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INTERIM DEVELOPMENT REPORT

DATE— FEB 1953

Navy Department Bureau of Ships

Electronics Division

CONTRACT NObsr-52423 INDEX NO. NE-111 615

Oklahoma A & M College

Electrical Engineering

Division of Engineering Research

Stillwater, Oklahoma

SECURITY INFORMATION

INTERIM DEVELOPMENT REPORT

ON

STUDIES TO DETERMINE THE RELIABILITY OF RELAYS

BUREAU OF SHIPS SPECIFICATION SHIPS-R-405

This report covers the period February 1, 1953 to February 28, 1953

OKLAHOMA A & M COLLEGE
STILLWATER, OKLAHOMA

NAVY DEPARTMENT BUREAU OF SHIPS ELECTRONICS DIVISION

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ABSTRACT

I. During the month the Relay Standards and Relay Test Code were revised and put into work book form. They will be distributed among various relay manufacturers and users.

II. The proposed Military Standard Sheets for relays were revised and a new general form for these sheets is submitted. Two typical examples of the use of these sheets are included.

III. Professors C. F. Cameron and D. L. Johnson took a trip to Washington D. C. to confer with officals of the Electronics Component Section of the Bureau of Ships.

IV. Work on a proposed revision of relay specification was started but is not complete. The completed proposal will be included in a later report.

V. A proposal for obtaining relay test equipment was drafted and forwarded to the Bureau of Ships. The proposal contains estimated equipment cost.

PART I

PURPOSE:

The preliminary work shall be comprised of the following phases:

Phase 1 - Study of existing relays. -

(a) Determination of the categories, styles and characteristics of relays to be considered. Tabulate characteristics of a number of relays to show types, ratings, RF-AF or DC, function for which designed, size, time of operation, coil resistance, and other pertinent data. The Bureau of Ships will forward, from time to time, additional information as to types of relays being used in existing equipment.

(b) Obtaining from relay manufacturers all available technical data (including drawings) describing the physical dimensions, tolerances, and electrical and mechanical characteristics of each relay.

(c) Arrangement by types of this technical data from the various relay manufacturers into a relay catalog.

(d) Tests of existing and representative categories of relays to ascertain performance and check against the rated values.

(e) Study of tests presently conducted by relay manufacturers to determine what tests should be modified or improved to find the necessary characteristics to increase the reliability of relays.

(f) Devise new procedures for relay-testing as indicated by present needs; also devise new test procedures for determining more completely and more accurately the desired performance, with a view toward improving the reliability of relays.

Phase 2 - Study of failure reports (these failure reports shall be obtained from the Bureau of Ships) to ascertain, insofar as possible, the causes of failures, to tabulate the results, and to analyze the findings.

Phase 3 - A study to devise a method to make relay specifications consistent with actual required relay operation. Determination (based largely on relay manufacturers' technical data) of types and stringency of tests to be imposed on the relays under the specification draft to improve the reliability of relays under specific application.

Phase 4 - Arrangement of technical data, in a form to serve as a basis for an amendment to the specification presently under consideration.

Phase 5 - A study of relay characteristics and functions with the view of developing a new design of relay construction to improve the reliability of operation

STANDARDS, TEST CODE & SPECIFICATIONS

Some confusion exists about the meaning of the terms "Standards", "Test Code" and "Specifications" as commonly used by the American Standards Association and related Engineering Organizations. The following Discussion is an attempt to point out the significance of these ideas.

A field inspection coordinator of a manufacturer who purchased relays from relay manufacturers to use on an assembled equipment gave the following illustration.

"Other points of disagreement have been measurement of contact pressure, closing time, contact resistance and contact bounce. Of these, we have had the most trouble with closing time or operating point of a relay. An example is using a relay consisting of Form "C" contacts. Some vendors consider the operating time of the relay to be the opening of normally closed contacts. Other vendors consider it to be at the time the normally open contacts close. It is true that the difference in this case is small, but if near the maximum tolerance, the difference in technique would mean acceptance or rejection of the relay."

The question is, "How can an argument of this sort be settled? Shouting, fast talk and pounding the desk, certainly have no place in this disagreement. Where can the answer to such a question be found? At the moment, there is no set of Standards which define the terms. There is no technique which is generally accepted to test for "closing time". To include all definitions, standards and testing procedures in a document is prohibitive. It is proposed to have separate "Standards", "Test Code" and "Specifications" for these and related problems.

STANDARDS

Quotations are given below which serve to illustrate the purpose and intent of "Standards" as related to electrical machinery or a related topic. It is proposed to apply the same methods to "Relay."

On page 7 of G50-1936 American Standards for Rotating Electrical Machinery is a statement, "In the development of the Standards emphasis has been laid on definition of terms and conditions which characterize the rating and performance of electrical machinery with special reference to the conditions upon which acceptance tests are based."

