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. MILITARY SPECIFICATION

FIRE CONTROL EQUIPMENT, NAVAL SHIPBOARD, GENERAL SPECIFICATION FOR

This specification is approved for use by all Departments and Agencies *of the* Department of Defense.

1 SCOPE

1.1 This specification covers the Common requirements for the procurement of *fire* control equipment to be used in Naval shipboard weapon systems. Such equipment may be a complete system or a part of such a system.

2 APPLICABLE DOCUMENTS

2.1 The following documents, of the issue in effect on the date of invitation for bids or request *"for* proposals, form a part of this specification to the extent specified herein. See *6.3.*

SPECIFICATIONS

Federal

J-W-1177	Wire, Magnet, Electrical
W-C-596	Connector, Plug, Electrical; Connector, Receptacle, Electrical
W-F-406	fittings for Cable, Power, Electrical and Conduit, Metal, flexible
HH-P-96	Paper, Gasket; Fiber (Animal or Plant), Sheet
QQ-A-200	Aluminum Alloy,"Bar, Rod, Shapes, Structural Shapes, Tube, and Wire, Extruded; General Specification for
QQ-A-225	Aluminum and Aluminum Alloy-Bar, Rod, Wire, or Special Shapes; Rolled, Drawn, or Cold finished, General Specification *for*
QQ-A-250/2	Aluminum Alloy 3003, plate and Sheet
QQ-A-250/6 ,	Aluminum Alloy 5052, Plate and Sheet
QQ-A-250/11	Aluminum Alloy *6061,* Plate and Sheet
QQ-A-591	Aluminum Alloy Die Castings
QQ-A-596	Aluminum Alloy Permanent and semipermanent Hold Castings
QQ-A-601	Aluminum Alloy Sand Castings
QQ-B-613	Brass, Leaded and Nonleaded: flat Products (Plate, Bar, Sheet, and Strip)
QQ-B-626	Brass, Leaded and Nonleaded: Rod, Shaped, forgings, and Flat Products with finished Edges (Bar and Strip)

WB-637	Brass, Naval: Rod, wire, Shapes, Forgings, and Flat Products with Finished Edges (Bar, flat wire, and Strip)
QQ-B-639	Brass, Naval: Flat Products (Plate, Bar, Sheet, and strip)
QQ-B-728	Bronze Maganese; Rod, Shapes, Forgings, and Flat Products (flat Wire . Strip, Sheet, bar, and Plate)
QQ-B-750	Bronze, Phosphor; Bar, Plate, Rod, Sheet, Strip, Flat Wire, and Structural *and* Special Shaped Sections
QQ-B-825	Bus Bar; Copper, Aluminum or Aluminum Alloy
QQ-C-320	Chromium Plating (Electrodepoeited)
QQ-C-390	Copper Alloy Castings (Including *Cast Bar)*
QQ-C-4S0	Coppe-Aluminm Alloy (Aluini.mm Bronze) Plate, Sheet, Strip, and Bar (Copper AlloY Numbers 606, 612, 613, 614, and 628)
QQ-C-502	Copper Rods and Shapes; end Flat Products with Finished Edges (Flat Wire, Strips, and Bars)
QQ-C-530	Copper Beryllium Alloy Bar, Rod, and wire (Copper Alloy Numbers 172 and 173)
QQ-C-533	Copper Beryllium Alloy Strip (Copper Alloy Numbers 170 and 172)
QQ-N-201	Nickel-Coppe~Alloy Bar, Plate, Rod, Sheet, Strip, wire, Forgings, and Structural and Special Shaped Sections
QQ-N-286	Mckel-Copper-Alumhm Alloy, Wrought
QQ-N-268	Nickel-Copper Alloy and Nickel-Copper-Silicon Alloy Castings
QQ-N-290	Nickel Plating (Electrodeposited)
QQ-P-416	Plating, Cadmium (Electrodeposited)
QQ-S-365	Silver Plating, electrodeposited; General Specification for
QQ-S-764	Steel Bar, Corrosion Resisting, free Machining
QQ-Z-32S	Zinc Coating, Electrodeposited, Requirements for
TT-C-490	Cleaning Methods and Pretreatment of Ferrous Surfaces for Organic Coatings
WW-T-70012	Tube, Aluminum Alloy, Drawn, Seamless, 3003
WW-T-700/b	Tube, Aluminum Alloy, Dram, Seamless, 5052
WW-T-700/6	Tube, Aluminum Alloy, Drawn, Seamless, 6061 .
ZZ-R-765	Rubber, Silicone

Military

MIL-V-173	Varnish, Moisture-and-fungus-Resistant (for TreatMent of Communications, Electronic, and Associated Equipment)
MIL-G-174	Glass, Optical

MIL-C-675	Coating of Glass Optical Elements (Anti-reflection)
MIL-R-900	Rubber Gasket Material, 45 Durometer Hardness
MIL-S-901,	Shock Tests, H.I. (High Impact); Shipboard Machinery, Equipment, and Systems, Requirements for
MIL-G-1149	Gasket Materials, synthetic Rubber, 50 and 65 Durometer Hardness
MIL-C-2212	Controllers, Electric Motor, A.C. or D.C. and Associated Switching Devices, Naval Shipboard
MIL-R-2726	Receptacles, Receptacle Plugs, Switch and Receptacles, and Outlets (Electrical), General Specification for
MIL-R-2765	Rubber Sheet, Strip, Extruded, and Holded Shapes, Synthetic, oil-Resistant
MIL-G-3036	Grommets, Elastic, Hot-Oil end coolant Resistant
MIL-D-3464	Desiccants, Activated, Bagged, Packaging Use and Static Dehumidify-tbn
MIL-C-3469	Canada Balsam
MIL-G-3787	Glass, Laminated, flat; Except Aircraft
MIL-A-3920	Adhesive, Optical, Thermosetting
MIL-S-4040	Solenoid, Electrical, General Specification *for*
MIL-P-S42S	Plastic, Sheet Acrylic, Heat Resistant "
MIL-G-S524	Gland Design; Packings, Hydraulic, General Requirements for
MIL-P-5516	Packing, Performed, Petroleum Hydraulic Fluid Resistant, 160° f
MIL-C-5541	*Chemical* Conversion Coatings of Aluminum and *Aluminum* Alloys
MIL-S-6855	Rubber, Synthetic, Sheets, Strips, Molded or Extruded Shapes
MIL-A-862S	Anodic Coatings, *for* Aluminum and Aluminum Alloys
MIL-T-10727	Tin Plating; Elecrotdeposited or Hot-Dipped, For ferrous and non-ferrous Metals
MIL-M-13S08	Mirror, I'rent Surface Aluminized: For Optical Elemtents
MIL-O-13830	Optical Components for fire Control Instruments; General Specification Governing the Manufacture, Assembly, and Inspection *of*
MIL-R-15624	Rubber Gasket Material, 50 durometer Hardness (Maximum)
MIL-C-15726	Copper-Nickel Alloy, Rod, Flat Products (Flat wire, *Strip,* Sheet. Bar, and Plate), and *Forgings*
MIL-P~16232	Phosphate Coatings, Heavy, Manganese or Zinc Base (for Ferrous Metals)
MIL-T-16387	Transformers, Synchro, Overload
MIL-T-17111	Fluid, Power Transmission
MIL-C-17112	Copper-Nickel-Zinc Alloy (Nickel-Silver): Castings

MIL-E- 17555	Electronic and Electrical Equipment, Accessories, and Repair Parts: Packaging and Packing of
MIL-P-18317	Plating, Black Nickel (electrodeposited) on Brass Bronze 01′ Steel
MIL-P-18388	Coils, Tube Deflection; and Coils, Tube *focusing*
MIl-H-19457	Hydraulic Fluid, Fire Resistant
MIL-C-201S9	Copper-Nickel Alloy (70-30 and 9o-10): castings
MIL-G-20699	Grommets, Rubber, Split, General Purpose
MIL-F-21241	filters, Color, Finished (for Optical Instruments)
MIL-F-21424	*Filters,* Polarizing (for Optical Instruments)
MIL-C-21609	Cable, Electrical, Shielded, 600-Volt, (for Nonflexing Service)
MIL-C-22087	Copper Alloy Investment Castings
MIL-G-22529	Grommet, Plastic
MIL-M-28787	Modules, Electronic, Standard Hardware Program, General Specification for
MIL-G-4S204	Gold Plating, electrodeposited
MIL-G-81168	Gyroscope, Rate Integrating

