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(See 6.8)

MILITARY SPECIFICATION

RELAYS - POWER, ELECTRICAL SPECIALTY, INDUCTION TYPE, NAVAL SHIPBOARD USE

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

1. SCOPE

1.1 Scope. This specification covers the general requirements for high-impact (HI) shockproof relays for electric equipment for Naval shipboard installation.

1.2 Classification. Relays shall be of the following categories as specified (see 6.2.1).

Category A - 500,000 operations.
Category B - 100,000 operations.
Category C - 25,000 operations.

2. APPLICABLE DOCUMENTS

2.1 Government documents.

2.1.1 Specifications and standards. The following specifications and standards form a part of this specification to the extent specified herein. Unless otherwise specified, the issues of these documents shall be those listed in the issue of the Department of Defense Index of Specifications and Standards (DoDISS) and supplement thereto, cited in the solicitation.

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: Commander, Naval Sea Systems Command, SEA 53Z3, Department of the Navy, Washington, DC 20362-5101 by using the self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

AMSC N/A FSC 5945

SPECIFICATIONS

FEDERAL

PPP-F-320 - Fiberboard: Corrugated and Solid, Sheet Stock (Container Grade) and Cut Shapes.

MILITARY

MIL-M-14 - Molding Plastics and Molded Plastic Parts, Thermosetting.
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-E-2036 - Enclosures for Electric and Electronic Equipment, Naval Shipboard.
MIL-P-15024 - Plates, Tags and Bands for Identification of Equipment.
MIL-P-15024/5 - Plates, Identification.
MIL-E-17555 - Electronic and Electrical Equipment, Accessories, and Provisioned Items (Repair Parts): Packaging of.
MIL-L-19140 - Lumber and Plywood, Fire-Retardant Treated.
MIL-R-19523 - Relays, Control, Naval Shipboard.

STANDARDS

MILITARY

MIL-STD-105 - Sampling Procedures and Tables for Inspection by Attributes.
MIL-STD-109 - Quality Assurance Terms and Definitions.
MIL-STD-130 - Identification Marking of US Military Property.
MIL-STD-167-1 - Mechanical Vibrations of Shipboard Equipment (Type I - Environmental and Type II - Internally Excited).
MIL-STD-202 - Test Methods for Electronic and Electrical Component Parts.
MIL-STD-461 - Electromagnetic Emission and Susceptibility Requirements for the Control of Electromagnetic Interference.
MIL-STD-462 - Electromagnetic Interference Characteristics, Measurement of.
MIL-STD-471 - Maintainability Verification/Demonstration/Evaluation.
MIL-STD-740 - Airborne and Structureborne Noise Measurements and Acceptance Criteria of Shipboard Equipment.
MIL-STD-781 - Reliability Testing for Engineering Development, Qualification and Production.
MIL-STD-810 - Environmental Test Methods and Engineering Guidelines.
DOD-STD-1399 Section 300 - Interface Standard for Shipboard Systems Electric Power, Alternating Current. (Metric)

thickness; required thickness; required thickness; required

2.1.2 Other Government document. The following other Government document forms a part of this specification to the extent specified herein. Unless otherwise specified, the issue shall be that in effect on the date of the solicitation.

DEPARTMENT OF LABOR
Code of Federal Regulations, Title 29
Part 1910 Occupational Safety and Health Standards

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

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

2.2 Order of precedence. In the event of a conflict between the text of this specification and the references cited herein (except for associated detail specifications, specification sheets or MS standards), the text of this specification shall take precedence. Nothing in this specification, however, shall supersede applicable laws and regulations unless a specific exemption has been obtained.

3. REQUIREMENTS

3.1 First article. When specified in the contract or purchase order, a sample shall be subjected to first article inspection (see 4.3 and 6.3).

3.2 Safety. The equipment shall provide fail-safe features for safety of personnel during the installation, operation, maintenance, and repair or interchanging of a complete equipment assembly or component parts thereof. Equipment design for personnel safety shall be equal to or better than the appropriate requirements of the Occupational Safety and Health Act (OSHA) as identified in Title 29, Part 1910, of the Code of Federal Regulations (CFR). Except as required herein, safety design requirements shall be in accordance with MIL-E-917.

3.2.1 Leakage current. Leakage current shall not exceed 5 milliamperes in accordance with MIL-E-917 (see 4.5.4.7).

3.2.2 Carcinogens. Certain chemicals have been identified in OSHA as cancer producing substances (carcinogens). Before using any materials which might contain these chemicals, they shall be evaluated in accordance with the CFR, Title 29, Chapter XVII, Part 1910.

3.2.3 Ozone. Ozone shall not be liberated by or from the equipments in amounts to cause a concentration greater than either 0.1 part per million (p/m) average or 0.3 p/m peak within a 28.3 cubic meter room during an 8 hour period.

3.3 Materials, parts, and processes. Materials, parts, and processes shall be in accordance with MIL-E-917.

3.3.1 Recovered materials. Unless otherwise specified herein, all equipment and articles incorporated in the products covered by this specification shall be new and may be fabricated using materials produced from recovered materials to the maximum extent practicable without jeopardizing the intended use. The term "recovered materials" means materials which have been collected or recovered from solid waste and reprocessed to become a source of raw materials, as opposed to virgin raw materials. None of the above shall be interpreted to mean that the use of used or rebuilt products is allowed under this specification unless otherwise specifically specified.

3.3.2 Toxicity. The material shall have no adverse effect on the health of personnel when used for its intended purpose (see 4.3.4). Questions pertinent to this effect shall be referred by the contracting activity to the Naval Medical Command who will act as an advisor to the contracting activity.