Paragraph topics and in some cases the entire paragraph will be of interest. For instance, under Direct-Current Rotating Machines, "The standards in this section apply to the following types of rotating machines:"

"Allowable Variation From Rated Voltage For Motors. Motors shall operate successfully at rated-load at any voltage not more than 10 per cent above or below the rated voltage, but not necessarily in accordance with the standards of performance established for operation at normal rating."

"Rating. The rating of a machine shall consist of the output together with any other characteristic such as speed, voltage and current, assigned to it by the manufacturer. The output given in the rating shall not exceed the maximum output which can be taken from the machine under the conditions of test and other limitations prescribed in this standard."

From the foregoing, it is seen that Standards are divised for the purpose of defining the various terms as applied to the subject under consideration: the setting of limits for operation, defining the rating and other factors such as heating, efficiency, losses, dimensions, terminals and other significant points.

TEST CODE

The purpose of the Test Code is stated clearly in the Foreward of A.I.E.E. Test Code for Polyphase Induction Machines No. 500 August 1937.

"In order to determine the performance characteristics of electrical machines, methods of testing have been developed and are in common usage. It is the purpose of these tests codes to provide in convenient reference form the more generally applicable and accepted methods of conducting and reporting tests of a commercial nature, which apply to the fulfillment of performance guarantees and to acceptance tests. It is not intended that the codes shall cover all possible tests or those of a research nature. It must be recognized that the selection of the most suitable test depends upon local conditions and the degree of precision desired."

SPECIFICATIONS

A specification is an attempt to have a meeting of minds about a given piece of equipment. It is usual to itemize the parts of the piece of equipment, the function and the rating. The rating may be composed of several significant details such as: volts, amperes, watts, temperature, continuous duty or intermittent. The physical dimensions may be an important factor as well as the weight , finish, color and how connected.

The kinds and quality of materials and workmanship are other details which are significant. Very often, the materials such as copper and insulation may be defined as to grades of quality in other standards.

Probably the most important point in the specification is to state clearly and exactly the necessary result to be accomplished by the proposed piece of equipment. The tolerances which may be allowed and how rigid the performance characteristics must be adhered to are other things to consider.

These specifications are worded to use the defining terms of the standards of that industry and the tests which the equipment must undergo are detailed in the Test Code. It is seen that Standards, Test Code and Specifications are intimately related but should be separate documents.

Engineering Societies and Trade Associations have, in the past, worked out the Standards and Test Codes. The specifications have been prepared by the engineers representing the purchaser. It is believed that for Relays, the Standards, Test Code and specifications should be separate and distinct documents.

In all cases, these three documents must be and will be revised to suit such conditions as may arise. In other words, there will be a gradual change as progress and improvement takes place.

REVISED RELAY STANDARDS AND RELAY TEST CODE IN WORKBOOK FORM

On the following pages appear the Relay Standards and Relay Test Code with the latest revisions. They are presented with one item per page and with room left on the page for comments and criticisms. Copies will be sent to relay manufacturers and users with requests for their comments to be written on each page and the entire set then be returned.

This procedure was adopted and used to great advantage at previous meetings with relay manufacturers (The Test Code, only, was used). As a result of this experience it was thought to be advantageous to publish a revised set of Standards and Test Code in the same form and present them to relay manufacturers.

RELAY STANDARDS

PART I

Definition of Relay- A relay is an electromechanical device which is operated by variation in the conditions of one electric circuit to effect the operation of other devices in the same or other electric circuits by opening and/or closing contacts, the load on which does not exceed 25 amperes, 115 volts, 60 c.p.s., non-reactive.

Definition of Contactor - A contactor is an electromechanical device which is operated by variation in the conditions of one electric circuit to effect the operation of other devices in the same or other electric circuits by opening and/or closing contacts, the load on which is in excess of 25 amperes, 115 volts, 60 c.p.s., non-reactive.

PART II

GENERAL CLASSIFICATION OF RELAYS

Every relay belongs in one of the categories of each classification depending upon its design, characteristic, application and rating.

1. CLASSIFICATION BY DESIGN TYPES

1.1 Armature Type - An armature type relay is a relay the operation of which depends upon the energizing of an electromagnet which in turn attracts to a fixed pole piece a hinged or pivoted lever-type armature.

1.2 Plunger Type - A plunger type relay is a relay which is operated by the energizing of an electromagnetic coil which in turn operates a movable core or plunger by solenoid action.

1.3 Thermal Type - A thermal type relay is a relay which is operated by the heating effect caused by electric current flow rather than by magnetic or induction principles.

1.4 Rotary or Motor Driven - A rotary type relay is a relay the operation of which depends upon motor action. The motor may or may not be restricted in its degree of travel. This relay type does not refer to an armature driven ratchet type relay.