STANDARDS

Military

MIL-STD-108	Definititions *of* and Basic Requirements for enclosures for electric and Electronic Equipment
MIL-STD-143	Standards and Specifications, Order of Precedence for the Selection of
MIL-STD-150	Photographic Lenses
MIL-STD-167	Mechanical Vibrations of Shipboad Equipment
MIL-STD-210	Climatic Extremes for Military Equipment
MIL-STD-242	Electronic Equipment Parts Selected Standards
MIL-STD-454	Standard General-Requirements for *Electronic* Equipment
MIL-STD-725	Method *of* Marking Scales for Sights and Fire Control Instruments
MIL-STD-740	Airborne and Structureborne Noise measurements and Acceptance *Criteria* Shipboard equipment
MIL-STD-810	environmental Test Methods
MIL-STD-1241	Optical forms and Definitions
MIL-STD-1303	Painting *of* Naval ordnance Equipment
MIL-STD-1364	Standard General Purpose Electronic test Equipment

MIL-STD-1378	Requirements for employing *Standard Hardware Program Modules*
MIL-STD-1389	*Design* Requirements for Stanard hardware Program Electronic ModuLes
MIL-STD-1399	Interface Standard for Shipboard Systems
MS9386	Packing, preformed - MS 7267, "0" Ring
MS9388	Packing, Preformed - WS 7278, " O'. ring
MS28900	Tacking, Preformed, for Electrical Use

DRAWINGS

230989	Polarizing Plates (for Optical Instruments), Sizes of Plates in Service
264831	Fire Control Instruments, Dials, Typical Arrangements
264832	fire Control Instruments, Standard Dials, Details
275109	Spot Dials
SK 84259	instrument window, Gasket Assembly
SK 87448	Gun Mount Dials
SK LD132263	ColoF *Filters for* Optical Instruments

PUBLICATIONS

Naval Sea Systems Command

OD 13726	Nonflexing Cable (WMOS) Installation and Data Handbook
OD 39223	Maintainabilty Engineering Handbook
OP 1700	Standard Fire Control Symbols
or 2230	workmship and Design Practices for electronic Equipment
OP 3440	Special Purpose Test Equipment for Support *of* Naval Ordnance weapon Systems
OR-1	Hark and Hod Nomenclature System

Naval Ship Engineering Canter

Buships STD
9000-S6202-73980 Electrical Standards and type plans

(Copies of specifications, standards, drawings, and publications required by suppliers connection with specific procurement functions should be obtained from the procuring a

2.2 Other publications. The following document forms a part of this specification to the extent specified herein. Unless otherwise indicated, the issue in effect on the date of invitation for bids or request for proposals shall apply. See 6.3

American Society for Testing and Materials

ASTM B117-64 Salt Spray (Fog) Testing

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

3 REQUIREMENTS

3.1 First ARticle. First articles shall be manufactured using the method proposed for production. These first articles will be tested to determine if the proposed production method yields an item which meets the requirements of this specification. The number of first articles shall be as specified in the procurement documents invoking this specification. See 6.2(b).

3.2 Selection of documents. All parts, materials, and processes required for the fabrication of fire control equipment and not specified herein shall be governed by appropriate documents selected in accordance with MIL-STD-143.

3.2.1 Conflicts. In the event of a conflict between the provisions of this specification and a document invoked herein, the former shall govern. In the event of a conflict between the provisions of this specification and the procurement documents invoking this specification, the latter shall govern.

3.3 General design. Fire control equipment (hereinafter referred to as "equipment") shall be designed in accordance with OP 2230. The parts and materials used shall be standardized to the greatest practicable extent in order to lower costs, to enhance parts availability, and to increase the supportability necessary for proper maintenance and service. In order to assure proper interface with the ship and other equipment thereon, fire control equipment shall be in accordance with all appropriate sections of MIL-STD-1399.

3.3.1 Standard parts end materials. Standard parts and materials shall be utilized to the maximum practicable extent. Standard parts and materials are defined as those covered by documents listed in MIL-STD-242 or invoked herein or in the procurement documents invoking this specification.

3 1 1 NON-Standard parts and Materials. Approval for the use of nonstandard parts and materials, defined as any parts or materials not covered by documents listed in MIL-STD-242 or invoked herein or in the procurement documents invoking this specification shall be in accordance with MIL-STD-454, Requirement 22.

3.3.1.2 Interchangeability. Interchangeability shall be in accordance with MIL-STD-454, Requirement 7.

3.3.2 Safety. Equipent shall be designedto minimize hazards to personnel in accordance with MIL-STD-454, Requirement 1.

3.3.3 Human engineering. Human engineering shall be in accordance with MIL-STD-454, Requirement 62.

3.3.3.1 The number of adjustments necessary for normal operation shallbe minimized. Where adjustments must be made in a certain sequence, the proper sequence shall be clearly and permanently indicated near the points of adjustment.

3.3.4 Reliability. A relability program shall be established in accordance with MIL-STD-454, Requirmeents 36.

3.3.5 Maintainability, Maintainability engineering shall be in accordance With OD 39223. A maintainability program shall be established in accordance with MIL-STD-454, Requirement 54,

3.3.6 Accessibility. Accessibility shall be in accordance with MIL-STD-454, Requirement 36. Access to all parts shall be from the front panel unless otherwise specified. See 6.2(d).

3.3.6.1 Cable entrances shall not be in the front *of* equipment, unless below floor level. Controls shall not be located on covers that must be removed for servicing

3.3.7 Tools . Tools needed for calibration, operation, or servicing shall be in accordance with MIL-STD-454, Requirement 63.

3.3.8 Test equipment. Equipment shall be designed such that test equipment required for calibration, operation, and ,maintenance shall be PReferred General Purpose Electronic Test Equipment as defined by and listed in MIL-STD-1364, to the maximum extent practicable. Special purpose test equipment shall be selected from OP 3440 if practicable. The need to develop new test equipment for use with fire control equipment shall be minimized.

3.3.9 Test revisions. equipment shall be designed to Interface with Automatic Test ATE available at the service location. See 6.2(e). Where ATE is not available or not applicable, the equipment shall include self-test devices to verify proper operation end indicate malfunctions. Parameters essential to proper operation and subject to drift out of tolerance during normal operation or as a result of operator *error* shall be monitored by appropriate self-test devices. Test provisions shallbe in accordance with MIL-STD-454, Requirement 32.

3.3.10 Size. Equipment intended for interior installation shall be no more than 72 inches (in.) (1.83 metres) in overall height, including resilient mounts. Equipment intended for interior installation on surface ships shall. be capable *of passage* through a doorway 26 in. (720 millimeteres (MM) wide by 45 in (1.14 m)high with corners rounded on 8- in. (200 mm) radii; and through a hatch 30 in. (760 mm) square with corners rounded on 7.5-in. (190 mm) radii. Equipment intended for installation in submarines shall be capable of passage through a circular hatch 25 in. (635 mm) in diameter; and through an opening 20 in. (500 M) wide and 38 in. (965Mm) high with corners rounded on 10 in. (255 mm radii.. See6.4.

303.10.1 Equipment too large to meet the above requirements shall be separable into units, each of which shall meet *the above* requirement .

3.3.11 Weight Equipment weight shall be minimized. Each individually housed assembly or section of more than 100 pounds (45 kilograms) shall be provided with eye bolts or similar lifting devices which will accomodate a 1-inch (26 mm) line. These devices may be either integral OF removable. removable devices shall be stowed in the equipment and secured so as to avoid loss or displacement during operation of the equipment,

3.3.12 Noise, acoustical. The volume of noise generated by *the* equipment shell not exceed a sound *pressure level,* referenced to 0.0002 microbar (20 vpa), of 50 decibels in enclosed areas and 75 decibels in exposed areas. See 6.2(f).

3.3.13 Enclosures. Enclosures shallbe in accordance with MIL-STD-454, Requirment 55.

3.3.13.1 The degree *of* enclosure shall be at least dripproof for protected areas and splash proof for exposed areas. See 6.2(g).

3.3.13.2 Handles or bails shall be provided *for handling the equipment* and its sections. Handles shall be compatible with the bards and the service environment Each handle shall be capable *of* supporting the entire weight of the item to which it is attached, Handles on the sides or top of enclosures shall be of a recessed, folding, or hinged design.

3.3.13.3 eclosures Shall be fitted with resilient mounts as specified in the procurement documents invoking this specification. See 6.2(h). Shock-mounted equipment shall be designed for mounting not closer than 2 in. (50 mm) to adjacent bulkheads or obstructions. Resilient mounts shall be in accordance with those listed in MIL-STD-740 and shall be replaceable without disassembling equipment within the enclosure to which they are ● ttached.

3.3.14 Moisture pockets. Locations within the equipment which would be likely to collect moisture shall be in accordance with MIL-STD-454, Requirement 31.

3.3.15 Compressed air. Equipment requiring compressed air shall be designed to utilize air supplied in accordance with MIL-STD-1399, Section 106.

3.3.16 Thermal design. Thermal design shall be in accordance with MIL-STD-454 , Requirement 52 , and MIL-STD-1399, Section "204. "

3. 3.16.1 Water cooling of equipment shall be in accordance with MIL-STD-1399, Section 101.