3.3.3 Material compatibility. Materials which through outgassing or other physical phenomena cause deterioration of other materials or degradation of equipment performance shall not be used.

3.3.4 Nonstructural parts. Nonstructural parts such as terminal boxes, housing, ducts, and similar parts shall be fabricated from aluminum alloy.

3.4 Construction. Unless otherwise specified herein, the construction of the relay shall be in accordance with MIL-E-917.

3.4.1 Class of insulation. The class of insulation shall be in accordance with MIL-E-917, class B, except that coils may be class A or H.

3.4.2 Molded plastic. In general, molded plastic parts used for electrical insulating purposes shall conform to type MAI-60 in accordance with MIL-M-14. An orderly changeover to these new glass-filled fire and arc resistant materials shall be made. Existing stocks of molded parts using approved grades of asbestos-phenolic molding material may be utilized until exhausted. Additional shock tests on devices using the new materials produced from old molds or dies (originally designed for CFI or MFI material) shall not be necessary. Where existing molds or dies are not reasonably adaptable to molding the new materials, it will be satisfactory to continue using the present molding compound for the life of the mold subject to approval of the contracting activity. The use of any other molded material shall be subject to the approval of the contracting activity.

3.4.3 Input power. The relay shall fully meet the performance requirements of 3.7 when energized by type I power in accordance with DOD-STD-1399, section 300 (see 4.5.4.8).

3.4.4 Characteristics. Relays shall have the following characteristics as specified (see 6.2.1):

Type:
Overload: magnetic
Auxiliary
Voltage
Current
Reverse current

Activating characteristics:
Instantaneous
Inverse time
Definite time

Voltage:
Alternating current (ac)
28 volts, single phase
115 volts, single phase
230 volts, single phase
440 volts, single phase
110 volts, three phase
220 volts, three phase
440 volts, three phase
Special, all others
Direct current (dc)
28 volts
115 volts
230 volts
250 volts (nominal), operating range
175 to 355 volts, submarine service
500 volts (nominal), operating range
350 to 710 volts, submarine service
Special, all others

Current:
Ac or dc (operating values shall be as specified (see 6.2.1))

Time delay:
0.1 second - 10 seconds

3.4.5 General features.

3.4.5.1 Frequency. Unless otherwise specified (see 6.2.1), ac relays shall be designed for operating at a frequency of 60 hertz (Hz).

3.4.5.2 Duty.

3.4.5.2.1 Continuous duty. Relays designed for continuous duty shall operate under rated conditions for an indefinite period without exceeding the limitations specified herein.

3.4.5.2.2 Intermittent duty. Relays designed for intermittent duty shall operate under the specified load and time conditions of the connected load without exceeding the limitations specified herein.

3.4.5.3 Contacts. Contacts shall be of simple and rugged construction and, except for those used on overload relays, shall be easily renewable. The design shall be such that slight projections which may occur during service use shall not prevent proper operation of the contacts.

3.4.5.4 Springs. Springs shall insure the proper functioning of the equipment to which attached. In no case, however, shall they be stressed beyond their fatigue limits. Where the design is such that springs are utilized to carry current, the value of current shall be limited to such a degree that the mechanical characteristics of the springs are not impaired. The preferred method of limiting current in springs is shunting by means of a pigtail or braid.

3.4.5.5 Magnet coils. Magnet coils, of the removable type, shall be readily removable from the relay without injury to the coil. The coils shall be rigidly held so as to prevent damage to the coil leads. Magnet coils shall be marked for ready identification.

3.4.5.6 Endurance. Moving parts and parts subject to burning shall withstand the endurance requirements for the relay specified in 1.2 for mechanical durability and arc rupturing ability (see 4.5.4.11.2).

3.4.5.7 Shockproofness. Relays shall withstand class HI shock (electrical operation and mechanical damage) in conformance with MIL-S-901 grade, class and type as specified (see 4.5.4.13 and 6.2.1).

3.4.5.8 Vibration. Relays shall withstand type I vibration tests as specified in MIL-STD-167-1, without mechanical damage, contact chatter, or other maloperation.

3.4.5.9 Enclosures. Enclosure shall be in accordance with the applicable requirements of MIL-E-2036 (see 4.5.4.5).

3.5 Reliability. The upper test mean time between failure (MTBF), for continuous and intermittent operation, in accordance with MIL-STD-781, shall be 1500 hours under the environmental conditions specified for the equipment when tested in accordance with 4.5.4.17.

3.6 Maintainability. The relay shall facilitate troubleshooting, fault isolation and repair, down to the lowest non-repairable part or non-repairable assembly (see 4.5.4.18).

3.6.1 Interchangeability. In no case shall parts be physically interchangeable or reversible unless such parts are also interchangeable or reversible with regard to function, performance and strength.

3.7 Performance.

3.7.1 Relay coil resistance, power consumption, and power factor. Relay coil resistance, power consumption and power factor shall be within 10 percent of the value shown on drawings specified in 3.15 (see 4.5.4.11.1).

3.7.2 Auxiliary relays, two position relays, latching relays, and magnetic resets. When employing shunt coils, auxiliary relays, two position relays, latching relays, and magnetic resets, they shall operate satisfactorily within the limits specified in table I.

TABLE I. Operating limits.

Voltage	Application	Percent of nominal voltage	
		Pick-up and seal	Operation
Ac	All vessels	75 ± 5	80 to 120
Dc	Surface vessels only	75 ± 5	80 to 120
Dc	Submarines only	65 ± 5	70 to 140

3.7.2.1 Drop-out voltage. Relays shall drop out at between 35 to 65 percent of the rated voltage at the rated frequency unless otherwise approved by the contracting activity (see 6.4.20).