1.5 Instrument Type - A combination relay is a relay the operation of which depends upon principles commonly employed to measure electrical quantities; i. e., induction disk, D'Arsonval, electrodynamometer, etc.

1.6 Combination Type - A combination relay is a relay employing any combination of the above design types.

2. CLASSIFICATION BY CHARACTERISTIC OPERATION

2.1 On-Off - An on-off relay is a relay of such design that its only requirement for operation and release is to apply and remove power.

2.2 Polarized - A polarized relay is a relay the operation of which is dependent upon the direction of energizing current flow.

2.3 Marginal - A marginal relay is a relay which operates in response to predetermined changes in value of current or voltage. Or (A marginal relay is a relay which operated and/or releases in response to predetermined changes in value of coil current or voltage.)

2.4 Differential - A differential relay is a relay, having two or more windings, which functions when the current or voltage difference between the windings reaches a predetermined value.

3. CLASSIFICATION BY USE

3.1 General Purpose - (a) A general prupose relay is a relay which has deisgn, construction, characteristics, and rating such that it is adaptable to a wide variety of used. (b) General Purpose Relay - A general purpose relay is one which functions upon application of the operating voltage to the coil and has no special features.

3.2 Definite Purpose - A definite purpose relay is a relay which, in addition to its function as such, performs a single ulterior duty which usually necessitates some added electrical or mechanical feature.

3.2.1 Interlock Relay - An interlock relay is a relay composed of two or more coils with their amatures and associated contacts so arranged that the freedom of one armature to move or its coil to be energized is dependent upon the position of the other armature.

3.2.2 Selector Relay - A selector relay is a relay capable of automatically selecting one or more circuits from a number of circuits.

3.2.3 Stepping Relay - A stepping relay is a relay which requires a predetermined number of separate impulses to complete its cycle of operation.

3.2.4 Sequence Relay - A sequence relay is a relay which is a combination of a selector relay and a stepping relay, and works its contacts in some predetermined manner. Or (A sequence relay is one which controls two or more sets of contacts in a definite predetermined sequence.)

3.2.5 Latch-in Relay - A latch-in relay is a relay with contacts which lock in either the energized or deenergized position until the relay is either manually or electrically reset.

3.2.6 Time delay Relay - A time delay relay is a relay in which some means, either electrical or mechanical, has been specifically incorporated to obtain a delay between the time the relay is energized or deenergized and the instant its contacts operate. Time delay features may be incorporated on operate, release, or both. Or (A time delay relay is one in which a delayed action is purposely introduced.)

3.3 Special Purpose - A special purpose relay is a relay which has an application that requires special features which are not on the convential general purpose or definite purpose relay.

4. CLASSIFICATION BY ENCLOSURES

4.1 An Open Or Unenclosed Relay - An open relay is a relay which does not have its contacts or coil protected from the surrounding medium by a cover.

4.2 Partially Enclosed Relay - A partially enclosed relay is a relay which has either its contacts or coil (but not both) protected from the surrounding medium by the use of removable covers.

4.3 Enclosed Relay - An enclosed relay is a relay which has both its coil and contacts protected from the surrounding medium by use of a removable cover, examples of which are as follows:

4.3.1 Dust-proof
4.3.2 Waterproof
4.3.3 Explosion-proof

4.4 Partially sealed - A partially sealed relay is a relay which has either its contacts or coil (but not both) sealed.

4.5 Sealed Relay - A sealed relay is a relay having both its coil and contacts sealed.

4.5.1 Gasket-Sealed Relay - A gasket-sealed relay is a sealed relay, the sealing of which involves the use of a gasket which is neither glass nor metal and which may or may not be bonded to the other sealing material.

4.5.2 Hermetically Sealed Relay - A hermetically sealed relay is a sealed relay, the sealing of which involves the fusion of glass, ceramic or metal to metal, but does not use a gasket. Or (A hermetically sealed relay is a sealed relay, the sealing of which involves the fusion of insulating material to metal, but does not use a gasket.)

5. CLASSIFICATION BY DUTY RATING

5.1 Continuous Duty
5.2 Intermittent Duty
5.3 Specified Duty

5.1 Continuous Duty Relay - A continuous duty relay is a relay which may be energized at its maximum operating voltage or current with rated contact load, for an indefinite period without failure and without exceeding its specified temperature rise or maximum temperature requirements.

5.2 Intermittent Duty Relay - An intermittent duty relay is a relay which must have occasional or periodic intervals without contact load and/or energization tc avoid damage or exceeding its temperature rating.

5.3 Specified Duty Relay - A specified duty relay is a relay which is designed to function with a specified duty cycle but which might not be suitable for other duty cycles.

6. CLASSIFICATION BY OPERATE POWER

6.1 Power Relay - A power relay is a relay which requires an operate power greater than 100 milliwatts.

6.2 Sensitive Relay - A sensitive relay is a relay which requires an operate power within the range of 1 to 100 milliwatts, inclusive.