3.3.16.2 Air cooling of equipment shall be in accordance with MIL-STD-1399, Section 102.

3.3.17 Balance. Rotatable and rotating parts, except locking adjustment controls, should be statically and dynamically balanced and supported to prevent damage or unintentional movement under any environmental condition specified herein or in the procurement documents invoking this specification. If weights are necessary for balancing, they shall be securely mounted to prevent dislodgement during operational Or environmental conditions specified herein or in the procurement documents invoking this specification.

3.3.18 Illumination. All lights required for illumination shall be dimmer controlled from zero to full brilliance by optical or electrical means, either singly or in groups. Edge lighting is acceptable. Where observation is necessary for proper operation, illumination shall be from two or more sources. Back-lighted dials illuminated by edge lighting shall be made of material conforming to MIL-P-5425. hunt-lighted plastic dials shall not be used.

3.3.19 Lubrication. Moving parts shall have provisions for appropriate lubrication. Lubrication points and systems shall be arranged so as to prevent the lubricant from escaping or dripping onto anything (such as circuitry) which may be damaged or degraded. Electrical "contacts or connectors shall not be lubricated. Access to lubrication points requiring regular servicing shall not require that the equipment be moved or disassembled. Lubricants and lubrication shall be in accordiance with MIL-STD-454, Requirement 43.

3.3.20 Hydraulics. Hydraulics shall be in accordance with MIL-STD-454, Requirement 49. Hydraulic fluid shall conform to MIL-F-17111 or MIL-H-19457.

3.3.21 Windows.

3.3.21.1 Glass used for protection of indicators and readouts shall be clear and present no distortion when viewed from any angle. Provision shall be made to eliminate glare. Prevision shall be made where appropriate to absorb or remove condensation between surfaces. Glass shall conform to MIL-G-3787, class I, grade C.

3.3.21.2 Plastic viewing windows shall not be used.

3.3.21.3 The thickness of glass windows not having to withstand a pressure differential shall depend upon the minimum linear dimension in accordance with the following:

Dimension of Window	Thickness, in. (mm)	Tolerance, in. (mm)
Less than 7 in. (180 mm)	0.250 (6)	+0.016, -O (+0.5, -O)
7 to 10 in. (180-255 mm)	0.375 (10)	+0.016, -0 (+0.5, -O)
10 to 15 in. (255-320 mm)	0.500 (13)	+0.031, -o (+1.0, -0)
More than 15 in. (330 mm)	0.625 (16)	+0.031, -o (+1.0, -0)

3.3.21.4 Windows shall be installed with gaskets on both sides in accordance with SX 84259, and shall provide the same degree of enclosure as the enclosure in which they are mounted.

3.3.21.5 Window masks shall be installed directly behind the window and treated with a dull black finish.

3.3.22 Tuning dial mechanisms. Tuning dial mechanisms shall be in accordance with MIL-STTD-454, Requirement 42.

3.3.23 Miscellaneous parts. Miscellaneous parts shall be in accordance with table I and the following subparagraphs. If more than one document is listed for a part, the most appropriate one shall apply.

3.3.23.1 Flatted shafts for control knobs shall not be used unless the shaft is an integral part of a standard part, such as a potentiometer, capacitor, or switch.

3.3.23.2 Gaskets shall be attached so as to prevent their displacement when the door or cover over them is removed.

Table I. MISCELLANEOUS PARTS

Parts	Governing documents
Bearings	MIL-STD-454, Requirement 6
Gears and Cams	MIL-STD-454, Requirement 48
Dials and scales	DUG 264831, DWG 264832, DWG 275109, or SK 87448
Grommets	MIL-G-3036, MIL-G-20699, or MIL-G-22S29
Threaded fasteners	MIL-STD-454, Requirement 12
Shafts	QQ-S-764, grade 416
Springs	MIL-STD-454, Requirement 41
controls	MIL-STD-454, Requirement 28
O-rings	MS9386, MS9388, or MS28900
Castings	MIL-STD-454, Requirement 21
Aluminum alloy castings	QQ-A-591, QQ-A-596, or QQ-A-601

3.3.24 Materials. Materials used shall be in accordance with table XI and the following subparagraphs, If more than one document is Listed for a material, the most appropriate one shall apply.

Table II. MATERIALS

Materials	Governing documents
Flammable material	MIL-STD-454, Requirement 3
Fungus-inert material	MIL-STD-454, Requirement 4
Organic fibrous material	MIL-STD-454, Requirement 44
tic-resistant material	MIL-STD-454, Requirement 26
Adhesives	MIL-STD-454, Requirement 23
Electrial Insulators	MIL-STD-454, Requirement 11
Desiccants	MIL-D-3464
Gaskets: For windows, doors and Covers	MIL-G-1149, Class 2 or 3
Gaskets or packing material for hydraulic or pneumatic applications	MH-P-96 or MIL-G-5514
Gaskets or packimg material for other applications	MIL-G-1149, MIL-R-2765, MIL-P-5516, MIL-R-15624, ZZ-R-765, MIL-S-6855, class IL, or MIL-R-900
Dissimilar metals	MIL-STD-454, Requirement L
Ferrous metals and alloys	MIL-STD-454, Requirement: M
Aluminum alloy bars, rods, and shapes	QQ-A-200 or QQ-A-225
Aluminum alloy plates and sheets	QQ-A-250/2, QQ-A-250/8, or QQ-A-250/11
Aluminum alloy tubing	WW-T-700/2, WW-T-700/4, or WW-T-700/6
Brass	QQ-B-613, QQ-B-626, QQ-B-637, or QQ-B-639
Bronze	QQ-B-728, QQ-B-750, QQ-C-390, or QQ-C-450
Copper	QQ-B-825, or QQ-C-502
Copper-beryllium alloy	QQ-C-530, QQ-C-533, or MIL-C-22087
Copper-nickel alloy	MIL-C-15726 or MIL-C-20159
Copper-nickel-zinc alloy	MIL-C-17112
Nickel-copper alloy (Monel)	QQ-N-281, QQ-N-286, or QQ-N-288

[1] or use only where ozone resistance is not necessary.

3.3.24.1 Materials which produce toxic gases or are toxic themselves during normal equipment operation under any environmental condition specified herein or in the procurement documents invoking this specification shall not be used:

3.3.24.2 Unless specifically required, the following materials shall not be used. When so required, their use shall be in accordance with the requirements herein and in the procurement documents invoking this specification. See 6.2(i).

a. Radioactive material
b. Mercury and its compounds and amalgams
c* Magnesium and its alloys
d. Zinc alloy die castings
e. Adhesive tape, except when appropriate for coil-wrapping
f. Wood
Organic fibrous material
h. Plastic having cotton fabric base laminate
i. Cotton or wood flour filld molding compounds

3.3.25 Processes and procedures.

3.3.25.1 Metal treatments shall conform to those of table III. A protective plating or coating shall be applied to all metals which are not corrosion-resistant except for the following:

a. Items bathed in lubricant
b. Interior surfaces of tube, relay, or coil shields
c. Items which are potted, encapsulated, or heretically sealed
d. Where electrical grounding through the surface is required

Table III. METAL TREATMENTS

Treatment	Specification	Additional requirements
Anodic treatment	MIL-A-8625	Shall be used on aluminum and aluminum alloy surfaces where electrical continuity is not required.
Chemical film	MIL-C-5541	Shall be used on corrosion-resistant aluminum alloy surfaces where electrical continuity is required.
Chromium plating	QQ-C-320	
Gold plating	MIL-G-45204	
Nickel plating	QQ-N-290	
Platinum sheathing		Shall be no less than 0.003 in. (0.075 mm) thick.
Silver plating	QQ-S-365	Shall not be used where arcing or corona is likely.
Tin plating	MIL-T-10727	Shall be used for galvanic decoupling on brass or bronze bushings and inserts in aluminum.
Zinc plating	QQ-Z-325	Shall not be used on items in close proximity to electrical circuitry
	type I, class 2	Type I, class 2 plating shall be used on parts exposed to 65°C during normal operation or intermittently exposed to 150°C for short periods.
	type II, class 2	
	type III, class 2	
	type II, class 3	Shall be used on externally threaded parts and washers.
Cadmium plating	QQ-P-416, type II, class 1	Shall not be used on items in close proximity to electrical circuitry.
Phosphate coating	MIL-P-15232	

3.3.25.2 Parts having riveted or welded lap joints shall be plated after all machining operations have been completed, but before welding or riveting. Plating shall be removed from weld areas prior to welding. Subsequent to welding operations, the areas from which plating has been removed shall be replated by hot metal spraying.

3.3.25.3 Bright, reflective finishes shall not be used on exterior surfaces except where functionally necessary.

3.3.25.4 Painting shall be in accordance with MIL-STD-1303. The cleaning and preparation. of ferrous metal and zinc-coated surfaces shall be in accordance with TT-C-490. Plastics shall not be painted unless specifically required. See 6.2(j).

3.3.25.5 Porous plastics or plastics having porous surfaces after machini.ng shallbe coated with varnish conforming to MIL-V-173.