3.7.3 Reverse current.

3.7.3.1 Polarity. The polarity for reverse current relays shall be clearly marked to insure proper connection in the circuit.

3.7.3.2 Sensitivity. Operation shall occur when current in the reverse direction has reached a value not greater than 5 percent of the rating, unless otherwise approved by the contracting activity.

3.7.4 Overload relays.

3.7.4.1 Compensation. Overload relays shall be of the compensated type. The change in rating of the relay shall not exceed 3.0 percent for each 10 degrees Celsius (°C) change in ambient temperature in the range between 20 and 70°C. Neither the average change per 10°C between the 20°C and the 70°C curves, nor the average change per 10°C between any other two curves shall exceed 3.0 percent, based on the lower ambient curve.

3.7.4.2 Adjustability. Overload relays shall be adjustable over the range of plus or minus 10 percent of the normal rating. Overload relays shall be easily adjustable without the use of special tools.

3.7.4.2.1 Magnetic type relay. Magnetic type relays shall have an adjustability of 90 to 160 percent of the normal rating, when designed for applications other than motor protection of the same type afforded by thermal relays, when designed for applications other than motor protection.

3.7.5 Contact millivolt drop. Relays shall not exceed a contact millivolt (mv) drop of 175 mv for an individual reading, or 150 mv for an average reading.

3.8 Environmental.

3.8.1 Ambient temperature (see 4.5.4.9).

3.8.1.1 Fifty degrees Celsius ambient. The rating of the equipment shall be based upon an ambient temperature of 50°C. For those installations where the maximum normal operating temperature of the surrounding atmosphere or other cooling medium is greater than 50°C, the rating of the equipment shall be based upon the special ambient temperature specified in 3.8.1.2 (see 6.2.1).

3.8.1.2 Special ambient. Where the maximum normal operating temperature of the surrounding atmosphere or other cooling medium is higher than 50°C, the rating of the equipment shall be based upon the special ambient temperature specified.

3.8.2 Temperature rise. Temperature rises shall not exceed limits as specified in MIL-R-19523 as applicable.

3.8.3 Humidity. The relay shall meet the requirements of this specification when exposed to the humidity range as specified in MIL-STD-810 (see 4.5.4.10).

3.8.4 Electromagnetic interference (EMI). The relay shall fully meet the EMI requirements in accordance with MIL-STD-461.

3.8.5 Noise. Noise reduction control of noise generated by relays shall be accomplished by proper design of the equipment and of those parts which are inherently a source of airborne and structureborne noise including the dynamic balancing of rotating equipment. The use of exterior soundproof enclosures and of sound isolation mounts is prohibited. If resilient mounting of components or equipment is authorized, metal parts of such components (for example, transfer cores) shall be connected to the equipment frame by a ground lead, to reduce potential electric shock hazard (see 4.5.4.16).

3.8.6 Insulation resistance. The insulation resistance when corrected to 25°C shall be not less than 10 megohms (see 4.5.4.6).

3.8.7 Dielectric strength. 60 Hz relays rated at 600 volts or less shall withstand a dielectric ac root mean square (rms) test voltage of twice the rated voltage plus 1,000 volts for a period of 1 minute. Equipment rated over 600 volts shall withstand a dielectric ac rms test voltage of 2-1/2 times the rated voltage plus 2,000 volts for a period of 1 minute (see 4.5.4.12).

3.9 Resistance. The relays shall withstand the resistance test specified in 4.5.5.

3.10 Sealing. The relays shall withstand the sealing test specified in 4.5.6.

3.11 Inclination. Relays shall be designed to operate at rated voltage when inclined at an angle of 60 degrees from the vertical in any direction (see 4.5.8).

3.12 Visual and mechanical examination. The relays shall be examined as specified in 4.5.1.

3.13 Identification plates. Identification plates shall conform to type A, B, or C in accordance with MIL-P-15024, MIL-P-15024/5 and MIL-STD-130. These plates shall be installed on the relay for which they are intended. They shall be attached to the part of the relay which will not ordinarily be renewed during its normal service life. Unless otherwise approved by the contracting activity, the minimum data to be marked on identification plates shall include the following items:

(a) Manufacturer's name and catalog number.
(b) Blank space for Government inspector's official stamp.
(c) Standard Navy stock number; (this number may be obtained from the ordering activity prior to shipping).

3.14 Workmanship. All metal surfaces shall have a smooth finish. Details of manufacture, including the preparation of parts and accessories, shall be in accordance with the best practice for high quality electrical equipment. Particular attention shall be given to neatness and thoroughness of soldering, wiring, impregnation of coils, marking of parts, plating, lacquering, riveting, clearance between connections, ruggedness, and suitability of enclosure.

3.15 Drawings. When specified in the contract or order, drawings shall be prepared (see 6.2.2).

4. QUALITY ASSURANCE PROVISIONS

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

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

4.1.2 Terms and definitions. Quality assurance terms and definitions shall be in accordance with MIL-STD-109.

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

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

4.3 First article inspection. First article inspection shall consist of three samples subjected to tests specified in table II. Unless otherwise specified, inspections and tests shall be conducted in the order listed herein. First article tests shall be repeated every 3 years, or after every 10,000 relays.

4.3.1 First article inspection report. When specified in the contract or order, the contractor shall prepare first article test reports (see 6.2.2).

4.3.2 Sample for first article inspection. One relay of each type shall be submitted for examination and tests at its rated frequency system applications, as specified in table II.

TABLE II. First article and quality conformance inspection.