6.3 Very Sensitive Relay - A very sensitive relay is a relay which requires an operate power less than 1 milliwatt.

7. CLASSIFICATION BY SPEED

7.1 Slow-Speed Relay - A slow-speed relay is a relay which has been specifically designed for slow speed in operation, release, or both.

7.1.1 Slow-Operate Relay - A slow-operate relay is a slow-speed relay which has been specifically designed for long operate time, but not long release time.

7.1.2 Slow-Release Relay - A slow-release relay is a slow-speed relay which has been specifically designed for long release time, but not long operate time.

7.1.3 Slow-Operate Slow-Release Relay - A slow-operate slow-release relay is a slow-speed relay which has been specifically designed for both long operate time and long release time.

7.2 Normal-Speed Relay - A normal-speed relay is a relay in the design of which no attempt has been made either to increase or decrease the operate time or the release time.

7.3 High-Speed Relay - A high-speed relay is a relay which has been specifically designed for high speed in operation, release, or both.

7.3.1 Fast-Operating Relay - A fast-operate relay is a high-speed relay which has been specifically designed for short operate time but not short release time.

7.3.2 Fast-Release Relay - A fast-release relay is a high-speed relay which has been specifically designed for short release time but not short operate time.

7.3.3 Fast-Operate Fast-Release Relay - A fast-operate fast-release relay is a high-speed relay which has been specifically designed for both short operate time and short release time.

7.4 Slow-Operate Fast-Release Relay - A slow-operate fast-release relay is a relay which has been specifically designed for long operate time and short release time.

7.5 Fast-Operate Slow-Release Relay - A fast-operate slow-release relay is a relay which has been specifically designed for short operate time and long release time.

PART III

8. STANDARD RELAY FRAMES (To be completed)

8.1 Standard types or styles
8.2 Standard sizes
8.3 Standard mountings
8.4 Standard method of frame numbering
8.5 Standard terminal types
8.6 Standard dimension drawings

PART IV

9. MARKING

9.1 Identification Marking - There shall be permanently and legibly marked on the relay as much of the following information as possible. Where space limitations do not permit the inclusion of all infomation, items farthest down the list shall be eliminated first.

9.1.1 Procuring Service's number
9.1.2 Customer's number (if different)
9.1.3 Manufacturer's name or trademark
9.1.4 Manufacturer's number
9.1.5 Rated voltage
9.1.6 Rated frequency
9.1.7 Rated coil current
9.1.8 Rated contact current
9.1.9 Duty cycle
9.1.10 Other ratings

9.2 Terminal Identification - On sealed relays, and on others where confusion might otherwise exist, some means shall be incorporated on the relay to identify its terminal connections.

PART V

10. NOMINAL AND PERFORMANCE RATINGS

10.1 The values of voltage, current, power and frequency at which the Performance Ratings in 10.2.1 through 10.2.17 are determined shall be termed Nominal Ratings.

10.1.1 All relays shall be capable of operation in accordance with their Performance Ratings at ±10% of their Nominal Ratings.

10.2 Performance Rating - All relays shall be Performance Rated for the following items, provided such tests are relevant to the function the relay is to perform.

10.2.1 Vibration resistance
10.2.2 Shock Resistance
10.2.3 Life
10.2.4 Minimum operate voltage
10.2.5 Maximum release voltage
10.2.6 Operate power
10.2.7 Temperature rise (see 11.1.10)
10.2.8 Insulation resistance
10.2.9 Insulation dielectric
10.2.10 Capacitance (only for relays intended for applications involving frequencies of 10,000 c.p.s. or greater)
10.2.11 Contact resistance
10.2.12 Contact bounce
10.2.13 Contact pressure
10.2.14 Contact gap (not for a sealed relay or a partially sealed relay whose contacts are sealed).
10.2.15 Terminal strength
10.2.16 Characteristic impedance (only for relays intended for applications involving frequencies of 1 mc.p.s. or greater)
10.2.17 Operate time
10.2.18 Release time
10.2.19 Acceleration

10.3 Basis of Rating - Relay ratings for a particular type of relay are to be determined from tests conducted on representative samples of that type. Sampling and tests must be conducted in the manner specified in the Relay Test Code.

PART VI

11. MANUFACTURING STANDARDS

11.1 Following are the minimum acceptable test results for relays manufactured and sold as a standard product. All tests conducted to determine the values for various items listed must be in accordance with the Relay Test Code.

11.1.1 Sealed Relays - All sealed relays shall show no evidence of leaking when tested in accordance with the Relay Test Code.

11.1.2 Insulation Dielectric Strength - Relays up to 60 volts shall be tested at 450 volts r.m.s. (root-mean-square); relays from 60 to 250 volts, at 1000 volts r.m.s.; relays from 250 to 500 volts at four times the working voltage; and relays above 500 volts, at two times the working voltage, plus 1000 volts r.m.s.