3.3.25.6 Structural welding shall be in accordance with *MIL-STD-454,* Requirement *13.*

3.3.25.7 Brazing shall be in accordiance with MIL-STD-454, Requirement 59,

3.4 Optical design. Optical design shall be as specified in the procurement documents invoking this specification. See 6.2(k). Optical terms used herein are defined in MIL-STD-1241.

3.4.1 Rim edges. Rim edges of all optical parts shall have a *chamfer of 0.020* to 0.015 in. (0.5 to 0.35 mm) at 45° ±5 l.5° as measured along the *face* width. Edges meeting at angles of *135° or more or edges* forming a "roof" shall not be chamfered,

3.4.2 Reticles. Letters and numerals shall be fully legible. Stencil-type letters or numbers shall not be used except for perforated retitles. Line breaks of no more than one-half the line width are acceptable. For retitles containing more than 15 lines, one break per *five* lines or fraction thereof is acceptable. All lines shall appear of uniform width, and the intersections shall appear sharp. Hllet radii at the intersections of reticle lines shall not exceed the line width.

3.4.2.1 The brightness *of any* defect shall not exceed that of the illuminated reticle.

3.4.2.2 Parallelism of reticle flat surfaces shallbe within 5 minutes of arc (1.5 mrad) in " deviation of the light path.

3.4*3 Optical element padding. Shims, wedges, or peening under or around optical elements shall not be used unless specifically approved by the procuring activity. See 6.2(1).

3.4.4 Optical element defects. All polished surfaces shall be free *of* adhesions, grayness, scratches, pits, stains, or other defects that are visible in the field of view or which impair optical performance .

3,4.4,1 Scratches, digs, and bubbles shall not exceed the limits specified in MIL-O-13830.

3.4.4.2 Lenses may have edge chips which do not encroach upon the free aperture of the lens, provided the chips do not interfere with the sealing of the lens In the mount or increase the likelihood of breakage. The surface of chips larger than 0.02 in. (0.5 mm) across their largest dimension shall be "stoned'' to roughen them and lessen reflections and additional chipping.

3.4.5 Diopter setting. Fixed-focus eyepieces shall have a diopter setting of -2.7 ±3 0.3.

3.4.6 *Resolution, visual, In* the center of the field, the limit *of* resolution, defined as the angle separating the centers of the most closely-spaced-lines seen separately and distinctly through the optical system, shall not exceed the greater of:

a. 60 divided by the magnification of the instrument. or
b. 145 divided by the diameter of the entrance pupil-in millimetres (5.7 divided by the diameter of the entrance pupil in inches)

When the limit of resolution is measured in seconds of arc. If the limit of resolution is measured in microradians, it shall mot exceed the greater *of:*

a. 300 divided by the magnification of the instrument, or
b. *700* divided by the diameter of the entrance pupil in millimetres *(28* divided by the diameter of the entrance pupil in inches).

3.4.6.1 Unless the exit pupil of the instrument is leas than 0.05 in. (1.3 mm) in diameter, an auxiliary telescope shall be used between the eyepiece of the instrument end an observer's eye. The auxiliary telescope shall be of such magnification. that the exit pupil of the combination is not greater than *0.05* in. (1.3 mm).

3.4.6.2 The optical system shall be free of visible chromatic aberration, coma, and astigmatism. The loss *of resolution* at increasing angles from the center *af* field shall not be apparent When the eye is focused at the center of the field. Radial distortion of images shall not be noticeable or cause the reticle divisions to fall outside the specified angular tolerance.

3.4.7 Resolution, photographic. The resolution of photographic lenses, together with other Optical characteristics, shall be in accordance with the applicable requirements of MIL-STD-l50.

3.4.8 Stray light. No stray or scattered light or reflections from surfaces within the optical instrument shall be visible in the field of view or enter the exit pupil or be visible in the vicinity *of* the exit pupil. All internal surfaces of parts from which stray or scattered light might be reflected shall be treated to avoid such reflections, and darkened in accordance with MIL-P-18317.

3.4.9 Line of sight shift (LOSS). Variable *focus* optical instruments having cross-line retitles or the equivalent and designed to focus on objects between optical infinity and short distances (e.g., a few hundred yards and a few feet) shall be designed for a minimm value of LOSS, commensurate with operational requirements. The value of LOSS shall not exceed the value specified in the procurement documents invoking this specification. See 6.2(m).

3.4.9.1 LOSS is defined as the change in the line of-sight direction as the instrument focus is changed with the instrument otherwise fixed in position. There is a line *of* sight,. defined as the imaginary line between the center of the reticle and Its projection on the object plane, for each object distance between optical infinity and the minimum focus distance. Iᴅ an ideal instrument, all these lines Would be colinear. In real instruments, the mechanism for accomplishing a change In *focus is less* than perfect, with the result that each line *of* sight is in a slightly different direction. One line of sight is taken as the reference, and the angle that any other line of sight 'makes with the reference is the LOSS for that object distance. Usually the reference line of sight is that for the shortest focus distance.

3.4.9.2 The reference line of sight shall be as specified in the procurement documents invoking this specification. See 6.2(n).

3.4.9*3 The optical instrument shall include one or more external reference surfaces or the equivalent to permit testing the instrument for LOSS in accordance with the method specified herein or in the procurement documents invoking this specification. See 6.2(0). At least one such surface or its equivalent shall be provided to insure that as the instrument is rotated through its range, the optical center of the objective lens or the equivalent remains coincident with the axis of rotation. The design pertaining to the external reference surfaces or equivalent and their function in testing fur LOSS shall be as specified in the procurement documents invoking this specification. See 6.2(p). ,

3.4.10 Reflecting surfaces.

3.4.10.1 *First surface* reflectors on glass or other dielectric shall be of evaporated aluminum *or* equivalent. There shall be no visible discontinuities that adversely affect the field *of view* as seen with the eye in the normal viewing position. First surface mirrors shall *be* protected by an overcoat of silicon monoxide free *of* holes, foreign matter, or perceptable variations in density. A magnesium fluoride protective coating of equivalent uniformity may be used, when approved by the procuring activity, if silicon monoxide is impractical. See 6.2(q). Coatings shall be in accordance with MIL-M-13508. The white light reflectance of any first surface reflector shall be not less than 87.5 percent.

3.4.10.2 The backing for a first surface reflector shall be optical glass or annealed heat-resistant glass having a low coefficient of thermal expansion.

3.4.10.3 Coated internal reflecting surfacs shall be chemically deposited silver. Such sur*faces cm* the outside of a prism or mirror shall be backed with copper and an outer black finish.

The uniformity of the surface shall be such as to cause no discernible unevenness in the field of view.

3.4.10.4 Partially reflecting surfaces shall be of evaporated aluminum titanium dioxide or equivalent material. When evaporated aluminum is used, the surface shall be protected as specified for first surface reflectors.

3.4.11 Cleanliness. The optical surfaces shall be clean and free of condensates and volatile substances.

3.4.12 Lubricants. Lubricants and dust retention greases shall not be used in optical instruments.

3.4.13 Lens caps. Caps shall be provided for exposed lenses and windows.

3.4.14 Filters, optical. Optical filters shall not alter the line of sight alinement by more than 30 percent of its specified tolerance.

3.4.14.1 Color filters shallbe in accordance with MIL-F-21241 and shall be selected from those listed on SK LD132263.

3.4.14.2 Polarizing filters shall be in accordance with MIL-F-21424 and shall be selected from those listed on Drawing 230989.

3.4.1403 Variable density filters shall consist of an assembly containing both a fixed and a rotatable polarizing filter. A clear glass correction plate shallbe positioned in the line of sight when the filter assembly is rotated out of the field, if necessary to avoid refocusing when changing from "clear" to variable density". In the filter assembly the rotatable polarizing filter shall be nearer to the eye. When the planes of polarization of the two plates in the assembly are parallel, this common plane shall be oriented so as to:

a. Reduce surface glare in the target field to a minimum if there are no optical elements between the fixed polarizer and the target which cause nonuniformity in the illumination of the exit pupil as a result of rotation of the plane of polarization, or

b. Reduce surface glare and produce a uniformly illuminated exit pupil when the incident light is plane-polarized in the horizontal or vertical plane and if then is an optical element between the fixed polarizer and the target which causes nonuniformity in the illumination of the exit pupil as a result of rotation of the plane of polarization.

3.4.14.3.1 A single-knob control shall be provided for variable density filters. Rotation of the knob shall move the filter into and out of position for use and shall also adjust the density of the filter between maximum and minimum. An overrun of approximately 5° at each end shall be provided. When the knob is rotated to remove or insert the clear correction plate, the polarizer pair shall be oriented at minimum density.

3.4.15 Optical materials.

3.4.15.1 Optical glass shall be in accordance with MIL-G-174.

3.4.15.1.1 Window glass for use with telescopes shall be parallel to within 1 minute of arc (0.3 mrad), equivalent to 30 seconds of arc (0.15 mrad) image deviation, with a surface figure of not over one fringe for dimensions up to 6 in. (150 mm) and not over one fringe for any circular area up to 6-in. (150-mm) radius.