Test	Requirement	Test method	First article	Quality conformance inspection	
				Group A	Group C
Resistance	3.9	4.5.6			X
Sealing (sealed relay only)	3.10	4.5.7	X		X
Inclination	3.11	4.5.8	X	X	
Dielectric test	3.8.7	4.5.4.12	X		X
Heating	3.8.2	4.5.4.9		X	
Effectiveness of enclosure	3.4.5.9	4.5.4.5	X	X	X
Insulation resistance	3.8.6	4.5.4.6	X	X	X
Shock	3.4.5.7	4.5.4.13	X		X
Vibration	3.4.5.8	4.5.4.14	X		X
Relay coil resistance, power consumption, and power factor	3.7.1	4.5.4.11.1	X	X	
Endurance	3.4.5.6	4.5.4.11.2	X	X	
Compensation	3.7.4.1	4.5.4.11.3	X	X	
Short circuit		4.5.4.11.4	X	X	
Operating characteristics	3.4.4	4.5.4.11.5	X	X	
Visual and mechanical	3.12	4.5.1			X
General examination	3.2, 3.3, 3.4, 3.13	4.5, 4.4, 4.5.9	X	X	X
Contact voltage drop	3.7.5	4.5.11	X	X	X

4.3.3 Inspection conditions. Unless otherwise specified herein, all inspections shall be performed in accordance with the test conditions of MIL-STD-202.

4.3.4 Toxicity. To determine conformance to requirements of 3.3.2, the manufacturer of the material shall disclose the formulation of his product to the Naval Medical Command, MEDCOM-242, Washington, DC 20372. The disclosure of proprietary information, which shall be held in confidence by the Naval Medical Command, shall include: the name, formula, and approximate percentage by weight and volume of each ingredient in the product; the results of any toxicological testing of the product; identification of its pyrolsis products; and any such other information as may be needed to permit an accurate appraisal of any toxicity problem associated with the handling, storage, application, use, disposal, or combustion of the material.

4.4 Quality conformance inspections. Quality conformance inspections shall be as specified in tables II and III. Unless otherwise specified, inspections and tests shall be conducted in the order listed.

4.4.1 Sampling. Method of sampling shall be as specified in 4.4.1.1 through 4.4.1.3.

4.4.1.1 Inspection lot. Relays of one design and offered for delivery at one time shall be considered a lot.

4.4.1.2 Sampling for group A tests. A random sample of relays shall be selected in accordance with table III from each inspection lot by the Government inspector and shall be subjected to each of the group A tests specified in 4.5.4.1. Lot acceptance is based on fulfilling the requirements of table III.

TABLE III. Sampling for group A tests.

Number of electric relays in inspection lot	Number of relays in sample	Number of equipments non-conforming on any group A test	
		Acceptance number	Rejection number
2 to 8	5	0	1
9 to 15	7	0	1
16 to 25	10	0	1
26 to 65	15	0	1
66 to 180	25	1	2
181 to 300	35	1	2
301 to 500	50	2	3
501 and over	75	3	4

4.4.1.3 Sampling for group C tests. A sample number of relays in accordance with table IV shall be selected by Government inspection from the end of each month's production and shall be subjected to the group C tests.

TABLE IV. Sampling for group C tests.

Number of relays on contract or order	Number of relays to be selected for group C tests
5 and under	1
66 to 300	2
301 to 800	3

4.4.2 Classification of defects. Failure to satisfy any test of 4.5 shall be counted as a defect. Unless otherwise approved by the contracting activity, all defects are classified as major.

4.4.3 Resubmittal of lots. Resubmittal of rejected lots shall be in accordance with MIL-STD-105.

4.5 Examination and test methods.

4.5.1 Visual and mechanical examination. The relays shall be examined to verify that the materials, design, construction, dimensions, weight, marking and workmanship are in conformance with the specification.

4.5.2 Test equipment. Test equipment shall be as required in MIL-E-917 except that the shock machine shall be in accordance with MIL-S-901.

4.5.3 Test conditions. Unless otherwise required in the detailed test herein, the inspection and tests of 4.5 shall be performed under the following conditions (ambient conditions with the specified ranges need not be controlled):

(a) Temperature: 50 ± 10°C.
(b) Humidity: In accordance with MIL-STD-810.
(c) Input power: Nominal power (see 3.4.3).
(d) Altitude: Normal operating position.

4.5.4 Detailed tests. Detailed tests shall be as follows:

4.5.4.1 Group A tests. Each of the sample relays selected in accordance with table III shall be subjected to each of the group A tests specified in table II, and the results of each test compared with specification requirements. Failure to conform to the specification requirements for any group A tests shall be classified as a defect and the relay shall be rejected. If the number of such nonconforming relays in any sample exceeds the acceptance number for that sample, the lot represented by the sample shall be rejected.

4.5.4.2 Group C tests. Each of the sample relays selected in accordance with table IV shall be subjected to each of the group C tests specified in table II and the results of each test compared with specification requirements.

4.5.4.3 Inspection at the place of manufacture.

4.5.4.3.1 Relays. Each relay shall be subjected to a thorough examination to ascertain that the material, workmanship, and design are in conformance with this specification. The fit of parts shall be observed with particular reference to the interchangeability of such parts as are likely to require replacement during the normal service life of the equipment.

4.5.4.4 General examination. The completed relay shall be given a thorough examination which will include the following:

(a) Workmanship, assembly, and fit.
(b) Parts and materials.
(c) Treatment for prevention of corrosion correctly placed.
(d) Markings correct for their application and correctly placed.
(e) Conformance with safety requirements of 3.2.
(f) Labeling and identification.
(g) Ascertaining that all parts are accounted for in the final deliverable package.