11.1.3 Insulation Resistance - The minimum allowable insulation resistance for a relay is 100 megohms. During, or as a result of, the moisture resistance test the insulation resistance may drop to a minimum of 1 megohm but must return to 50 megohms within 24 hours after the test when left standing at standard atmospheric conditions.

11.1.4 Minimum Operate Voltage - Unless otherwise specified, the minimum operate voltage shall not be greater than 80% of the rated voltage.

11.1.5 Maximum Release Voltage - Unless otherwise specified, the maximum release voltage shall not be greater than 70% of the rated voltage.

11.1.6 Contact Bounce - Unless otherwise stated, the duration of contact bounce shall not exceed 10% of the total transfer time.

11.1.7 Contact Millivolt Drop - The contact Millivolt drop shall be of such value that there is less than 50 millivolts drop across the contact terminals.

Discussion

With the contact millivolt drop stated as 50 mv, the total resistance from terminal to terminal would have to be no more than .002 ohm. This is difficult to attain in sealed relays and seems needlessly low, as the heat dissipated with 25 amperes through .002 ohm is only 1.25 watts.

11.1.8 Contact Overload - When tested as specified there shall be no evidence of excessive contact burning or pitting. The contact resistance shall not exceed the maximum allowable after the contact over-load test.

11.1.9 Direct-Current Coil Resistance - The tolerance for direct-current resistance of relay coils shall be ±10%.

11.1.10 Temperature Rise - For continuous duty relays the temperature rise shall not exceed the values given below for the different types of insulation as given in A.I.E.E. standards. These allowable rises are based on 25°C ambient temperature. If under any conditions the ambient temperature is other than 25°C, the allowable temperature rises shall be obtained by subtracting the ambient temperature in degrees centigrade from the maximum allowable temperatures given later in this section (11.1.10), the results of which must be a positive temperature difference.

Class 0 insulation - 45°C
Class A insulation - 60°C
Class B insulation - 80°C
Class H insulation - 120°C

For intermittent duty relays the maximum allowable temperature rise is given below:

	Energized less than 2 hrs. but more than 30 minutes	Energized less than 30 min. but more than 5 minutes	Energized less than 5 min. but more than 1 minute	Enerigezed less than 1 minute
Class 0	55°C	65°C	75°C	85°C
Class A	70°C	80°C	90°C	100°C
Class B	90°C	100°C	110°C	125°C
Class H	130°C	150°C	170°C	190°C

(Standards of AIEE, No. 1A, Sept. 1941, p 10)

The times at the column headings of the table are the lengths of time the relays are energized. The limits on allowable temperature rises as given in the table are to be used only if the ratio of energized time to deenergized time is less than one (1). If this ratio is greater than one (1), the allowable temperature rise shall be that given for continuous operation.

In any relay the maximum temperature experienced in operation shall not exceed the maximum allowable temperatures listed below.

Class 0-- 70°C
Class A-- 85°C
Class B-- 105°C
Class H-- 145°C

If other types of insulation are used the maximum allowable temperatures shall be those recommended by the AIEE or Asa. In the event no AIEE or ASA standards are available, the permissible temperature rise shall be that stated by the manufacturer after satisfactroy evidence has been submitted that the insulation will properly and safely withstand the final temperature.

11.1.11 Operate & Release Time - The maximum permissible tolerance for rated operate and release time is $\pm$20%. If stated otherwise the tolerance may be less. (Refer to figure which illustrated contact bounce, sec.11.1.6).

11.1.12 Vibration - Minimum vibration standards are given below:

Vibration-proof relay -- 10 g's
Vibration-resistant relay -- 1.0 g.
All relays, unless positively stated contrariwise, have a minimum vibration resistance of 0.10 g.

11.1.13 Shock - Minimum shock standards are given below:

Shock-proof relay -- 10 g's
Shock-resistance relay -- 1.0 g.
All relays, unless positively stated contrariwise, have a minimum shock resistance of 0.10 g.

11.1.14 Corrosion - After being subjected to the corrosion test there shall be no visible evidence of corrosion.

11.1.15 Terminal strength - There shall be no mechanical or electrical damage as a result of the terminal strength test. Bending of the terminal shall not be construed as mechanical damage.

11.1.16 Life Test (To be completed)

PART VII

12. STANDARD RATINGS

12.1 Voltages

12.2 Frequencies

12.3 Contact-current capacity

12.11 Standard Voltage Ratings, D.C. - Direct-current relays shall have Standard Voltage ratings of: 6, 12, 24, 48 and 120 volts.

12.12 Standard Voltage Ratings, A.C.- Alternating-current relays shall have Standard Voltage ratings of: 2, 6, 12, 24, 48, 115, 230 and 440 volts.

