MIL-R-6106J
2 November 1981
SUPERSEDING
MIL-R-6106H
15 December 1977

MILITARY SPECIFICATION

RELAYS, ELECTROMAGNETIC (INCLUDING ESTABLISHED RELIABILITY (ER) TYPES), GENERAL SPECIFICATION FOR

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

1. SCOPE

1.1 Scope. This specification establishes general requirements for electromechanical relays (including ER types) with nominal contact ratings from five amperes (resistive) and upward for use in electrical applications. Auxiliary contacts may be rated at lower currents. Relays covered by this specification are capable of meeting the electrical and environmental requirements when mounted directly to the structure of aircraft, missile, spacecraft, ship, and other primary vehicles or in ground support and shipboard equipment. Other ratings may be as specified (see 3.1).

1.2 Classification. Relays covered by this specification shall be classified by the type specified in 1.2.1, and by the environment levels of 1.2.2 (see 3.1 and 6.1).

* 1.2.1 Type designators. The type is identified by one of the following designators:

Type I - Continuous duty, hermetically sealed.
Type I ER - Continuous duty, hermetically sealed, established reliability, the maximum failure rate is to be identified by the reliability identifying letter (eg: M for 1 percent/10,000 operations, U for 0.5 percent/10,000 operations, X for 0.3 percent/10,000 operations or P for 0.1 percent/10,000 operations).
Type II - Continuous duty, unsealed.
Type III - Intermittent duty (hermetically sealed, environmentally sealed, unsealed).
Type IV - Continuous duty, environmentally sealed, (nonhermetic).

1.2.2 Environment levels.

1.2.2.1 Vibration characteristic (sinusoidal). Relays covered by this specification shall meet one of the vibration characteristics shown in table I and 4.7.17 (see 3.1).

TABLE I. Vibration characteristic.

Characteristic	Maximum acceleration value	Frequency range, Hz
a	15 g	10 to 2,000
b	20 g	10 to 2,000
c	30 g and random	10 to 3,000
d	Other	Other

1.2.2.2 Temperature range. Relays covered by this specification shall meet one of the temperature ranges shown in table II (see 3.1).

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: Commander, Air Force Acquisition Logistics Division, Electronic Support Division (AFALD/PTSP), Gentile Air Force Station, Dayton, Ohio 45444, by using the self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

TABLE II. Temperature range.

Range	Temperature range, °C
a	-55 to +85
b	-70 to +125
c	-70 to +200
d	Other

1.2.2.3 Shock characteristic. Relays covered by this specification shall meet one of the shock characteristics shown in table III (see 3.1).

TABLE III. Shock characteristic.

Characteristic	Shock level (in accordance with MIL-STD-202)
a	50 g (test condition A, method 213)
b	75 g (test condition B, method 213)
c	100 g (test condition C, method 213)
d	High-impact (method 207)
e	Other

1.2.2.4 Altitude rating. Relays covered by this specification shall meet one of the altitude ratings of table IV (see 3.1).

TABLE IV. Altitude level.

Rating	Maximum altitude - feet
a	10,000
b	50,000
c	80,000/300,000 1/
d	Other

1/ Altitude dielectric withstanding voltage shall be performed at 80,000 feet.

1.3 Class "0" relays. Information concerning Class "0" relays is covered in 6.5.

2. APPLICABLE DOCUMENTS

2.1 Government specifications and standards. Unless otherwise specified, the following specifications and standards, of the issue listed in that issue of the Department of Defense Index of Specifications and Standards specified in the solicitation, form a part of this specification to the extent specified herein.

SPECIFICATIONS

FEDERAL

*	J-W-1177	- Wire, Magnet, Electrical.
	NN-P-71	- Pallet, Materials-handling, Wood, Stringer Construction, 2-Way and 4-Way (Partial).
	QQ-S-571	- Solder, Tin Alloy: Lead-Tin Alloy; and Lead Alloy.
	QQ-S-781	- Strapping, Steel, and Seals.
	QQ-W-343	- Wire, Electrical (Uninsulated).
	ZZ-R-765	- Rubber, Silicone.
	GGG-W-641	- Wrench, Socket (and Sockets, Handles, and Attachments for Socket, Wrenches, Hand).
	PPP-B-566	- Boxes, Folding, Paperboard.
	PPP-B-585	- Boxes, Wood, Wirebound.
	PPP-B-601	- Boxes, Wood, Cleated-Plywood.
	PPP-B-621	- Boxes, Wood, Nailed, and Lock-Corner.
	PPP-B-636	- Boxes, Shipping, Fiberboard.
	PPP-B-676	- Boxes, Setup.
	PPP-T-60	- Tape: Packaging, Waterproof.
	PPP-T-76	- Tape, Packaging, Paper (For Carton Sealing).

MILITARY

	MIL-I-10	- Insulating Materials, Electrical, Ceramic, Class L.
	MIL-M-14	- Molding Plastics and Molded Plastic Parts, Thermosetting.
	MIL-P-116	- Preservation-Packaging, Method of.
	MIL-P-997	- Plastic Material, Laminated, Thermosetting, Electrical Insulation: Sheets, Glass Cloth, Silicone Resin.
	MIL-D-1000	- Drawings Procurement (Identical Items), for Electronics Command Equipment.
*	MIL-C-5015	- Connector, Electrical, Circular Threaded, AN Type.
	MIL-W-5088	- Wiring, Aerospace Vehicle.
	MIL-T-5624	- Turbine Fuel, Aviation, Grades JP-4 and JP-5.
	MIL-S-6872	- Soldering Process, General Specification for.
	MIL-L-7808	- Lubrication Oil, Aircraft Turbine Engine, Synthetic Base.
	MIL-A-8243	- Anti-icing and Deicing-Defrosting Fluid.
	MIL-Q-9858	- Quality Program Requirements.
*	MIL-S-12883	- Sockets and Accessories For Plug-In Electronic Components.
	MIL-P-15037	- Plastic Sheet, Laminated, Thermosetting, Glass-Cloth, Melamine-Resin.
	MIL-P-15047	- Plastic Material, Laminated Thermosetting, Nylon Fabric Base, Phenolic-Resin.
	MIL-F-15160/2	- Fuses; Instrument, Power, and Telephone (Nonindicating), Style FO2.
	MIL-F-15160/3	- Fuses; Instrument, Power, and Telephone (Nonindicating), Style FO3.
*	MIL-S-19500	- Semiconductor Devices, General Specification for.
	MIL-L-23699	- Lubricating Oil, Aircraft Turbine Engines, Synthetic Base.
	MIL-C-25769	- Cleaning Compound, Aircraft Surface, Alkaline Waterbase.
*	MIL-C-28748	- Connectors, Electrical, Rectangular, Rack and Panel, Solder Type and Crimp Type Contacts.
*	MIL-M-38510	- Microcircuit, General Specification for.
	MIL-G-45204	- Gold Plating, Electrodeposited.
	MIL-S-45743	- Soldering, Manual Type, High Reliability, Electrical and Electronic Equipment.
	MIL-P-46133	- Plastic Molding and Extrusion Material, Poly (Aryl Sulfone Ether) Resin, Thermoplastic.
	MIL-I-81023	- Inductor, 28 V.D.C. Laboratory Test, General Specification for.
	MIL-H-83306	- Hydraulic Fluid, Fire Resistant, Phosphate Ester Base, Aircraft.

(See supplement 1 of list of applicable specification sheets.)

STANDARDS

FEDERAL

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

MILITARY

MIL-STD-129 - Marking for Shipment and Storage.
MIL-STD-143 - Standards and Specifications, Order of Precedence for the Selection of.
MIL-STD-147 - Palletized and Containerized Unit Loads 40 inch X 48 inch Pallets, Skids, Runners or Pallet Type Base.
MIL-STD-202 - Test Methods for Electronic and Electrical Component Parts.
MIL-STD-454 - Standard General Requirements for Electronic Equipment.
MIL-STD-461 - Electromagnetic Interference Characteristics Requirements for Equipment.
MIL-STD-462 - Electromagnetic Interference Characteristics, Measurement of.
MIL-STD-704 - Aircraft, Electric Power, Characteristics.
MIL-STD-706 - Power Supply Voltages, Regulated, D.C. within Electronic Equipment.
* MIL-STD-794 - Parts and Equipment Procedures for Packaging and Packing of.
MIL-STD-810 - Environmental Test Methods.
MIL-STD-831 - Test Reports, Preparation of.
* MIL-STD-883 - Test Methods and Procedures for Microelectronics.
* MIL-STD-889 - Dissimilar Metals.
* MIL-STD-1188 - Commercial Packaging of Supplies and Equipment.
MIL-STD-1285 - Marking of Electrical and Electronic Parts.
MIL-STD-45662 - Calibration Systems Requirements.
MS20659 - Terminal Lug, Crimp Style, Copper, Uninsulated, Ring-Tongue, Type I, Class 1.
MS25036 - Terminal Lug, Crimp Style, Copper, Insulated, Ring-Tongue, Bell-mouthed, Type II, Class 1.

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

2.2 Other Government documents, drawings, and publications. The following other Government documents, drawings, and publications form a part of this specification to the extent specified herein.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

* ANSI C83.16 - EIA/NACM Standard definitions and terminology for Relays for Electronic Equipment.
* ANSI Y10.19 - Letter symbols for units used in science and technology.
* ANSI/IEEE STD 100-1977 - IEEE Standard Dictionary of Electrical and Electronic term.
D470-59T - Methods of Testing Rubber and Thermoplastic Insulated Wire and Cable (Tentative).

(Copies of ASTM publications may be obtained from the American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103.)

3. REQUIREMENTS

3.1 Specification sheets, Military Standard (MS) sheets and Air Force-Navy Aeronautical (AN) standards. The individual item requirements shall be as specified herein and in accordance with the applicable specification sheets, MS sheets or AN standards. In the event of any conflict between requirements of this specification and the applicable specification sheets, MS sheets or AN standards, the latter shall govern.

3.2 Qualification. The relays furnished under this specification shall be a product which has been tested, and has passed the qualification inspection specified herein, and has been listed on or approval for listing on the applicable qualified products list.

* 3.2.1 Established reliability. A relay which has been qualified to this specification may be qualified for established reliability by testing the additional relays specified in 4.5.1. A total of 2.30 million operations with no failures on the loads specified in 4.5.1 will demonstrate a failure rate of 1 percent per 10,000 operations at a 90 percent confidence level. For improved failure rate levels (see 4.5.6), additional cumulative operations are required in accordance with this specification. When established reliability is specified (see 3.1) separate qualification and acceptance procedures are required to demonstrate the required failure rate (eg: 1 percent/10,000 operations, 0.5 percent/10,000 operations, etc.) at a 90 percent confidence level for qualification and a 60 percent confidence level for acceptance testing (maintenance of qualification). Acceptance data will verify the qualified failure rate level and this maintenance testing will be performed in accordance with 4.6.2.2.2 and 4.6.2.2.3. Accumulation of the qualification and acceptance data is used to reach the next higher reliability level (see 4.5.6). Upon reaching the new failure rate (FR) plateau, the maintenance of qualification at that level must be maintained or qualification at that plateau will be forfeited.

3.2.2 Qualification by similarity. Relays furnished under this specification may be qualified by similarity to other relays in its generic family. The qualifying activity shall require additional testing, (as specified, see 3.1), in which case the additional testing shall become the sole requirements for group C inspection. For the purpose of sampling for group B inspection and group C inspection for type I ER relays, all relays within the generic family may be considered as one part number and any relay part number within the generic family may be selected for test to represent the entire family unless directed otherwise by the qualifying activity.

3.3 Materials. The materials shall conform to requirements specified herein. When a definite material is not specified, the selection of material shall be at the discretion of the relay manufacturer. Wherever practicable, the manufacturer shall select materials, standards and specifications in accordance with MIL-STD-143. Materials selected shall be such that the relays will meet the performance requirements and product characteristics specified herein. After qualification, any change of parts or materials shall be submitted to the Government qualifying activity for approval. Acceptance or approval of any constituent part or material shall not be construed as a guaranty of acceptance of the finished product.

* 3.3.1 Metals. Metals shall be of a corrosion-resistant type or shall be plated or treated to resist corrosion. Zinc plating, cadmium plating, or unfused pure tin plating shall not be used on internal parts of hermetically sealed relays.

* 3.3.1.1 Dissimilar metals. Unless otherwise specified (see 3.1), the use of dissimilar metals shall be as specified in MIL-STD-889.

3.3.2 Nonmetals. Nonmetals, including protective finishes shall be moisture resistant, nontoxic, arc resistant, flame resistant, and self extinguishing, shall not support fungus growth, and shall not be adversely affected by weathering in aircraft, missile, and spacecraft fluids at the temperature as specified (see 3.1). The manufacturer shall submit certification to the Government qualifying activity that materials will not support fungus growth. Materials in hermetically sealed envelopes are not required to meet the moisture and fungus resistance requirements.

3.3.2.1 Plastic material. Except as specified herein, plastic material shall conform to MIL-M-14 and MIL-P-46133 for molded material, MIL-P-997, MIL-P-15037, and MIL-P-15047 for laminated material. Other types of plastic materials possessing superior characteristics may be used, provided the manufacturer submits acceptable evidence to the activity responsible for qualification that such material meets the performance requirements of MIL-M-14, MIL-P-997, MIL-P-15037, MIL-P-15047, or MIL-P-46133, whichever is applicable. In addition to these specifications and the requirements of 3.3.2, the plastic material shall not support combustion, give off noxious gases in harmful quantities, give off any gases in quantities sufficient to cause explosion of sealed housing, give off any gases in a sealed housing that will cause contamination of the contacts or other parts of the component, or form current-carrying tracks when subjected to arcing conditions encountered when any of the tests in this specification are performed.

3.3.2.2 Ceramic. Ceramic insulating material shall conform to grade L311 (or better) of MIL-I-10. All external ceramic surfaces shall be glazed in accordance with MIL-I-10.

* 3.3.2.3 Magnet wire. Magnet wire shall conform to J-W-1177 except when wire not covered by J-W-1177 is required due to physical size or temperature range considerations; then a suitable wire may be substituted, as evidenced by meeting the performance requirements of this specification.

3.3.2.4 Rubber. Rubber shall conform to ZZ-R-765.

3.4 Design and construction. The relays shall be of compact design and of sufficiently rugged construction to withstand all stresses and operational conditions as specified herein. Relay parts shall be secured to the relay assembly by mechanical means, except that attachment may be secured by welding, solder, or other fusible materials with melting points above 260°C, or 100°C above the maximum temperature of the class of relay in question, whichever is more severe. Relays shall be designed for operation in aircraft, missile, and spacecraft and shipboard electrical systems, and associated ground support equipment as specified in MIL-STD-704 and MIL-STD-706. Enclosures of hermetically sealed relays shall be securely attached to the relay structure by rolling, crimping, welding, or other suitable means prior to the application of any solder.

3.4.1 Selection of military specifications and standards. Specifications and standards for all parts, materials, and Government certification and approval of processes and equipment, which are not specifically designated herein and which are necessary for the execution of this specification, shall be selected in accordance with MIL-STD-143, as applicable, except as provided in the following paragraph.

3.4.1.1 Standard parts. Standard mounting and terminal hardware (i.e., screws, lockwasers, etc.) (MS and AN) shall be used wherever practicable. Nonstandard equivalents may be used, provided they possess suitable properties and are replaceable by the standard parts (MS or AN) without alteration.

3.4.2 Attitude. The relay shall be constructed to insure proper operation when mounted in any position.

3.4.3 Mounting bracket. When brackets are used, they shall be an integral part of the relay housing or shall be securely attached thereto in a manner to prevent any movement between the relay and the mounting bracket in service use.

3.4.4 Mechanical failure (fail-safe) feature. Construction shall be such that failure of any part of the linkage between the actuator and movable contacts will result in action to move the movable contacts to the de-energized position. In the case of a latched relay, contacts will remain in the position they were in at the time of the failure.

3.4.5 Enclosures. Enclosures shall be of sufficient mechanical strength to withstand the normal abuse incurred in handling, transit, storage, and installation without causing malfunction or distortion of parts. The case shall not part of the contact or coil electrical circuits, but it may be part of the magnetic circuit.

3.4.5.1 Unsealed enclosures. Unsealed relays shall be totally enclosed for mechanical and dust protection and shall be explosion-proof (see 3.31). The enclosure shall be so designed that when the cover is removed, the relay shall be capable of operating without adjustment. The enclosure design shall be such that pressure differentials cannot exist between the inside and outside to aggravate the moisture accumulation problem. The cover shall be rugged in design, constructed of high impact materials, and securely mounted to the relay. Metal covers shall be provided with a means for grounding as specified.

* 3.4.5.2 Hermetically sealed enclosures. Hermetically sealed enclosures shall be constructed as a gas-tight enclosure which has been completely sealed by fusion of glass or ceramic to metal or bonding of metal to metal. Hermetically sealed relays shall be purged of all air and filled with a suitable inert gas of such characteristic that the leakage rate may be determined by conventional means. Except for solder sealed types, relays of a sealed gas construction of less than 2 cubic inches of external volume shall be sealed within a chamber containing a backfill gas. Solder sealed relays and relays greater than 2 cubic inches of external volume must be sealed within 60 seconds maximum after filling.

The fill gas shall have a dew point of at least 5°C colder than the low temperature specified. The relays shall be filled to a pressure of 15 ±1 pounds per square inch absolute (see 3.37). No adjunct sealants (see 6.4.22), shall be used on the headers.

3.4.5.3 Environmentally sealed (non-hermetic enclosures). Environmentally sealed enclosures shall be constructed by any means other than that defined under hermetically sealed enclosures (see 3.4.5.2) to achieve the degree of seal specified (see 3.1). Environmentally sealed relays shall be purged of all air and filled with a suitable gas of such characteristics that the leakage rate may be determined by conventional means. The fill gas shall have a dew point of at least 5°C lower than the low temperature rating of the relay. The relay shall be filled to a pressure of 15 ±1 pounds per square inch absolute (see 3.37).

3.4.5.4 Grounding enclosures. The mounting shall provide an effective electrical contact to ground when the relay is mounted (see requirement 1 of MIL-STD-454) (personnel safety).

* 3.4.6 Threaded parts. All threaded parts shall be in accordance with FED-STD-H28. Where practical, all threads shall be in conformity with the coarse thread series. The fine thread series shall be used only for applications that might show a definite advantage through their use. Where a special diameter-pitch combination is required, the thread shall be of American National Form and of any pitch between 16 and 36 which is used in the fine thread series.

3.4.7 Installation clearances. Adequate clearance shall be provided for installation of terminals and mounting hardware. Clearance for socket wrenches shall be governed by GGG-W-641. Special installation tools shall not be required.

* 3.4.8 Terminals (electric). Relays shall have electric terminals as specified (see 3.1). No rotation or other loosening of a terminal, or any fixed portion of a terminal, shall be caused by material flow or shrinkage, or (for threaded terminals) any mechanical forces specified in table V involved in connection or disconnection, throughout the life of the relay.

TABLE V. Strength of threaded terminals (static value of pull and torque).

Thread size	Force in pounds	Torque in pound-inches
4-40 (.112 UNC)	5	4.4
6-32 (.138 UNC)	30	10.0
8-32 (.164 UNC)	35	20.0
10-32 (.190 UNC)	40	32.0
10-24 (.190 UNC)	40	35.0
1/4-28 (.250 UNC)	50	75.0
5/16-24 (.312 UNF)	70	100.0
3/8-24 (.375 UNF)	100	150.0
7/16-20 (.438 UNF)	100	150.0
1/2-20 (.500 UNF)	100	150.0

3.4.8.1 Stud terminals (threaded). Stud terminals shall be supplied with hardware as specified (see 3.1). A minimum of three complete threads shall remain above the nut when it is backed off three complete turns from a position with all parts tightened in place.

3.4.8.1.1 Stud terminal seat. For threaded terminals, each terminal shall have a terminal seat that shall provide the normal current-conducting path. The diameter of the seat shall be equal to, or greater than, the diameter across the corresponding MS20659 or MS25036 lug designed for the particular current and stud or screw size, or never less than the area necessary to assure that the current density shall not exceed 1,000 amperes per square inch. The seat area does not include the cross sectional area of the stud.

3.4.8.1.2 Strength of stud terminals. Stud terminals shall be designed to withstand the static value of pull and torque specified in table V (see 3.17).

3.4.8.2 Solder-lug, plug-in, and wire lead terminals.

3.4.8.2.1 Solder-lug terminals. Solder lug terminals used for a 2 ampere rating or less shall be designed to allow the securing of two AWG #20 stranded wires with 19 strands in accordance with QQ-W-343. Terminals used for more than 2 ampere rating shall be designed to allow the securing of three wires the size of which shall be as specified (see 3.1).

* 3.4.8.2.2 Plug-in termination. Plug-in terminations shall conform to the arrangements or dimensions necessary for proper mating with the associated connectors or sockets covered by MIL-C-5015, MIL-C-28748 or MIL-S-12883. The mounting arrangement of the relay and its corresponding socket shall be so designed that the entire weight of the relay will be suspended and the stability of its mounting will be provided by an auxiliary mounting means other than the electrical terminals of the socket. Relays with plug-in terminals shall have electrical and environmental tests of section 4 performed with the appropriate or specified socket or connector assembled to the relay.

3.4.8.2.3 Strength of solder-lug, plug-in, and wire lead terminals. The relay terminals shall be designed to withstand the applicable terminal strength performance procedure specified in 3.17 and 4.7.11.2.

* 3.4.8.3 Terminal finish. Finish of terminals shall provide a good electrical contact and meet the performance requirements specified herein. All terminals used for external soldered connections shall be tin plated or coated with composition Sn60, Sn63, or Sn70 solder conforming to QQ-S-571 to facilitate soldering. Plug-in terminals shall be gold plated in accordance with MIL-G-45204, Type II, Class 1 over an underplate of 50 - 150 microinches of nickel plate.

3.4.8.4 Terminal marking. Terminal identification shall be durably and legibly marked as specified (see 3.1), and in accordance with figure 1. For dual coil relays, the relationship between coil and contacts shall be as specified in table VI.

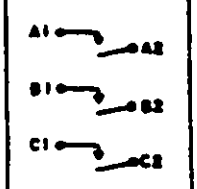
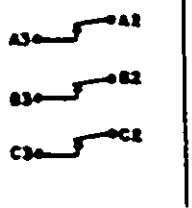
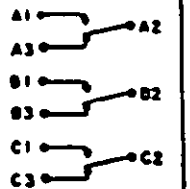
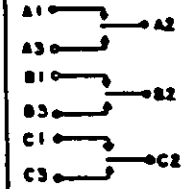
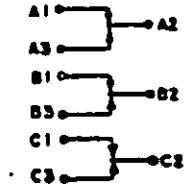
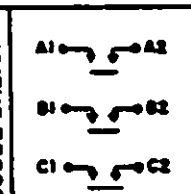
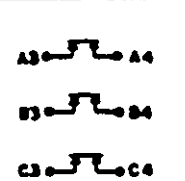
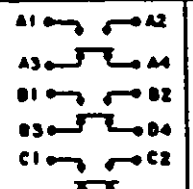
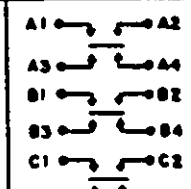
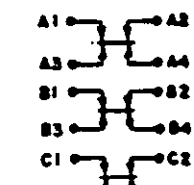
TABLE VI. Dual coil relay markings.

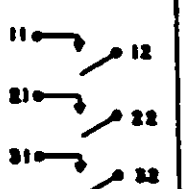
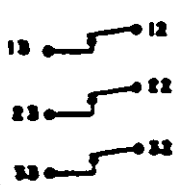
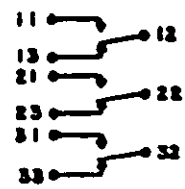
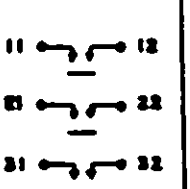
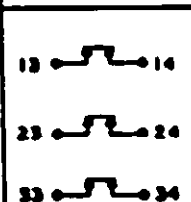
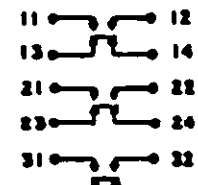
Coil energized	Contacts closed	
	Load	Auxiliary
X1-X2	A1-A2	11-12
	B1-B2	31-32
	C1-C2	51-52
	Etc.	Etc.
Y1-Y2	A3-A2 (or A3-A4)	21-22
	B3-B2 (or B3-B4)	41-42
	C3-C2 (or C3-C4)	61-62
	Etc.	Etc.

3.4.8.4.1 Leadwire marking. Leadwires shall be color coded in accordance with figure 2.

3.4.8.5 Terminal covers and barriers. The relay shall be provided with adequate covering or separation of terminal parts to provide protection against inadvertent shorting, grounding, or contact by personnel. Barriers may be removable or may be integral with removable covers. Terminal covers and barriers shall be designed to meet performance requirements applicable to the relay. The enclosure(s) shall be so designed that when the cover is removed, the relay shall be capable of operating without adjustment. The cover design shall be such that pressure differentials cannot exist between the inside and outside (see 3.1).

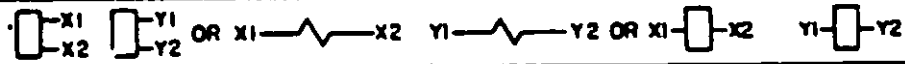
3.4.9 Mounting studs. Mounting studs shall be as specified (see 3.1). No rotation, loosening, or deformation of fixed portions shall occur because of material flow or any mechanical forces involved in installation or removal of the relay. The mounting studs shall withstand for 1 minute, without damage, the static values of pull and torque specified in table VII (see 3.17).

CONTACT ARRANGEMENTS, SYMBOLS AND TERMINAL MARKING (SEE NOTE)					
	SINGLE THROW		DOUBLE THROW		
	FORM "A"	FORM "B"	FORM "C"	FORM "K" SPDT	FORM "M"
	NORMALLY OPEN	NORMALLY CLOSED	(TWO POSITION)	3 POS CENTER OFF	3 POS CENTER ON
SINGLE BREAK					
	FORM "X"	FORM "Y"	FORM "Z"	FORM "KK"	FORM "MM"
DOUBLE BREAK					
NOTE: CONTACTS ARE SHOWN WITH COIL(S) DE-ENERGIZED.					