3.4.15.2 Transparent plastics shall not he used in optical systems except for reticle illuminators,

3.4.15.3 Etch optical surface shall be coated with a reflection-reducing film in accordance with MIL-C-675, with the following exceptions:

a. Surfaces in a focal plane.
b. Surfaces of elements bearing reticle graduations.
c. Surfaces to be cemented.
d. Reflection surfaces (including total internal reflection surfaces).

e. Suraces exposed to the action of a window wiper.
f. Color, neutral. or polarizing filters.

3.4.15.4 Cement used for optical instruments shall be thermosetting adhesive in accordance With MIL-A-3920, Canada Balsam in accordance with MIL-C-3469, cellulose caprate, or epoxy type, as specified in the procurement documents invoking this specification. See 6.2(r). Epoxy cements or similar compounds may be used to support parts within replaceable assemblies. . The cement film binding optical elements shall be free of ford particles, bubbles, cement starts, milkiness, or other defects which reduce the effectiveness of the optical instrument. Excess cement shall be ,removed from the exterior of parts. No reagent shall be used which could be absorbed into the cement film and cause cement starts or other defects, or subsequent deterioration of the cement film.

3.5 Electrical design.

305.1 Standard Hardware Program. The design of fire control equipment shall enploy the Standard Hardware Program to the maximum practicable extent, in accordance with MIL-STD-1378. Electronic modules used or developed for use with the Standard Hardware program shall be in accordance with MIL-STD-1389. and MIL-M-28787.

3.5.2 Electromagnetic compatibility. The equipment shall be in accordance with MIL-STD-454, Requirement 61 and MIL-STD-1399, Sections 401, 408, and 409. See 6.2(s).

3.5.3 Grounding and shielding

3*5.3.1 Neither the chassis nor the enclosure shall be used as a circuit" ground. All grounds within a subassembly or component shall be routed to a single common ground connection within the respective subassembly or component. The ground terminal of each subassembly or component shall be routed to a common ground connection the the enclosure which, in turn, will be routed to the ship structure. Multiple ground terminals on terminal boards and individual grounding of transmission line shields are permissible.

3.5.3.2 Bonding straps of braided or woven copper wire, or a solid strap, shall be provided to bond all enclosures electrically to the ship structure. The method used shall be uniform throughout the equipment.

3.5.3.3 Devices affected by magnetic fields, such as cathod-ray tubes, shall be suitably shielded to minimize the effects of such fields likely to be encountered at the service location of the equipment.

3.5.3.4 The number of mechanical discontinuities in the enclosures shall be minimized. All discontinuities,. such as covers and doors, shall be electrically continuous across the discontinuity. Multiple-point, spring-loaded contacts are a desirable method of obtaining low impedance electrical continuity. Electrical bonding shall be provided where access doorszw or cover plates form a part of the shielding. Hinges, in themselves, are not acceptable as electrical bonds. The mating surfaces of the chassis, enclosure and mounts shall be free of insulation in order to allow a continuous electrical bond between these items and to enable the installing activity to accomplish bonding contact.

3.5.4 Electrical power sources.

3.5.4.1 Unless otherwise specified, the equipment shall be designed to utilize a 440-volt, 3-phase, 60 Hz power source in accordance with MIL-STD-1399, Section 103. See 6.2(t).

3.5.4.2 The use of batteries shall be in accordance with MIL-STD-454, Requirement 27.

3.5.4.3 Electrical power plugs and receptacles shall be in accordance with MIL-R-2726 and shall be identified to indicate the type of power involved.

3,5.5 Electrical power source loading. When power with alternating current as specified herein, the equipment, in any normal operating mode, shall draw no current at any frequency between the 2nd and 23rd harmonic at an amplitude greater than 3 percent Qf the rated load current and nO current at any frequency between the 23rd harmonic and 20kHz at an amplitude greater than $1700/n^2$ percent of the rated load current, where n is the order of the harmonic.

3.5.6 Warmup. The equipment shall be designed to reach stable operation after no more than 30 minutes of warmup time when supplied with the specified input power under anY environmental situation specified herein or in the procurement documents invoking this specification.

3.5.7 Circuit and component protection.

3.5.7.1 Electrical overload protection shall be in accordance with MIL-STD-454, Requirement 8.

3.5.7.2 . Where practicable; circuit breakers in accordance with MIL-STD-454, Requirement 37, . shall be used in lieu of fuses, A circuit breaker shall not be used as a switch.

3.5.7*3 Fuses, fuseholders, and associated hardware shall be in accordance with MIL-STD-454, Requirement 39. At least one spare fuse of each type and rating used in the equipment shall be provided and secured in an easily-accessible location, and identified in an appropriate manner.

3.5.7.4 Electronic circuits that would be damaged by the application of operational voltages without a sufficient warmup period shall include circuitry to delay the application of such voltages after primary power is applied.

3.5.7.5 Electronic parts and materials which are to operate at temperatures above ambient shall be appropriately derated in accordance with MIL-STD-454, Requirement 18.

3.5.7.6 Corona and electrical breakdown prevention shall be in accordance with MIL-STD-454, Requirement 45.

3.5.8 Wiring practices.

3.5.8.1 Stuffing tubes shall be used where applicable to preserve the degree of enclosure at the point of entry of each cable. All stuffing tubes for an enclosure shall be mounted on a plate having enough spare area to accommodate an additional stuffing tube of the largest size mounted thereon. This plate shall be on either of at least two sides of the enclosure. The unused stuffing tube mounting plate areas on the enclosure shall be covered with blank plates of the same configuration as the stuffing tube plate.

3.5.8.2 The equipment shall be equipped with suitable provisions for interfacing properly with data input and communication facilities at the service location, and shall be in accor- . dance with MIL-STD-1399, Sections 502 and 505. See 6.2(u).

3.5.8.3 Internal wiring practices shall be in accordance with MIL-STD-454, Requirement 69.

3.5.5.3.1 Neither side (or phase) of the input power line shall be used as an enclosure or circuit ground. All shipboard AC power is electrically "floating"

3.5.8.4 Synchro wiring shall be in accordance with MIL-STD-1399, Section 702.

3.5.8.5 Printed wiring shall be in accordance with MIL-STD-454, Requirement 17.

3.5.9 Mounting of parts.

3.5.9.1 Cathode-ray indicators shall be mounted so the visual axis, during normal operation, is perpendicular to the face of the indicator at its center. Range rings, angular bearing lines, and and markings shall be easily definable and shall be spaced in accordance with accuracy requirements. Background brightness and surface reflections shall be minimized and viewing " hoods provided in high ambient light areas.

3.5.9.2 Circuit and terminal boards shall be mounted in such a manner that no relative movement between the board and frame occurs during normal operation, Circuitryand parts on circuit boards shall clear all frame parts and other boards by a suitable distance for the voltages involved. Replaceable boards shall be provided with a means of removal which allows removal without damage to board, frame, or parts mounted on the board. Circuit boards shall not be secured solely by connectors.

3.5.9.3 Electronic or electrical parts shall not be mounted on other electrical parts. Part binds, at terminals or elsewhere, shall not be connected directly to other part leads. Part

weighing more than one-half ounce (15 grams) shall be supported by means other than their leads.

3.5.9.4 Readouts and meters shall be removable from the front of *the panel in* which they are mounted and their leads shall be long enough to allow removing the readout or meter without disconnecting it.

3.5.9.5 Each part, module, Or assembly which maybe removed or replaced during normal servicing or maintenance shall be mounted wing electrical connectors and hardware which allows nondestructive disconnection and reconnection.

3.5.9.6 Indicator lamps and fuses shall be replaceable from the front of the panel in which they are mounted.

3.5.10 Potting, impregnation, and encapsulation.

3.5.10.1 All enclosed coils end transformer windings shaLl be potted to insure positional stability, except when electrical characteristics would be adversely affected. Prior to potting, the coils shall be treated to remove moisture and foreign substances.

3.5.10.2 All coils and windings except those which are potted or are contained in hermetically sealed cases shall be dried and impregnated with insulating varnish. The varnish shall completely cover. the wiring wrapping, and coil *form* to create en unbroken film.

3.5.10.3 Encapsulatlm and embedment (potting) shallbe in accordance with MIL-STD-454, Requirement 47.

3.5.11 Electrical interconnections.

3.5.11.1 Electrical soldering shall be in accordance with MIL-STD-454, Requirement S.

3.5.11.2 Resistance welds *for electrical* interconnections shall be in accordande with MIL-STD-454, Requirement 24.

3.5.12 Electrical and electronic Parts and materials. Electrical and electronic parts and materials shall be in accordance with the appropriate documents listed in table IV, and the following:

a. Fluorescent lamps shall not be used as indicators.
b. Operating time meters shall be incorporated as specified in the procurement documents invoking this specification. See 6.2(v).
c. Synchros shall be in accordance with MIL-STd-1399, Section 702.