4.5.4.5 Effectiveness of enclosure. The relay enclosure shall be tested in accordance with the MIL-E-2036 appropriate requirements. Enclosures shall be accepted or rejected based on inspection.

4.5.4.6 Insulation resistance. Insulation resistance shall be as specified in 3.8.6. The measurement of insulation resistance shall be made with all circuits of equal voltage above ground connected together. Circuits or groups of circuits of different voltage above ground shall be tested separately. Insulation resistance shall be measured with an insulation resistance indicating meter at 500 volts dc. The time of test voltage application shall not be less than 60 seconds. Measurements shall be made at normal room temperature. The relative humidity and ambient temperature shall be recorded. The relay shall not be damaged when the generator cables or the external relay leads are tested between phases with the 500 volts dc tester.

4.5.4.7 Leakage current tests. Leakage current shall be tested for compliance with MIL-E-917 (see 3.2.1).

4.5.4.8 Input power tests. Input power tests shall be in accordance with DOD-STD-1399, section 300 (see 3.4.3).

4.5.4.9 Temperature tests. Tests detailed in 4.5.4 shall be conducted at normal room temperature. The temperature rise shall be in accordance with 3.8.2.

4.5.4.10 Humidity tests. Humidity tests shall be in accordance with MIL-STD-810 (see 3.8.3).

4.5.4.11 Performance tests.

4.5.4.11.1 Relay coil resistance, power consumption, and power factor tests. Relay coil resistance, power consumption and power factor shall be tested for compliance with 3.7.1.

4.5.4.11.2 Endurance. Relays shall be subjected to the required number of operations (see 3.4.5.6) under conditions of rated voltage, current and frequency and to 50 on-off-on operations at 150 percent rated current at rated voltage and frequency. Ac relays shall be tested using a 0.5 power factor inductive load. Dc relays shall be tested with a resistive load. The operating cycle shall be at least 10 cycles per minute except that in no case shall it be such that the temperature rise limits specified in 3.8.2 are exceeded by more than 20°C. For 500,000 and 100,000 operations endurance tests the following tests should be made after every 50,000 cycles for the first 100,000 cycles and after every 200,000 cycles thereafter. For 25,000 operation endurance test these tests shall be made at the end of the endurance test:

(a) Coil resistance (see 4.5.4.11.1).
(b) Insulation resistance (see 4.5.4.6)
(c) Pickup and dropout voltage (see 4.5.10).
(d) Contact voltage drop (see 4.5.11).

4.5.4.11.3 Compensation. Data for obtaining ambient compensation curves shall be taken to determine that the percent change in rating of the relay does not exceed the value specified in 3.7.4.1.

4.5.4.11.4 Current-carrying capacity under short circuit conditions. Tests shall be made on overload relays to determine the ability of the relay to operate satisfactorily under the following overload conditions:

(a) Provide short-circuit protection adjusted to open the circuit within one-half cycle. Start with the circuit impedance so adjusted as to permit (with overload relay in the circuit) a current flow at least 10 times the relay current. Repeat this operation by suitable current (amperes) steps until 1,000 times the rating of the relay (in amperes) is obtained or until the limit of the circuit is reached (least possible impedance in circuit). Report the condition of the relay as regards heating and contacts, at each short circuit current adjustment, particularly that point (in amperes) where damage to the relay heating element or contacts first becomes apparent.
(b) Provide short circuit protection adjusted to open the circuit within one cycle; otherwise repeat the conditions specified in 4.5.4.11.4(a).

4.5.4.11.5 Operating characteristics for relays. Prior to the shock tests, performance tests shall be made on each type of relay to completely show the relay design characteristics over the range of applicable operating quantities, and for the range of available time adjustment and tap settings. These tests shall establish the bandwidth or limitation of the characteristic curves of the relay. Tests shall be repeated on each relay following the shock tests to determine those operating characteristics that would be affected by shock. Alternating current relays shall be tested at a frequency of 60 Hz, except those relays used on electric propulsion systems, in which case the performances shall be determined at the minimum, intermediate (corresponding to cruising speed), and the maximum design frequency.

4.5.4.12 Dielectric strength tests.

4.5.4.12.1 General. The dielectric strength test shall be made after all of the specified tests in 4.5.4 have been completed. The dielectric test shall be made on the completely assembled monitor and not on individual parts (see 3.8.7).

4.5.4.12.2 Test voltage. The frequency of the testing voltage shall be not less than 60 Hz and shall approximate a true sine wave. The value of the test voltage shall be as specified in 3.4.3 and shall be applied continuously for a period of 1 minute. All rectifiers, bridges, and Zener references shall be shorted out before applying the voltage.

4.5.4.12.3 Measurement of test voltage. The measurement of the voltage used in dielectric tests shall be made by the voltmeter method whereby the meter derives its voltage from the high-voltage circuit either directly, by means of a voltmeter coil placed in the testing transformer, or through an auxiliary ratio transformer.

4.5.4.12.4 Points of application. The test voltage shall be successively applied between each electric circuit and all other electric circuits and grounded metal parts not electrically connected to it.

4.5.4.13 Shock tests. Relays shall be tested in accordance with MIL-S-901. The tests shall be lightweight, type C. During tests, relays shall be adjusted and energized as shown in table V. The relay shall not be caused to operate (see note 2, table V) as a result of any of the shock blows. Contact chatter of less than 20 microseconds (msec) is acceptable. After completing the shock tests, the relay shall be tested to determine the deviation in operating characteristics from those determined as specified in 4.5.4.11.5. Variations in the closing value of the contacts shall not exceed plus or minus 10 percent for current relays and plus or minus 5 percent for voltage relays. These variations shall be based on the performance of the relay established in accordance with 4.5.4.11.5 before the shock tests (see 3.4.5.7).