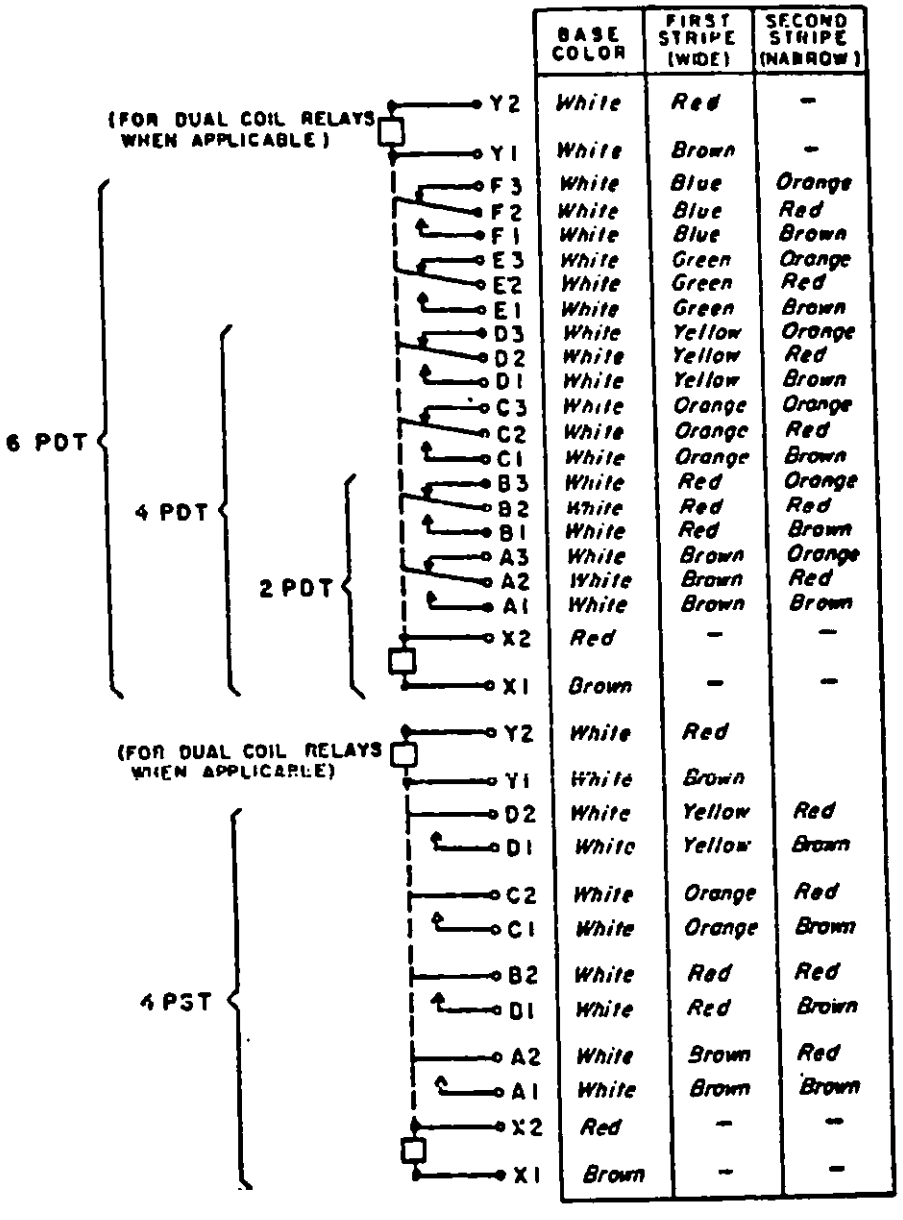
AUXILIARY TERMINALS		
SINGLE THROW		DOUBLE THROW
NORMALLY OPEN	NORMALLY CLOSED	NORMALLY CLOSED
		
		

SYMBOLS AND MARKING FOR TERMINALS.

SINGLE COIL TERMINALS


DUAL COIL TERMINALS


* FIGURE 1. Terminal markings.



	BASE COLOR	FIRST STRIPE (WIDE)	SECOND STRIPE (NARROW)
Y2	White	Red	–
Y1	White	Brown	–
F3	White	Blue	Orange
F2	White	Blue	Red
F1	White	Blue	Brown
E3	White	Green	Orange
E2	White	Green	Red
E1	White	Green	Brown
D3	White	Yellow	Orange
D2	White	Yellow	Red
D1	White	Yellow	Brown
C3	White	Orange	Orange
C2	White	Orange	Red
C1	White	Orange	Brown
B3	White	Red	Orange
B2	White	Red	Red
B1	White	Red	Brown
A3	White	Brown	Orange
A2	White	Brown	Red
A1	White	Brown	Brown
X2	Red	–	–
X1	Brown	–	–
Y2	White	Red	
Y1	White	Brown	
D2	White	Yellow	Red
D1	White	Yellow	Brown
C2	White	Orange	Red
C1	White	Orange	Brown
B2	White	Red	Red
D1	White	Red	Brown
A2	White	Brown	Red
A1	White	Brown	Brown
X2	Red	–	–
X1	Brown	–	–

STANDARD COLOR CODE

Brown - 1 or A
Red - 2 or B
Orange - 3 or C
Yellow - 4 or D
Green - 5 or E
Blue - 6 or F

FIGURE 2. Schematic diagram and color code.

TABLE VII. Strength of mounting studs (static values of pull and torque).

Thread size	Force in pounds	Torque in pound-inches
4-40 (.112 UNC)	7	10
6-32 (.138 UNC)	25	18
8-32 (.164 UNC)	35	37
10-32 (.190 UNF)	50	60
1/4-28 (.250 UNC)	60	100
5/16-24 (.312 UNF)	80	160
3/8-24 (.375 UNF)	115	275
7/16-20 (.438 UNF)	140	475

3.4.10 Coil. The coil shall be adequately insulated electrically from the frames, the contacts, and any grounded parts.

3.4.10.1 Coil mounting. Coils shall neither be loose or become loosened throughout service life or during the performance tests specified herein.

3.4.10.2 Latching relays. Two coil latching relays shall be so designed that if both coils are energized simultaneously, the contacts will not achieve a null position (neither the NC or NO contacts are closed). Drop out voltage (current) and release time are not applicable to latching relays.

3.4.11 Contacts. Relays shall have the contact arrangement specified (see 3.1).

* 3.4..11.1 Contact springs. Contact springs shall be of corrosion resistant material or shall be suitably plated to resist corrosion. Zinc plating, cadmium plating, or unfused pure tin plating shall not be used on internal parts of hermetically sealed relays.

3.4.12 Dimensions and weight. Relay physical dimensions and weight shall be as specified (see 3.1).

* 3.4.13 Solder. Solder shall have a minimum softening point 55°C above the maximum temperature rating for the relay. Wherever suitable for the purpose, compositions Sn70, Sn60, and Sb5, conforming to QQ-S-571, shall be used. Solder of other compositions may be used, provided they meet or exceed the requirements of this specification.

3.4.13.1 Soldering processes. Soldering processes shall conform to MIL-S-6872 or MIL-S-45743. Soldering shall be so executed that both a positive electrical and strong mechanical connection is assured. Electrical joints shall be mechanically secured before soldering and shall not depend upon solder alone for mechanical strength.

3.4.14 Degassing. Sealed relays shall be degassed (see 6.9).

3.4.15 Rated duty. Unless otherwise specified (see 3.1), relays shall be designed for continuous duty (see 6.8).

3.4.16 Stabilization of permanent magnets. Permanent magnets and magnetic assemblies shall be artificially aged to prevent decay of flux levels. The residual induction (flux) in permanent magnetic assemblies shall be reduced to a level where it will not be affected by demagnetizing forces encountered in normal service, handling, and any tests specified herein. The retraceability characteristics shall be compatible with all performance requirements of the relays.

* 3.4.17 Electronic components (see table VIII). Electronic components shall be selected in accordance with the applicable requirements of MIL-STD-454. Components selected shall be such that the relays shall meet the performance requirements and product characteristics specified herein. After qualification, any change of parts of material shall be submitted to the Government qualifying activity for approval.

* 3.4.17.1 Discrete semiconductor devices (see table VIII). Discrete semiconductor devices including diodes, zener diodes and transistor devices shall be selected from MIL-S-19500. For Type I ER relays JAN TX devices as a minimum shall be used. Non-standard discrete semiconductor devices may be used in Type I ER and non-ER relays provided that these devices are tested to and meet the screening requirements of MIL-S-19500 for level JAN TX.

* 3.4.17.2 Microcircuits (see table VIII). Monolithic microcircuits shall be selected from MIL-M-38510, Class B as a minimum for Type I ER relays and class E as a minimum for non-ER relays. Non-standard parts, multichip devices and hybrid devices may be used provided that they are tested to and meet the requirements for the appropriate class type as shown in table VIII.

* TABLE VIII. Quality levels for semiconductors and microcircuits.

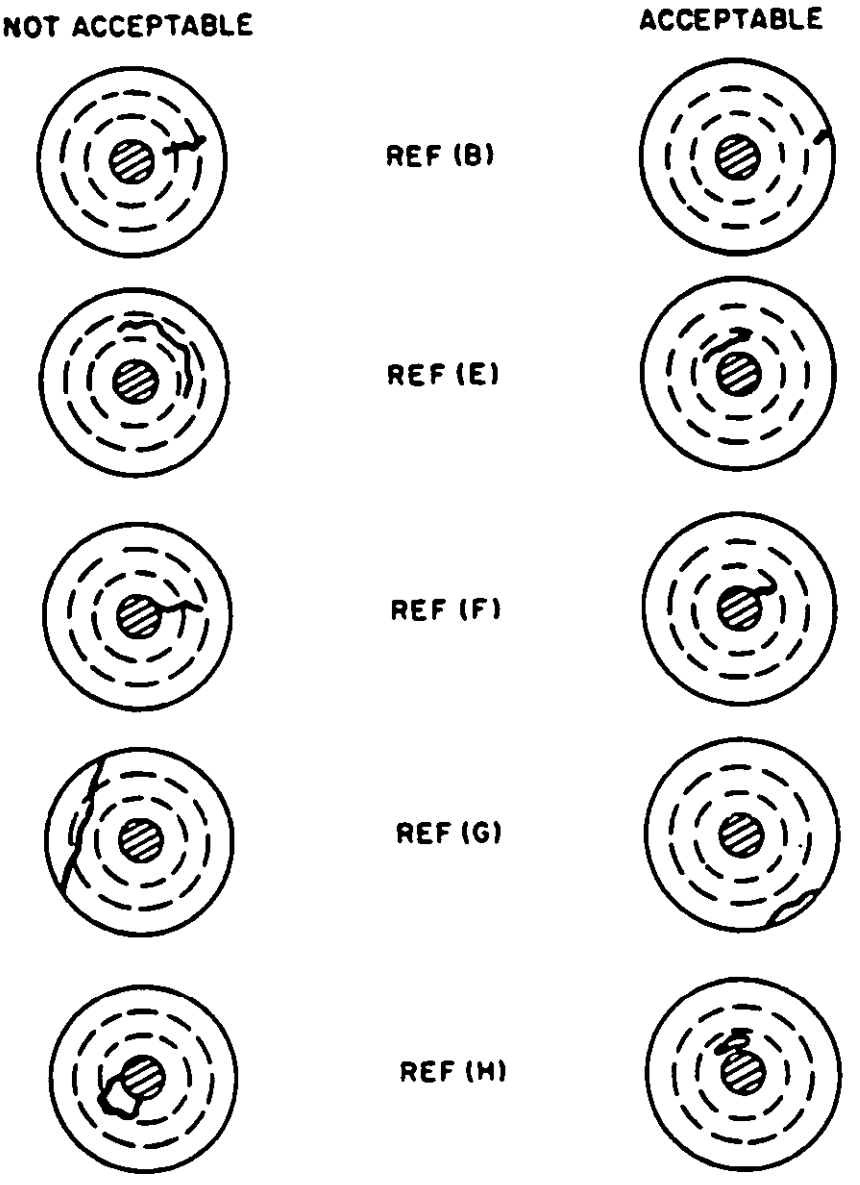
Relay Class / Circuits and Components (Note 2)	Non - ER	Type I ER
	MIL-S-19500	
Discrete Semiconductors MIL	JAN	JAN TX
Non-MIL	Screen to JAN TX	
	MIL-M-38510	
Sealed Monolithic Circuit MIL	Class C	Class B
Non-MIL	Screen to Class C	Screen to Class B
Sealed Hybrid Circuits MIL-M-38510,	MIL-STD-883, Method 5004, except internal visual per Method 2017	
	Class C	Class B
All Unsealed Components/Circuits (Note 3)	MIL-STD-883, Method 5004, modified as noted.	
	Class C (Notes 1 and 3)	Class B (Notes 1 and 3)

NOTES:
1. Internal visual per MIL-STD-883, Method 2017 and delete constant acceleration and seal tests.
2. Definitions shall be per MIL-M-38510.
3. Temperature cycling per MIL-STD-883 on unsealed components/ circuits is not required provided the finished sealed relay with the device installed is equivalently temperature cycled.

* 3.5 Interchangeability. All parts having the same military part number shall be directly and completely interchangeable with each other with respect to installation and performance to the extent specified in the military specification sheet (see 3.1). Changes in manufacturer's part numbers shall be governed by the drawing number requirements of MIL-D-1000.

3.6 Performance. The relays shall meet the performance requirements and product characteristics of this specification and of the applicable specification sheets (see 3.1), when tested as specified.

3.6.1 Examination of product. When relays are examined and tested as specified in 3.43 and 3.44, they shall conform to requirements for materials, design, construction, physical dimensions, weight, item marking, and workmanship as specified (see 3.1, 3.3, 3.4, 3.43, and 3.44).



NOTE: Dashed lines indicate radial distance between terminal and header metal, dividing the glass into three equal parts (zones).

FIGURE 3. Inspection aid.

* 3.6.1.1 Header glass. Header glass may have small irregularities, such as bubbles, chips, cracks, etc. The acceptability of these defects will be based on figure 3, and the following:

a. Broken or open blisters having sharp edges are not acceptable.
b. Blisters whose diameters exceed one-third the radial distance between terminal and the corresponding header metal (for a cluster of blisters the combined diameters shall apply) are not acceptable.
c. Foreign material in or on the surface of the glass is not acceptable.
d. Dark spots (pigment concentrations) whose diameters exceed one-third the radial distance between terminal and the corresponding header metal are not acceptable.
e. Circumferential cracks which extent more than 90 degrees are not acceptable (see figure 3).
f. Radial cracks whose lengths exceed one-third the distance between the terminal and corresponding header metal are not acceptable (see figure 3).
g. Tangential cracks which are not confined to a single zone are not acceptable (see figure 3).
h. Surface chips whose lengths or widths exceed one-third the distance between the terminal and corresponding header metal are not acceptable (see figure 3).
i. Chipped meniscuses are acceptable to the extent that they do not extend below the surface of the glass, and to the extent of (h) above.
j. Meniscuses which extend up the terminal greater than .020 inch or one-third the terminal diameter, whichever is greater, are not acceptable.
k. Peripheral cracks at the boundary of the glass and surrounding header metal are not acceptable.
l. Any terminals which appear to be separated from the glass are not acceptable.

Microscopic examination with up to 10 power magnification shall be used. All relays must meet the applicable seal requirements, regardless of the acceptability of the header glass. In case of dispute, the relay may be subjected to the applicable seal requirement or any test deemed appropriate in order to determine its integrity.

3.7 Pickup voltage. When relays are tested as specified in 4.7.2, 4.7.2.1, and 4.7.2.2, each set of contacts shall make positive contact or open, as applicable, in the energized position when a potential voltage not in excess of the specified pickup voltage is applied to the relay coil. All normally open switching circuits shall close with positive contact and all normally closed circuits, if applicable, shall open. Once the relay has picked up, the contacts shall not change state (break and re-make) when the coil voltage is increased from the point of pickup to the maximum coil voltage, excluding normal contact bounce. For qualification inspection, the pickup voltage shall fall within the maximum specified when the relay is mounted in each of three mutually perpendicular planes.

* 3.8 Dropout voltage (not applicable to latching relays). When relays are tested as specified in 4.7.2.3, each set of normally open contacts shall open, and each set of normally closed contacts shall close, as applicable, when the applied coil voltage is at the specified dropout voltage. Excluding normal contact bounce, once the relay has dropped out, the contacts shall not change state when the voltage is reduced from the point of dropout to zero volts. For qualification inspection, the dropout voltage shall be measured with the relay in each of three mutually perpendicular planes.

* 3.9 Hold voltage. When relays are tested as specified in 4.7.3, there shall be no change in contact state (neither an opening of contacts that are closed, nor closure of contacts that are opened) until the coil voltage is less than the specified hold voltage (see 3.1).

* 3.10 Contact bounce, operating and release time (release time is not applicable to latching relays). When relays are tested as specified in 4.7.4, the contact bounce, operating and release times shall be within limits specified (see 3.1). The operating and release times shall not include the contact bounce time. The operate time and release time of each pole of a multipole relay shall be within 1 millisecond of each other pole of that relay for relays with contact ratings of 15 amperes or less and within 2 milliseconds for relays with contact ratings greater than 15 amperes. Unless make-before-break action is specified (see 3.1), double throw relays shall show no evidence of any normally open contacts closing before all normally closed contacts open; any normally closed contacts shall not make before all normally open contacts break. Contact break bounce on release of normally open contacts (when specified, see 3.1) shall be less than 100 microseconds.

3.11 Insulation resistance. When relays are tested as specified in 4.7.5, the insulation resistance shall be 100 megohms, or greater.

3.12 Dielectric withstanding voltage. The relays shall withstand, without damage, the ac dielectric test voltages between all mutually insulated parts and between these points and case or ground in accordance with values specified in table IX. When the relays are tested as specified in 4.7.6 and 4.7.6.1 (at atmospheric pressure), any arc-over (air discharge), flash-over (surface discharge), or breakdown (puncture discharge) causing a leakage current of more than 1.0 milliampere (mA) at the specified test voltage shall constitute failure. When dielectric withstanding voltage is performed following a load or endurance test specified in 4.7.26, the dielectric test voltage may be reduced to 75 percent of the sea level value shown in table IX, but not less than 1,000 volts.

3.12.1 At high temperature, high altitude pressure. Relays which are rated for use above 50,000 feet altitude shall be designed to withstand the altitude potentials specified in table IX. When relays are tested as specified in 4.7.6.2, they shall meet requirements specified in 3.12.

* TABLE IX. Dielectric withstanding voltage (50/60 Hz).

System voltage 3/	Sea level		Altitude 80,000 feet 1/
	Test voltage (1 minute) rms 2/	Test voltage (2-5 seconds) rms 4/ Manufacturer only	Test voltage (1 minute) 2/ rms
28 dc	1,050	1,250	500
115 ac	1,250	1,500	500
115/200 ac 5/	1,500	1,800	700

1/ Or altitude as specified (see 3.1). When an altitude above 80,000 feet is specified, the dielectric withstanding voltage is performed at 80,000 feet.

2/ The test potential shall be applied or reduced at a maximum rate of change of 250 volts (V) per second.

3/ If coil and contacts are rated for different voltages, each shall be tested to case in accordance with its respective system voltage. However, the test between coil and contact terminals shall be in accordance with the higher of the two system voltages.

* 4/ For performing quality conformance inspection on production samples, the 2-5 second test may be used by the manufacturer only in lieu of the one minute test. The one minute test is mandatory for qualification inspection or when defects are discovered in production inspection.

5/ For relays rated above 200 volts, the test potential for 1 minute shall be twice rated voltage plus 1,000 volts, with a minimum of 1,500 volts. The test potential for 2-5 seconds shall be 20 percent higher than the 1 minute test voltage. The test voltage at maximum specified altitude shall be 50 percent of the 1 minute value with a minimum of 750 volts root mean square (rms).

* 3.13 Contact voltage drop or contact resistance. Relays shall not exceed the contact voltage drop specified in table X when tested as specified in 4.7.7. Relays rated for low level or with auxiliary contacts which are rated at 2 amperes or less shall have a contact resistance value no greater than 0.05 ohm prior to load-endurance (life) cycling test and .15 ohm after load endurance cycling (life) test when tested as specified in 4.7.7.1.

TABLE X. Contact voltage drop (volts).

Type	Before load cycling		After load cycling	
	Average reading	Maximum individual reading	Average reading	Maximum individual reading
I, II, and IV	0.125	0.150	0.150	0.175
III	0.150	0.175	0.175	0.200

3.14 DC coil resistance. When relays are tested as specified in 4.7.8, the dc coil resistance shall be as specified (see 3.1).

3.15 Maximum coil current. When relays are tested as specified in 4.7.9, the maximum coil current shall be as specified (see 3.1).

3.16 Electromagnetic interference of coil circuit (Back EMF, coil kick).

3.16.1 Electromagnetic interference (applicable to coils of ac operated relays). When relays are tested as specified in 4.7.10.1, coils of ac operated relays shall not create electrical interference in excess of the limits specified in MIL-STD-461 for equipment Class IIB and MIL-STD-462 when continuously energized under steady state conditions.

3.16.2 Electromagnetic interference (applicable to dc operated relays with internal coil suppression). When relays are tested as specified in 4.7.10.2, coils of dc operated relays shall not generate a back EMF greater than that specified (see 3.1), as maximum induced transient voltage.

3.17 Strength of terminals and mounting studs.

3.17.1 Strength of threaded terminals and mounting studs. Relays having threaded stud type terminals or stud type mountings shall be tested to determine compliance with terminal strength design requirements specified in 3.4.8.1.2 and 3.4.9. When relay terminals are tested as specified in 4.7.11.1, the terminals shall not loosen or rotate, nor shall there be any other damage such as cracking or flaking of glass insulator other than crazing or chipping of the glass meniscus (see 3.6.1.1). There shall be no deterioration of relay performance beyond limits specified (see 3.1).

3.17.2 Strength of solder, plug-in, and wire-lead terminals. When relay terminals are tested as specified in 4.7.11.2, there shall be no loosening or breakage of terminals, cracking or flaking of glass insulators other than crazing or chipping of the glass meniscus, or any other damage that would affect relay performance beyond specified limits.

3.18 Thermal shock. When relays are tested as specified in 4.7.12, there shall be no damage to the relay, loosening of terminals, or cracking or flaking of glass insulation (other than cracking or chipping of the glass meniscus).

3.19 Low temperature operation. When tested as specified in 4.7.13, there shall be no damage to the relay, loosening of terminals, cracking or flaking of glass insulation (other than crazing or chipping of the glass meniscus) or of the hermetic seal. Following the test and at the specified low temperature, the pickup voltage, dropout voltage, and contact voltage drop shall meet the requirements of 3.7, 3.8, and 3.13, respectively, and shall continue to meet pickup and dropout voltage requirements until the relay returns to room temperature. Relays which contain permanent magnets in the magnetic circuit shall, in addition to the above test, be subjected to the demagnetizing effect of a sudden application of maximum coil voltage for one operation at the beginning of the second 24-hour period and the high temperature pickup voltage shall meet the requirements of 3.7.

3.20 Sand and dust (applicable to unsealed relays) (see 3.1). When relays are tested as specified in 4.7.14, there shall be no evidence of damage sufficient to impair the operation of the relay.

3.21 Continuous current. When relays are tested as specified in 4.7.15, there shall be no damage such as loosening of terminals, or any deterioration of performance beyond the limits specified (see 3.1). The terminal temperature rise shall not exceed 75°C.

3.22 Shock. When relays are tested as specified in 4.7.16 and 4.7.16.1, there shall be no closing of open contacts, no opening of closed contacts for a total time longer than specified in 3.22.1 or 3.22.2. Following the shock test there shall be no structural failure, loss of seal or other damage which might impair the operation of the relay. Latching type relays shall remain in each latched position with no voltage applied to coil.

3.22.1 Shock characteristics a, b, and c (see table III). The permissible contact opening shall not exceed 10 microseconds and the permissible contact closing shall not exceed 1 microsecond.

3.22.2 High-impact shock characteristic d (see table III) (when specified) (see 3.1). When relays are tested as specified in 4.7.16.1, the permissible contact opening or closing shall not exceed 20 milliseconds.

3.23 Vibration. When relays are tested as specified in 4.7.17, there shall be no contact opening in excess of 10 microseconds and the contact closing shall not exceed 1 microsecond, unless otherwise specified (see 3.1). It is required that the high temperature shall be the maximum specified (see 3.1). Following the resonance endurance and cycling endurance tests, there shall be no structural failure, loss of seal or other damage which might impair the operation of the relay. Latching type relays shall remain in each latched position with no voltage applied to the coils.

3.24 Acoustical noise (when specified) (see 3.1). When relays are tested as specified in 4.7.18, there shall be no contact opening in excess of 10 microseconds and the contact closing shall not exceed 1 microsecond. There shall be no deterioration of relay performance or physical damage.

3.25 Salt spray (corrosion). When subjected to the salt spray test of 4.7.19, and following washing in cold running tap water and drying for 6 hours at 65°C, the relay shall show no evidence of corrosion sufficient to impair the operation of the relay.

3.26 Mechanical life (endurance at reduced load). The relay shall be capable of operating at 25 percent of rated resistive load for four times the minimum operating cycles for relays under 25 amperes contact rating (resistive) and two times the specified minimum operating cycles for relays 25 amperes and over. When the relays are tested as specified in 4.7.20, relays shall remain mechanically and electrically operative. There shall be no indication of mechanical resonance due to the frequency of energizing voltage.

3.27 Altitude-temperature humidity test. When relays are tested as specified in 4.7.21, and immediately following drying for 6 hours at 65°C, the pickup voltage, dropout voltage, insulation resistance, and dielectric withstanding voltage shall meet the requirements specified in 3.7, 3.8, 3.11, and 3.12, respectively, and shall satisfactorily operate for 1/10 of the specified minimum cycles at rated resistive load. There shall be no welding or sticking of the contacts and there shall be no excessive corrosion or accumulation of moisture in the relay during the test sufficient to cause improper operation of the relay.

3.28 Humidity (applicable to unsealed, environmentally sealed, and hermetically sealed relays with potted wire leads) (see 3.4.5). When subjected to the humidity test of 4.7.22, relays shall not exhibit a leakage current in excess of 100 mA with a potential of 150 V rms applied between the terminals and other exposed metal parts.

3.29 Ozone (applicable to unsealed, environmentally sealed, and hermetically sealed relays with potted wire leads) (see 3.4.5). When relays are tested as specified in 4.7.23, the relay shall exhibit no cracking of materials or other damage which will adversely affect subsequent performance of the relay.

3.30 Acceleration. When relays are tested as specified in 4.7.24, the contacts of the relay shall remain in the de-energized conditions with no voltage across the coil and in the energized position when the coil voltage is reduced from the specified pickup voltage to one-half of the specified pickup voltage. Latching relays remain in each latched position with no voltage applied to the coils. Following the test there shall be no structural failure, loss of seal or other damage which might impair the operation of the relay.

3.31 Explosion proof (applicable to unsealed relays (see 3.4.5.1)). When relays are tested as specified in 4.7.25, any explosion internal to the relay shall not rupture the case or ignite the external fuel mixture in the test chamber.

* 3.32 Overload. When relays are tested as specified in 4.7.26.1, there shall be no electrical failure, such as contact sticking, welding, or failure to make or break the specified overload current. Blowing of the fuse connected between case and load system ground or neutral shall constitute failure. The terminal temperature rise shall not exceed 75°C. (Monitoring of terminal temperature rise required only during qualification testing.)