12.2 Standard Frequency Rating - Alternating-current relays shall have standard frequency ratings of: 25, 50, 60 and 400 cycles per second.

12.3 Standard Current Rating of Contacts - Standard contact current carrying capacities are:

PART VIII

14. APPLICATION DATA

14.1 Usual Service Conditions

14.1.1 Temperature
14.1.2 Humidity
14.1.3 Ventialation
14.1.4 Vebration
14.1.5 Pressure

14.2 Unusual Service Conditions

14.2.1 Varying or unstable supply voltage
14.2.2 Abnormal shock and vibration
14.2.3 Exposure to salt water
14.2.4 Exposure to oil vapor
14.2.5 Abnormal temperatures
14.2.6 Poor ventilation
14.2.7 Exposure to grit or conducting dust
14.2.8 Exposure to explosive atmosphere
14.2.9 Excessive dampness
14.2.10 Exposure to chemical
14.2.11 Subjection to cyclic variations of temperature, pressure, humidity, or all three, over a fairly wide range
14.2.12 Elevation above or below sea level

This explanation is intended to aid the prospective purchaser in giving proper information to the relay manufacturers. The ideas treated here are of a general nature, but their complete understanding by the purchaser is vital in the intelligent selection of a desired relay.

I. SERVICE CONDITIONS

Proper selection of a relay requires that extreme care be exercised in order that the relay may operate in the intended manner. Correct operation of relays determines whether or not the operation of numerous other pieces of equipment will be successful. Therefore, it is necessary that the manufacturer of relays know with as much accuracy as possible the environmental conditions under which the relay will be expected to perform. All possible variations in service conditions may be defined and grouped as shown below.

A. Usual Service Conditions

If the purchaser makes no pertinent statements regarding the service conditions under which the relay would operate when specifying the relay, then the manufacturer will understand that the service conditions are to be "usual". These "usual" conditions are defined as follows:

1. An ambient temperature not to exceed 40°C and not less than -20°C.
2. The difference in the applied voltage and the rated coil voltage of the relay not more than ±10% of rated coil voltage.
3. A variation in the frequency of the applied voltage not to exceed ± 5% of rated coil voltage frequency.
4. If the applied voltage and its frequency are both variable, then the arithmetic sum of both variations shall not exceed ± 10%. (does not apply to D. C. relays).
5. An altitude not to exceed 3300 ft. above sea level.
6. Vibration not in excess of _____.
7. Shock not in excess of _____.
8. Not exposed to conditions listed below as "Unusual Service Conditions".

B. Unusual Service Conditions

The following list of unusual service conditions are given to help the purchaser decide whether or not certain service conditions would be classified as "unusual".

1. Impressed coil voltage other than ± 10% of rated value.
2. Impressed frequency other than ± 5% of rated value.
3. Exposed to temperature below -20°C.
4. Exposed to temperature above 40°C.

5. Operated at elevations more than 3300 ft. above sea level.
6. Exposed to excessive humidity.
7. Exposed to salt spray.
8. Exposed to chemical fumes.
9. Exposed to combustible gases or dust.
10. Exposed to oil vapor.
11. Exposed to excessive shock.
12. Exposed to excessive vibration.
13. Exposed to steam.
14. Other unusual conditions.

C. Service Conditions More Favorable Than Usual

In event that it is known that the relay will actually operate within closer limits than indicated under "Usual Service Conditions" the purchaser should indicate this as such might result in a more economical and yet more accurate relay. Some possibilities are listed below.

1. The relay operates at rated voltage.
2. The relay operates at rated frequency.
3. The ambient temperature is constant or varies within narrow limits.
4. Shock and vibration are negligible.
5. Atmosphere free from any type of pollution, fumes, or moisture.
6. Altitude constant and below 3300 feet.

II SHORT-TIME RATED RELAYS

In general for applications where an intermittent duty relay would be applicable, it is advisable to use a relay which is designed for that particular cycle of operation. Under certain conditions, however, it might be desirable to use a continuous duty relay for intermittent operation. In such cases it might be possible to operate the relay in excess of its continuous

ratings. In this event the purchaser should act only on the recommendation of the manufacturer.

III FACTORS OF SAFETY

A. Total Life Operations

A careful analysis should be made to determine the actual number of operations desired. Depending upon the importance of each operation, an appropriate factor of safety should be used. It should be emphasized that if the importance of the relay operation does not warrant a high degree of reliability, then only a reasonable factor of safety should be used, as a greater factor of safety would only increase the cost of the relay and might result in the loss of other desirable features.

B. Contact Rating

It is not desirable to specify desired contact capacities far in excess of actual expected contact load. Such would only lead to heavier contacts and consequently, a slower relay due to increased inertia.