TABLE V. Relay adjustment and excitation during shock tests.

Adjustment and tap setting			Excitation		
Type of relay	Pick-up setting % of coil rating	Time setting (see note 1)	Current coil	Voltage coil % of rating	Position of contacts (see note 2)
Overcurrent:					
Plunger type	Minimum	Minimum	75% pick-up	---	Open
Inductive type	Minimum	Minimum	80% pick-up	---	Open
Reverse current	Minimum	Minimum	80% pick-up	90	Open
Overpower	100	Minimum	80% pick-up 30 degrees lagging (see note 3)	100	Open
Current phase balance	Minimum	Lever 1.0	0.1 ampere balanced at 8 Hertz	---	Open
Voltage	---	---	---	0	Normal
				90	Normal

NOTES:

1. The minimum time setting shall be considered the minimum setting at which the relay is designed to operate.
2. The contacts of the relays shall be connected to operate a latching or self sealing relay with a maximum 8-watt coil breaker energized at 120 volts. The operation of the relay contacts shall be determined by latching the relay. An oscillograph record of the tripping current and voltage for actual tripping conditions shall be included in the test report. Oscillograph shall have a frequency response of at least 2000 Hz.
3. Stated in terms of forward 3-phase power. Equivalent in phase values may be used in the shock test, if desired.

4.5.4.14 Vibration. Relays shall be subjected to type I tests in accordance with MIL-STD-167-1. There shall be no mechanical damage, contact chatter, or failure to operate in either the energized or de-energized position due to vibration. Operation shall be checked at each vibration frequency. An oscilloscope shall be used to check opening or closing of contacts during the test. Any maloperation shall be recorded with an oscillograph having frequency reponse of at least 2000 Hz. At the end of the test, pickup and dropout voltages shall be measured and recorded.

4.5.4.15 Electromagnetic interference tests. The relay shall be tested in accordance with the methods of MIL-STD-462 for compliance with the EMI requirements of MIL-STD-461 (see 3.8.4).

current

4.5.4.16 Noise tests. Noise tests shall be conducted in accordance with MIL-STD-740, type 3, grade C (see 3.8.5). The relay shall be energized simulating actual operation.

4.5.4.17 Reliability tests.

4.5.4.17.1 Demonstration phase. If required in the contract or order (see 6.2.1), the demonstration phase of reliability testing shall be conducted on at least five (but not more than 10) relays in accordance with MIL-STD-781. MTBF shall be as required in 3.5.

4.5.4.17.1.1 Test schedule. The test shall consist of an uninterrupted series of three 8-hour periods per day. One of the three periods shall be manned. The remaining two periods need not be manned.

4.5.4.17.1.2 Stress conditions. Unless otherwise specified in the contract or order (see 6.2.1), environmental and electrical stress conditions shall be as specified under the combined environments for shipboard equipment (sheltered) in accordance with appendix B of MIL-STD-781 or as follows:

(a) Electrical stress: When operation from two or more nominal voltages is required, the nominal voltage for reliability testing shall be the highest required nominal voltage.
(b) Thermal stress: The test time for each thermal cycle shall be 8 hours.

4.5.4.17.2 Sampling phase. If required in the contract or order (see 6.2.1), the sampling phase of reliability testing shall be conducted on at least five (but not more than 10) relays in accordance with test plan IVC of MIL-STD-781. The upper test MTBF shall be as required in 3.5. The test schedule and stress conditions of 4.5.4.17.1.1 and 4.5.4.17.1.2 shall apply.

4.5.4.18 Maintainability demonstration. When required in the contract or order (see 6.2.1), compliance with 3.6 shall be verified through a maintenance demonstration procedure, maintenance test selection, and maintenance task performance in accordance with test method 1-A of appendices A and B of MIL-STD-471.

4.5.4.19 Noncompliance. The relay shall be rejected if it fails any one of the following:

(a) Breakage or appreciable distortions of any parts.
(b) Electrical malfunction. The sensing features shall not malfunction, become inoperative, or deviate from specifications.
(c) Insulation resistance shall not vary from its original value.

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

4.5.6 Resistance. The overall resistance of coils shall be measured to determine that they are within plus or minus 10 percent of the values shown on drawings specified in 3.15. The temperature at which resistance readings are taken shall be recorded.

4.5.7 Sealing. Sealed relays shall be subjected to either sealing test I as specified in 4.7.5.1 or sealing test II as specified in 4.5.7.2 at the option of the contractor. Relays being inspected for quality conformance shall be subjected to the test specified in 4.5.7.3.

4.5.7.1 Sealing test I (nondestructive). Relays shall be immersed in a saturated solution of sodium chloride and shall be subjected to an absolute pressure equal to 2.5 inches of mercury for 4 hours. The immersed relay shall be observed for evidence of leakage indicated by bubbles emanating from the case.

4.5.7.2 Sealing test II (destructive). Relays shall be immersed in a saturated solution of sodium chloride and shall be subjected to an absolute pressure equal to 2.5 inches of mercury for 4 hours and then returned to normal. After 4 hours at normal pressure, relays shall be removed from the case and examined for any evidence of leakage. If this method of performing sealing test is selected, it shall be the last test performed.

4.5.7.3 Sealing (for test for quality conformance). Sealed relays shall be immersed in an enclosure containing water and a wetting agent. The enclosure shall be subjected to an absolute pressure of 2.5 inches of mercury for 1 minute, or until air bubbles cease to be given off by the water, whichever is longer. The immersed relay shall be observed for evidence of leakage indicated by bubbles emanating from the case.