* 3.33 Rupture. When relays are tested as specified in 4.7.26.2, there shall be no electrical failure, such as contact welding or failure to make or break the specified rupture current. Blowing of the fuse connected between case and load system ground or neutral shall constitute failure (see 6.4.11). The terminal temperature rise shall not exceed 75°C. (Monitoring of terminal temperature rise required only during qualification testing.)

* 3.34 Circuit breaker compatibility (when specified, see 3.1). When relays are tested as specified in 4.7.26.3, there shall be no evidence of contact welding or sticking and the contact voltage drop shall meet the requirements of 3.13 after the test. The terminal temperature rise shall not exceed 75°C. (Monitoring of terminal temperature required only during qualification testing.) Blowing of the fuse connected between case and load system ground or neutral shall constitute failure (see 6.4.48).

* 3.35 Endurance (life) at rated contact loads. Relays shall be tested as specified in 4.7.26.4. Relays shall be tested at each contact rating specified (see 3.1). Relays having two or more sets of contacts and rated for multiphase (115/200 V ac 3 phase), shall be capable of handling multiphase power on adjacent contacts. Phase to phase arcing shall constitute failure. There shall be no mechanical or electrical failure. Welding of contacts, failure to make, carry or break the load, or blowing of the fuse connected between case and load system ground or neutral shall constitute a failure. The terminal temperature rise shall not exceed 75°C. (Monitoring of terminal temperature rise required only during qualification testing.)

3.35.1 Load transfer, single or polyphase ac. When polyphase load transfer is specified (see 3.1), the relays shall be subjected to load transfer cycling tests specified in 4.7.26.5. During test there shall be no phase-to-phase arc-over or welding (sticking) of relay contacts. Blowing of the case-to-ground fuse shall constitute failure.

3.35.2 Intermediate current (see 6.1.4). When relays are tested as specified in 4.7.26.6, there shall be no mechanical or electrical failures. The contact voltage drop shall not exceed values specified in 4.7.26.6.

* 3.35.3 Low level (when specified, see 3.1). When relays are tested as specified in 4.7.26.7, one miss shall constitute failure. Monitoring of terminal temperature rise is not applicable.

* 3.35.4 Mixed loads (when specified, see 3.1). Multipole relays shall be capable of switching low level and high (or intermediate) level loads on adjacent contacts. The requirements for endurance (3.35), intermediate current (3.35.2) and low level (3.35.3) shall apply to the contacts switching these loads. Relays shall be tested in accordance with 4.7.26.8.

* 3.35.5 High/low load transfer (when specified, see 3.1) (not applicable to single throw contact combinations). Relays with double throw contact combinations shall be capable of switching to ground through movable contacts both a high level load on a fixed contact and a low level load on the corresponding other fixed contact. The requirements for endurance (3.35) and low level (3.35.3) shall apply to the contacts switching these loads. Relay shall be tested in accordance with 4.7.26.9.

3.36 Vibration scan. When subjected to one cycle of vibration scan as specified in 4.7.27, there shall be no contact opening in excess of 10 microseconds and the contact closing shall not exceed 1 microsecond.

3.37 Seal. Relays shall be tested as specified in 4.7.28. Hermetically sealed and environmentally sealed relays shall comply with seal design requirements of 3.4.5.2 or 3.4.5.3.

3.37.1 Hermetic seal. The gas leakage rate shall not exceed 1×10^{-6} atmospheric cubic centimeters per second per cubic inch of net sealed gas volume, except for relays of 2 cubic inches volume or less, in which case the leakage rate shall not exceed 1×10^{-8} atmospheric cubic centimeters per second.

3.37.2 Environmental seal. The leakage rate for environmentally sealed relays shall be as specified (see 3.1).

3.38 Mechanical interlock (where applicable, see 3.1). For relays provided with the mechanical interlocking feature, it shall be impossible to close one set of relay contacts whenever the other set of relay contacts is maintained closed in the manner specified in 4.7.29.

* 3.39 Operational reliability (applicable to type I ER relays and relays screened to Group A type I ER testing (see 3.1)). When tested in accordance with 4.7.30 and with contacts continuously monitored, contact drop shall not exceed 0.2 volt for individual contacts or multiples thereof for contacts in series. In the event of failure of any one contact set to make the circuit with the above specified maximum contact drop during the specified number of operations, the test may be continued.

However, the counting of operations shall start over at the point of failure. In the event of subsequent failure of any one contact set, the relay shall be rejected. The low level test specified in 4.7.30 shall be used for relays rated at low level and may be used as an alternate for the above. When the low level test is used the contact resistance shall not exceed 100 ohms and no misses are allowed. For internal moisture detection the insulation resistance shall be at least 10 percent of its initial value (.1 times initial value). Any reading above 20,000 megohms shall be recorded as 20,000 megohms.

3.40 Resistance to solvents. When relays are tested as specified in 4.7.31, the marking shall remain legible.

* 3.41 Particle impact noise detection test (P.I.N.D., when specified, see 3.1). When relays are tested as specified in 4.7.32, there shall be no evidence of free moving particulate contamination.

* 3.42 Insertion and withdrawal force. When sockets are tested in accordance with 4.7.33, the insertion and withdrawal force shall be as specifed (see 3.1).

* 3.43 Identification of product. The relay shall be marked in accordance with MIL-STD-1285 and shall include the following information:

a. Noun name "Relay".
b. M, MS, or AN part number (including failure rate level identifying letter) as applicable.
c. Manufacturer's part number.
d. Contact configuration and circuit diagram (see 3.43.2).
e. Coil voltage 1/.
f. Manufacturer's name or source code.
g. Date code.
h. Contact ratings, ac or dc, and frequency, when applicable (maximum resistive rating available).
i. Serial number 2/.

* 3.43.1 Identification of qualification level for type I ER relays. Relays that have been qualified to a failure rate level shall be assigned an identifying letter indicating the level. The identifying letter for each failure rate level shall be as follows:

1 % - M
0.5% - U
0.3% - X
0.1% - P

This letter shall be added after the dash number portion of the relay's Military part number to provide the failure rate level information. (e.g. MS27400-005M, M6106/21-003U.)

* 3.43.2 Failure rate level substitution. Relays qualified to an improved failure rate may be substituted for high failure rate parts. For example, a relay qualified to failure rate level "U" (0.5 percent/10,000 operations) may be substituted for a failure rate "M" (1.0 percent/10,000 operations) relay. Relays shall not be remarked unless specified in the contract or purchase order.

3.43.3 Circuit diagram. Unless otherwise specified (see 3.1), a diagram showning the internal wiring connections shall be permanently and legibly marked on the exterior of each relay. Symbols shall be in accordance with figure 1. When a relay case contains more than one separate relay mechanism with separate armatures so the contacts connect independently (e.g., one might pick up at 13 volts and another at 10 volts), the circuit diagram shall show separate coils as associated with respective contacts.

3.43.3.1 Circuit diagram for dual coil relays. For the relays with dual coils, the circuit diagram shall have a relationship between coil and contacts as specified in 3.4.8.4. Contacts shall be attracted toward a coil symbol when energized.

1/ Coil voltage, ac or dc, and frequency, as applicable, shall be shown.
2/ When specified.

3.43.4 Use of MS or MIL designations. MS or MIL designations shall not be applied to a product except for qualification test samples, not referred to in correspondence, until notice of approval has been received from the activity responsible for qualification.

3.44 Workmanship. The relays shall be fabricated in such a manner as to be uniform in quality, and shall be free from cracked or displaced parts, sharp edges, burrs, and other defects that will affect life or serviceability.

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for inspection. Unless otherwise specified in the contract, the contractor is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified in the contract, 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 Test equipment and inspection facilities. Test and measuring equipment and inspection facilities of sufficient accuracy, quality, and quantity to permit performance of the required inspection shall be established and maintained by the contractor. The establishment and maintenance of a calibration system to control the accuracy of the measuring and test equipment shall be in accordance with MIL-STD-45662.

4.2 Classification of inspection. The examination and testing of relays shall be classified as follows:

a. Materials inspection (see 4.3).
b. Qualification inspection (see 4.5).
c. Quality conformance inspection (see 4.6).

4.3 Materials inspection. Materials inspection shall consist of certification supported by verification data that the materials listed in table XI, used in fabricating the relays are in accordance with the applicable referenced specifications prior to such fabrication.

* TABLE XI. Materials inspection.

Material	Requirement paragraph	Applicable specification(s)
Contact springs	3.4.11.1	---
Plastic	3.3.2.1	MIL-P-997, MIL-P-15037, MIL-P-15047, MIL-M-14, MIL-P-46133
Ceramic	3.3.2.2	MIL-I-10
Magnet wire	3.3.2.3	J.W.1177
Rubber	3.3.2.4	ZZ-R-765
Nonmetals	3.3.2	---

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

4.4.1 Power supply. Unless otherwise specified, the power supply shall be capable of simulating the normal and abnormal power conditions described in MIL-STD-704 in such a way that the voltages, both ac and dc, shall be within the steady-state voltage limits as specified in MIL-STD-704 (400 ±20 hertz (Hz) range), including transient conditions. AC overload and rupture test loads shall be performed at the specified frequency (see table XII and 3.1). Where applicable, the power supply shall meet the requirements of MIL-STD-706.

TABLE XII. Power supply regulation.

System	Open circuit voltage	Calibrated fault current amperes	Transient rms voltage after calibrated fault current interruption
"Y" connected 50/60/400 Hz 115/200 volts	Single phase 120 ±5	Current specified (see 3.1) in 10 to 25 cycles after fault initiation	120 within 3 cycles 150 within 6 cycles 165 maximum
	3-phase 205 ±5		205 within 3 cycles 255 within 6 cycles 280 maximum
28 V dc	30 ±5	Current specified (see 3.1) in 0.01 to 0.03 seconds after fault initiation	28 within 0.002 seconds 50 maximum

4.4.2 Temperature. Unles otherwise specified, relays shall be tested at an ambient temperature of 23°C ±2°C and, at the discretion of the manufacturer, the quality conformance inspection (see 4.6), may be conducted at ambient temperatures in the range of 20° to 35°C, inclusive.

* 4.4.3 Wire. In any of the specified load tests (see 4.7.26), each individual wire shall be a minimum of 3 feet in length and of an applicable size conductor (copper) for use in free air as listed in table XIII determined by the rated resistive load of the relay. If the relay rating does not coincide with wire size, the next larger diameter wire shall be used.

* 4.4.3.1 Wire application criteria. In application MIL-W-5088 may be used as a guide to wire selection; however, when wire gauges selected are smaller than those specified in table XIII, or as specified (see 3.1), environmental and load deratings must be considered since relay overheating and failure may occur due to the reduced heat sinking capacity of the smaller gauge wire.

4.4.4 Terminal lugs. Wire shall be terminated with an applicable size and type of terminal lug according to MS20659 or MS25036, or other currently approved military specification.

4.4.5 Terminal covers and barriers. When terminal covers or barriers, or both, are specified (see 3.1), all load and environmental tests shall be conducted with the terminal covers or barriers, or both, in place.

4.4.6 Altitude. Unless otherwise specified, the qualification inspection (see 4.5), shall be conducted with the relay mounted in the position most likely to cause malfunctioning. This position shall be shown or otherwise noted in test reports.

4.4.7 Altitude-temperature tests. Unless otherwise specified, the relay under test shall be surrounded by a metal enclosure, the surface of which is established at the specified high temperature. The enclosure inner surface shall have an emissivity between 0.7 and 1.0 for the test temperature employed. The air within the test enclosure shall be still and held at the specified altitude.

4.5 Qualification inspection. Qualification inspection shall be performed at a laboratory acceptable to the Government (see 6.3). Report of qualification and sampling plan tests shall be prepared in accordance with MIL-STD-831. The qualification test report shall state whether or not the qualification sample units were production units. For type I ER relays, qualification sample units shall be normal production units. For established reliability relays, type I ER, the manufacturer's facilities shall be approved under MIL-Q-9858.

* TABLE XIII. Current-carrying capacity of conductors.

Wire size		Continuous-duty current - amperes	
Aluminum	Copper	Single wire in free air	Wires in conduit or bundles
	24	---	2
	22	---	5
	20	11	7.5
	18	16	10
	16	22	13
	14	32	17
	12	41	23
	10	55	33
	8	73	46
	6	101	60
	4	135	80
	2	181	100
	1 1/	211	125
	0 1/	245	150
	00 1/	283	175
	000 1/	328	200
	0000 1/	380	225
8		60	36
6		83	50
4		108	66
2		152	82
1		174	105
0		202	123
00 1/		235	145
000 1/		266	162
0000 1/		303	190

1/ Use of these sizes of wires requires specific approval of the procuring activity.

* 4.5.1 Sample size. The number of sample units required for qualification shall be as indicated in table XIV or as specified by the activity responsible for qualification. Sample units shall be selected at random and numbered serially to agree with sample numbers specified in tables XIV and XV. Additional sample units required for ER rated relays shall be as indicated in table XV.

* 4.5.2 Inspection routine. Sample units shall be subjected to the qualification tests in the sequence specified in table XV. One or more relays will be required for each sequence of tests as indicated at the top of each column of table XV. The numbers appearing in each column opposite the applicable tests indicate the sequence in which the tests shall be performed. Relays having higher contact ratings for lower temperature altitude classifications shall have applicable load tests performed separately. Extra sample units shall be provided for this purpose as specified in table XIV or XVI.

TABLE XIV. Qualification test samples.

Type of relay	Number of sample units 1/	Relay sample number (testing sequence in table XV)
a. Single-throw relay, 28 V or other single voltage rating	6	1,2,3,4,5,6
b. DC and ac service	4 additional	8,9,10,11
c. For lamp load	1 additional	7
d. For double-throw relays 5/	1 additional 2/	4,9, 2/
e. For higher ratings in lower classifications dc 4/	4 additional 3/	3,4,5,6 3/
f. For higher ratings in lower classifications ac	3 additional 3/	8,9,10 3/

1/ Additional sample units may be required when the intermediate current test is to be performed on relays having less than four poles (see 4.7.26.5).
2/ At contractor's option for motor load (see 4.7.26.4.2).
3/ Quantity shown is for higher rating for each type of load, inductive motor, and resistive. Reduce by one sample unit for each type of load not involved.
4/ For definition of higher ratings in lower classifications, see 6.10.
5/ When the 3-phase load transfer test of 3.35.1 is specified, add relay sample number 12.

4.5.2.1 Inspection sample units and test data. The tested sample units, together with certified test reports and test data, shall be forwarded to the activity responsible for qualification (see 6.3). The test data shall include representative oscillograms of all circuit interrupting tests. In addition, relay outline drawings based on the applicable specification sheet (see 3.1) shall be furnished.

* 4.5.3 Failures. Two or more failures shall be cause for refusal to grant qualification approval. For type I ER relays, failures in excess of those allowed in table XV shall be cause for refusal to grant qualification approval.

4.5.4 Retention of qualification (types I, II, III, and IV). To retain qualification, the contractor shall forward a report at 36-month intervals to the qualifying activity. The qualifying activity shall establish the initial reporting date. The report shall consist of:

a. A summary of the results of the tests performed for inspection of product for delivery, (group A), indicating as a minimum the number of lots that have passed and the number that have failed. The results of tests of all reworked lots shall be identified and accounted for.
b. The results performed for periodic check tests (groups B and C), including the number and mode of failures. The test report shall include results of all periodic check tests performed and completed during the 36-month period. If the test results indicate non-conformance with specification requirements, and corrective action acceptable to the qualifying activity has not been taken, action may be taken to remove the failing product from the qualified products list.

* TABLE XV. Qualification inspection.

Inspection	Requirement paragraph	Test paragraph	Testing sequence — Relay sample unit number																
			1 1/	2	3	4 1/	5	6	7 1/	8 1/	9 1/	10 1/	11 1/	12	13 8/ 14 7/	14	15	16	17
Examination of product	3.1, 3.3, 3.4, 3.43, 3.44	4.7.1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
Pickup voltage	3.7	4.7.2 4.7.2.1	2	2,12	2,13	2,11, 17	2,11	2,11, 16	2	2	2	2,14	2,12	2,12	2	2	2	2	
Dropout voltage	3.8	4.7.2.3	3	3,13	3,14	3,12, 18	3,12	3,12, 17	3	3	3	3,15	3,12	3,13	3	3	3	3	
Hold voltage	3.9	4.7.3	4	4,14	4,15	4,13, 19	4,13	4,13, 18	4	4	4	5	4,13	4,14	4	4	4	4	
Contact bounce, operating and release time	3.10	4.7.4	5	5	5,16	5	5	5,19	5	5	5	5,17	5,14	5,15	5	5	5	5	
Insulation resistance	3.11	4.7.5	6	6,15	6,18	6,20, 24	6,14, 20	6,20	6,10	6,10	6,11	6,10, 18	6,15	6,16	6,10	6,10	6,10	6,10	
Dielectric withstanding voltage	3.12	4.7.6	7	7,16	7,19	7,21, 25	7,15, 21	7,21	7,11	7,11	7,12	7,11, 19	7,16	7,17	7,11	7,11	7,11	7,11	
Contact voltage drop or resistance	3.13	4.7.7	8	8,17	8,20	8,14, 26	8,16, 22	8,14, 22	8,12	8,12	8,13	8,12, 20	8,17	8,18	8,12	8,12	8,12	8,12	
High temperature pickup voltage	3.7	4.7.2.2				15	9	9											
DC coil resistance	3.14	4.7.8						23											
Maximum coil current	3.15	4.7.9						24											
Electromagnetic interference (ac or dc as applicable) 2/	3.16	4.7.10	9	9															
Strength of terminals and mounting studs	3.17	4.7.11			9														
Thermal shock 3/	3.18	4.7.12				9													
Low temperature operation	3.19	4.7.13				10													
Sand and dust 4/	3.20	4.7.14						10											
Continuous current	3.21	4.7.15						15											
Shock 5/	3.22	4.7.16			10														

See footnotes at end of table.

TABLE XV. Qualification inspection - Continued.

Inspection	Requirement paragraph	Test paragraph	Testing sequence — Relay sample unit number																
			1 1/	2	3	4 1/	5	6	7 1/	8 1/	9 1/	10 1/	11 1/	12	13 8/ 14/	14	15	16	17
Vibration 7/	3.23	4.7.17						25											
Acoustical noise 8/	3.24	4.7.18												9					
Salt spray (corrosion) 9/	3.25	4.7.19					10												
Mechanical life (endurance at reduced load)	3.26	4.7.20		10										11					
Altitude-temperature humidity	3.27	4.7.21		11		16													
Humidity 10/	3.28	4.7.22										13	10						
Ozone 10/	3.29	4.7.23					17												
Acceleration	3.30	4.7.24			12														
Explosion proof 1/ 8/	3.31	4.7.25		18															
Overload dc	3.32	4.7.26.1				22	18												
Overload ac	3.32	4.7.26.1									9								
Rupture 11/ 12/	3.33	4.7.26.2	11										9						
Circuit breaker compatability 8/ 13/	3.34	4.7.26.3														9			
Inductive load, dc 11/	3.35	4.7.26.4.1			17														
Motor load, dc 11/	3.35	4.7.26.4.2				23													
Resistive load, dc 11/	3.35	4.7.26.4.3					19												
Lamp load 11/	3.35	4.7.26.4.4							9										
Inductive load, ac 11/ 13/	3.35	4.7.26.4.5								9									
Resistive load, ac	3.35	4.7.26.4.7										9							
Motor load ac 11/ 13/	3.35	4.7.26.4.6									10								
Load transfer, single or polyphase ac 8/	3.35.1	4.7.26.5																	
Intermediate current	3.35.2	4.7.26.6	10					26											

See footnotes at end of table.

* TABLE XV. Qualification inspection - Continued.

Inspection	Requirement paragraph	Test paragraph	Testing sequence / Relay sample unit number																
			1 1/	2	3	4 1/	5	6	7 1/	8 1/	9 1/	10 1/	11 1/	12	13 8/ 14/	14	15	16	17
Low level 8/ 13/	3.35.3	4.7.26.7													9		9		
Mixed loads 8/ 14/	3.35.4	4.7.26.8																9	
High/low load transfer 8/14/	3.35.5	4.7.26.9																	
Vibration scan 4/	3.36	4.7.27							13										
Seal	3.37	4.7.28	12	19	21	27	23	27	14	13	14	21	17	19					
Mechanical interlock	3.38	4.7.29	13																
Resistance to solvents	3.40	4.7.31	14	20	22			28	15	14	15	22	18	20					
Insertion and withdrawal force	3.42	4.7.33																	1 15/

* 1/ Additional sample units may be required (see 4.5.1 and table XIII).
2/ When ac is applicable, 2 relays shall be tested. When dc is applicable, 12 relays shall be tested.
3/ Insulation resistance and dielectric withstanding voltage is to be conducted immediately after stabilizing at room temperature.
4/ Applicable to unsealed relays.
5/ Additional sample unit may be provided when high shock is specified.
6/ Additional sample unit may be provided when random vibration is specified.
7/ Resonance or cycling endurance tests shall be conducted for 1 hour in the plane most likely to cause malfunction.
8/ Applicable only when specified (see 3.1).
9/ Pickup voltage, dropout voltage, insulation resistance, dielectric withstanding voltage, and contact voltage drop are to be conducted immediately following a 6 hour drying period at 65°C.
10/ Applicable to unsealed, environmentally sealed, and hermetically sealed relays with potted wire leads.
11/ Omit tests that do not apply.
12/ If dc ratings are not involved, these tests shall be performed on samples 1, 3, 4, and 5 instead of the corresponding dc tests.
13/ When applicable, an additional sample unit shall be provided.
*14/ Additional samples are required to complete the mixed load test (see 4.7.26.8).
*15/ Three samples are required.

Failure to submit the report within 30 days after the end of each 36-month period may result in loss of qualification for the product. In addition to the periodic submission of inspection data, the contractor shall immediately notify the qualifying activity at any time that the inspection data indicates noncompliance of the product to meet the requirements of this specification. In the event that no production occured during the reporting period, a report shall be submitted certifying that the company still has the capabilities and facilities necessary to produce the relay. If during two consecutive reporting periods there has been no production, the manufacturer may be required, at the discretion of the qualifying activity, to submit a representative relay to testing in accordance with the qualification inspection requirements.

TABLE XVI. Additional qualification testing and sample breakdown for 1 percent per 10,000 operation failure rate.

Sample units required 2/	Endurance (life) test	Requirement paragraph	Test paragraph	Total failure-free operations 1/ (no failures permitted) million
4	Resistive, dc	3.34	4.7.25.4.3	.4
4	Inductive, dc	3.34	4.7.25.4.1	.08
3	Motor, dc	3.34	4.7.25.4.2	.3
3	Resistive, ac	3.34	4.7.25.4.7	.3
4	Inductive, ac	3.34	4.7.25.4.5	.08
3	Motor, ac	3.34	4.7.25.4.6	.3
3	Lamp	3.34	4.7.25.4.4	.3

1/ 1.76 million failure-free operations are required for qualification. If the number of specified operations at any or all loads are such that this table results in more than 1.76 million operations, the number of sample units may be reduced, with the approval of the Government qualifying activity, with approximate equal reduction in sample units of each type of loading.

2/ When load transfer, polyphase of 3.35.1 of this specification is a requirement (see 3.1), two additional sample units must be added for qualification and for maintenance of qualification.

4.5.4.1 Retention of qualification for type I ER.

* a. To retain qualification to a specific type I ER relay, the manufacturer must either continue to retain qualification to the type I companion relay or submit type I ER samples to the Group B inspection of paragraph 4.7.2.1 (in which case qualification to the type I companion is automatically retained.

b. Perform group C tests.

* c. The retention period for endurance tests (see 4.7.26) shall be as outlined in table XVII.

d. Submission of test data shall be as specified in 4.5.4.

* TABLE XVII. Retention of qualification period for type I ER.

Failure rate/ 10,000 operations	Period
1 percent (M)	6 months
0.5 percent (U)	12 months
0.3 percent (X)	18 months
0.1 percent (P)	18 months

4.5.5 Configuration control. Changes in a relay's design, material, or manufacturing process shall be submitted to the Government qualifying activity for approval of qualification test procedure. All major changes in relay design shall require complete qualification inspection.

* 4.5.6 Cumulative operations to attain a higher FR level. All data obtained from initial qualification, additional qualification to ER, group B, and retention of qualification shall be cumulative. When the number of cumulative operations, with the corresponding number of failures, as indicated in table XVIII is reached, the relay type will be qualified to the next higher failure rate level. From that point, all retention of qualification shall be governed by the requirements at this new higher level.

* TABLE XVIII. Number of operations (cumulative operations) to achieve failure rate (FR).

	(U) FR = 0.5%/ 10,000 ops	(X) FR = 0.3%/ 10,000 ops	(P) FR = 0.1%/ 10,000 ops
Cumulative operations (no failures)	4.6 million	7.9 million	23.0 million
Cumulative operations (1 failure)	7.9 million	13.0 million	39.0 million
Cumulative operations (2 failures)	10.5 million	17.5 million	53.0 million

4.6 Quality conformance inspection. The examination and testing of production relays shall be conducted in accordance with quality conformance inspection requirements specified herein. Quality conformance tests shall consist of groups A, B, and C inspections. Complete records shall be kept for three years of all sampling plan test data. Data for type I ER relays shall be identified with the serial number of the particular relay in test.

4.6.1 Inspection of product for delivery. Inspection of product for delivery shall consist of group A inspection.

4.6.1.1 Inspection lot. An inspection lot shall consist of all relays covered by a single specification sheet, produced under essentially the same conditions within a period not to exceed 1 month, and offered for inspection at one time.

* 4.6.1.2 Group A inspection. Group A inspection shall consist of the tests and examination shown in table XIX. If the manufacturer performs equal or more stringent tests than required by table XIX as the final step of his production process, table XIX tests may be waived for other than type I ER relays or relays screened to group A type I ER testing. For type I ER relays or relays screened to group A type I ER testing, one copy of variables test data shall be supplied with each serialized device. Actual measured values shall be shown for pickup voltage, dropout voltage, contact bounce, operating and release times, contact voltage drop or resistance, coil resistance or current, and electromagnetic interference (dc) as specified in 4.7.2.1, 4.7.2.3, 4.7.4, 4.7.6.1, 4.7.7, 4.7.8 or 4.7.9 and 4.7.10.2, respectively.

* 4.6.1.2.1 Sampling plan. All relays shall be subjected to group A inspection specified in table XIX; testing sequence is optional, except for type I ER relays or relays screened to group A type I ER testing, vibration scan followed by operational reliability shall be conducted first.

4.6.1.2.2 Failure criteria. Relays which have failed to pass group A inspection may be reworked or have parts replaced to correct the defects and resubmitted for acceptance.