PART IX

15. DEFINITION OF RELAY TERMS

DEFINITIONS AND NOMENCLATURE AS APPLIED TO RELAYS

The definitions and nomenclature as applied to relays is a compilation of terminolgy from various sources. Literature from the American Standards Association; the American Standard Definitions of Electrical Terms as published by the American Institute of Electrical Engineers; Relays, Relay Testing and Relay Testing Equipment, by C. E. Foster, Research Laboratory of Electronics, M.I.T. and numerous other sources were consulted.

It is highly desirable to have available, such terms and their definitions as are commonly used in any branch of work. No attempt has been made to devise a new definition, however, may statements have been restated. The AIEE definitions have been so indicated.

RELAY TERMS AND DEFINITIONS

Ambient Temperature - Ambient temperature is the temperature of the surrounding cooling medium, such as gas or liquid, which comes in contact with the heated parts of the apparatus. (A.I.E.E. definition)

Ampere Turns - The ampere turns is the product of the number of turns in the coil and the current in amperes passing through the coil.

Annunciator Relay - An annunciator is a signaling apparatus operated electromagnetically, and serving to indicate whether a current is flowing or has flowed in one or more circuits. It is usually employed in connection with electric bells or buzzers. (A.I.E.E. definition)

Anti-Capacity Springs - Anti-capacity springs is a type of spring construction providing low insulation loss and capacitance effects.

Armature - The armature is the moving part found in the magnetic circuit of a relay.

Armature Ratio - Armature ratio is the ratio of the distance through which the armature buffer moves, to the distance through which the armature midpoint moves. The armature ratio is a determining factor in the release and operate speeds of a relay. A higher armature ratio provides a faster release and action speed.

Armature Travel - With the armature of a relay resting against the back stop or adjusting nut, armature travel is the space between the core or the separator and the nearest stop pin, or if stop pins are not provided, the nearest point on the armature itself.

Armature Type Relay - An armature type relay is a relay which is operated by the energizing of an electromagnet which attracts a pivoted lever type armature to its fixed pole piece.

Auxiliary Relay - An auxiliary relay is a relay which operates in response to the opening and closing of its operating circuit to assist another relay or device in the performance of a function. (A.I.E.E. definition)

Back Contact - The back contact is the relay contact, normally closed.

Backstop - The backstop is the part of a relay which limits the backward movement of the armature.

Bar Relay - A bar relay is an electromechanical device of low current-carrying capacity, used to close a large number of isolated circuits simultaneously.

Blow-Out Coil - A blow-out coil is an electromagnetic device located in such a position as to place a magnetic field in the space where an electric circuit is to be broken. This field causes the arc to be displaced, thus, lengthening it and helping to extinguish it more rapidly.

Bobbin - The bobbin is the insulated spool upon which the magnetic coil is wound.

Break - A break is the interruption of an electrical circuit.

Break-Before-Make - Break-before-make is a type of double-throw switch where the moving contacts interrupt one circuit before establishing another.

Bridging - Bridging is a term used to describe a stepping relay in which the wipers touch two successive contacts simultaneously during the stepping action, thus never completely opening the circuit.

Buffer - A buffer is the part used in some types of relays to transmit the armature lever movements to the movable spring contact. The buffer is generally of a non-conducting material and firmly attached to the armature and makes pressure contact with the spring.

Chatter - With reference to relay contacts, chatter is an undesired opening and closing of the contacts.

Coefficient of Resistance, Temperature - The temperature coefficient of resistance is the factor which relates the change in resistance of a conductor to a change in temperature.

$$R_2 = R_1 \left[1+\alpha_1 (T_2 - T_1) \right]$$

where

$$\alpha_1 = \frac{R_2 - R_1}{(T_2 - T_1) R_1}$$

T_1 = Original temperature, degrees C

T_2 = Final temperature, degrees C

R_1 = Resistance of conductor at T_1

R_2 = Resistance of conductor at T_2

α_1 = The temperature coefficient of resistance at T_1

Coil - A coil is a relay component consisting of a suitable form or support wound with a number of turns of insulated wire.

Coil Frame - The coil frame is the part of the magnetic structure of a relay which supports the coil.

Concentric Wound Coils - Concentric wound coils are two coils having their windings placed one on top of the other.

Contact - The contact is the part of a relay which engages or disengages to actually make or break the electrical circuit.

Contact Arrangement - Contact arrangement refers to the arrangement of the different basic contact forms to make up the entire relay contact action.

Contact Bounce - When relay contacts are closed the energy possessed by the moving arm may cause the contacts to make and break several times before firm contact is established. This is known as contact bounce.

Contact Follow - For relays using spring combinations as part of the contact arrangement, there should be provided, at the tip of the flexible front contact spring before the spring strikes the stop spring at the point opposite the contact.

Contact Notation - The contacts of a relay which are moved by the armature are designated as the movable contacts, each of which constitutes a pole of the relay.