4.5.8 Inclination. Tests of 4.5.7 shall be repeated with the relay inclined in each of the positions specified herein. This test may be done at any convenient ambient temperature.

Positions:

Inclined 60 degrees forward
Inclined 60 degrees backward
Inclined 60 degrees to right
Inclined 60 degrees to left

Inclination shall not cause a change in the state of contacts (open contacts shall not close nor closed contacts open) with relay either energized or deenergized.

4.5.9 Creepage and clearance distances. Creepage and clearance distances shall be demonstrated by actual measurement to be in accordance with MIL-E-917. On sealed relays distances shall be considered only on live parts, external to the sealed enclosure.

4.5.10 Pickup and dropout voltage. Relays shall be tested at their maximum operating temperature to show that the pickup and dropout voltages are within the limits specified in table I. Tests on ac relays shall be at rated frequency.

4.5.11 Contact millivolt drop. Relays shall be tested in accordance with method 307 of MIL-STD-202. The contact millivolt drop across the relay shall be measured across one pair of mating contacts with the relay in the energized position and one pair with the relay in the deenergized position with rated current passing through the contact. The relay shall be operated 10 times and the millivolt drop shall be measured during each operation.

5. PACKAGING

(The packaging requirements specified herein apply only for direct Government acquisition. For the extent of applicability of the packaging requirements of referenced documents listed in section 2, see 6.6.)

5.1 General.

5.1.1 Navy fire-retardant requirements.

5.1.1.1 Lumber and plywood. Unless otherwise specified (see 6.2.1), all lumber and plywood including laminated veneer material used in shipping container and pallet construction, members, blocking, bracing, and reinforcing shall be fire-retardant treated material conforming to MIL-L-19140 as follows:

Level A and B	-	Type II - weather resistant. Category I - general use.
Level C	-	Type I - non-weather resistant. Category I - general use.

5.1.1.2 Fiberboard. Fiberboard used in the construction of class-domestic, non-weather resistant fiberboard, and cleated fiberboard boxes shall meet the flame spread index and the specific optic density requirements of PPP-F-320 and amendments thereto.

5.2 Preservation, packing and marking. Relays shall be preserved level A, C or commercial, packed level A, B, C or commercial as specified (see 6.2.1) and marked in accordance with MIL-E-17555 and shall include bar code, electrical and mechanical operational characteristics or ratings (as applicable).

6. NOTES

6.1 Intended use. The relays covered by this specification are intended for use with controllers, switchboards, and related electrical equipment aboard Naval vessels.

6.2 Ordering data.

6.2.1 Acquisition requirements. Acquisition documents should specify the following:

(a) Title, number, and date of this specification.
(b) Category required (see 1.2).
(c) Design characteristics (see 3.4.4).

(d) Frequency (see 3.4.5.1).
(e) Duty (see 3.4.5.2).
(f) Shock, grade, class and type (see 3.4.5.7).
(g) Ambient temperature (see 3.8.1.1).
(h) Demonstration phase and sampling phase of reliability testing relays (see 4.5.4.17.1 and 4.5.4.17.2).
(i) Environmental and electrical stress conditions (see 4.5.4.17.1.2).
(j) Maintainability demonstration (see 4.5.4.18).
(k) If fire-retardant treated material is not required (see 5.1.1.1)
(l) Level of preservation, packaging or commercial requirements (see 5.2).

6.2.2 Data requirements. When this specification is used in an acquisition and data are required to be delivered, the data requirements identified below shall be developed as specified by an approved Data Item Description (DD Form 1664) and delivered in accordance with the approved Contract Data Requirements List (CDRL), incorporated into the contract. When the provisions of DoD FAR Supplement, Part 27, Sub-Part 27.475-1 (DD Form 1423) are invoked and the DD Form 1423 is not used, the data specified below shall be delivered by the contractor in accordance with the contract or purchase order requirements. Deliverable data required by this specification are cited in the following paragraphs:

Paragraph no.	Data requirement title	Applicable DID no.	Option
4.3.1	First article inspection report	DI-T-4902	---
3.15	Drawings, engineering and associated lists	DI-E-7031	---

(Data item descriptions related to this specification and identified in section 6 will be approved and listed as such in DoD 5010.12-L, AMSDL. Copies of data item descriptions required by the contractors in connection with specific acquisition functions should be obtained from the Naval Publications and Forms Center or as directed by the contracting officer.)

6.2.2.1 The data requirements of 6.2.2 and any task in sections 3, 4, or 5 of this specification required to be performed to meet a data requirement may be waived by the contracting/acquisition activity upon certification by the offeror that identical data were submitted by the offeror and accepted by the Government under a previous contract for identical item acquired to this specification. This does not apply to specific data which may be required for each contract regardless of whether an identical item has been supplied previously (for example, test reports).

6.3 First article. When a first article inspection is required, the items should be a first article sample. The first article should consist of three units. The contracting officer should include specific instructions in acquisition documents regarding arrangements for examinations, approval of first article test results and disposition of first articles. Invitations for bids should provide that the Government reserves the right to waive the requirement for samples for first article inspection to those bidders offering a

product which has been previously acquired or tested by the Government, and that bidders offering such products, who wish to rely on such production or test, must furnish evidence with the bid that prior Government approval is presently appropriate for the pending contract.

6.4 Definitions. The following definitions shall apply to the various technical terms wherever such terms appear in this specification:

6.4.1 General. The definitions of DOD-STD-1399, section 300 are applicable herein.

6.4.2 Relay. A relay is a device which is operative by a variation in the conditions of one electric circuit to affect the operation of other devices in the same or another electric circuit.