3.6 Marking. Marking shall be in accordance with MIL-STD-454, Requirement 67 and the following subparagraphs.

3.6.1 Symbols and terminology. symbols *and* terminology shall be in accordance with OP 1700 and MIL-STD-1399, Section 501.

3.6.2 Dials and scales.

3.6,2.1 Dial and scale markings shall be direct reading and shall not require the use of calibration curves or conversion charts.

3.6.2.2 Dial and scale markings shall be in accordance with MIL-STD-725.

3.6,2.3 Where verniers are employed to subdivide scale divisions, the marking and numbering shall have continuity throughout the dial range.

3.6.2.4 Dials and sales shall be mounted so that at least three identifying graduation symbols are visible at any setting or reading.

3.6.3 Optical elements. Optical elements cemented with cellulose caprate shall be marked "cc" on the edges.

Table IV

Electrical and Electric Parts and Materials

Part or material	Governing document
Electron tubes	MIL-STD-454, Requirement 29
Semiconductor devices .	MIL-STD-454, Requirement 30
Microelectronic devices	MIL-STD-454, Requirement 64
Resistors	MIL-STD-454 , Requirement 33
Shunts	MIL-STD-454, Requirement 40
Capacitors	MIL-STD-454, Requirement 2
Transformers, inductors, and coils	MIL-STD-454, Requirement 14
Transformers, synchro overload	MIL-T-16387
Coils, deflection and focusing, CRT	MIL-C-18388
Solenoids	MIL-S-4040
Relays	MIL-STD-454, Requirement 57
Switches	MIL-STD-45S4, Requirement 58
Controllers and master switches	MIL-C-2212
Electrical connectors	MIL-STD-454, Requirement 10
Sockets, shields, and clamps	MIL-STD-454, Requirement 60
Convenience power outlets	W-C-596
Terminals, terminal boards, and terminal strips	MIL-STD-454, Requirement 19
Clamps and supports, cable	OD 13726 and BuSHIPS STD 9000-S6202-73980
Clamp, cable entrance, nonwatertight	W-F-406
Crystal units, quartz	MIL-STD-454 , Requirement 38
Filters, electrical	MIL-STD-454, Requirement 70
Motors, dynamotors, rotary power converters, and rotor generators	MIL-STD-454, Requirement 46
Rotary servo devices	MIL-STD-454, Requirement 56
Gyroscopes, rate integrating	MIL-G-81168
Meters, electrical indication, and accessories	MIL-STD-454, Requirement 51
Readouts	MIL-STD-454, Requirement 68
Indicator lights	MIL-STD-454, Requirement 50
Filters , indicator lamp	MIL-P-5425
Waveguides and related equipment	MIL-STD-454, Requirement 53
Wire, magnet	J-W-1177
wire, hookup, internal	MIL-STD-454, Requirement 20
Cable, multiconductor	MIL-STD-454, Requirement 66
Cable, multiconductor, interconnecting between units	*MIL-STD-454*, Requirement 71
Cable, coaxial (RF)	MIL-STD-454, Requirement 65
Cable, nonflexing	MIL-C-21609 and OD 13726

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

3.6. S Motor rotation. Motors shall be marked in a permanent manner to indicat e the *direction of* rotation. Bidirectional motors shall be identified as bidirectional.

3.6.6 Interior wires. Except for jumpers on a termimal strip or connector, each wire within an enclosure or unit of the quipment shall be uniquely identifiable. Interior wires shall be identified by one of the following methods:

Having the wire designation printed on the wire at intervals along its entire length,
b. Being color-coded along its entire length, or
a. Having appropriately marked white plastic sleeves over the wire at each end.

3.6.6.1 when method a or c is used, the Identification shall consist *of* the terminal designations for the two points connected by the wire, The marking shall be arranged so that the designation of the terminal to which an and of the wire is connected is closest to that and. Intrasystem wiring and cabling connecting equipment under the cognizance *of* the same Navall Command, within the same compartment, mount, or directors and where the cable length Is no greater than 50 *feet* (16 metres), shall be identif ied by method C.

3.7 Nomenclature. The nomenclature for fire control equipment shall be in accordance with OR-1.

3.8 Environmental requirements. Fire control equipment shall be designed to withstand the environmental conditions specified herein, in the procurement documents invoking this specification, and in MIL-STD-1399, Sections 301 and 302, without damage or performance degradation beyond specified tolerances See 6.2(w).

3.8.1 Temperature, ambient, operating. The equipment shall operate normally at any ambient temperature in the operating temperature range specified after a warmup period of no more than 30 minutes. See 6.2(x).

3.8.2 Temperature, storage nonoperating. The equipment shall not be damaged nor its performance degraded after exposure to any temperature between -62°C and 75°C for a period of not less than 72 hours, or by exposure to a temperature change of 135°C over a period of 10 minutes.

3.8.3 Altitude, nonoperating. The equipment shall not be damaged nor its performance degraded after exposure to an altitude of 60,000 feet (18 km) for not less than 8 hours.

3.8.4 Sea pressure (submarine). Any part, accessory, or structural member of an equipment intended for submarine use which may be exposed to external sea pressure shall be capable of withstanding a continuous hydrostatic pressure of 700 pounds per square inch (4.9 HPa) without damage or leakage, and shall be in accordance with the submersible enclosure requirements of MIL-STD-108.

3.8.5 Shock, mechanical. The equipment shall not be damaged nor its performance degraded after being subjected to the Grade A shock tests of MIL-S-901, as applicable for the particular equipment specified. See 6.2(y).

3.8.6 Vibration. The equipment shall nut be damaged nor its performance degraded during exposure to the vibration tests of MIL-STD-167, as applicable for the particular equipment specified. See 6.2(z).

3.8.7 Salt atmosphere. The equipment shall not be damaged nor its performance degraded by exposure to the "salt atmosphere" associated with sea water.

3.8.8 Ice load. Equipment exposed to the elements shall operate normally with an ice load of not less than 4.5 pounds per square foot (22 kg/m²) on all surfs-s subject to the formation of ice. See 6.2(f).

3.8..9 Wind load. Equipment exposed to the elements shall not be damaged by winds of up to 100 knots (50 m/s), and shall operate normally during exposure to winds of not less than 75 knots (40 m/s). See 6.2(f).

3.8.10 Solar radiation. Equipment exposed to the sun at its service location shall not be damaged nor its performance degraded by exposure to solar radiation as defined in MIL-STD-210. See 6.2(f).

3.9 Life, operating. The equipment shall operate normally without the need for maintenance for not less than 200 continuous hours. The equipment should be designed to have a minimum operating life of 12,000 hours, given normal maintenance.

3.10 Workmanship. Workmanship shall be in accordance with MIL-STD-454, Requirement 9.

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 facilties 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.

4.2 Classification of inspections. Inspections specified herein are *of two types:*

a. First article inspection. See 4.4
b. Quality conformance inspection. See 4.5

4.3 Inspection conditions. Unless otherwise specified, the conditions specified in the following subparagraphs shall exist during inspections.

4.3,1 Ambient conditions.

a. Temperature: 25° ± 5°C
b, Humidity: 55 ± 30 percent relative
c* Pressure: normal atmospheric

4.3.2 - Attitude. The equipment shall be tested in the attitude it would assume at its service location on a calm sea. See 6.2(f).

4.3.3 Power. The equipment shall be supplied with electrical power from a source capable of supplying full load current at nominal voltage and frequency. The power source shall maintain its output voltage within 2 percent of nominal and its frequency within 0.1 percent of nominal under all load conditions. When supplying full had current, the power source output shall have a harmonic voltage content at any harmonic from the 2nd to the 23rd not exceeding 0.75 percent of the fundamental and from the 23rd harmonic through 20kHz not exceeding $425/n^2$ percent of the fundamental, where n is the order of harmonic. See 6.2(t).

4.4 . First article inspection.

4.4.1 Samples. Each first article shall be inspected. See 6.2(b).

4.4.2 Procedure. Unless otherwise. specified, the first article samples shall be subjected to the first article inspection of table V in the order listed and using the test procedures specified therein. See 6.2(aa).

4.4.3 Failures. The failure of any first article sample to meet any requirement *specified* herein shall-e *for* denial of production approval.

4.5 Quality conformance Inspection.

4.5.1 Samples. Unless otherwise specified, each fire control equipment submitted *for* acceptance shall be inspected (100 percent inspection). See 6.2(ab).

4.5.2 Procedure. Unless otherwise specified, the quality conformance samples shall be subjected to the quality conformance inspection *of* table V In the order listed and using the test procedures specified therein. See 6.2(ac).

4.5.3 Failure of a sample. The failure of a quality conformance inspection sample to meet any requirement specified herein shall be cause for rejection of that sample and may be cause for revocation of production approval.