4.6.2 Periodic inspection. Periodic inspection shall consist of groups B and C. Except where the results of these inspections show noncompliance with the applicable requirements (see 4.6.2.2.5), delivery of products which have passed group A shall not be delayed pending the results of these periodic inspections.

* TABLE XIX. Group A inspection.

Inspection	Requirement paragraph	Test method paragraph
Vibration scan 1/	3.36	4.7.27
Operational reliability 1/ 2/	3.39	4.7.30
P.I.N.D. test (when specified, see 3.1)	3.41	4.7.32
Contact voltage drop or resistance	3.13	4.7.7
Pickup voltage 3/	3.7	4.7.2, 4.7.2.1
Dropout voltage 3/	3.8	4.7.2.3
Hold voltage	3.9	4.7.3
Insulation resistance	3.11	4.7.5
Dielectric withstanding voltage 4/	3.12	4.7.6.1
DC coil resistance 5/	3.14	4.7.8
Maximum coil current 5/	3.15	4.7.9
Electromagnetic interference (dc) 2/	3.16.2	4.7.10.2
Seal 6/	3.37	4.7.28
Contact bounce, operating and release times 9/	3.10	4.7.4
Break bounce 7/	3.10	4.7.4
Examination of product 8/	3.1, 3.3, 3.4, 3.43, and 3.44	4.7.1

1/ Additional test required for type I ER and relays screened to group A ER testing.
2/ When specified.
3/ Omit 30-minute conditioning period except for sample units to be further tested under group B (see 4.7.2).
4/ 2-5 seconds sea level test specified in table IX may be used.
5/ Maximum coil current shall be performed only when dc coil resistance is not specified.
* 6/ Seal test may be performed as a final assembly operation prior to performing group A tests on types I, II, and III provided this test is performed on all of the relays. Seal test shall be performed after the P.I.N.D. test.
* Type I ER and relays screened to group A type I ER testing seal tests shall be performed after vibration scan and operational reliability.
7/ When break bounce is specified (see 3.1).
* 8/ Physical dimensions shall be measured on two sample units per MS number on one lot each year.
9/ Not applicable to relays fully rated at 25 amperes and above.

* 4.6.2.1 Group B inspection. Group B inspection shall consist of the tests specified in table XX in the order shown. Note: On endurance tests, the motor load test shall be run at the highest voltage rating specified, ac or dc, the first time group B tests are run after initial qualification. The second time group B tests are run, the resistive load rating shall be run at the highest voltage rating specified, ac or dc, and so on in the order shown. After each type of current load has been run at the highest voltage rating, one sequence shall start over using the lowest specified voltage rating, ac or dc. It is intended that all loads specified (see 3.1), shall have been run at least once at both maximum and minimum specified voltage between the time of initial qualification and requalification and between all subsequent requalifications. If the lamp load rating is equal to or less than 0.5 times the motor load rating, the lamp load test need not be run. In addition, relays rated for low level (see 3.1), mixed loads (see 3.1), or high/low load transfer (see 3.1) shall be tested each time group B inspection is performed. The high (or intermediate) level load used in the mixed load test shall be the same as the high (or intermediate) level load being tested during the performance of the group B inspection.

* TABLE XX. Group B inspection.

Inspection	Requirement paragraph	Test method paragraph
Low temperature operation	3.19	4.7.13
Thermal shock 1/	3.18	4.7.12
Insulation resistance	3.11	4.7.5
Dielectric withstanding voltage	3.12	4.7.6
Endurance (life) tests 2/ 3/:		
Motor load dc	3.35	4.7.26.4.2
Motor load ac	3.35	4.7.26.4.6
Resistive load dc	3.35	4.7.26.4.3
Resistive load ac	3.35	4.7.26.4.7
Inductive load dc	3.35	4.7.26.4.1
Inductive load ac	3.35	4.7.26.4.5
Lamp load	3.35	4.7.26.4.4
Intermediate current	3.35.2	4.7.26.6
Mechanical life (endurance at reduced load) 4/	3.26	4.7.20
Low level (when specified, see 3.1)	3.35.3	4.7.26.7
Mixed loads (when specified, see 3.1)	3.35.4	4.7.26.8
High/low load transfer (when specified, see 3.1)	3.35.5	4.7.26.9
Vibration scan	3.36	4.7.27
Insulation resistance	3.11	4.7.5
Dielectric withstanding voltage	3.12	4.7.6
Contact voltage drop or resistance	3.13	4.7.7

1/ Immediately after stabilizing at room temperature, insulation resistance and dielectric withstanding voltage shall be measured.

2/ Each time sampling plan B is run on two relays, only one type of endurance test shall be run. Sequence of testing on subsequent groups of two relays shall be in the order shown in accordance with 4.6.2.1.

3/ The altitude requirements for all types of relays during endurance may be waived provided that 50 percent of the required operating cycles are conducted at an ambient temperature 10 percent above the maximum specified for the class of relay being tested.

4/ Following mechanical life, pickup voltage, dropout voltage, and contact bounce, operate and release time shall be measured as specified in 4.7.2, 4.7.2.1, 4.7.2.3, and 4.7.3, respectively.

* 4.6.2.1.1 Sampling plan. For group B inspection, relays rated up to 25 amperes shall be selected at random from every 500 units or 2 units for every 3 months production unless these two units constitute more than 10 percent of that period's production in which case the period shall be extended as required but not to exceed 12 months. For relays 25 amperes and over, one relay shall be selected after 100 units have been produced in a quarter. If production exceeds 1,000 units in a quarter, one relay shall be selected from each subsequent 1,000 units. If no relays are selected in 1 year based on the above, two units shall be selected at the end of that year. If these two units represent more than 1 percent of production, no testing is required. The sampling plan shall be used whichever shall result in the largest number of samples, of each manufacturer's part number manufactured. Relays rated for low level, mixed loads, or high/low load transfer shall have additional sample(s) submitted to allow one relay to be tested for each load each time group B inspection is performed. Sample units that have completed and passed group A inspection shall be used unless the Government decides to use separate samples. For type I ER relays, no group B tests over and above those required for the type I companion unit are required. If there is no production of type I companion relay, the type I ER may be submitted to the group B inspection for purposes of maintaining qualification of the type I companion. For type I ER relays, maintenance of qualification is required at the end of each maintenance period (see table XVII). If there is no production for the maintenance period, retention of qualification group C inspection shall be run in lieu of group B.

4.6.2.1.2 Failure criteria. When one or more relays fail to pass group B inspection, further acceptance shall be withheld until the cause of failure is determined. In the event of a single isolated failure on group B testing, and if the relay in question satisfactorily completed 50 percent of the specified minimum cycles on the particular load being tested, the manufacturer may, at his option, have two additional relays selected for the same group B testing. If the two relays pass, the lot shall be accepted and production and acceptance testing resumed. In the event of an additional failure on the two samples, acceptance shall be withheld and corrective action will be necessary. After corrective action has been taken, production and acceptance testing may be resumed. For production reasons, group A tests may be continued pending the investigation of group B failures.

4.6.2.1.3 Disposition of sample relays. Sample relays which have been subjected to group B inspection shall not be delivered on the contract or purchase order.

4.6.2.2 Group C inspection.

* 4.6.2.2.1 Sampling plan. Group C inspection shall consist of the examinations and tests specified in table XXI. Six sample units that have been subjected to and have passed group A inspection shall be used. The tests shall be performed on the required number of relays within three years after initial qualification and every three years thereafter on each manufacturer's part number manufactured. If initial qualification was not run on production units, a sufficient number of sample units necessary for conducting the tests under this plan shall be selected from the first production lot of relays. The qualifying activity may recognize similarity within families of relays in waiving environmental tests other than vibration, providing at least one member of a family of relays is subjected to the particular tests.

* TABLE XXI. Group C inspection.

Inspection	Requirement paragraph	Test method paragraph	Relay sample number					
			1	2	3	4	5	6
			Sequence of testing					
Humidity 1/	3.28	4.7.22	1					
Sand and dust 2/	3.20	4.7.14		1				
Overload, dc	3.32	4.7.26.1			1			
Overload, ac	3.32	4.7.26.1				1		
Motor load, dc 3/	3.35	4.7.26.4.2			2			
Motor load, ac 3/	3.35	4.7.26.4.6				2		
Intermediate current	3.35.2	4.7.26.6					1	
Vibration	3.23	4.7.17						1
Strength of terminals and mounting studs	3.17	4.7.11						2
Pickup voltage	3.7	4.7.2, 4.7.2.1	2	2				3
Hold voltage	3.9	4.7.3	3	3				4
Dropout voltage	3.8	4.7.2.3	4	4				5
Insulation resistance	3.11	4.7.5	5	5	3	3	2	6
Dielectric withstanding voltage	3.12	4.7.6	6	6	4	4	3	7
Contact voltage drop or resistance	3.13	4.7.7	7	7	5	5	4	8
Contact bounce, operating and release times	3.10	4.7.4	8	8	6	6	5	
Seal	3.37	4.7.28	9	9	7	7	6	9

1/ Applicable to unsealed, environmentally sealed, and hermetically sealed relays with potted wire leads.
2/ Applicable to unsealed relays.
3/ If the relay is rated 10 amperes or less, or if there is no specified motor load ratings, the resistive load, dc, 4.7.26.4.3, and resistive load, ac, 4.7.26.4.7, shall be used.

* 4.6.2.2.2 Sampling plan, type I ER. For type I ER relays, group C tests, except overload and endurance tests (see 4.7.26, shall be performed within one year after initial qualification and every year thereafter on each manufacturer's part number as specified in table XXI except when group C test coincides with group C test for type I relays, these tests need not be performed for the type I ER relays. Sample units for endurance (see 4.7.26), are to be selected as specified in table XXII and tested within the retention of qualification period specified in table XVII. If one of the loads specified in table XXII is not applicable, the sample allocated for this non-specified load shall be tested at the resistive load (dc or ac).

* TABLE XXII. Retention of qualification (no failures) test sample units selection for endurance tests (type I ER).

Test	Number of operations			
	Failure rate 1% (M)	Failure rate 0.5% (U)	Failure rate 0.3% (X)	Failure rate 0.1% (P)
Resistive load, dc	200,000	500,000	1,000,000	3,000,000
Inductive load, dc	60,000	80,000	160,000	500,000
Motor load, dc	100,000	300,000	500,000	1,500,000
Resistive load	200,000	300,000	400,000	1,200,000
Inductive load, ac	60,000	60,000	120,000	500,000
Motor load, ac	100,000	300,000	400,000	1,400,000
Lamp load	200,000	300,000	500,000	1,500,000

* 4.6.2.2.3 Failures, type I ER. In the event of one failure, the additional sample units specified in table XXIII shall be tested. In the event of more than one failure, additional sample units may be tested at the failed rating to bring the failure rate to the previously established level.

* TABLE XXIII. Retention of qualification (1 failure per period) sample unit selection for endurance tests (type I ER).

Test	Number of operations			
	Failure rate 1% (M)	Failure rate 0.5% (U)	Failure rate 0.3% (X)	Failure rate 0.1% (P)
Resistive load, dc	400,000	800,000	1,400,000	4,200,000
Inductive load, dc	100,000	200,000	300,000	900,000
Motor load, dc	300,000	600,000	1,200,000	3,500,000
Resistive load, ac	300,000	600,000	1,200,000	3,500,000
Inductive load, ac	100,000	200,000	300,000	900,000
Motor load, ac	300,000	600,000	1,200,000	3,500,000
Lamp load	300,000	600,000	1,200,000	3,500,000

4.6.2.2.4 Disposition of sample units. Sample units which have been subjected to group C inspection shall not be delivered on the contract or purchase order.

4.6.2.2.5 Noncompliance. If a sample fails to pass group B or C inspections, the contractor shall take corrective action on the materials or processes, or both, as warranted, and on all units of product which can be corrected and which were manufactured under essentially the same conditions, with essentially the same materials, processes, etc., and which are considered subject to the same failure. Acceptance of the product shall be discontinued until corrective action, acceptable to the Government, has been taken. After the corrective action has been taken, groups B and C inspections shall be repeated on additional sample units (all inspections, or the inspection which the original sample failed, at the option of the Government). Group A inspection may be reinstituted; however, final acceptance shall be withheld until the groups B and C reinspection has shown that the corrective action was successful. In the event of failure after reinspection, information concerning the failure and corrective action taken shall be furnished to the cognizant inspection activity and the qualifying activity.

* 4.6.3 Inspection of packaging. Except when commercial packaging is specified, the preservation and interior pack marking shall be in accordance with the groups A and B quality conformance inspection requirements of MIL-P-116. The sampling and inspection of the packing and marking for shipment and storage shall be in accordance with the quality assurance provisions of the applicable container specification and the marking requirements of MIL-STD-129. The inspection of commercial packaging shall be as specified in the contract or purchase order (see 6.2).

4.7 Methods of examination of product.

* 4.7.1 Examination of product. Relays shall be inspected to verify that the materials, design, construction, physical dimensions, weight, marking and workmanship are in accordance with the applicable requirements (see 3.1, 3.3, 3.4, 3.6.1, 3.43, and 3.44). Visual and mechanical inspection shall be performed with professional quality measuring equipments to determine dimensions, weights, and surface defects.

* 4.7.1.1 External parts (where applicable, see 3.4). Any external part attached to the relay solely by solder shall be tested in the following manner. The test relay shall be mounted in such a manner that a weight can be hung from the part attached by solder. The weight shall be equal to 25 times the weight of the soldered part. The force from the weight shall be in such a direction as to most likely cause the part to separate from the relay proper. With the weight suspended from the soldered part as prescribed above, the assembly shall be stabilized at 260°C or 100°C above the maximum temperature or whichever is higher. Separation of the soldered part from the relay proper shall constitute failure. The above test shall be repeated for each external part on a relay that is solely attached by solder.

* 4.7.2 Pickup and dropout voltage (see 3.7 and 3.8). Relays shall be tested as specified in 4.7.2.1, 4.7.2.2 and 4.7.2.3. The pickup and dropout voltages shallbe as specified (see 3.1), when checked within the temperature limits for the relay class. The following additional tests shall be performed during qualification, group B and group C inspections. With the relay de-energized for 30 minutes prior to test, the relay contacts shall not change state (break and re-make) when the coil voltage is increased from the point of pickup to the maximum coil voltage. With the relay energized for 30 minutes at maximum coil voltage prior to test (for continuous duty coils only), the relay contacts shall not change state (break and re-make) when the coil voltage is reduced to the specified hold voltage, or when the coil voltage is reduced from the point of dropout to zero volts.

4.7.2.1 Pickup voltage (see 3.7). The relay shall be tested to determine that the energized function is completed when a potential not in excess of the specified pickup voltage is applied to the relay coil. For relays under 25 amperes contact rating (resistive), the pickup voltage (or current) shall be applied by gradually increasing the voltage to the relay coil. A suitable indicating device shall be used to determine that the contacts operate satisfactorily.

4.7.2.2 High temperature pickup voltage (see 3.7). The relay shall be subjected to an operating test at the maximum ambient temperature specified (see 3.1). The voltage applied to the coils shall be the maximum specified. The duration of this test shall be one hour. During this test, types I and II relays shall be energized continuously. Type I'; relays shall be cycled at the rate specified in 4.7.26.4 for resistive load. Contacts shall not be loaded during this test. Within 30 seconds following this period, and with the relay maintained at the test temperature, the pickup voltage shall be within the limit specified (see 3.1).

4.7.2.3 Dropout voltage (not applicable to latching relays) (see 3.8). Maximum operating voltage shall be applied to the coil terminals. The voltage shall then be reduced. The relay shall release to the de-energized position within the specified limits of dropout voltage (see 3.1). A suitable device shall be used to determine that the contacts operate satisfactorily.

* 4.7.3 Hold voltage (see 3.1 and 3.9). Maximum operating voltage shall be applied to the coil terminals. The voltage shall then be reduced. A device such as indicator lamps (or, at the option of the manufacturer, a more sensitive device) shall be used to determine if there is any change of state of contacts.

* 4.7.4 Contact bounce, operating and release times (release time is not applicable to latching relays) (see 3.8). Photographic records of contact operating and release times and contact bounce at nominal coil voltage shall be submitted for qualification test approval. Time duration of contact bounce shall not exceed the values specified (see 3.1). Contact operating and release times shall be within the limits specified (see 3.1). Contact loading, number of activations, and resolution for these measurements shall be as specified in 4.7.4.1, 4.7.4.2, or 4.7.4.3. Contact make bounce shall be checked on both normally open and normally closed contacts. Contact break bounce (when specified, see 3.1) shall be checked on release of normally open contacts. Contact bounce shall include both the initial bounce with the contact's first make and any additional bounce caused by the hammer blow of the armature going home and reflected in the contacts. Caution should be observed to be sure that the photographic record includes any of the above so called secondary armature bounce, if it exists. Contact break bounce occurs when a closed contact initially opens, then recloses one or more times before fully opening. Open circuit voltage of 90 percent or greater shall constitute contact bounce, less than 90 percent is to be considered dynamic contact resistance.

* 4.7.4.1 Relays rated for low level on power contacts (see 3.1).

a. Open circuit voltage - 6 V dc maximum.
b. Contact current - 10 mA maximum.
c. Number of activations for contact bounce - 5 minimum - no measurement may exceed the time values specified (see 3.1).
d. Resolution - 10 microseconds.

* 4.7.4.2 Relays rated between low level to 25 amperes (see 3.1). (See figure 4 for suggested circuit.)

a. Open circuit voltage - 6 V dc (or peak ac) maximum.
b. Contact current - 100 mA maximum.
c. Number of activations for contact bounce - The average of 5 consecutive readings shall not exceed the time value specified (see 3.1).
d. Resolution - 10 microseconds.

* 4.7.4.3 Relays whose lowest specified load (resistive, inductive, motor, lamp) for the power contacts is 25 amperes or greater (see 3.1).

a. Open circuit voltage - 6-28 V dc (or peak ac).
b. Contact current - 100 mA maximum.
c. Number of activations for contact bounce - The average of 5 consecutive readings shall not exceed time value specified (see 3.1).
d. Resolution - 100 microseconds.

4.7.5 Insulation resistance (see 3.11). The insulation resistance of the component shall be measured between all mutually insulated terminals and between all terminals and case in accordance with method 302, test condition B of MIL-STD-202. The relative humidity shall be 30 to 50 percent. This shall be done with the relay in the de-energized and in the energized positions. It will be permissible to perform the insulation resistance test at humidities above 50 percent, but in the event of failure, the device shall be checked at 30 to 50 percent relative humidity prior to rejection.

4.7.6 Dielectric withstanding voltage (see 3.12). Relays shall be tested as specified in 4.7.6.1 and, when applicable (see 3.1), in accordance with 4.7.6.2.
NOTE: To avoid unnecessary failures, test voltages shall not be applied indiscriminately.

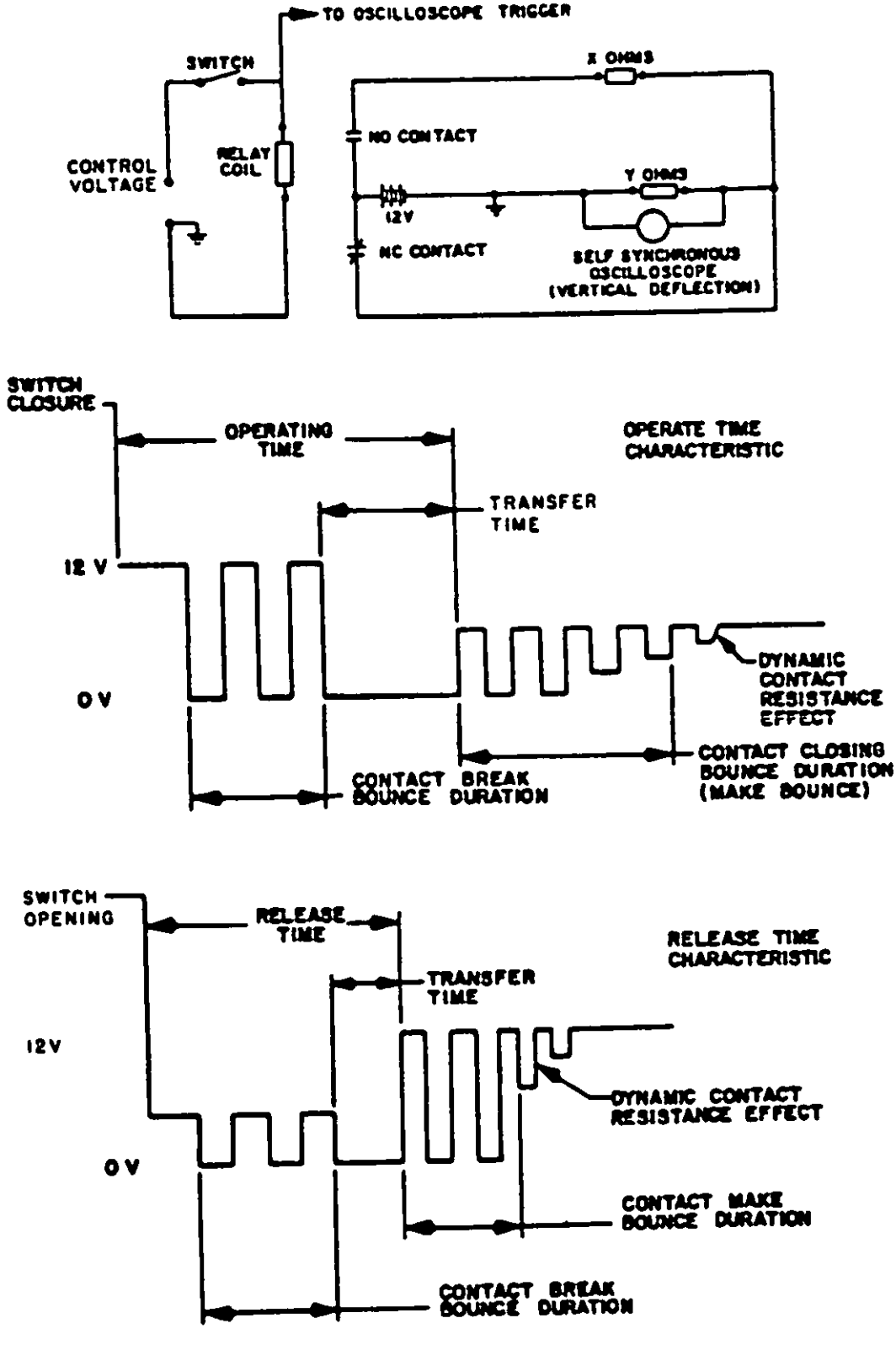


FIGURE 4. Contact bounce (typical circuit) - Continued.

7.6.1 At atmospheric pressure (see 3.12). Relays shall be tested in accordance method 301 of MIL-STD-202. The component shall withstand without damage ated dielectric withstanding voltage tests when ac potentials conforming to table re applied between the following points: (a) between all terminals and ground; between all contact terminals of different polarity; (c) between all contact inals and coil terminals with the test potential specified for the highest system age of the contacts ; and (d) between all unconnected terminals of the same rity. These tests shall be performed with the relay coil de-energized and gized, with the exception that the coil to enclosure need not be tested in the gized condition. The relative humidity shall be in the range of 30 to 50 ent, except for altitude tests. It will be permissible to perform the dielectric standing voltage at humidities above 50 percent, but in the event of failure, the ce shall be checked at 30 to 50 percent relative humidity prior to rejection.

7.6.2 At high temperature, high altitude pressure (see 3.12.1). Relays shall be ed in accordance with methods 105 and 301 of MIL-STD-202. This test applies only elays for use above 50,000 feet altitude. The relay shall be brought to a ilized condition at the high temperature, high altitude pressure specified (see . When in the above condition, the tests of 4.7.6.1 shall be performed.

7.7 Contact voltage drop (see 3.13). The contact voltage drop across the relay acts shall be measured at the points to which external circuits are normally ected. Normally closed and normally open contacts shall be measured separately. y contacts which are rated 25 amperes (resistive) and over shall carry rated stive current at the primary rated ac or dc voltage. Relay contacts rated under but over 2 amperes shall carry rated resistive current at 6 V dc and power relays contacts rated 25 amperes and over, all contacts may be tested at 28 V dc. When ified after the load tests, the contact voltage drop shall be measured at the inals corresponding to the tested contacts. The contacts shall be caused to k and then make the test current before each of 10 consecutive measurements. voltage shall be as specified. Individual readings and the average value of 10 ecutive readings shall meet the requirements of 3.13 and not exceed the values ified in table X. In performing the contact voltage drop tests on plug-in ys, and in the event of a reading that exceeds the maximum allowable contact age drop when measured external to the connector, a measurement may be made ctly at the pins of the relay. If the readings are then within the allowable ts, the relay will be considered to have passed. In the case of relays with ed connections, special provisions should be made to allow for voltage drop due esistance of leadwires. For Group A inspection, one reading per contact will ice and may be performed at a lower current level. At the option of the facturer, the relay contacts may be closed prior to the application of test ent. The contact voltage drop shall be measured within 10 seconds after the acts close and the flow of current begins. The contact voltage drop shall be in the average limits specified in table X adjusted for the lower current level in test. For type I ER and relays screened to group A type I ER testing, the rded data shall specify the current level used.

7.7.1 Contact resistance. This test is applicable to relays which have contact ngs of 2 amperes or less as specified in 3.13. Relays shall be tested in rdance with method 307 of MIL-STD-202. The following details shall apply:

a. Method of connection - Connection jigs or other suitable means.
b. Test current shall be 100 mA for all contacts except those rated for low level. For low level, the current shall be 10 mA maximum.
c. The open-circuit test voltage shall be 6 V dc maximum or peak ac.
d. Points of measurements:
    1. Between all normally closed mated contacts.
    2. Between all normally open mated contacts, with the coil energized with rated voltage (or current). The relay shall be operated with no load applied to the contacts.
e. Number of activations prior to measurement - None.
f. Number of test activations - Three.
g. Number of measurements per activation - One in each contact position.

4.7.8 DC coil resistance (see 3.14). The dc coil resistance shall be measured in accordance with method 303 of MIL-STD-202. The relay shall have been stabilized at 23°C ±1°C for a minimum of 2 hours prior to making the measurement. In the event that measurement at 23°C is impractical, the relay may be stabilized at any other ambient temperature for 2 hours, the resistance measured and the resistance recalculated to 23°C using the temperature coefficient of resistance formula for copper magnet wire.

$$R_{23} = \frac{R_T}{1 + K\,(T-23)}$$

R_T = Resistance at the new ambient temperature.

R_{23} = Resistance at 23°C.

K = Temperature coefficient (0.00393 for copper 23°C).

T = New ambient temperature in degrees C.

