the use of the specification in procurement of products for ultimate use by the Department of Defense. This sheet is provided for obtaining information on the use of this specification which will insure that suitable products can be procured with a minimum amount of delay and at the least cost. Comments and the return of this form will be appreciated. Fold on lines on reverse side, staple in corner, and send to preparing activity *(as indicated on reverse hereof)*.

SPECIFICATION

ORGANIZATION *(Of submitter)*

CITY AND STATE

CONTRACT NO.

QUANTITY OF ITEMS PROCURED

DOLLAR AMOUNT
$

MATERIAL PROCURED UNDER A

☐ DIRECT GOVERNMENT CONTRACT ☐ SUBCONTRACT

1. HAS ANY PART OF THE SPECIFICATION CREATED PROBLEMS OR REQUIRED INTERPRETATION IN PROCUREMENT USE?

A. GIVE PARAGRAPH NUMBER AND WORDING.

B. RECOMMENDATIONS FOR CORRECTING THE DEFICIENCIES.

2. COMMENTS ON ANY SPECIFICATION REQUIREMENT CONSIDERED TOO RIGID

3. IS THE SPECIFICATION RESTRICTIVE?

☐ YES ☐ NO IF "YES", IN WHAT WAY?

4. REMARKS *(Attach any pertinent data which may be of use in improving this specification. If there are additional papers, attach to form and place both in an envelope addressed to preparing activity)*

SUBMITTED BY *(Printed or typed name and activity)*

DATE

DD, FORM 1 APR 63 1426 REPLACES NAVSHIPS FORM 4883, WHICH IS OBSOLETE 0101-807-2000

FOLD

DEPARTMENT OF THE NAVY
Naval Ship Engineering Center
Center Building
Prince George's Center
Hyattsville, Maryland 20782

OFFICIAL BUSINESS

POSTAGE AND FEES PAID
NAVY DEPARTMENT

Commander, Naval Ship Engineering Center
DOD Standardization Program & Documents Branch
Center Building
Prince George's Center
Hyattsville, Maryland 20782

FOLD