4.6 Test procedures.

4.6.1 Preparation for delivery. The material and procedures used to prepare the equipment for delivery shall be examined for conformance to the requirements of section 5 herein.

4.6.2 Size. Each equipment enclosure shall be measured to determine conformance to the requirements of 3.3.10.

4.6.3 Weight. Each equipment enclosure shall be weighed and examined to determine conformance to the requirements of 3.3.11.

4.6.4 Configuration, parts, and materials. The equipment shall be examined to determine conformance to requirements concerning configuration, parts, and materials specified in section 3 herein and in the procurement documents invoking this Specification. see 6.2(C). Assembled equipment shall be prepared for this examination by being exposed as for servicing, with all

Table V

EXAMINATIONS AND TESTS

Name of examination or test and requirement	Requirement	Method"	Order of examinations and tests	
			First article	Quality conformance
Preparation for delivery		4.6.1		1
Size	3.3.10	4.6.2	1	
Weight	3.3.3.1	4.6.3	2	
Configuration, parts, materials	3.3 to 3.7, 3.10, 6.2(c)	4.6.4	3	2
Warmup, electrical	3.5.6	4.6. S	4	3
Performance, detailed	6.2(c)	4.6.6.1	5	
Performance, overall	6.2(c)	4.6.6.2		4
Noise, acoustical	3.3.12	4.6.7		5
Electromagnetic compatibility	3.5.2	4.6.8	7	
Power source loading	3.5.5	4.6.9	8	6
Power source variations	3.5.4.1	4.6.10	9	7
Altitude	3.8.3	4.6.11	10	
Shock, mechanical	3.8. S	4.6.12	11	
Vibration	3.8.6	4.6.13	12	
Temperature, storage	3.8.2	4.6.14	13	
Temperature, operating	3.8.1	4.6.15	14	
Humidity	3.8	4.6.16	15	
Salt atmosphere	3.8.7	4.6.17	16	
Sea pressure	3.8.4	4.6.38	17	
Degree of enclosure	3.3.13.1	4.6.19	18	
Performance, overall	6.2(c)	4.6.6.2	19	
Ice load	3.8.8	4.6.20	20	
Wind load	3.8.9	4.6.21	21	
Attitude	3.8	4.6.22	22	
Other specified tests	6.2(ag)	4.6.23	23	
performance, detailed	6.2(c)	4.6.6.1	24	
lar radiation	3.8.10	4.6.24	25	
Life, operating	3.9	4.6.25	26	

doors, panels, covers, chasses, assemblies, and modules opened, removed, or exposed, as appropriate for a thorough visual examination.

4.6. S Warmup, electrial. The *equipment* shall be energized with electrical power as specified in *3.5.4, using a power source specified in 4.3.3,* shall be allowed to warm up for 35 ± 5 minutes, and shall then be monitored for overall performance in accordance with 4.6.6.2.

4.6.6 *Performance testing.* *Performance, or* operational, testing shall be performed when required to deteermine whether the equipment is capable of accomplishing its intended purpose.

4.6.6.1 Performance, detailed. The equipment shall be operated using all modes, settings, and ranges of its controls and input signals necessary to determine conformance to the specified performance requirements. See 6.2(c), (u). For this test, input signals typical of those which would be received in service shall be supplied, and shall include enough variety to exercise all specified equipment functions. Equipment output signals and internal parameters shall be monitored to determine proper operation. The test procedure shall be as specified in the procurement documents invoking this spcification. See 6.2(k), (o), and (ad).

4.6.6.2 Performance, overall. This test is intended to indicate the occurrence of operational damage or impairment as a result of testing. This test should be simple and easy to set up, and should be in the form of continuously monitoring critical parameters whose deviation from tolerances would indicate impending or actual failure. See 6. 2(ae).

4.6.7 Noise, acoustical. The equipment, operating in its loudest mode, shall be monitored for acoustic noise level in. accordancs with *MIL-STD-740.*

4.6.8 Electromagnetic compatibility. The equipment shall he tested for electromagnetic emissions and susceptibility in accordance with MIL-STD-454, Requirements 61. See 6.2(s).

4.6.9 Power source loading The equipment shall be operated in the the producing the highest input voltage harmonics. while supplied with power from a source in accordance with 4.3.3 . herein. The harmonic voltage content of the input power shall be determined at all frequencies up to 20 KHz.

4.6.10 Power source variation. The equipment shall be supplied with power from a source capable of providing the variations specified herein, shall be allowed to warm up, and shall be subjected to the overall performance test of 4.6.6,2. The power soure shall then be varied as described herein for a period of not less than 6 hews, during which time the overall performance of the equipment shall be monitored in accordance with 4.6.6.2. Each characteristic being varied shall continue for the remainder of the test in the Varying condition .The Variations from nominal specified herein represent deviations to be expected from shipboard power supplies, end are described in MIL-STD-1399, Section 103. When the following procedures refer to "limits specified", the limits specified in MIL-STD-1399, Section 103 shall be utilized,

4.6.10.1 The line-to-line voltage shall be continuously cycled between the limits specified, each cycle taking 4 ± 0.5 minutes, The cycling shall continue for not less than one hour.

4.6.10.2 At the start of the second hour an unbalance, of the limits specified, shall be introduced between phases. Single-phase power is exempt from this portion of the test. This phase unbalance shall continue for not less than one hour.

4.6.10.3 At the start of the third hour, amplitude modulation of the limits specified shall be included, and shall continue for not less than one hour.

4.6.10.4 At the start of the fourth hour, the frequency shall be cycled between the limits specified, each cycle taking 3 ± 0.5 minutes. This cycling shall continue fur not less than one hour.

4.6.10.5 At the start of the fifth hour, transients of the type and limits specified shall be introduced once every 5 ± 0.5 minutes. A total of thirteen such transients shall be epplfed.

4.6.10.6 At the start of the sixth and last hour, the sinusoidal waveform of the power source shall be distorted to the limits specified, and the distortion shall continue for not less than one hem.

4.6.11 Altitude. The equipment, not energized, shall be subjected to reduced atmospheric ressure (55 mm HG or 7.3 k pa) corresponding to an altitude of not less than 60,000 feet (18 km) for not less than 8 hours, and shall then be examined for mechanical damage.

4.6.12 shock mechanical. The equipment, not energized, shall be subjected to applicable shook testing in accordance with MIL-S-901, and shall then be examined for mechanical damage, See 6.2(y).

4.6.13 Vibration. The equipment shall be energized and allowed to warm up in accordance with 4.6.5, '1 be monitored for overall performance in accordance with 4.6,6.2 for the duration of this test. The operating equipment shall be subjected to type I vibration testing applicable to the equipment in accordance with MIL-STD-167, and shall then be examined for mechanica1 damage. See 6.2(z).

4.6.14 Temperature, storage. The unenergized equipment shall be placed in a temperature chamber Maintained at -62° t 0°, -5°C for not less than 72 hours. After this cold storage, the equipment shall be transferred to a temperature chamber maintained at 75° ± 3°c. The transfer shall be completed within 10 minutes. The equipment shall remain in the hot chamber for not less than 72 hours.

4.6.34.1 After the 72-hour hot storage period, the equipment Shall again be transferred, within 20 minutes, to the cold storage chamber of 4.6.14, where it shall remain for not less than 4 hours. In this manner, the cold-hot cycle shall be repeated four times after the initial 144-hour cycle , except that the repeated cycles shall consist of not less than 4 hours at ● ach temperature extreme.

4.6.14.2 At the conclusion of this test, the equipment shall have been in cold storage for not less than 88 hours, in hot storage for not less than 88 hours, and will have been transferred from one to the other nine times. After the last 4-hour hot storage period, the equipment shall be returned to room temperature and left for not less than 4 hours before further testing.

4.6.15 Temperature, operating. The equipment shall be placed in a temperature chamber at room temperatures energized and warmed up in accordance with 4.6.5, and shall be mitered for overall performance in accordance with 4.6.6.2 for the remainder of this test.

4.6.15.1 The temperature shall be lowered in 10° ± 0.5°C increments every 30 ± 5 minutes until the lowest specified operating temperature +0°, -5° C is attained. This temperature shall be obtained for not less than 24 hours. See 6.2(x).

4.6.15.2 The temperature shall then be raised in 10° ± 0.5° C increment every 30 ± 0.5 minutes until the highest specified operating temperature +0°, -So C is attained. This temperature shall be maintained for not less than 4 hours. See 6.2(x).

4.6.15.3 The tempature shall then be lowered in 10° ± 0.5° C increments every 30 ± 5 minutes until room temperature is attained, after which the equipment shall be operated for not less than 4 hours.

4.6.16 Humidity. .

4,6.16.1 The equipment, exposed as for servicing and not energized, shall be dried for notrv less than two hours at a temperature of 45° ± 5° C and at relative humidity not exceeding 30 percent in a suitable temperature-humidity chamber.