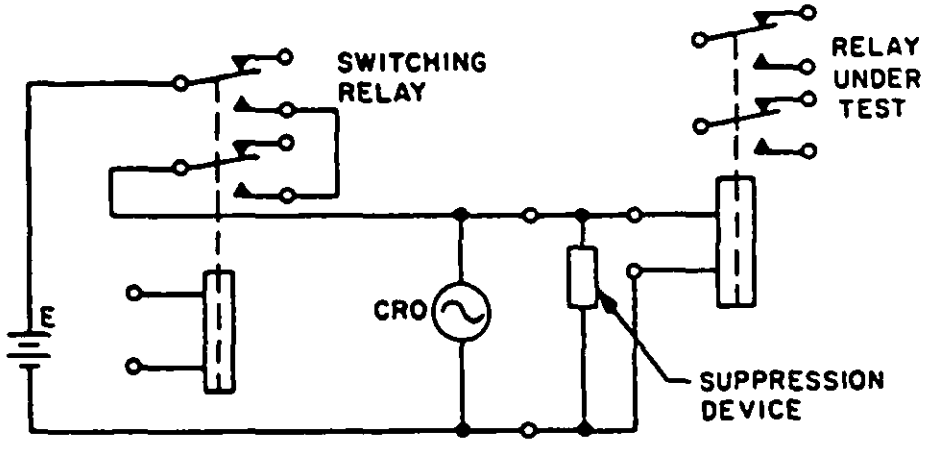
4.7.9 Maximum coil current (see 3.15). The maximum coil voltage shall be impressed across the coil with the relay stabilized at room ambient conditions. Within 60 seconds after the application of the coil voltage, the coil current shall be measured.

4.7.10 Electromagnetic interference of coil circuit.

4.7.10.1 Electromagnetic interference (applicable to coils of ac operated relays) (see 3.16.1). Coils of ac operated relays shall be subjected to the electromagnetic interference test as specified in MIL-STD-461 and MIL-STD-462.

4.7.10.2 Electromagnetic interference (applicable to coils of dc operated relays with internal suppression) (see 3.16.2). The relay shall be connected as shown in figure 5. Prior to this test, apply maximum operating coil voltage with reverse polarity for greater than 2 seconds to insure that internal diodes are connected with proper polarity and zener diode rating is greater than maximum line voltage.

NOTE: Voltage greater than the maximum specified may damage the coil suppression device.



* FIGURE 5. Electromagnetic interference test circuit.

a. The switching relay shall be the same type as the relay under test. E is the nominal operating voltage for the relay under test. The switching relay is operated from a source voltage independent of E. CRO is a cathode-ray oscilloscope with a rise time of .020 microseconds or less. The horizontal (time) deflection scale shall be set at 5 milliseconds per division (5 ms/cm) and the vertical (voltage) deflection scale shall be 20 volts per division (20 V/cm). Both horizontal (time) and vertical (voltage) deflection traces shall be of a calibrated grid spacing (i.e., cm or mm).

b. The source, E, shall be a low impedance source (such as batteries) capable of delivering the nominal coil voltage with no limiting resistor or potentiometer used to regulate the line voltage. (Having low source impedance representing a typical application is more important than having the exact nominal voltage.)

c. The switching relay shall be closed for a minimum of 5 seconds allowing the oscilloscope and circuit network to stabilize and then opened to obtain the induced voltage deflection trace.
   1. The reading shall be observed on the oscilloscope. The magnitude of the induced voltage transient shall be recorded. A typical trace is presented in figure 6.
   2. The maximum value of three consecutive readings shall be recorded.
   3. Unless otherwise specified, the temperature at the time of the testing shall be 25 ±5°C.

d. For group A testing, only one measurement and other suitable test methods may be used to verify that the back EMF (coil kick) is within the specified limit.

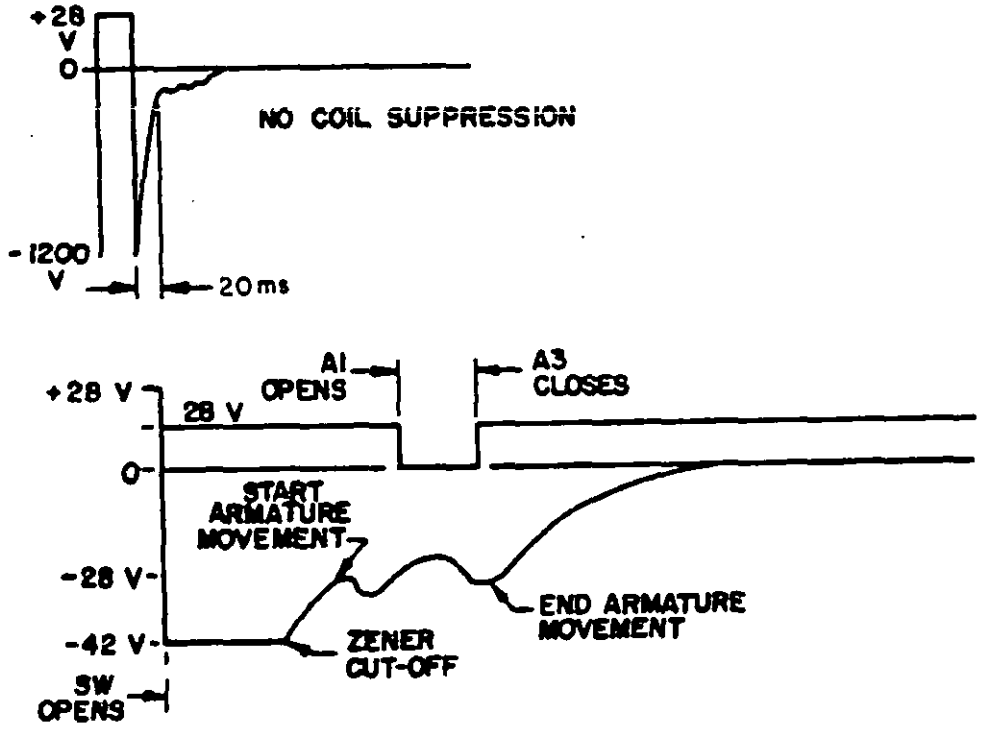


FIGURE 6. Typical transient voltage.

4.7.11 Strength of terminals and mounting studs (see 3.17).

4.7.11.1 Strength of threaded terminals and mounting studs (see 3.17.1). Relays, having mounting studs or threaded terminals, shall be tested to determine compliance with the strength requirements specified in 3.17.1, and table V and VII. The specified pull force shall be applied both coaxially with the threaded terminal in a direction away from the main body of the relay, and again normal to the threaded axis of the terminal in approximately the same plane as the seat for the terminal lug. The specified torque shall be applied to the terminal mounting nut, or screw with all terminal mounting hardware, including one terminal lug of proper size, assembled in proper order. The relays shall withstand the specified forces for 1 minute without damage. Relays, with threaded terminal assemblies soldered in place, shall be tested as follows (not applicable to relays with maximum temperature rating above 125°C). The relay shall be stabilized in a 180°C ambient temperature. After stabilizing at this temperature for a minimum of 2 hours, the terminals shall be subjected to the pull and torque test as specified above.

4.7.11.2 Strength of terminals (see 3.17.2).

4.7.11.2.1 Solder terminals, 0.047 inch diameter or less. Each terminal shall be twisted 90 ±10 degrees clockwise. The twisting force shall be applied at the point where connections would normally be made. Following the twist test, the applicable pull force specified in table XXIV shall be applied to each terminal at the point where connections would normally be made. The pull shall be applied in any one direction 45 ±5 degrees from the normal axis of the terminal for a period of 15 to 30 seconds. Terminals shall be returned to their normal position.

* TABLE XXIV. Pull force.

Terminal diameter (inches)	(mm)	Pull force (pounds)
0.035 - 0.047	(.89 - 1.19)	5 ±0.5
0.023 - 0.0349	(.58 - .886)	3 ±0.3
Less than 0.023	(.58)	2 ±0.2

4.7.11.2.2 Plug-in terminals, 0.047 inch diameter or less. Each terminal shall be bent 20 to 30 degrees in both directions from the normal axis in a given plane and after returning it to normal, the terminal shall be bent 20 to 30 degrees in both directions perpendicular to the previous plane. The terminals shall be returned to their normal positions. Following the bend test, the applicable pull force specified in table XXIV shall be applied to each terminal for a period of 15 to 30 seconds.

4.7.11.2.3 Solder and plug-in terminals greater than 0.047 inch diameter. A pull force of 10 ±1 pounds shall be applied from the normal axis of the terminal for a period of 15 to 30 seconds. The force shall be applied to solder terminals at the point where connections would normally be made or to plug-in terminals in the last one-fourth of length.

4.7.11.2.4 Wire lead terminals. Each terminal shall be bent 90 ±10 degrees in any direction from the normal axis of the terminal at 1/4 ±1/16 inch from the terminal header. The bend radius shall be three to five times the diameter of the wire. The terminal shall then be grasped 1/2 ±1/16 inch from the bend and twisted by rotating the 1/2 inch length 90 ±10 degrees clockwise, 180 ±10 degrees counterclockwise, and then 90 ±10 degrees clockwise. Repeat four times. Following the twist test, the applicable pull force specified in table XXIV shall be applied to each terminal at the point where connections would normally be made. The pull shall be applied in any one direction 45 ±5 degrees from the normal axis of the terminal for a period of 15 to 30 seconds.

4.7.12 Thermal shock (see 3.18). Relays shall be tested in accordance with method 107, test condition B, MIL-STD-202 for the relay temperature range specified (see 3.1). The following details shall apply:

a. Measurements after cycling - Relays shall be visually examined for breaking, cracking, chipping, or flaking of the finish or loosening of the terminals and the insulation resistance, dielectric withstanding voltage, and contact voltage drop shall then be measured as specified in 4.7.5.1, 4.7.6.1, and 4.7.7.

4.7.13 Low temperature operation (see 3.19). The relay shall be subjected to the low temperature specified (see 3.1), for a period of 48 hours. At the end of this period, and with the relay at the low temperature, the pickup voltage, dropout voltage, and contact voltage drop shall be measured as specified in 4.7.2.1, 4.7.2.3, and 4.7.7, respectively, except that a 30 minute pre-conditioning is not required. (These tests shall be accomplished in the sequence listed and in a minimum amount of time to prevent significant heating of the coil.) The relay shall then be tested intermittently for pickup and dropout voltage until it attains room temperature. Relays which contain permanent magnets in the magnetic circuit, shall, in addition to the above tests, be subjected to the demagnetizing effect of the cold coil energized with maximum voltage specified. During the low temperature test, after approximately 24 hours, these relays shall be operated by the sudden application of maximum coil voltage for one operation. Latch relays and center-off relays containing permanent magnets shall be operated in both directions with coil energized, for a period not exceeding 2 seconds, so no appreciable heating will occur. All units subjected to this demagnetizing effect shall be tested in accordance with high temperature pickup voltage (see 4.7.2.2), at the conclusion of this test.

4.7.14 Sand and dust (applicable to unsealed relays, see 3.4.5.1) (see 3..20). Relays shall be tested in accordance with method 110 of MIL-STD-202. The following details and exceptions shall apply:

a. Procedure - Steps 1, 3, and 4 except that when the temperature is raised and maintained for 6 hours, the temperature to which it is raised shall be the maximum specified for the relay being tested. The sand and dust velocity through the test chamber shall be between 100 to 500 feet per minute.
b. Measurements - See table XV.

4.7.15 Continuous current (see 3.21). This test shall be performed at the maximum temperature and altitude specified for the class of relay being tested (see 3.1). Other conditions of the test shall be in accordance with 4.7.26. During the first 3 hours of this test, the relay coil shall not be energized. Normally closed contacts shall be loaded with the highest rated resistive load. At the end of the 3-hour period with no change in the ambient conditions, the pickup voltage of the relays shall be determined and shall be within the limit specified. During the next portion of the test, the coils of types I and II relays shall be energized continuously for 97 hours. Type III relays shall be cycled for a minimum operating cycles specified (see 3.1), at a duty cycle as shown in 4.7.26.4 for resistive load. The coil voltage shall be the maximum specified. Contacts that are in the closed position when the relay coil is energized shall carry the rated resistive current at any convenient voltage. Immediately following the operating period and with the relay still at the specified temperature, the relay shall be tested to determine that the energized function is completed when pickup voltage is applied. The relay shall sustain no visible damage such as loosening of terminals or loss of seal. Terminal temperature rise shall be monitored throughout the test and shall not exceed 75°C.

4.7.16 Shock (see 3.22, 3.22.1). The relays shall be tested in accordance with method 213 of MIL-STD-202. The following details shall apply:

a. Mounting - The relays shall be rigidly fastened, using its regular mounting means, to the drop carriage of the shock testing machine. The relay shall be mounted in each of its mutually perpendicular axes in turn.
b. Test condition - The relay shall be subjected to impacts of the intensity and duration specified for the shock characteristics of component being tested (see 3.1). The test condition letter and test procedure shall be selected accordingly.

c. Number of impacts - Four shocks shall be applied (a total of 24 shock pulses), in each direction along each of three mutually perpendicular body axes, one of the axes being in the direction most likely to cause malfunction.
d. Electrical operating conditions - The shock test shall be performed with the relay de-energized (2 shocks) and, repeated with the relay energized (2 shocks) with nominal coil voltage or current.
e. For magnetic latching relays - In each direction there shall be two pulses in the latch position and two pulses in the reset position, with no coil current being applied during these pulses.
f. Measurements during shock - Contacts shall be monitored as specified in method 310 of MIL-STD-202, test circuit B, test condition A (open contacts shall be wired in a parallel and closed contacts may be connected in series).

4.7.16.1 High-impact shock characteristic d (see 3.22.2) (when specified) (see 3.1). The relays shall be tested in accordance with method 207 of MIL-STD-202. The test details as specified in 4.7.16a through 4.7.16f shall apply, except test condition E shall apply to 4.7.16f.

4.7.17 Vibration (see 3.23). Vibration tests shall be performed in accordance with the requirements specified (see 3.1 and figure 7). The high temperature shall be the maximum high temperature specified for the relay being tested. Low temperature shall be as specified (see 3.1). When vibrating intermittent duty, type III relays, in the energized position, the coil voltage shall be reduced to a level that will prevent overheating and subsequent damage to the relay's insulation system.

4.7.17.1 Test installation. The relay shall be rigidly attached to the vibrator table, either directly or with an adapter of sufficient rigidity to be non-resonant in the test frequency range. If necessary, an independent frequency scan shall be conducted on the adapter with a suitable dummy load in lieu of the relay to determine whether the adapter has resonances in the test frequency range. The test configuration shall be such that rotational motion of the vibrator table or adapter bracket is not induced owing to any unsymmetrical weight or stiffness distribution of the component.

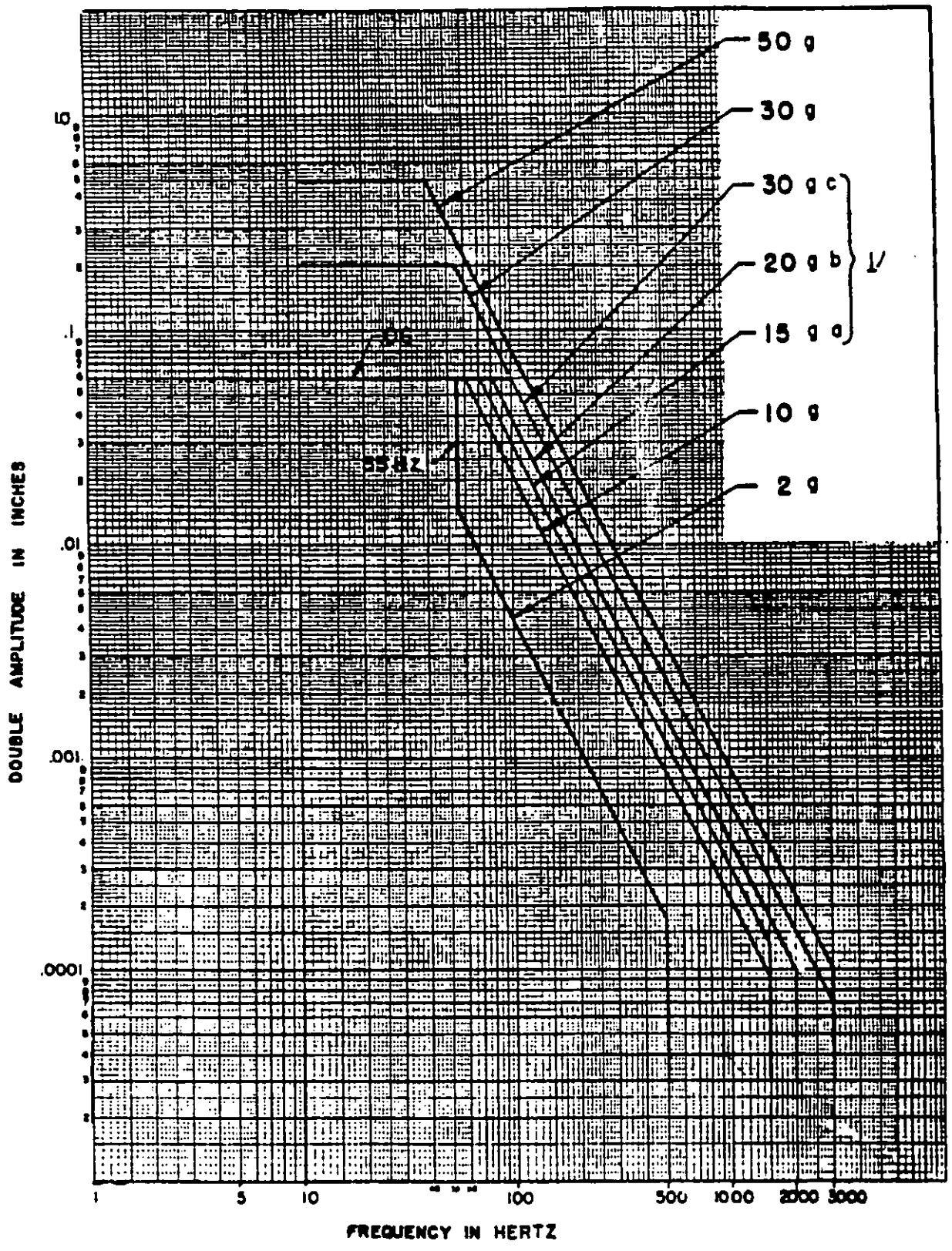
4.7.17.1.1 Amplitude measurement. Measurements of vibratory accelerations or amplitudes shall be made at the mounting base of the components. If vibratory accelerations is increased by its own resonances, then this response or acceleration shall not be considered as part of the applied vibration. The means of measuring vibratory amplitudes of acceleration shall not be considered as part of the applied vibration. The means of measuring vibratory amplitudes or acceleration must provide a clear distinction between the applied vibration and the response to the vibration of the relay assembly.

4.7.17.1.2 Frequency measurements. All frequency measurements shall be accurate within ±5 percent. All amplitude or acceleration measurements shall be accurate within ±10 percent. The motion of the vibrator table shall be simple harmonic motion with not more than 10 percent distortion. Distortion of the table motion caused by the operation or response of the component itself shall not be considered part of the distortion of the driving motion.

4.7.17.1.3 Contact disturbance. Contact disturbance shall be detected by a circuit, similar to that shown on figure 4. Multiple open contacts shall be connected in parallel, and multiple closed contacts shall be connected in series during testing. An optional test procedure may be the contact chatter indicator in method 310 of MIL-STD-202.

4.7.17.1.4 Voltage. The test voltage shall be between 12 and 25 volts with a series non-inductive resistor of suitable resistance to limit the closed circuit current to some value between 5 and 10 milliamperes. The indicator shall be an oscilloscope with high input impedance and a bandwidth of 1 megahertz, or greater.

4.7.17.2 Frequency scan. The relay shall be vibrated first in the energized and then in the de-energized position along each of three mutually perpendicular axes for resonance under the conditions defined (see 3.1). Frequency scan shall be conducted slowly and carefully. The frequency range shall be broken into small convenient



1/ CHARACTERISTIC, SEE TABLE I.

FIGURE 7. Range curve for vibration tests.

intervals, and each interval scanned at a constant applied acceleration or amplitude which produces approximately the table amplitude or acceleration defined by the applicable test curve. The table amplitude or acceleration shall be observed closely during the frequency scans to detect frequencies of minimum table motion which define some of the frequencies at which some components may be in resonance. These frequencies are quite sharply tuned and do not necessarily coincide with the frequencies at which maximum component amplitude or noises occur when scanning at constant applied force amplitude. When the resonant components are small, the reduction of table motion at resonance may not be discernible, in which case the resonant frequencies may be determined for observation of maximum amplitudes, noises or changes in performance such as contact disturbance. In all cases, the resonant frequencies shall be verified, if possible, by checking for minimum table motion.

4.7.17.3 Resonance endurance. After completion of the frequency scanning, resonance endurance tests shall be conducted as specified (see 3.1), modified as follows: The duration of a test shall be one million cycles or 8 hours, whichever occurs first. A separate test shall be performed for each resonance found in frequency scan specified in 4.7.17.2; the test time shall not be divided between resonances. Separate resonsnace endurance tests may be performed on separate relays, if the resonance is common to more than one sample. The specimen shall be vibrated for 15 minutes at the specified maximum temperature and 15 minutes at the specified minimum temperature. The relay shall be stabilized at the maximum and minimum temperature before conducting resonance endurance tests at these temperatures. If total time at resonance is less than 30 minutes, the time shall be divided equally between high and low temperatures. Vibrations shall be continued at room temperature for the duration of the test. The resonance endurance time shall be divided equally between vibration with the relay coil in the energized and the de-energized conditions. For type III relays, the coil shall be energized for 3 minutes at the end of each temperature level of the cycle. Endurance tests shall not be conducted at any frequency at which the table amplitude abruptly increases when scanning at constant applied force amplitude. If a change in resonant frequency occurs during testing or owing to change in test temperature, the frequency of vibration shall be adjusted to follow the resonance. However, if large or abrupt resonant frequency shifts occur, the item shall be examined for structural failure or excessive wear.

4.7.17.4 Cycling endurance. The relay shall be cycled for 30 minutes at maximum and 30 minutes at minimum rated ambient temperature. The relay shall be in the energized position for the first half of each test period. During the other half, the relay shall be de-energized. The frequency shall be cycled for 15 minute periods between the frequency limits and at the vibration levels specified on figure 5 for the class of relay being tested. The rate of change of frequency shall be logarithmic. Where there is no provision for logarithmic cycling, a linear rate of frequency change may be used. The cycling test may be broken into convenient frequency ranges, providing cycling rates and test times for each range are not changed.

4.7.17.5 Random vibration (when specified, see 3.1). The relays shall be tested in accordance with method 214 of MIL-STD-202. Test condition and duration shall be as specified (see 3.1).

4.7.18 Acoustical noise (when specified, see 3.1) (see 3.24). Relays shall be tested in accordance with method 515, test grade A of MIL-STD-810. The overall noise level and relative power distribution shall be as specified (see 3.1). The relay shall be subjected to wide band acoustical noise in the de-energized position and in the energized position with rated voltage applied to the coil. The relay contacts shall be continuously monitored by a circuit similar to that shown on figure 4.

4.7.19 Salt spray (corrosion) (see 3.25). The relays, with MS20659 or MS25036 terminal lugs attached when applicable, shall be tested in accordance with method 101, test condition B of MIL-STD-202. At the completion of the test, the relay shall be cleaned by washing in cold running tap water and examined for deterioration, after which it shall be dried for approximately 6 hours in a circulating air oven at approximately 65°C.

4.7.20 Mechanical life (endurance at reduced load) (see 3.26). With rated coil voltage, the relay shall be cycled at 25 percent of rated resistive load for four times the specified minimum operating cycles for relays under 25 amperes contact rating (resistive), and two times the specified minimum operating cycles for relays 25 amperes and over. The cycling rate shall be that specified for resistive loads in 4.7.26.4. Each relay circuit (normally open and normally closed contacts of all poles), including interlock circuits if they exist, shall be loaded at 25 percent of rated resistive load current (steady-state) at 28 V dc or rated ac voltage. Associated with each load shall be a circuit that will detect failure to open and close the circuit. Failure to close shall be specified as a voltage drop across the contacts exceeding 10 percent of full load voltage. During the test, each set of contacts shall open and close its individual circuit in proper sequence.

4.7.21 Altitude-temperature humidity test (see 3.27). This test shall apply to all non-hermetic sealed relays and to all hermetic sealed relays with auxiliary non-hermetic sealed spaces or enclosures. Qualification test samples shall be placed in an environmental test chamber for 15 days, during which the temperature, pressure, and humidity shall be varied in accordance with the schedule shown on figure 8. The relay shall be connected to permit operation with its minimum rated load. The relay shall be energized and then de-energized three consecutive times at the end of each 24 hours during the test to determine satisfactory operation. Following the test, the relay shall be dried in circulating air at 65°C for 6 hours. Immediately after drying, the pickup voltage, dropout voltage, insulation resistance, and dielectric withstanding voltage shall be measured as specified in 4.7.2.1, 4.7.2.3, 4.7.5 and 4.7.6, respectively, and shall satisfactorily operate at 1/10 of the minimum operating cycles specified at rated resistive load and maximum operating voltage.

* 4.7.22 Humidity (see 3.28) (applicable to unsealed, environmentally sealed, and hermetically sealed with potted wire leads) (see 3.4.5). Relays with MS20659 or MS25036 terminal lugs attached when applicable, shall be subjected to humidity test in accordance with, MIL-STD-810, method 507.1, procedure one, except the temperature in step two shall be raised to 71°C. During the cycling test on unsealed relays, a potential of 150 V rms at commercial frequency shall be applied between between terminals and other exposed metal parts. The current leakage shall not exceed 100 mA at any time during this test. After the relay has been removed from humidity, it shall be dried for approximately 6 hours in a circulating air oven at approximately 65°C. The relay shall meet the requirements of 3.28.

4.7.23 Ozone (see 3.29) (applicable to unsealed, environmentally sealed, and hermetically sealed relays with potted wire leads) (see 3.4.5). The relay shall be placed in an enclosure and subjected for a period of 2 hours at room temperature to ozone having a concentration of from 0.010 to 0.015 percent by volume. At the end of the test period, the sample shall be examined for signs of ozone deterioration. A satisfactory method of producing and testing the required ozone concentration is described in ASTM D470-59T.

4.7.24 Acceleration (see 3.20). The relays shall be tested in accordance with method 212 of MIL-STD-202. The following details or exceptions shall apply:

a. Mounting - The relays shall be rigidly fastened, using normal mounting means, in each of three mutually perpendicular positions.
b. Test condition letter - The relays shall be subjected to test condition A, except that accceleration shall be applied in each direction along three mutually perpendicular axes of the specimen and one of the axes shall be in the direction most likely to cause malfunction. The acceleration force shall be 15 G.
c. Electrical operating conditions during acceleration - The acceleration test shall be performed with the relay in de-energized condition and repeated with the relay coil energized as specified in 3.20. An indicating instrument shall be connected across the contacts while the relay is undergoing this test to determine the ability of relay contacts to remain in the proper position. Open contacts shall be wired in parallel and closed contacts may be connected in series.