6.4.3 Current relay. A current relay is a relay which functions at a predetermined value or current. It may be an over current relay, an under current relay or a combination of both.

6.4.4 Step-back (jamming) relay. A step-back relay is a relay which operates to limit the current peaks of a motor when the armature or line current increases. A step-back relay usually operates to remove such limitation when the cause of the high current has been removed.

6.4.5 Field relay.

6.4.5.1 Full-field relay (FF). A full-field relay is a relay which functions to maintain full-field excitation on a motor while accelerating on reduced armature voltage.

6.4.5.2 Field-accelerating relay (FA). A field-accelerating relay is a device which functions to force a dc machine field to accelerate the machine up to speed, in some cases as a function of certain limits of line current.

6.4.5.3 Field-decelerating relay (FD). A field-decelerating relay is a device which functions to force a dc machine field for the express purpose of slowing the machine down.

6.4.5.4 Field-failure relay (FL). A field-failure relay is a relay which functions to disconnect the motor from the line in the event of loss of field excitation.

6.4.5.5 Field-protective relay (FP). A field-protective relay is a relay which functions to prevent overheating of the field by reducing the excitation of the shunt field.

6.4.5.6 Field-forcing relay (DF or CF). A field-forcing relay is a relay which functions to accelerate the rate of change of field flux by under-exciting or over-exciting the field of a rotating machine.

6.4.6 Voltage relay. A voltage relay is a relay which functions at a pre-determined value of voltage. It may be an over voltage relay, an under voltage relay, or a combination of both.

6.4.7 Two position relay. A two position relay is a relay without a normally open or a normally closed position. The relay is transferred from one maintained position to the other maintained position by the momentary energizing of an operating coil. The relay may have one or two operating coils, but the position of the relay shall not be affected by subsequent impulse from one source until a transfer has occurred because of an impulse from the other source.

6.4.8 Latching relay. A latching relay utilizes a mechanical latch to hold the relay in the energized position after power is removed. The latch requires an electrical pulse to reclose the controls.

6.4.9 Reverse current relay. A reverse current relay is a relay which functions when current flows through a circuit in a direction opposite to its normal direction.

6.4.10 Auxiliary relay. An auxiliary relay is a relay which operates in response to the opening or closing of its operating circuit to assist another relay or device in the performance of a function.

6.4.11 Instantaneous. Instantaneous is a qualifying term indicating that no delay is purposely introduced in the action of the device.

6.4.12 Inverse time. Inverse time is a qualifying term indicating that there is purposely introduced a delayed action, which delay decreases as the operating force increases.

6.4.13 Definite time. Definite time is a qualifying term indicating that a delay in action is purposely introduced, which delay remains substantially constant regardless of the magnitude of the quanity that causes the action.

6.4.14 Continuous duty. Continuous duty is a requirement of service that demands operation at substantially constant load for an indefinitely long time.

6.4.15 Intermittent duty. Operation for periods of (1) load and no load, (2) load and rest, or (3) load, part load, and rest, and in which the load conditions are well defined as to magnitude, duration, and character, is considered intermittent duty.

6.4.16 Interlock. An interlock is a device actuated by the operation of some other device with which it is directly associated, to govern succeeding operations of the same or allied devices. Interlocks may be either electrical or mechanical.

6.4.17 Normally open and normally closed. Normally open and normally closed signify the position taken by contacts when the device is de-energized. The de-energized condition for a manual device is when the device is in the off position. These terms apply only to nonlatching types of devices.

6.4.18 Pick-up voltage (or current). The pick-up voltage (or current) of a magnetically operated device is the minimum voltage (or current) at which the device moves from its de-energized into its energized position.

6.4.19 Sealing voltage (or current). The sealing voltage (or current) is the voltage (or current) necessary to complete the movement of the armature of a magnetic circuit-closing device from the position at which the contacts first touch each other.

6.4.20 Drop-out voltage (or current). The drop-out voltage (or current) of a magnetically operated device is the maximum voltage (or current) at which the device will release to its de-energized position.

6.4.21 Ultimate tripping current. The ultimate tripping current is the least current which will cause tripping in an extended period of time.

6.5 Provisioning. Provisioning Technical Documentation (PTD), spare parts, and repair parts should be furnished as specified in the contract.

6.5.1 When ordering spare parts or repair parts for the equipment covered by this specification, the contract should state that such spare parts and repair parts should meet the same requirements and quality assurance provisions as the parts used in the manufacture of the equipment. Packaging for such parts should also be specified.

6.6 Sub-contracted material and parts. The packaging requirements of referenced documents listed in section 2 do not apply when material and parts are acquired by the contractor for incorporation into the equipment and lose their separate identity when the equipment is shipped.

6.7 Subject term (key word) listing.

Carcinogens
Electromagnetic compatibility/interference
Hazardous material
Materials
Ozone
Power
Recycled materials
Toxicity

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

Preparing activity:
Navy - SH
(Project 5945-N634)

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1. DOCUMENT NUMBER	2. DOCUMENT TITLE
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3a. NAME OF SUBMITTING ORGANIZATION	4. TYPE OF ORGANIZATION *(Mark one)*
	☐ VENDOR ☐ USER ☐ MANUFACTURER ☐ OTHER *(Specify)*:
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5. PROBLEM AREAS

a. Paragraph Number and Wording:

b. Recommended Wording:

c. Reason/Rationale for Recommendation:

6. REMARKS

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

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two position relay. A two position relay is a relay without a