4.6.16.2 The equipment shall then be securedd for normal operation, shall be energized and warmed up in accordance with 4.6.5, and shall be monitored for overall performance in accordance with 4.6.6.2 for the remainder of this test.

4.6.16.3 The equipment shall be subjected to five temperature-humidity cycles as follows:

a. The temperature shall be raised gradually for 1.3 ± 0.2 hours to 60° ± So C or the maximum specified operating temperatures whichever is lower, and maintained for not less then 16 hours. See 6.2(x). During the 16-hour period, the relative humidity shall be not less than. 95 percent.

b. The temperature shall then be lowered gradually for 1.3 ± 0.2 hours to 30° ± 5°C, and maintained for not less than 8 hours. During the 8-hour period, the relative humidity shall be not less than 95 percent.

4.6.16.4 The temperature shall then be raised gradually for 0.8 ± 0.2 hour to 50° ± 5°C or the maximum specified operating temperature, whichever is lower, and maintained for not less than 8 hrs. See 6.2(x). During the first 2 ± 0.2 hours of the 8-hour period, the relative humidity shall be 50 ± 5 percent. For the following 4 ± 0.3 hours, the relative humidity shall be not less than 90 percent. During the reading the, the relative humidity shall be 40 ± 5 percent.

4.6.16.5 At the conclusion of the test, the equipment shall be exposed as for serrvicing, and shall be examined for evidence of corrosion, deterioration, or damage caused by condensation.

4.6.17 Salt atmosphere. A salt spray test in accordance with ASTM Bl17-64 shall be performed on frames and enclosure of the equipment. Only one of similar frames or enclosures need be tested. The test duration shall be 200 hours.

4.6.18 Pressure tests as specified in the procurement documents invoking this specificat on shall be conducted on the equipment, as applicable. See 6.2(af).

4.6.19 Degree of enclosure. The degree of enclosure shall be determined in accordance with MIL-STD-108.

4.6.20 " Ice load. The surfaces of the equipment subject to ice loading shall be ice-loaded or treated to simulate ice weight, thickness, and temperature, to no less than 4.5 pounds per

square foot (22kg/m²). The equipment shall then be energized and warned up in accordance with 4.6,5 and its performance monitored in accordance with 4.6.6.2, The equipment shall also be exercised as applicable to determine ifthe ice loading has damaged the equipment or restricted its moments beyond tolerances. See 6.2(c) and (f)*

4.6.21 Wind load. Equipment components subject to wind loads shall be wind-loaded or treated to simulate a wind load of not less than 100 knots (50 m/s) for 5 ± 1 minutes in each-of four directions 90° ± 5° apart. The wind load shall then be decreased to 75 ± 5 bets (40 m/s), and the test repeated. The equipment SW have been energized and warned up in acccmlance with 4.6.5 and shall have its overall performance monitored in accordance with 4.6.6.2 during the 75-knot test. The 75-knot wind shall be maintained in each of the four directions long enough to exercise the equipment and detect any damage Or restrictions of movement beyond tolerances specified. See 6.2(c) and (f).

4.6.22 Attitude. The equipment shall be energized and warmed up in accordance with 4.6.5 and monitored for overall. performance in accordance with 4.6.6.2 for the remainder of this test. The equipment shall be subjected to the maximum roll angle and rate for its intended service location in accordance with MIL-STD-1399, Section 301, for not less than 2 hours. The test shall then be repeated with the roll axis rotated 90° in the horizontal plane. See 6.2(f).

4.6.23 Other tests. The equipment shall be subjected to other test procedures as specified in the procurement documents invoking this specification. See 6.2(ag).

4.6.24 Solar radiation. The equipment shall be warmed up in accordance With 4.6.5 and shall be monitored for overall performance in accordance with 4.6.6.2 for the remainder of this test. Those portions of the equipment subject to solar exposure shall be subjected-to procedure 11 of Method 505 of MIL-STD-810. See 6.2(f).

4.6.25 Life, operating. The equipment shall be warned up in accordance with 4.6.5 and shall be monitored for overall performance in accordance with 4.6.6.2 for the remainder of this test. The equipment shall be operated continuously for not less than 200 hours, during which time only normal operating adjustments shall be made. The need for service, maintenance, or recalibration shall indicate failure.

5 PREPARATION FOR DELIVERY

5.1 Preservation, packaging, and packing preservation, packaging, and packing shall be in accordance with MIL-E-17555 and the procurement documents invoking this specification. See 6.2(ah).

5.2 Level of packaging and packing. The level of packaging and packing shall be as specified in the procurement documents invoking this Specification. See 6.2(ai).

6 NOTES

6.1 Intended use. Equipment furnished in accordance with this specification is intended for use as a component or subsystem of a fire control system, or a complete fire control system, for a weapon system installed aboard a ship or submarine.

6.2 Ordering data. This specification includes the general requirements for the procurement of fire control equipment, There are, however, numerous instances herein where additional or specific information or requirements are necessary to make the procurement package complete. The ordering data list which follows notes only those instanccs herein where the procurement documents invoking this Specification" are referenced. In addition to the following information, the procurement documents invoking this specification should also include, in detail, specific additions, modifications, and exceptions to the provisions herein.

(a) Title, number , and date of this specification.

(b) Number of first articles to be manufactured (3.1, 4.4.1)

(c) Specific requirments concerning configuration, physical design, dimensions, parts materials, operation and performance, etc. (4.6.4, 4.6.6.1, 4.6.21)

(d) Whether access *for service* shall be from other than the front. (3.3.6)

(e) Type, extents and interfacing requirements for automatic test equiprnmt to be used in or *with* the equipment at its service location. . .

(f) Extended service location *or* locations aboard ship. (3.3.32, 3.8.8, 3.8.9, 3.8.10, 4.3.2, 4.6.20, 4.6.21, 4.6.22, 4.6.24)

(g) Degree of enclosure if other than drip proof for protected areas and splash proof for exposed areas. (3.3013.1, 4.6.19)

(h) Whether a resilient mounting *system* is to be used, and, *if* so, the specific requirements *for* it. (3.3.23.3)

(i) whether any of the restricted materials listed in 3.3.24.2 are to be used.

(j) whether plastic parts shall be painted. (3.3.25.4)

(k) Optical system requirements. (3.4)

(1) Whether shims, wedges, or peening around optical elements is acceptable. (3.4.3)

(m) Line *of* sight shift tolerance, if applicable. (3.4.9)

(n) *Reference* line of sight, if applicable. (3.4.9.2)

(0) method of reassurimg the LOSS, if applicable. (3.4.9.3)

(p.) Optical *reference* surface requirements, inapplicable. (3.4.9.3)

(q) whether magnesium *fluoride mirror* coating is acceptable. (3.4.10.1)

(r) The cement to be used *for* optical elements. (3.4.15.4)

(s) Class of equipment as defined *in* MIL-STD-461. (3.5.2, 4.6.8)

(t) Power source required if other than type I, 440 *V,* 3 phase, 60 Hz in accordance with MIL-STD-1399, Section 103; and full load input current requirements, (3.5.4.1, 4*3.3)

(u) *Interfacing* requirements *for data* inputs. *(3.5.8.2, 4.6.6.1)*

(v) requirement *for* and location *of* time totalizing maters. (3.5.12b)

(u) Environmental requirements(;o:)incltid in this specification, and exemptions *or* additions to those *which are* included. .

(x) Operating ambient temperature range. (3.8.1)

(Y) Portions of MIL-S-901 which apply. (3.8.5, .4.6.12)

(z) Portions of MIL-STD-167 which apply. (3.8.6, 4.6.13)

(aa) Deviations from table V for first article inspection. (4.4.2)

(ah) Sampling plan for quality conformance inspection, *if* other than l00%. (4.5.1)

(at) Deviations from table V for quality conformance inspection. (4.5.2)

(ad) detailed performance and operations verification procedure. (4.6.6.1)

(ae) Overall performance monitoring procedure. (4.6.6.2)

(af) Sea pressure test, if applicable, (4.6.18)

(ag) environmental testing procedures for environmental requirements not included in this specification (4.6.23)

(ah) Preservation, packaging, and packing requirements. (5.1) .

(ai) Level of packaging and packing. (5.2)

6.3 Applicable documents cross-references. Because of the large number of documents referenced herein, the following tabulations are included to assist the reader in assembling the references,

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6.4 Metrication. This document has been annotated with metric equivalents of quantities not expressed in the International System of Units. The equivalent units are in accordance with ASTM E380-72 as adopted by the DOD on 29 November 1973, and are included for the purpose of encouraging metrication. Rather than exact equivalents, the metric quantities are given in conveniently rounded amounts within the tolerances specified.

PReparing Activity:

NAVY - 0s

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Note: Due to the extensiveness of the changes, the margins of this specification have not been marked to indicate changes from the previous issue.

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SUBJECT INDEX (Cont'd)

SUBJECT INDEX(Cont'd)

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