4.7.25 Explosion proof (applicable to unsealed relays, see 3.4.5.1) (see 3.21). Relays shall be tested in accordance with method 109 of MIL-STD-202 modified as follows: The temperature of the ambient explosive mixture and of the equipment shall

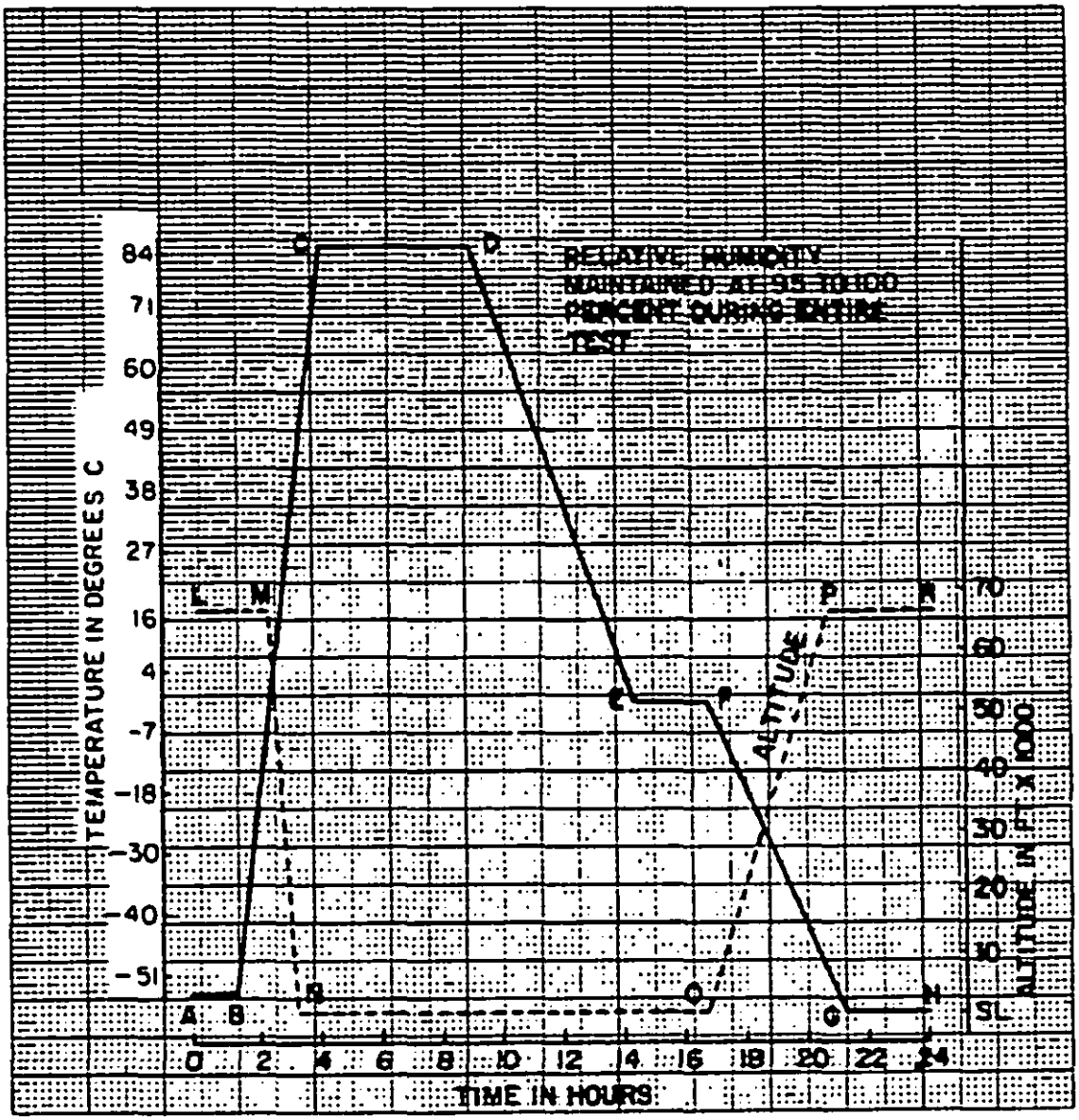


FIGURE 8. Temperature-altitude-humidity test schedule.

be maintained at the maximum temperature specified for the relay. At least five tests for internal explosions shall be accomplished at each 1/2 percent mixture increment from 3 percent to 6 percent by volume of commercial butane, using dry air in establishing the mixture. The spark may be obtained by operating at rated inductive load. Tests at altitude conditions not required.

4.7.26 Loads and endurance (life) (see 3.32, 3.33, 3.34, and 3.35). Test loads and circuits shall be so arranged that the specified current will flow through each pole. During all load or endurance (life) tests, the relay enclosure shall be maintained at the electrical system ground to neutral through an F02 or F03 fuse in accordance with MIL-F-15160/2 or MIL-F-15160/3, rated at 5 percent of the rated resistive load but in no event greater than 3 amperes or less than 100 milliamperes. Blowing of this fuse shall constitute failure. Line-to-line and line-to-ground voltages shall be as specified (see 3.1). The load test cycles shall be performed in any number of continuous periods, each not less than 3 hours. The relays shall be suspended or mounted in still air, by a thermal insulating material. Double-throw relays shall have the normally open (NO) and normally closed (NC) contacts tested. If the NO and NC contacts are separately, an additional sample unit shall be provided for this test which shall be required to meet all other tests in the test sequence. If both NO and NC contacts of double-throw relays are being tested at the same time, a separate load shall be provided for each NO and each NC contact. The movable contacts shall be connected to the power source, except for double break contacts. All loads shall be connected between the contacts and power supply ground or neutral. When testing mutipole relays with three-phase ratings, three-phase loads shall be connected to adjacent contacts. During endurance tests, every operation of each contact shall be monitored for failure to make, carry, and break specified load, any of which constitutes a relay failure. The minimum sensing period shall be 10 percent of the dwell time in the open or closed position. Test equipment must either lock in the state of failure or record the sequence number of the miss. Failure to close shall be specified as a voltage drop across the contacts exceeding 10 percent of full load voltage, except for intermediate current tests when the intermediate current voltage drop shall be as specified. A failure on vibration or dielectric withstanding voltage after load tests shall constitute one failure for purposes of establishing MCBF.

* 4.7.26.1 Overload (see 3.32). The contacts of the relay shall be caused to make and break the overload values and durations as shown in table XXV for 50 operations at each of the maximum system voltage (open circuit) ratings. For double-throw relays, separate tests shall be performed for the normally open and for the normally closed contacts.

* TABLE XXV. Overload values and durations.

Relay rating	Percent rated resistive load			Duty cycle (seconds)	
Amperes	28 V dc	115 V ac	115/200 V ac 3 phase	ON. *0.05	OFF *1
0 - 24	400	400	600	0.2	20
25 and up	800	800	800	0.2	20
All (Type III)	800	800	800	0.2	20

* 4.7.26.2 Rupture (see 3.33). The relay shall be made to make and break its rated rupture current at each of the maximum system voltage (open circuit) ratings, for a minimum of 50 operations using the values of current and cycling time in table XXVI. For double-throw relays, separate tests shall be performed for the normally closed and normally open contacts. For those relays with both ac and dc ratings, ac and dc rupture tests shall be performed on separate samples at highest system voltage (open circuit), as specified (see 3.1).

* TABLE XXVI. Rupture values and durations.

Relay resistive rating	Percent rated resistive load			Duty cycle (seconds)	
Amperes	28 V dc	115 V ac	115/200 V ac 3 phase	ON ±0.05	OFF ±1
10 and under	500	500	800	0.2	30
Greater than 10	1,000	1,000	1,000	0.2	30

4.7.26.3 Circuit breaker compatibility (when specified, see 3.1) (see 3.34). Each relay tested shall sustain 5 applications (make and carry only) of power concurrently on adjacent poles at each of the current levels and for the associated time duration as specified (see 3.1). Relays shall be tested at 28 V dc and 115/200 V ac, 400 Hz, 3-phase. The load shall be resistive. The cooling time between successive application of current shall be 30 minutes. Tests shall be performed at room ambient conditions and both the normally open and normally closed contacts shall be tested.

* 4.7.26.4 Endurance (life) at rated contact loads (see 3.35). Endurance load cycling tests shall be performed as specified (see 3.1), and succeeding paragraphs, and with a duty cycle in accordance with table XXVII. Loads, connections, and test conditions shall be in accordance with 4.7.26. The endurance test shall be conducted with 50 percent of the required operating cycles performed at the maximum temperature altitude specified for the class of relay being tested. The altitude requirement for hermetically sealed relays may be waived, provided that the ambient temperature is increased by 10 percent of that specified for the class of relay being tested. Unless otherwise specified, during all endurance tests, the control and contact voltages shall be the applicable dc or ac (open circuit) system voltage specified (see 3.1). The minimum number of operating (life) cycles shall be 100,000 cycles (unless otherwise specified, see 3.1) at each contact load rating.

* 4.7.26.4.1 Inductive load, dc. The relay shall be subjected to the minimum operating cycles with the inductive loads specified, using the duty of table XXVII. Inductive dc loads shall use MIL-I-81023 inductors.

4.7.26.4.2 Motor load, dc. The relay shall be subjected to the minimum operating cycles for making six times the rated motor load at rated system voltage and breaking the normal rated motor load.

* TABLE XXVII. Duty cycle (seconds).

Relay	Inductive (ac or dc)		Motor (ac or dc)		Resistive (ac or dc)		Lamp (28 V dc)	
	ON	OFF 1/	ON	OFF 1/	ON	OFF 1/	ON	OFF 1/
Types I and II, single throw	.5 ±.05	3.0 ±0.1	.35 ±.09 2/	2 ±0.1	1.5 ±1.0	1.5 ±1.0	2 ±.05	7 ±2
Types I and II, double throw	.5 ±.05	3.0 ±0.1	.35 ±.09 2/	2 ±0.1	1.5 ±1.0	1.5 ±1.0	2 ±.05	7 ±2
Type III	.5 ±.05	3.0 ±0.1	.35 ±.09 2/	10 ±0.1	0.5 ±0.05	2.5 ±0.1	2 ±.05	7 ±2

1/ "OFF" time may be decreased at the option of the manufacturer.
2/ Duration of the specified inrush current shall be 0.07 ±0.02 second, after which it shall be reduced to its rated motor load for the remainder of the "ON" period.

4.7.26.4.3 Resistive load, dc. The relay shall be subjectd to the minimum operating cycles in a non-inductive, resistive circuit, the current being maximum rated resistive loads specified (see 3.1), at each rated system voltage. Resistors used fo loads shall have an L/R ratio not exceeding 1 x 10^{-4}.

4.7.26.4.4 Lamp load. Unless otherwise specified, the lamp load shall be performed with the 28 V dc power supply voltage. Relays shall be subjected to the minimum operating cycles specified (see 3.1), making 12 times the rated lamp load and breaking the rated lamp load. The duration of the 12 times inrush shall be 0.015 - 0.020 second, the total "ON" time shall be 2 ±0.05 seconds and the "OFF" time shall be 7 ±2 seconds. Except for single-throw relays, one normally closed contact shall be tested. Multipole relays shall be tested with the loads on two separate poles which shall be selected at random by the testing activity.

* 4.7.26.4.5 Inductive load, ac. The relay shall be subjected to the minimum operating cycles with inductive loads for the rated current and voltage using the duty cycle of table XXVII. Inductive load circuits shall consist of inductive and resistiveload elements connected in series. The circuit parameters shall be rated inductive current, voltage and frequency, and a 0.7 ±0.05 lagging power factor.

4.7.26.4.6 Motor load, ac. The ac motor load test shall be as specified in 4.7.26.4.2, except that the value of the ac inrush current shall be five times rated motor load current, or as specified (see 3.1).

4.7.26.4.7 Resistive load, ac. This test shall be the same as 4.7.26.4.3, except that the ac load shall be the resistive current specified.

4.7.26.5 Load transfer, single or polyphase ac (see 3.35.1). The relay contacts shall be connected to two separate and independent 4-wire, 3-phase (wye-connected) power supply systems in accordance with figure 9. The system (generator) voltage and load currents shall be as specified (see 3.1). The frequency of generator number one shall be maintained within 1 percent of specified rating. The frequency of generator number two shall be maintained 2 to 10 percent below the specified frequency (see 3.1).

As an alternate, a single power supply system may be used and the load switched between phases, provided the system voltage can be raised to 133/230 V rms, 3ϕ ac (e.g., by use of a variable auto-transformer) or a transformer is used as shown of figure 10. Transformer continuous duty rating must be at least as great as the loads to be switched. Voltage regulation at the load shall not exceed 2.5 percent when the line current of one or more phases is 10 times the specified load current.

With rated coil voltage and current, the relay shall be subjected to 10,000 cycles of operation at a duty cycle of 5 ±1 seconds ON and 5 ±1 seconds OFF. Loads shall be inductive ac (see 4.7.26.4.5). Current and voltage values shall be as specified (see 3.1). Each phase of the power supply system, and each movable contact of the relay shall be continuously monitored to determine phase to phase arc-over and contact sticking or welding. Single and two pole relays may be tested in the same manner by omitting contacts and loads not applicable. The test circuitry may be modified for testing interlock relays and relays with double break contacts. Interlock relays are to be energized alternately by use of a SPDT transfer switch device.

4.7.26.5.1 Load transfer, single phase. Relays meeting requirements of 4.7.26.5 are suitable for load transfer use on single phase.

* 4.7.26.6 Intermediate current (see 3.35.2 and 6.1.4). The relay shall be subjected to 50,000 cycles as follows. (For group B tests, the number of cycles shall be 1/10 of the specified minimum cycles.) Normally open and normally closed contacts shall be tested. Tests on normally open and normally closed contacts of double-throw relays shall be performed concurrently. The test voltage shall be 28 V ±1 V dc. During each cycle, the relay coil shall be energized for 29 ±3 seconds and de-energized for 1.5 ±0.5 seconds. During each cycle, the contacts to be tested shall make, carry, and interrupt the test current specified in the applicable paragraph below. While the contacts are carrying the test current, contact voltage drop measurements shall be made at the start of the test and shall not exceed the values shown in table XXVIII. Monitoring shall be performed to provide either a

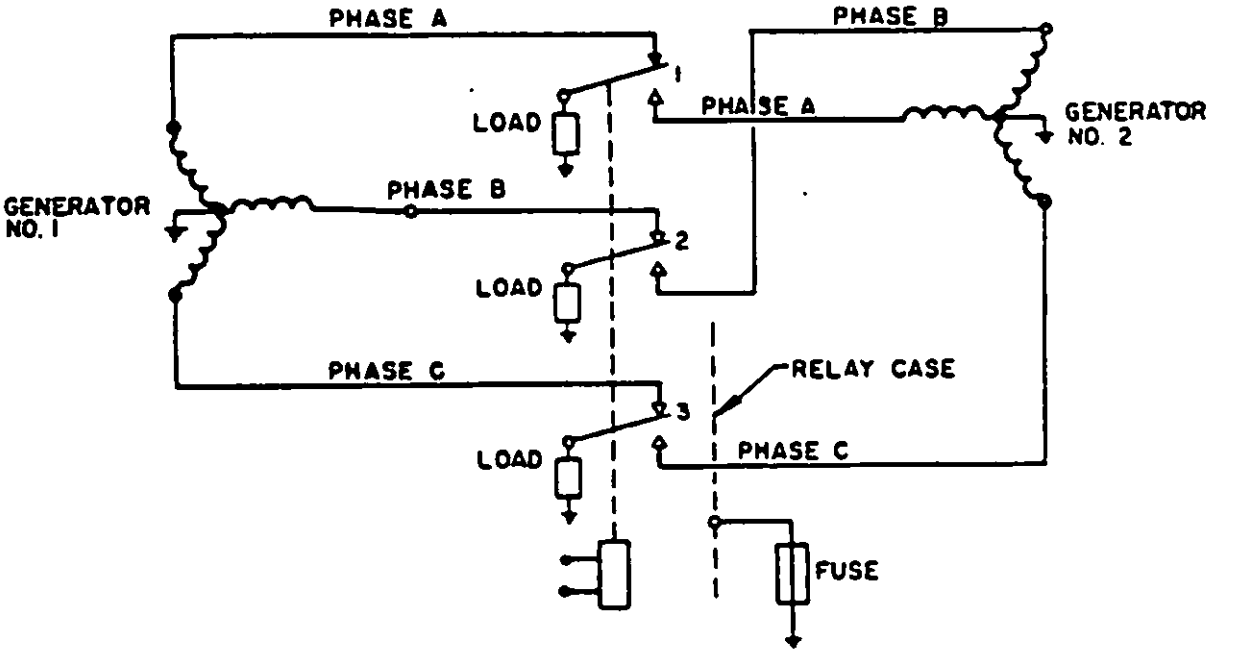


FIGURE 9. Test circuit, three phase load transfer.

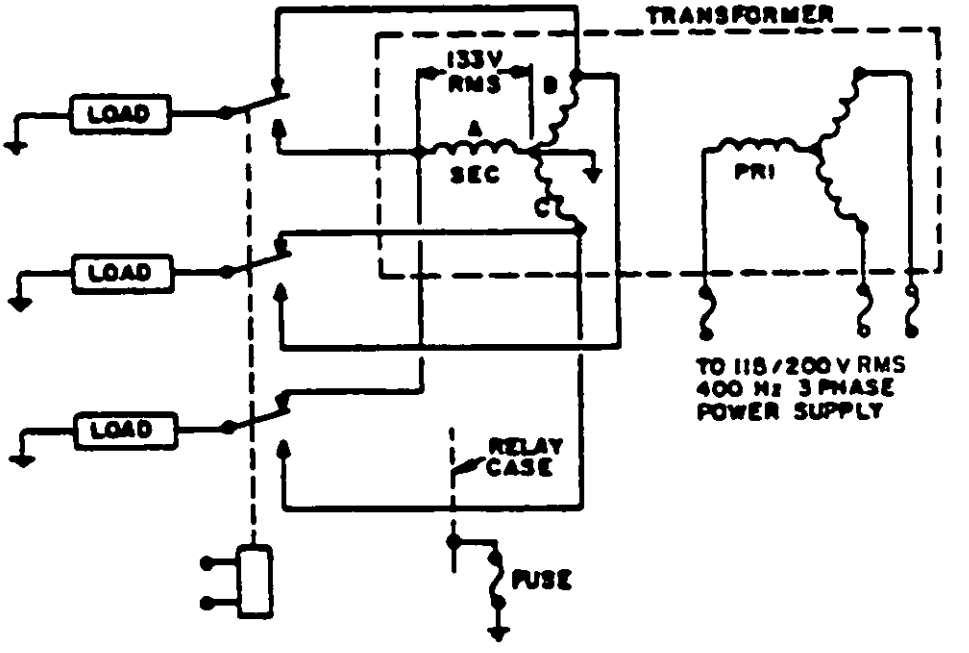


FIGURE 10. Alternate test circuit, three phase load transfer.

continuous record of contact voltage drop or cause cessation of the test if the values of table XXVII are exceeded. Tests on main and auxiliary contacts shall be performed concurrently. The test shall be performed at the maximum ambient temperature specified (see 3.1). The test shall be performed at sea level. Where a relay is required to be cycled for more than 50,000 cycles, the cycling in excess of 50,000 may be accomplished at the rate specified in table XXVIII. Type III relays relays will be exempted from this test. The inductor shall be calibrated prior to load-endurance test. Photographic record of oscillograms showing compliance with curves 1 and 2 of MIL-I-81023 shall be submitted for qualification approval.

* TABLE XXVIII. Contact voltage drop.

Contact ratings amperes rated resistive load	Initial millivolt drop (max.) (see 4.7.6)	Initial allowable resistance calculated (ohm)	Allowable millivolt drop after test begins (max.) 1/ 2/			
			Amperes 0.5	Amperes 0.3	Amperes 0.1	Rated resistive load
2 (auxiliary contacts)	150	0.075	63	38	13	175
5	150	0.030	40	24	8	175
10	150	0.015	32	20	7	175
15	150	0.010	30	18	6	175
20	150	0.010	30	18	6	175

1/ Maximum allowable contact voltage drop for ratings not listed shall be determined by adding 0.05 ohm to calculated initial allowable resistance based on initial allowable contact voltage drop with a maximum of 200 millivolts. The millivolts drop at rated current shall not exceed the limits of contact voltage drop specified in 4.7.7.

$$E_{max}\ (mV) = I_{load} \times \left(\frac{0.150}{I_{rated}} + 0.05\right) \times 1{,}000$$

For relays rated above 20 amperes and intermediate current 10 percent of rated resistive load, E_{max} (mV) shall be as calculated by the above formula, or 200 mV, whichever is less.

* 2/ Where the lowest specified load (resistive, motor, inductive, lamp) of a relay's power contacts is 25 amperes or greater:

a. Two percent of the specified operations may exceed the mV drop listed in the table, but no more than three (3) operations may exceed 1,000 mV drop.
b. Cycle rate to be 20 seconds on, 10 seconds off.

4.7.26.6.1 Rating, not specified. When the value of the intermediate current rating is not specified (see 3.1), each normally open and normally closed contact shall be connected to loads in accordance with the following:

Circuit no. pole no.	Loads
1	0.5 ampere resistive load
2	0.3 ampere inductive load
3	0.1 ampere resistive load
4	Rated resistive load

If the relay has more than four poles, the above loads shall be repeated in the sequence listed. Rated load shall be omitted for single pole, single throw relays. For single pole, double throw relays, each sample unit shall be tested with rated load on the normally open and specified intermediate current on the closed contact.

One pole of all other relays shall be tested with rated load on one normally open and one normally closed contact. The test shall be performed at the maximum ambient temperature specified (see 3.1). Both normally open and normally closed contacts shall make and break the above specified loads with no failure throughout the test. For relays rated above 20 amperes resistive load (dc), one pole of the relay power contacts shall be loaded at rated resistive load (dc), and all other poles shall be loaded at 10 percent of rated resistive load.

4.7.26.6.2 Rating, specified (see 3.1). When the value of intermediate current rating is specified, one pole of the relay shall be loaded at the rated resistive current specified (see 3.1), with intermediate current on the other pole(s).

* 4.7.26.7 Low level (when specified, see 3.1 and 3.35.3). Relays shall be tested in accordance with method 311 of MIL-STD-202, and the following details shall apply, unless otherwise specified (see 3.1).

a. Contact load: 10 to 50 microamperes at 10 to 50 millivolts (dc or peak ac).
b. Cycling rate: The minimum cycling rate shall be 60 operations per minute. The maximum cycling rate shall be 10 times the sum of the maximum specified operate and release times for the relay under test.
c. Total cycles: 100,000.
d. Sticking of contacts is applicable.
e. Coil voltage: Nominal.
f. Miss detection monitoring level: 100 ohms.

* 4.7.26.8 Mixed loads (when specified, see 3.1 and 3.35.4). The NO and NC contacts of one pole of a multipole relay shall be loaded with the low level load defined in the detail specification sheet (see 3.1). All the NO and NC contacts of the remaining poles shall be loaded with the following loads as defined in the detail specification sheet (see 3.1):

a. Inductive load (dc)
b. Inductive load (ac)
c. Resistive load (dc)
d. Resistive load (ac)
e. Lamp load
f. Motor load (dc)
g. Motor load (ac)

NOTE: One relay shall be provided for each of the above load (e.g., one sample will switch low level and (dc) inductive, one will switch low level and (ac) inductive, etc.).

Relays of three or more poles shall be so wired that the contact switching the low level load is in between the poles switching the high level loads. The cycle rate and number of cycles of operation shall be as required for each of the applicable high level loads. All other tesstng requirements (including monitoring) shall be per the applicable loads as defined in 4.7.26.

* 4.7.26.9 High/low load transfer (when specified, see 3.1 and 3.35.5) (not applicable to single throw contact combinations). The normally closed contact of one double throw contact combination shall be loaded with the low level contact load and the normally open contact of the same pole shall be loaded with the maximum resistive contact load. For multipole relays, the high level and low level loads shall be alternately reversed between the normally open contact and normally closed contact. See figure 11 for recommended circuit. The cycle rate and the number of cycles of operation shall be as required for the high level load. All other requirements (including monitoring) shall be per the applicable loads as defined in 4.7.26.

* 4.7.27 Vibration scan (see 3.36). Relays shall be subjected to the vibration test, method 204 of MIL-STD-202 at the specified G level and frequency (see 3.1); however, only one cycle shall be performed. Sweeptime shall be reduced to the time required to sweep the entire range of frequencies specified (see 3.1). The relay shall be vibrated in each of the three mutually perpendicular axes. Relays having

both normally open and normally closed contacts shall be subjected to one vibration scan in the de-energized condition and one scan in the energized condition. Contact monitoring shall be in accordance with 4.7.17.1.3. When vibrating intermittent duty, type III relays, in the energized position, the coil voltage shall be reduced to a level that will prevent overheating and subsequent damage to the relay's insulation system. For group A (ER) relays or relays screened to group A type I ER testing, and when specified (see 3.1), for all contact forms except form A, the cycle shall consist of 5 minutes up with the coil energized and 5 minutes down with the coil de-energized. The cycle for contact form A shall consist of 5 minutes up with the coil de-energized and 5 minutes down with the coil energized. For latching relays, the relay shall be in the latched position during the upsweep and in the reset position during the down sweep with the coil de-energized.

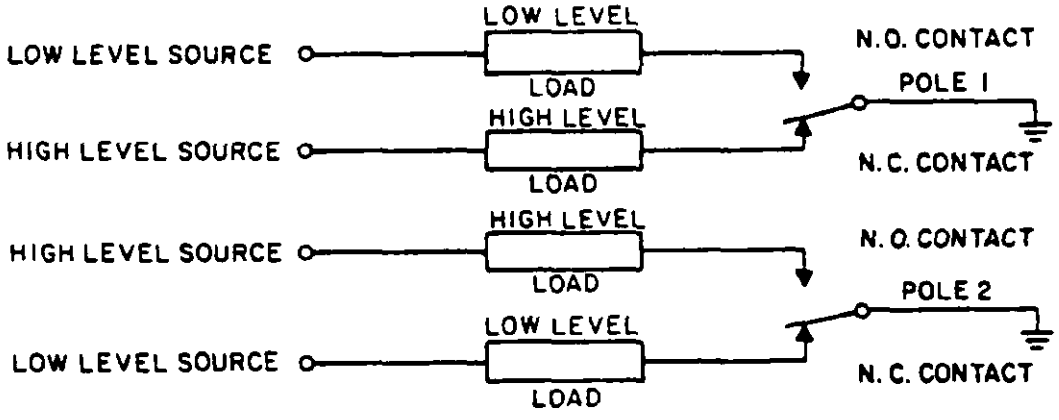


FIGURE 11. High/low load transfer recommended circuit.

* 4.7.28 Seal test (see 3.37). Hermetically sealed and environmentally sealed relays shall be tested for gross and fine leaks. Relays larger than 2 cubic inches with leakage rate requirements of 1×10^{-6} standard atmospheric cubic centimeters per second, (ATM Cm^3/s) per cubic inch of net sealed gas volume shall be tested in accordance with test condition C, procedure III or IV of method 112, MIL-STD-202 or the radioisotope procedure (see 4.7.28.1). Relays equal to or less than 2 cubic inches with gas leakage rate requirements of 1×10^{-8} standard (ATM Cm^3/s), per cubic inch of net sealed gas volume shall preferrably be tested to the radioisotope method which will be used in case of dispute but may be tested to test condition C, procedure III or IV of method 112, MIL-STD-202 (the international standard is air).

* 4.7.28.1 Radioisotope procedure (preferred).

1. Examine relay for physical damage to seal.
2. If necessary, wash relay to eliminate any foreign contaminant that might impact test.

* 4.7.28.2 Radioisotope dry gross leak test. This test shall be used only to test devices that internally contain some krypton-85 absorbing medium, such as electrical insulation, organic, or molecular sieve material. This test shall be permitted only if the following requirements are met:

a. A 5 to 10 mil diameter hole shall be made in a representative unit of the devices to be tested. (This is a one time test that remains in effect until a design change is made in the relay internal construction.)
b. The device shall be subjected to this test condition. If the device exhibits a hard failure, this test condition may be used for those devices represented by the test unit. If the device does not fail, this test shall not be used and instead a 125°C fluorocarbon gross leak shall be performed per MIL-STD-202, method 112, test condition D, except the specimen shall be observed from the instant of immersion for one minute minimum to three minutes maximum.

* 4.7.28.3 Apparatus. The following apparatus shall be required for this test.

a. Radioactive tracer gas activation console containing krypton-85/dry nitrogen gas mixture.
b. Counting station with sufficient sensitivity to determine the radiation level of krypton-85 tracer gas inside the device.
c. Tracer gas mixture - krypton-85/dry nitrogen with a minimum allowable specific activity of 100 microcuries per atmosphere cubic centimeter. The specific activity of the krypton-85/dry nitrogen mixture shall be a known value and determined on a once-a-month basis as a minimum.

* 4.7.28.4 Procedure. The devices shall be placed in a radioactive tracer gas activation tank and the tank shall be evacuated to a pressure not to exceed 0.5 torr. The devices shall then be subjected to a minimum of 10 psig of krypton-85/dry nitrogen gas mixture for 30 seconds. The gas mixture shall then be evacuated in storage until a pressure of 2.0 torr maximum exists in the activation tank. The evacuation shall be completed in 5 minutes maximum. The evacuation tank shall then be backfilled with air (air wash). The devices shall then be removed from the activation tank and leak tested within 2 hours after gas exposure with a scintillation-crystal-equipped counting station. Devices indicating 1,000 counts per minute or greater above the ambient background of the counting station shall be considered a gross leak failure.

* 4.7.28.5 Radioisotope fine leak test.

* 4.7.28.5.1 Apparatus. The following apparatus shall be required for this test:

a. Radioactive tracer gas activation console.
b. Counting station of sufficient sensitivity to determine through the device wall the radiation level of krypton-85 tracer gas present within the device. The counting station shall have a minimum detectability of 500 CPM above ambient background.
c. Tracer gas mixture - krypton-85/dry nitrogen with a minimum allowable specific activity of 100 microcuries per atmosphere cubic centimeter. The specific activity of the krypton-85/dry nitrogen mixture shall be a known value and determined on a once-a-month basis.

* 4.7.28.6 Activation parameters. The activation pressure and soak time shall be determined in accordance with the following equation:

1. $$Q_S = \frac{R}{skTPt}$$

The parameters of equation (1) are defined as follows:

Q_S = The maximum leak rate allowable, in atm, for the device CM^3/sKr to be tested. (Conversion factor from Krypton to air is 1.712).
R = 1,000 counts per minute above the ambient background after activation if the device leak rate were exactly equal to Q. This is the reject count above the background of both the counting equipment and the component if it has been through prior radioactive leak tests.
s = The specific activity, in microcuries per atmosphere cubic centimeter, of the krypton-85 tracer gas in the activation system.
k = The overall counting efficiency of the scintillation crystal in counts per minute per one microcurie of krypton-85 in the internal void of the specific component being evaluated. This factor depends upon component configuration and dimensions of the scintillation crystal. The K-factors of the relays in use today have already been determined and accepted throughout industry. If unavailable for a particular package consult test equipment manufacturer.
T = Soak time, in hours, that the devices are to be activated.
P = $P_e 2 - P_i 2$, where P_e is the activation pressure in atmospheres absolute and P_i is the original internal pressure of the devices in atmosphere absolute. The activation pressure (P_e) may be established by specification, or if a convenient soak time (T) has been established, the activation pressure (P_e) can be adjusted to satisfy equation (1).
t = Conversion of seconds to hours and is equal to 3,600 seconds per hour.

* 4.7.28.7 Evaluation of surface sorption. All device encapsulations consisting of other than glass, metal, and ceramic or combinations thereof, including coatings and external sealants, shall be evaluated for surface sorption of krypton-85 before establishing the leak test parameters. Representative samples of the questionable devices shall be subjected to the predetermined pressure and time conditions established for the device. The devices should then be checked for surface sorption of krypton-85 gas, using a surface beta detector. Such a surface detector will provide over 200 times the detectability obtained with a scintillation crystal, when measuring surface gas. A reading would normally be taken every 10 minutes until the surface was shown to be free of krypton-85. At that time, a final reading is made using the scintillation crystal for rejection of leakers.

* 4.7.28.8 Testing procedure. The devices shall be placed in a radioactive tracer gas activation tank. The tank shall be evacuated to 0.5 torr. The devices shall be subjected to a pressure limit determined for relay under test for a time determined from the equation above. (Actual pressure and soak time shall be determine in accordance with equation (1)). The krypton-85/dry nitrogen gas mixture shall be evacuated to storage until 0.5 torr vacuum exists in the activation tank. This evacuation shall be complete in 5 minutes maximum. The activation tank shall then be backfilled with air (air wash). The devices shall then be removed from the activation tank and leak tested immediately using a scintillation-crystal counting station. Devices which show surface sorption, shall be tested in the scintillation crystal after the surface measurements show that externally absorbed krypton-85 has dissapated. The actual leak rate of the component shall be calculated with the following equation:

$$Q = \frac{(\text{Actual readout in counts per minute})XQs}{R}$$

Where Q = actual leak rate in atm Cm^3/s and Qs and R are defined in equation (1). Unless otherwise specified, devices that exhibit a leak rate equal to or greater than 1.712×10^{-8} atmosphere cubic centimeters of krypton-85 per second shall be considered a failure. Relays which fail above seal test shall be considered failed relays. Failed relays shall be tagged and segregated from the test lot.

4.7.29 Mechanical interlock (where applicable, see 3.1) (see 3.38). Relays incorporting a mechanical interlocking feature shall be subjected to the following tests. With one set of relay contacts held in the closed position as specified below, maximum operating voltage shall be applied to the actuating coil of the opposing set of contacts for 200 cycles. The operational cycle shall consist of 0.5 second ON and 2.5 seconds OFF. The specified 200 cycles of operation shall be applied under each of the following conditions:

a. The first set of relay contacts being held in the closed position by maximum operating voltage applied to the actuating coil.
b. The second set of relay contacts being held in the closed position by maximum operating voltage applied to the actuating coil.
c. The first set of relay contacts held in the closed position by mechanical means. The manufacturer may submit an opened sample unit of a sealed relay for this test.
d. The second set of relay contacts held in the closed position by mechanical means. The manufacturer may submit an opened sample unit of a sealed relay for this test.

A suitable indicating device shall be used to determine conformance of the relay.

* 4.7.30 Operational reliability (applicable to type I ER relays and when specified, see 3.1) (see 3.39). Relays having contact load ratings of 25 amperes or greater shall be subjected to 500 cycles of miss-free operation and relays having contact ratings of less than 25 amperes shall be subjected to 1,000 cycles of miss-free operation with a duty cycle for resistive load specified in table XXVII. The contact test current shall be 0.1 ampere for relays rated up to but not including 25 amperes fully rated, and 1 ampere for relays rated from 25 amperes up to and including 50 amperes. The contact test current shall be 5 amperes for all relays rated higher than 50 amperes. The open-circuit voltage shall not exceed 6 V dc, except that for relays 25 amperes and up, the open-circuit voltage shall not exceed 28 V dc. All contacts shall be continuously monitored for contact voltage drop.

In place of the above test, relays rated for low level operation shall be subjected to the following 2,500-operation run-in test. The operation rate shall be one to five operations per second. Relays shall have the contacts loaded as follows: Open circuit load voltage shall be 10-50 millivolts (dc or peak ac). The load current shall be 10-50 microamperes. All contacts shall be continuously monitored for contact resistance as specified in 3.39.

4.7.30.1 Temperature cycling. Relays shall be tested in accordance with method 107 of MIL-STD-202, test condition B. The following details and exceptions shall apply:

The relay shall be subjected to three cycles of thermal shock at each of the temperature extremes. A cycle shall start at high temperature. During the first two cycles, the relay shall be energized with maximum rated coil voltage or current during high temperature and de-energized during low temperature. At high temperature, for magnetic latch relays, the latch coil shall be energized during the first 30 minutes and the reset coil energized during the last 30 minutes. During the third cycle, the relay shall be tested as described below:

* 4.7.30.2 High temperature operation. The relays shall be subjected to maximum rated temperature with maximum voltage or current applied to the coil for 1 hour. The pickup voltage shall be measured as specified in 4.7.2.2 and recorded. For magnetic latch relays, the coil voltage or current shall first be applied to the latch coil for 1 hour, and then the latch pickup voltage shall be measured as specified in 4.7.2.2 and recorded. The coil voltage or current shall then be applied to the reset coil for 30 minutes and the reset pickup voltage shall be measured as specified in 4.7.2.2, and recorded. While still at this temperature, the relays shall be tested as specified in 4.7.30.

* 4.7.30.3 Low temperature operation. Following the high temperature, relays shall be subjected to the minimum rated temperature with coil or coils de-energized for 1 hour. At the end of this period, the dropout voltage shall be measured as specified in 4.7.2.3 and recorded. For magnetic latch relays, the latch and reset voltage shall be measured as specified in 4.7.2.2 and recorded. While at this temperature, the relays shall be tested as specified in 4.7.30.

4.7.30.4 Internal moisture detection. Following low temperature, the relays (coils de-energized) shall be held at 25°C for a minimum of 1 hour. The insulation resistance of all contact pins to case only, shall be measured and recorded. The relay coil shall be energized with 140 percent of rated voltage for a period of 2-1/2 minutes. The insulation resistance of all contact pins to case only shall be monitored continuously during this period and the lowest value recorded.

4.7.31 Resistance to solvents (see 3.40). Relays shall be tested in accordance with method 215 of MIL-STD-202. The following details and exceptions shall apply:

a. Portion to be brushed - All marking areas.
b. Solvent solutions - The solvent solutions used in this test shall consist of the following:

Solvent	Test fluid	Solvent	Test fluid
1	MIL-L-7808	7	Solvent (a) specified in method 215 of MIL-STD-202
2	MIL-L-23699		
3	MIL-H-83306	8	Solvent (b) specified in method 215 of MIL-STD-202
4	MIL-A-8243 (or ethelyne glycol)		
5	MIL-C-25769 (diluted for cleaning)	9	Solvent (c) specified in method 215 of MIL-STD-202
6	MIL-T-5624		

* 4.7.32 Particle impact noise detection test (P.I.N.D.) (see 3.42). When specified (see 3.1), relays shall be tested as specified in method 217 of MIL-STD-202.

* 4.7.33 Insertion and withdrawal force (see 3.42). Insertion and withdrawal forces of the mating relay and socket shall be tested as specified in MIL-S-12883, unless otherwise specified (see 3.1).

5. PACKAGING

* 5.1 Preservation. Preservation shall be level A or C, or as specified (see 6.2).

5.1.1 Level A.

5.1.1.1 Cleaning. Relays shall be cleaned in accordance with MIL-P-116, process C-1.

5.1.1.2 Drying. Relays shall be dried in accordance with MIL-P-116.

5.1.1.3 Preservative application. Preservatives shall not be used.

* 5.1.1.4 Unit packs. Relays shall be individually unit packed in accordance with the methods of MIL-P-116 designated herein insuring compliance with the applicable requirements of that specification.

* 5.1.1.4.1 Hermetically sealed relays. Hermetically sealed relays shall be unit packed in accordance with method III. The unit container shall conform to PPP-B-566, PPP-B-676 or PPP-B-636, class weather resistant.

* 5.1.1.4.2 Nonhermetically sealed relays. Nonhermetically sealed relays shall be unit packed in accordance with submethod IIc. Each unit pack shall be placed in a supplementary container conforming to PPP-B-566, PPP-B-676 or PPP-B-636, class weather resistant.

* 5.1.1.5 Intermediate packs. Intermediate packs are not required.

* 5.1.2 Level C. The level C preservation for relays shall conform to the MIL-STD-794 requirements for this level.

5.2 Packing. Packing shall be level A, B, or C, or as specified (see 6.2). Packing may be omitted for unit packs, utilizing a container conforming to PPP-B-636 providing the requirements for closure, waterproofing, and banding, applicable to the level of packing, are met.

5.2.1 Level A. The packaged relays shall be packed in fiberboard containers conforming to PPP-B-636, class weather resistant, style optional, special requirements. In lieu of the closure and waterproofing requirement in the appendix of PPP-B-636, closure and waterproofing shall be accomplished by sealing all seams, corners and manufacturer's joint with tape, two inches minimum width, conforming to PPP-T-60, class 1 or PPP-T-76. Banding (reinforcement requirements) shall be applied in accordance with the appendix to PPP-B-636 using nonmetallic or tape banding only.

5.2.2 Level B. The packaged relays shall be packed in fiberboard containers conforming to PPP-B-636, class domestic, style optional, special requirements. Closure shall be in accordance with the appendix thereto.

* 5.2.3 Level C. The level C packing for relays shall conform to the MIL-STD-794 requirements for this level.

5.2.4 Unitized loads. Unitized load, commensurate with the level of packing specified in the contract or order, shall be used whenever total quantities for shipment to one destination equal 40 cubic feet or more. Quantities less than 40 cubic feet need not be unitized. Unitized loads shall be uniform in size and quantities to the greatest extent practicable.

5.2.4.1 Level A. Relays, packed as specified in 5.2.1, shall be unitized on pallets in conformance with MIL-STD-147, load type I, with a fiberboard cap (storage aid 4) positioned over the load.

5.2.4.2 Level B. Relays, packed as specified in 5.2.2, shall be unitized as specified in 5.2.4.1, except that the fiberboard caps shall be class domestic.

5.2.4.3 Level C. Relays, packed as specified in 5.2.3, shall be unitized with pallets and caps of the type, size, and kind commonly used for the purpose and shall conform to the applicable carrier rules and regulations.

* 5.3 Marking. In addition to any special or other identification marking required by the contract or purchase order (see 6.2), each unit pack, supplementary and exterior container, and unitized load shall be marked in accordance with MIL-STD-129.

5.4 General.

5.4.1 Exterior containers. Exterior containers (see 5.2.1, 5.2.2 and 5.2.3) shall be of a minimum tare and cube consistent with the protection required and shall contain equal quantities of identical stock numbered items to the greatest extent practicable.

5.4.2 Packaging inspection. The inspection of these packaging requirements shall be in accordance with 4.6.3.

5.4.3 Army procurements.

* 5.4.3.1 Level A unit packs. All unit and supplementary containers shall wither be weather (or water) resistant or overwrapped with waterproof barrier materials or, for paperboard containers, conform to PP-B-566 or PPP-B-676, variety 2 (see 5.1.1.4.1 and 5.1.1.4.2).

* 5.4.3.2 Level A and level B packing. For level A packing when quantities per destination are less than a unitized load, the fiberboard containers shall not be banded but shall be placed in a close fitting box conforming to PPP-B-601, overseas type; PPP-B-621, class 2, style 4 or PPP-B--585, class 3, style 2 or 3. Closure and strapping shall be in accordance with applicable container specification except that metal strapping shall conform to QQ-S-781, type I, finish A. When the gross weight exceeds 200 pounds or the container length and width is 48 x 24 inches or more and the weight exceeds 100 pounds, 3 x 4 inch skids (laid flat) shall be applied in accordance with the requirements of the container specification. If not described in the container specification, the skids shall be applied in a manner which will adequately support the item and facilitate the use of material handling equipment. For level B packing, fiberboard boxes shall be weather resistant as specified in level A and the containers shall be banded (see 5.2.1 and 5.2.2).

5.4.3.3 Level A and B unitization. For level A and B unitization, the fiberboard caps shall be weather resistant and softwood pallets conforming to NN-P-71, type VI, size 2 shall be used. The loads shall be bonded to the pallets by strapping conforming to QQ-S-781, type I, finish A or shrink film (see 5.2.4.1 and 5.2.4.2).

* 5.4.3.4 Commercial packaging. Commercial packaging shall be in accordance with the requirements of MIL-STD-1188.

6. NOTES. This section is provided as information only and is not a specification requirement.

6.1 Application data. For detail application and selection data, see MIL-STD-1346.

6.1.1 Intended use. Relays conforming to this specification are intended for use in direct or alternating current (single or multiphase) electrical systems as a means of controlling the making and breaking of circuits for electrically operated equipment and devices. Their principal areas of application are aircraft, missiles, spacecraft, and ground support equipment. This does not preclude the use of these relays in other military applications.

6.1.1.1 Contact rating. Unless otherwise specified, the contact rating of relays covered by this specification is based on load endurance tests which establish the relay's capability to switch intermediate loads from 100 mA up to maximum contact rated loads. Separate requirements are included in this specification for demonstrating a relay life failure rate of 1 percent in 10,000 relay operations (1 x 10^6 MCBF) with a 90.0 percent confidence level on qualification and a 60 percent confidence level on acceptance testing when established reliability is specified.

6.1.2 Contact switching capability. Relay contacts shall be capable of switching both a variety of different load types and do so under a variety of load levels. (The extent of the contact capability requirements shall be as specified (see 3.1).) In general, the requirements will fall into the following catagories:

6.1.2.1 Type of loads. The types of loads to be switched shall be classified as being among the following:

		dc	ac
a.	Resistive	(4.7.26.4.3)	(4.7.26.4.7)
b.	Inductive	(4.7.26.4.1)	(4.7.26.4.5)
c.	Motor	(4.7.26.4.2)	(4.7.26.4.6)
d.	Lamp	(4.7.26.4.4)	

6.1.2.2 Percent rated load capability. The contacts shall be capable of switching the specified load types not only at the full rated capacity values as specified (see 3.1), but also capable of doing so under the following different loading conditions:

a.	Low level (when specified)	(4.7.26.7)
b.	Intermediate current	(4.7.26.6)
c.	Rated (full) load	(4.7.26.4)
d.	Overload	(4.7.26.1)
e.	Rupture (interrupting capacity) (fail safe requirement)	(4.7.26.2)
f.	Circuit breaker compatibility (when specified)	(4.7.26.3)

6.1.3 Contact voltage rating. Users of relays are cautioned that a 115/200 volt rating indicates that the relay is designed for use in a 3-phase system. The relay may not be capable of having 200 volts applied per pole across one set of contacts. Prior to using relay with such a rating in a circuit where it is required to interrupt 200 volts across an individual set of contacts, the manufacturers of the relay should be consulted.

6.1.3.1 Load transfer rating, 3-phase ac. Unless a load transfer 3-phase ac rating specifying both current and system voltage is on the specification sheet, relays are not to be used in 3-phase load transfer applications.

6.1.4 Intermediate current. Contact performance may be impaired when contact current or voltage is substantially less than rated value. The intermediate current test area lies between "low level" circuit and full load. Passing the test for either or both of these extremes does not indicate operation in the intermediate current area; hence, this test provision. The intermediate current test was originally devised as a means of detecting contact contamination caused by breakdown, under certain arcing conditions of internal gases in hermetic sealed relays. These gases formed carbon deposited that increased contact resistance. The practice of using these values as an intermediate current rating is misleading as relays capable of complying with the test may also be used at lower values. If the relay is used to switch a current value which is substantially lower than that used in the intermediate current testing, the relay shoud be subjected to testing at that lower current value. Other terms of intermediate current include minimum, contamination, and mixed loads.

* 6.1.5 Capacitive loads. A capacitor load, or any load having a capacitor in parallel, can theoretically sustain an infinite current during switching transients. Therefore, the total circuit must be analyzed to determine the circuit impedance including wire resistance and power supply impedance in series with the capacitor, and the peak supply voltage (ac or dc). In order to insure that this current will not weld the contacts, a relay should be specified which has a motor load rating that is greater than 18 percent of the peak switching current. A second detrimental phenomena associated with capacitive loads and dc power supplies affects the number of life cycles. The arc generated during contact bounce when closing contacts will transfer material from one contact to the other. Since the break current is very low, the material transferred tends to build up like a stalactite leaving a corresponding cavity on the mating contact. (With loads having break currents, the material tends to disperse (smooth out) during contact break.) After a number of cycles, the stalactite will catch in the cavity and the contacts will not open. Thus, the number of life cycles may be reduced. Since it is difficult to predict the total life cycles for a relay used under these conditions, it is recommended that the applications engineer contact the manufacturer and discuss any application where the inrush current is greater than 18 percent of the motor load rating of the relay.

* 6.1.6 Transformer loads. A transformer with an open circuit secondary may have a very high in-rush current on the first half cycle of supply voltage, core saturation depends upon the supply voltage phase at turn-on relative to its phase at turn-off. (With average transformers, this in-rush current can be 40 to 50 times greater than the rated current.) The worst case surge current at turn-on would be equal to the peak supply voltage divided by the circuit impednce. The circuit impedance would be the dc resistance of the primary winding on the transformer in series with the wire resistance, the power supply impedance and any other elements in the primary circuit. A relay should be specified that has a motor load rating that is greater then 18 percent of the peak surge current.

* 6.1.7 Special applications. The criteria for selecting relays discussed in paragraphs 6.1.5 and 6.1.6 above apply for normal conditions. Some applications, such as squib firing, require only a few relay operations for test and the final operation. In these special cases, the relay manufacturer should be contacted to see if a smaller relay can perform the required service.

* 6.2 Ordering data. The acquisition document should specify the following:

a. Title, number, and date of this specification.
b. Type of relay (see 1.2).
c. If sampling plan C is required (see 4.6.2.2.1).
d. AN, MS, or specification sheet part number.
e. Inspection of commercial packaging (see 4.6.3).
f. Levels of preservation and packing required (see 5.1 and 5.2).
g. If special or other identification marking is required (see 5.3).

6.3 Qualification. With respect to products requiring qualification, awards will be made only for such products as have, prior to the time set for opening of bids, been tested and approved for inclusion in the applicable Qualified Products List, whether or not such products have actually been so listed by that date. The attention of the contractors is called to this requirement, and manufacturers are urged to arrange to have the products that they propose to offer to the Federal Government, tested for qualification in order that they may be eligible to be awarded contracts or orders for the products covered by this specification. The activity responsible for the Qualified Products List is the Air Force Acquisition Logistics Division, Electronic Support Division (AFALD/PTSP), Gentile Air Force Station, Dayton, Ohio 45444, and information pertaining to qualification of products may be obtained from that activity.

6.4 Definitions. The following terminology will be used in this specification.

6.4.1 Nominal voltage. The standard designation which approximates the normal voltage of the system on which the relay is designed to operate.

6.4.2 System voltage. The nominal voltage of the electric system in which the relay will be required to operate (see 4.4.1).

6.4.3 Control voltage. The voltage applied to the coil to control the relay.

6.4.3.1 Maximum control voltage. The design maximum voltage which may be applied continuously (or under a specified operating cycle for intermittent ratings) under the specified ambient conditions.

6.4.4 Pickup (operate) voltage. The maximum voltage of a relay at which the energized function will be completed (see 3.7 for the design requirement).

6.4.5 Dropout (release) voltage. The maximum or minimum voltage at which all the relay contacts will revert to the de-energized position (see 3.8 for the design requirement).

* 6.4.6 Hold voltage. Hold voltage is the voltage at or above which:

(a) The armature shall not move from its operated position, or
(b) The normally open contacts shall not open; the normally closed contacts shall not close.

Caution note: The use of any coil voltage less than the rated voltage will compromise the operation of the device.

6.4.7 Rated resistive load. The current load specified (see 3.1).

6.4.8 Rated inductive load. The current load specified (see 3.1).

6.4.9 Rated motor load. The normal current load specified (see 3.1).

6.4.10 Rated lamp load. The normal current load specified (see 3.1).

* 6.4.11 Inspection terms. MIL-STD-109 applies for definitions of inspection terms used herein.

6.4.12 Rupture test. A test defined to determine the interrupting capability of the contacts of the relay.

6.4.13 Coil current. The current which flows through the coil when maximum control voltage is applied with the relay stabilized at room temperature and the measurement taken within 60 seconds after application of coil voltage.

6.4.14 Economizer coils. An economizer coil is one that has a high inrush current for pickup and a lower holding current.

6.4.15 Minimum operating cycles. The minimum number of operations which the relay is capable of performing under the conditions specified.

6.4.16 Degassing. The vacuum baking process whereby unwanted contaminants are removed from hermetically sealed relays prior to sealing (see 6.9).

6.4.17 Operating time. The elapsed time from the instant the coil is energized with nominal voltage to the moment all the normally closed contacts open or all the normally open contacts close, whichever is longer.

6.4.18 Release time. The elapsed time from the moment the coil current starts to drop from its rated value to the moment all the normally open contacts open or the normally closed contacts close, whichever is longer. This time does not include the additional delay caused by external coil suppression.

6.4.19 Contact bounce. The time duration of uncontrolled making and breaking of contact when relay contacts are moved to the closed position or when closed contacts are open momentarily by dynamic forces.

6.4.20 Contract disturbance. Any voltage that occurs across a pair of closed contacts caused by vibration that is greater than 1 percent of the open circuit voltage.

6.4.21 Duty cycle. A statement of time relative to energizing and de-energizing relay contacts. When both normally open and normally closed contacts or relays are being tested simultaneously, the specified duty cycle applies to the normally open contacts.

6.4.22 Adjunct sealant. Any hydrocarbon or silicone material used on the exterior of the unit to improve the hermeticity of a hermetically sealed relay.

6.4.23 Examination of product (see 4.7.1). This test is performed to verify that materials, design, construction, physical dimensions, weights, marking, workmanship, and basic electrical operation are as specified in the detailed specification and this specification. Since this test is applicable for both qualification and quality conformance (group A tests) inspections, it is limited to those tests which are nondestructive.

6.4.24 Strength of terminals and mounting studs (see 4.7.11). This test is intended to verify that the terminals and mounting studs have sufficient inherent strength to withstand normal installation and wiring stresses without themselves failing or causing any part of the relay to fail.

6.4.25 Sealing (see 4.7.28). This test is performed to determine the effectiveness of the seal of a hermetically sealed relay which is either evacuated or contains air or gas. A defect in any portion of the surface area of a sealed relay can permit entrance of damaging contaminants that could reduce its effective life. Knowing the maximum leak rate and the net sealed gas volume may also be useful in determining the minimum time required for a relay to experience internal pressures in the corona region (e.g., gas back-filled relays in a space environment or a vacuum relay at sea level) which may result in dielectric failure. The two methods utilized for leak detection in this specification are helium detection and radioactive gas. (Refer to Engineers Relay Handbook section 2 for additional information.)

6.4.26 External parts (see 4.7.1.1). This test is performed to verify that if solder joints are used to attach external parts to the relay, they possess sufficient mechanical strength to withstand the combination of high temperature and mechanical stress without failure. (Welding is to be desired.)

6.4.27 Insulation resistance (see 4.7.5). The purpose of this test is to measure the resistance offered by the insulating members of the relay to an impressed direct voltage tending to produce a leakage of current through or on the surface of these members. A knowledge of insulation resistances is important, even when the values are comparatively high, as these values may be limiting factors in the design of high-impedance circuits. Low insulation resistances, by permitting the flow of large leakage currents, can disturb the operation of circuits intended to be isolated, for example, by forming feedback loops. Excessive leakage currents can eventually lead to deterioration of the insulation by heating or by direct-current electrolysis. Insulation resistance measurements should not be considered the equivalent of dielectric withstanding voltage or electric breakdown tests. A clean, dry insulation may have a high insulation resistance, and yet possess a mechanical fault that would cause failure in the dielectric withstanding voltage test. Conversely, a dirty, deteriorated insulation with a low insulation resistance might not break down under a high potential. Since insulating members composed of different materials or combinations of materials may have inherently different insulation resistances, the numerical value of measured insulation resistance cannot properly be taken as a direct measure of the degree of cleanliness or absence of deterioration. The test is especially helpful in determining the extent to which insulating properties are affected by deteriorative influences, such as heat, moisture, dirt, oxidation, or loss of volatile materials.

* 6.4.28 Dielectric withstanding voltage (see 4.7.6). The dielectric withstanding voltage test (also called high potential, (Hi-Pot) over potential, voltage-breakdown, or dielectric strength test) consists of the application of a voltage higher than rated voltage for a specific time between mutually insulated portions of a relay or between insulated portions and ground. This is used to prove that the relay can operate safely at its rated voltage and withstand momentary overpotentials due to switching, surges, and other similar phenomena. Although this test is often called a voltage breakdown test, it is not intended that this test cause insulation breakdown or that it be used for detecting corona, rather it serves to determine whether insulating materials and spacings in the component part are adequate. When a relay is faulty in these respects, application of the test voltage will result in either disruptive discharge or deterioration. Disruptive discharge is evidenced by flashover (surface discharge), sparkover (air discharge), or breakdown (puncture discharge). Deterioration due to excessive leakage currents may change electrical parameters or physical characteristics.

6.4.29 Contact voltage drop/contact resistance (see 4.7.7 and 4.7.7.1). These tests are performed to determine the voltage drop (or resistance) introduced by electrically contacting surfaces while carrying current. For practical reasons, leads and terminal drops (or resistances) may be included in the measurement. In many applications, contact voltage drop (or resistance) is required to be low and stable to avoid adverse effects on the accuracy of the circuit conditions and to prevent overheating at high currents. Different test methods may result in variances in measured values. The most stringent method is to close the contacts prior to the load application, use the lowest practical load, measure the contact resistance (or contact voltage drop) immediately following load aplication, remove the load, and open the contacts. Making and breaking the load and allowing the resistance to stabilize will result in the lowest contact resistance (or voltage drop) readings.

6.4.30 DC coil resistance (see 4.7.8). This test is performed to measure the direct current (dc) resistance of the relay coil winding.

6.4.31 Coil current (see 4.7.9). This test is provided to establish a standardized means to verify relay coil integrity when other means such as dc coil resistance are impractical, e.g., relays using diode polarization and relays using economizer coils may result in erroneous meter readings. The test measures the current which flows through the coil when maximum control voltage is applied with the relay stabilized at room temperature and the measurement taken within 60 seconds after application of coil voltage. It is important to realize that coil current will decrease with the length of time the voltage is applied to the coil. It is also possible to fail the coil current test if the readings are taken within the first few seconds of voltage application but pass the test if the readings are taken near the end of the allowable 60 second limit. (Maximum coil current values apply to 25°C and not at low temperature when they will be higher.)

6.4.32 Pickup (operate) voltage (see 4.7.2). This test is performed to verify that the relay will operate (pickup/pull in with all normally closed contacts open and all normally open contacts closed) within the limit of the specified pickup voltage. There are two basic methods of performing this test which may result in slight variances in readings. The first and most widely used (required for relays rated at 25 amperes and under) is to start at zero volts and ramp the voltage to the point of relay pickup. This method has the advantages of allowing determination of actual pickup voltage and differentials in contacts opening and closing. However, unless the ramp rate is specified, variations in measured pickup voltage may result due to differences in coil heating. The second method is to start at zero volts and step to the specified pickup voltage and determine if the relay has picked up. This method has the least heating effect on the coil and best approximates the coil source during actual application of the relay.

6.4.33 High temperature pickup voltage (see 4.7.2.2). The purpose of this test is to verify that the relay will operate (pickup/pull in with all normally closed contacts open and all normally open contact closed) within its specified pickup voltage at the maximum rated temperature after the coil has been energized for a specific period of time.

NOTE: Do not assume the specified high temperature pickup in actual application unless there is no load on the contact(s). Any contact loading at these temperatures will increase the pickup value.

6.4.34 Dropout voltage (see 4.7.2.3). The purpose of this test is to verify that the relay will dropout (with all normally closed contacts closed and all normally open contacts open) within the specified dropout voltage range. Like the pickup voltage test, there are two basic methods of performing this test which may provide slight variations in readings. The first and most widely used method is to instantaneously apply maximum rated voltage to the coil (long enough to cause the relay to pickup) and ramp the voltage down to the point of dropout. This method has the advantages of allowing determination of the actual dropout voltage and differentials in contacts opening and closing. However, unless the ramp rate is specified, variations in measured dropout voltage may result due to differences in coil heating. The second method is to instantaneously apply maximum rated voltage to the coil and step the voltage down to just above the maximum dropout voltage and determine if any of the normally closed contacts have closed. Then to step to the minimum dropout voltage and determine if all the normally closed contacts have closed. This method has the least heating effect on the coil and best approximates the coil source during actual application of the relay.

NOTE: It is important to instantaneously apply maximum rated voltage to the coil during the performance of this test since significant error may be introduced by ramping the voltage.

6.4.35 Contact bounce, operating and release times (see 4.7.4). The purpose of these tests is to verify the timing of the relay when nominal coil voltage is applied and removed from the coil. Although timing may not be critical in a particular application, it is important that the relay function within these limits in order to pass the rated load tests. All of the above tests are applicable to making of the contacts and do not apply to the breaking or transfer time which is often found critical in ac relays or dc relays with diodes.

6.4.36 Mechanical life (endurance at reduced load) (see 4.7.20). This test is performed to verify that at 25 percent of rated resistive load, relays rated under 25 amperes have a life capability of four times the specified minimum operating cycles, and relays rated at 25 amperes (and above) have a life capability of two times the specified minimum operating cycles. This test illustrates (very conservatively) the inverse relationship between contact loading and life.

6.4.37 Mechanical interlock (see 4.7.29). The purpose of this test is to determine that relays with dual coil circuits and a built-in mechanical interlock, will not switch to the opposite state as long as the first state is maintained closed, either by the coil being energized or due to a fault such as welded contacts. Catastrophic failures in such circuits as motor reversing and load transfer between power supplies could occur if this interlock feature does not function properly. The proper functioning of the mechanical interlock feature insures that only one set of main contacts can be closed at a time and preferably that those first closed remain closed as long as that coil is energized even when the second coil is energized subsequently. Some magnetic latch two-coil two-position relays will assume a neutral position with both coils energized.

6.4.38 Continuous current (see 4.7.15). This test is performed to verify that the relay will function properly and sustain no visible damage when exposed to conditions which result in maximum relay heating (i.e., maximum ambient temperature, altitude, rated load, and coil voltage).

6.4.39 Electromagnetic interference of coil circuit (see 4.7.10). These tests are performed to insure that the coils of ac operated relays do not emit EMI beyond specified limits, that transients suppression circuits on dc operated relays are functional, and that the transients generated by these suppressed coils (coil kick) are below specified limits. These tests are not applicable to EMI generated by contact switching.

6.4.40 Operational reliability (screening) (see 4.7.30). The purpose of this test is to screen out substandard relays. Cycling the relays for a limited number of operations at reduced current levels detects those relays that may develop high contact resistance or fail to operate in subsequent testing or service. It is a group A test requirement for established reliability relays. When this requirement is specified these is reasonable assurance that relays subject to "infant mortality" have been eliminated.

* 6.4.41 Load and endurance (see 4.7.26). The purpose of these tests is to prove, with a high degree of confidence that the design and construction of the relay is such that it meets the performance requirements of the specification. The duty cycles listed for each test are considered typical and are historically based on an application. The same rationale applies to the percent of rated load listed for each test. It is generally recognized that no one specific relay application will be required to see the loads listed, but the tests listed will be within the majority of the applications. In selecting a relay for its application, one must be familiar with the application and then select a qualified relay that has those design requirements listed. If the relay is used in the application in which the duty cycle, or life, or some other design characteristic listed in the specification is exceeded, additional testing or a new type of relay may be required.
Caution: Attention is directed to the fact that contact load tests are established with no external shunt across the coil.

6.4.42 Overload (see 4.7.26.1). This test is performed to verify that the relay is capable of making and breaking an overload condition as might be experienced when switching the inrush current of a motor load without significantly affecting the contact voltage drop requirement; i.e., contact voltage drop test passage is required after overload but not after rupture.

6.4.43 Rupture (see 4.7.26.2) (does not apply to fast cycling conditions). This test is performed to verify that the relay has sufficient thermal capability to make and break severe fault currents without catastrophic failure.

6.4.44 Intermediate (mixed load) current (see 4.7.26.6).

The purpose of this test is to verify the following:

(1) For relays whose main contacts are rated at 20 amperes and below and auxiliary contacts of any relay -- verify the capability to switch intermediate level loads, or intermediate and power level loads concurrently on adjacent contacts or poles. The contact loading of the relay is determined by its contact form/pole configuration.

(2) For relays whose main contacts are rated above 20 amperes -- verify the capability to switch reduced power level loads (i.e., 10 percent of rated resistive load) or reduced power level and rated loads concurrently on adjacent poles or contacts. The contact loading of the relay is determined by its contact pole configuration.

As a result of the foregoing, this test can be thought of and consisting of two sub-tests:

(1) Intermediate level load sub-test.
(2) Reduced level load sub-test.

6.4.45 Intermediate level load sub-test. The intermediate level load lies between low level and power level loads. Generally, it is considered to be in the order of from 0.050 to 1.0 amperes at from 0.100 to 28 volts open circuit with the contact material and the atmosphere in which switching takes place dictating specific boundary limits within this range. Contacts required to switch loads within this range may experience serious performance degradation if certain volatile contaminants are present. The energy available in the intermediate level load is sufficient to cause breakdown of these contaminants but insufficient to remove the resultant products from the contact interface. The end result is excessive contact voltage drop.

The test currents and voltage required by this specification are considered to result in the maximum adverse effect if the before-mentioned contaminants are present, and hence are best suited to detect their presence. The condition is accentuated by testing at maximum rated temperature, at a duty cycle designed to cause near maximum coil heating. The test values should not be construed as minimum ratings of voltage or current since relays complying with the specified requirements may also be used for switching lower values within the intermediate level load range. In addition to verification of intermediate level load capability, single pole double throw relays and multi-pole relays are tested to verify that arc-products produced during power level switching do not affect the intermediate level load capability sufficiently to exceed the specified performance requirements.

6.4.46 Reduced level load sub-test. The reduced level load sub-test provides verification that relays rated above 20 amperes have the capability of switching 10 percent of their rated load. For multi-pole relays, this verification is accomplished with an adjacentttpole concurrently switching rated load. Although this test is performed at a reduced level, the load is well within the power level range and as such should not be construed as providing verification of intermediate level load capacity.

6.4.47 Load transfer, single or polyphase ac (see 4.7.26.5). This test is performed to verify that a relay has sufficient contact gap to allow load transfer between unsynchronized ac busses. The load transfer current rating is normally less than the resistive rating to lessen the contact arcing. caution: Use of a diode across the relay coil will slow armature speed and thus allow sufficient time for ionization of contact airgap. The arcing must be reduced to preclude a source-to-source short from occurring due to the possiblity of up to a 180° phase angle difference between the two sources (resulting in twice the peak line-to-neutral voltage between the contacts). Relays without established load transfer ratings should not be used in catastrophic unless relay is so designed.

6.4.48 Low level (see 4.7.26.7). This test is conducted for the purpose of determining electrical contact relaibility under low-level switching conditions in the environment in which the contacts operate. A low level switching circuit is one in which the voltage and stored energy are sufficiently low so that the resistance of a pair of contacts is not affected by electrical phenomena associated with the elctrical current flow or the switching. Such a circuit is also one where the voltage or the current is too low to cause any physical change in the contacts; contact resistance can only be affected by changes in the contacts caused by mechanical action on the contacts. Electrical loads, which result in acring across electrical contacts, affect contact surfaces in many ways, mostly favorable to reductio of contact resistance, since insulating films and small rought raised areas on the contact are burned away or melted down, to reform as a more even and larger contact surface. Under low-level conditions, the advantages, as well as the occasional disadvantages of this arcing will be absent. If low-level loads and intermediate or power loads are to be applied to different pairs of contacts on the same component part simultaneously, reliability of the low-level conditions can be impaired. This is due to deposition of foreign materials resulting rom vaporization surrounding the contacts operating at larger loads in the same enclosure or in an adjacent area. Because of this fact, and because low-level contacts may develop films as a function of their environment, the contacts are tested in an evironment similar to that in which they are used. This test in no way reflects the contact capability in the intermediate or "minimum" current area and shall not be considered as a substitute for testing in this area when specified.

6.4.49 Circuit breaker compatibility (see 4.7.26.3). This test demonstrates a relay's capability of operating in electric circuits protected by circuit breakers. Specifically, it demonstrates the contact's capability of closing into and carrying overloads for durations approximating the overload trip times of circuit breakers without welding, sticking, or exhibiting excessive voltage drop. The rupture or overload tests do not provide adequate assurance that the relay application and circuit breaker are compatible.

6.4.50 Environmental tests. The following tests are performed to verify that a relay has been designed to withstand or satisfactorily operated when exposed to the various environmental stresses as may be experienced in application. It should be recognized that by their very nature some of the tests are in fact degrading to the relay (e.g., vibration shock) and hence may reduce its life expectancy if used as a screening criterion.

6.4.51 Thermal shock (see 4.7.12). This test is conducted for the purpose of determining the resistance of a relay to exposures at extremes of high and low temperatures, and to the shock of alternate exposures to these extremes, such as would be experienced when equipment or parts are transferred to and from heated shelters in arctic areas. These conditions may also be encountered in equipment operated noncontinuously in low-temperature areas or during transportation. Although it is preferred that the specimen reach thermal stability at the temperature of the test chamber during the exposure specified, in the interest of saving test time, parts may be tested at the minimum exposure durations specified, which will not insure thermal stability, but only an approach thereto. Permanent changes in operating characteristics and physical damage produced during thermal shock result principally from variations in dimensions and other physical properties. Effects of thermal shock include cracking and delamination of finishes, openin of case seams, rupturing or cracking of hermetic seals, and changes in electrical characteristics due to mechanical displacement, rupture of conductors or of insulating materials, or outgassing and subsequent red position of volatile contaminants on contact interfaces.

6.4.52 Low temperature operation (see 4.7.13). This test is performed to verify that the relay will function properly when exposed to extended periods of low temperature. In addition, relays using permanent magnets in their magnetic circuit are subjected to conditions which tend to promote de-magnetization of the permanent magnets and subsequently are checked for pickup ability at high temperature.

6.4.53 Shock (see 4.7.[illegible]). This test is conducted for the purpose of determining the contact stability and the suitability of the relay when subjected to shocks such as those which may be expected as a result of application, transportation, and rough handling.

6.4.54 Vibration (see 4.7.17). The vibration test is performed for the purpose of determining the effect on component parts and contact continuity of vibration in the frequency ranges as may be encountered in aircraft, missiles, and tanks. Consideration for the frequency range and g level are the design capabilities and the application requirements.

6.4.55 Acceleration (see 4.7.24). This test is performed for the purpose of determining the effects of acceleration stress on component parts, and to verify the ability of the relay to withstand exposure to acceleration stress such as would be experienced in aircraft, missiles, etc.

6.4.56 Salt spray (see 4.7.19). The salt spray test is performed for the purpose of determining the ability of protective finishes or coatings of sealed relay enclosures to withstand corrosion. It is intended as a practical qualitative evaluation of the protective properties of metallic and other finishes.

6.4.57 Sand and dust (see 4.7.14). This test is performed to ascertain an unsealed relay's ability to properly function following exposure to a dry dust (fine sand) laden atmosphere. This test simulates the effect of sharp edged dust (fine sand) particles, up to 150 micrometers (μm) in size, which may penetrate into cracks, crevices, bearings, and joints, and cause a variety of damage such as fouling moving parts, making relays inoperative, forming electrically conductive bridges with resulting "shorts" and acting as a nucleus for the collection of water vapor, and hence a source of possible corrosion and malfunction of equipment.

6.4.58 Ozone (see 4.7.23). This test is performed on all nonhermetically sealed relays (except those with potted wire lead terminals) to verify their ability to withstand ozone exposure without deterioration. Since ozone is formed when electrical arcing occurs in an atmosphere containing oxygen, and ozone causes deterioration of certain organic materials (such as natural rubber) this test discourages the use of such materials in the relay's construction which may be adversely affected by ozone.

6.4.59 Explosion proof (see 4.7.25). The purpose of this test is to determine if an unsealed relay, while operating, will ignite an ambient explosive atmosphere. Explosion proof relays must be designed on the principle that they will eventually fill with an explosive mixture, and sooner or later, this explosive mixture in the case will ignite. The relay case must have sufficient strength to withstand this internal explosion. Any open channel between the inside and the outside must be sufficiently long, tortuous, and narrow to cool any exploding gases so that they will not have sufficient heat to ignite the outside ambient atmosphere.

6.4.60 Vibration scan (see 4.7.27). This is a short form vibration test that is used for screening purposes similar to operational relaibility or for determining the integrity of contacts following an endurance test.

6.4.61 Acoustical noise (see 4.7.18). The acoustical noise test is conducted to determine the effects on relays and contact continuity of acoustic sound fields that are characteristic of aircraft, missile, and other high performance vehicles. The acoustic noise test is not intended to be a substitute for the conventional sinusoidal or random vibration test when specified in the equipment specification.

6.4.62 Resistance to solvents (see 4.7.31). The purpose of this test is to verify that the markings will not become illegible or discolored when subjected to solvents (normally used to clean solder-flux, fingerprints, and other contaminants from printed-wiring and terminal board assemblies, etc.), jet fuel, hydraulic fluids, and lubricating oil.

* 6.5 Class 0 relays. Class 0 relays previously covered by MIL-R-6106B no longer meet requirements of this specification. No new Class 0 relay standards will be issued. Existing Class 0 relay standards are inactive for new design and are being retained only for the purpose of procuring replenishment spare parts by government activities. Quality conformance requirements to procure Class 0 relays to this specification are listed in table XXVIII. Class 0 relays were defined in MIL-R-6106B as follows: Class 0 - Sealed or unsealed relays designed for 71°C maximum ambient temperature, and 50,000 feet maximum altitude.

6.6 Qualification of single-phase rating. Qualification for 115/200 volts, 400 Hz, 3-phase ratings will automatically qualify a relay for the same ratings at 115 volts, 400 Hz per pole.

6.7 Storage life. Relays conforming to this specification should be designed for a minimum of 2 years' shelf life, following which the relays should be satisfactory for intended use without further conditioning.

6.8 Rated duty.

TABLE XXVIII. Quality conformance requirements for Class "0" relays. 1/

Test	Requirement paragraph	Test paragraph
Examination of product 2/	3.1, 3.3, 3.4, 3.43 and 3.44	4.7.1
Contact voltage drop or resistance	3.13	4.7.7
Pickup voltage	3.7	4.7.2, 4.7.2.1
Dropout voltage	3.8	4.7.2.3
Dielectric withstanding voltage 3/	3.12	4.7.6
Seal	3.37	4.7.28

1/ Groups B and C not applicable.
2/ Reference to fungus growth not applicable.
3/ Change 2-5 seconds to 1 second.

6.8.1 Continuous duty. A continuous duty relay is a relay which may be energized with maximum rated coil power indefinitely with contacts carrying maximum rated currents at rated voltages without exceeding specified temperature limitations.

6.9 Degassing. Degassing is the process used to remove contaminants which could be trapped inside the relay after it is sealed. Depending on the relay design and load switching requirements, certain trapped gasses and contaminants can cause severe reduction in life cycle operations as well as contact resistance, dielectric strength, and insulation resistance problems. The backfill gas in an important element of the final degassing process and is selected specifically for the relay design and switching requirements.

6.9.1 Degassing procedure. There are many methods of degassing a relay and each method is selected based on the relay design as well as the contact rating. For some relays only an exchange of internal gasses is used and for others, more sophisticated baking and backfilling is used. The following is an example for one of the more sophisticated methods of degassing a relay without a tipoff hole.

a. Place relay without enclosure attached in vacuum oven.
b. Evacuate to less than 200 microns.
c. Heat to maximum rated ambient temperature with continued evacuation (see 3.1).
d. Maintain heat and vacuum for 12 hours or longer, continuing the treatment until a maximum pressure of 80 microns is reached.
e. Turn off heaters and maintain pressure for 4 hours.
f. Close evacuation valve and fill chamber with the desired pressurizing gas.
g. Open vacuum oven door into a controlled atmosphere chamber containing the desired relay fill gas, assemble enclosure and seal before removing from chamber.

6.10 Higher ratings in low classification. In certain instances, relays may have higher contact load ragings (load-endurance) for ambient operating temperatures and altitudes which are reduced from the maximum values specified (see 3.1). In these circumstances, the relay may be qualified to the higher contact ratings by testing the additional samples specified in table XII per items (e) and (f) at the reduced temperature and altitudes which are so specified (see 3.1).

6.11 Load transfer ratings. Caution: Relays should not be used to transfer loads between phases of unsynchronized ac power supplies unless suitable ratings have been established (see 3.1).

6.12 Coil transient suppression. The use of improper external coil transient suppression circuits to eliminate or reduce the generation of transients may seriously deteriorate the contact life capabilities of the relay and as such should be thoroughly evaluated with regard to the relay design.

6.13 AC coils. Coils rated for 400 Hz operation may not necessarily operate reliably at 60 Hz. Contact the manufacturer to determine whether this trade off is possible.

* 6.14 Particle impact noise detection test (P.I.N.D., see 4.7.32). This test is performed to detect the presence of free moving particulate contamination inside the relay. Particulate conramination is one of the major problems with sealed relays and this screening test was developed to detect hard particles by vibrating the relay at a low frequency and G level and monitoring for random noise bursts using an audio amplifier. This test is not 100 percent reliable since a particle may be lodged when the test is performed and later become dislodged during normal operation, but is considered the most reliable method of detecting hard particle contamination such as weld splatter. Because of tolerances in some larger relays, this test can not be used reliably because of inherent noise within the relay causing a masking of the noise made by a loose particle.

6.15 Changes from previous issue. The margins of this specification are marked with asterisks to indicate where changes (additions, modifications, corrections, deletions) from the previous issue were made. This was done as a convenience only and the Government assumes no liabbility whatsoever for any inaccuracies in these notations. Bidders and contractors are cautioned to evaluate the requirements of this document based on the entire content irrespective of the marginal notations and relationship to the last previous issue.

Custodians:
Army - ER
Navy - AS
Air Force - 85

Review activities:
Army -
Navy - EC
Air Force - 11, 99
DLA - ES

User activities:
Army -
Navy -
Air Force -

Preparing activity:
Air Force - 85

(Project 5945-0484)

INSTRUCTIONS: In a continuing effort to make our standardization documents better, the DoD provides this form for use in submitting comments and suggestions for improvements. All users of military standardization documents are invited to provide suggestions. This form may be detached, folded along the lines indicated, taped along the loose edge *(DO NOT STAPLE)*, and mailed. In block 5, be as specific as possible about particular problem areas such as wording which required interpretation, was too rigid, restrictive, loose, ambiguous, or was incompatible, and give proposed wording changes which would alleviate the problems. Enter in block 6 any *remarks* not related to a specific paragraph of the document. If block 7 is filled out, an acknowledgement will be mailed to you within 30 days to let you know that your comments were received and are being considered.

NOTE: This form may not be used to request copies of documents, nor to request waivers, deviations, or clarification of specification requirements on current contracts. Comments submitted on this form do not constitute or imply authorization to waive any portion of the referenced document(s) or to amend contractual requirements.

(Fold along this line)

(Fold along this line)

DEPARTMENT OF THE AIR FORCE

NO POSTAGE NECESSARY IF MAILED IN THE UNITED STATES

OFFICIAL BUSINESS
PENALTY FOR PRIVATE USE $300

BUSINESS REPLY MAIL
FIRST CLASS PERMIT NO. 73236 WASHINGTON D. C.

POSTAGE WILL BE PAID BY THE DEPARTMENT OF THE AIR FORCE

AFALD/PTS
Ge..cile AF Station Dayton, OH 45444

STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

(See Instructions – Reverse Side)

1. DOCUMENT NUMBER	2. DOCUMENT TITLE

3a. NAME OF SUBMITTING ORGANIZATION	4. TYPE OF ORGANIZATION *(Mark one)*
	☐ VENDOR
b. ADDRESS *(Street, City, State, ZIP Code)*	☐ USER
	☐ MANUFACTURER
	☐ OTHER *(Specify)*: _____

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)*

DD FORM 82 MAR 1426

PREVIOUS EDITION IS OBSOLETE.