The stationary contacts with which the movable contacts engage when the coil is unenergized are referred to as the "back contacts" or "normally closed" contacts. Abreviated "NC".

The stationary contacts with which the movable contacts engage when the coil is energized are referred to as the "front contacts". or "normally open contacts." Abbreviated "NO".

A "double throw", abbreviated "DT", is referred to when a movable contact switches connections between two stationary contacts, one of which is NO and the other NC.

A "Single throw", abbreviated "ST", is composed of a movable contact, either NO or NC.

Note: NO and NC are usually used for designating single-throw contacts only.

A "double break", abbreviated "DB", is composed of a movable contact which bridges or makes simultaneous connection between two stationary contacts.

Relay contact notations are given in the following order:

1. Poles
2. Throws
3. Normal Position
4. Number of breaks

Examples: SPST NO DB designates a single-pole, single-throw, normally open, double-break relay.

All contacts are single-break except when noted as double-break (DB).

Relays having several sets of differently-functioning contacts will have the contact groups listed separately.

Example: DPDT SP NO DB would mean a double-pole, double-throw relay with an additional set of single pole normally-open, double break contacts.

Contact Separation - Contact separation is the distance between relay contacts when the contacts are in the open position.

Contactor - A contactor is a device essentially the same as the relay but employed in circuits controlling currents above twenty-five emperes, whereas the term relay is used for devices controlling currents below twenty-five amperes.

Control Duty Contact - A control duty contact is a contact designed to handle the power generally encountered in control circuits. They are not dedigned to handle heavy loads.

Core - A core is the part of the magnetic circuit of a relay about which the coil is wound.

Counting - Counting is a term referring to a stepping switch that has its operating impulses controlled by the objects to be counted.

Current Balance Relay - A current balance relay is one which operates when the magnitude of one current exceeds the magnitude of a similar current by a predetermined degree. (A.S.A. defintion)

Current Rating - Current rating is the nominal current capacity of an electrical device. With reference to relay contacts, this may be a varying factor depending upon the type of load.

Current Relay - A current relay is a relay which functions at a predetermined value of current. It may be an overcurrent relay, an undercurrent relay, or a combination of both. (A.I.E.E. definition)

Cycle Timer - A cycle timer is a controlling mechanism performing operational functions along a cycle.

De-Energize - De-energize is a term used in reference to the disconnection of a device from a power source.

Differential Relay - A differential relay is a relay having two windings and functions when the voltage or current difference between the windings reaches a predetermined value.

Directional Relay - A directional relay is a relay which functions in conformance with the direction of power, or voltage, or current, or phase rotation, etc. (A.I.E.E. definition)

Double-Break (Switch) - A double-break switch is a switch which opens the connected circuit at two points. (A.I.E.E. definition)

Double-Pole - A double-pole is a contact arrangement of a switch or relay providing a means of switching two independent circuits simultaneously. Abbreviated DP .

Double-Throw (Switch) - A double-throw switch is a switch by means of which a change in circuit connections can be obtained by closing the switch blade into either of two sets of contacts. (A.I.E.E. definition)

Double Wound Coils - Double wound coils is a type of relay winding consisting of two windings wound either concentrically or end-to-end.

Drop-Out - The drop-out value of a relay is the maximum current, voltage, power etc., at which it will recede from its energized position. For example, an overcurrent relay which closes its contacts on pick-up will just open the contacts on the drop-out. (A.I.E.E. d fintion)

Duty Cycle - The duty cycle is the working time of a device compared to its idle time. A relay having a short duty cycle will have a higher load rating than one having a long or continuous duty cycle.

Duty Relay, Continuous - A continuous duty relay is a relay which may be energized at its maximum operating voltage or current with rated contact load, for an indefinite period without failure and without exceeding its specified temperature requirement.

Duty Relay, Intermittent - An intermittent duty relay is a relay which must have occasional or periodic intervals without contact load and for energization to avoid damage or exceeding its temperature rating.

Duty Relay, Specified - A specified duty relay is a relay which is designed to function with a specified duty cycle but which might not be suitable for other duty cycles.

Electrically Energized - An electromagnetic device is electrically energized upon passing operating current through the coil, but the armature is prevented from moving by some device inserted between the core and the armature.

Electrically Operated - When sufficient current is passed through the coils of an electromagnetic device, so that the armature assumes its normal operated position, it is said to be electrically operated.

Electric Reset - Electric reset is a qualifying term applied to a relay indicating that following an operation its contacts must be reset electrically to their original positions. (A.S.A. definition)

Electromagnetic Relay - Electromagnetic relay is the term used to distinguish a type of relay from other "so-called" relay devices such as piezo-electric, electro-static, thermal types, and induction types.

Electrostatic Spring Shields - Electrostatic spring shields are metallic shields between two relay springs to prevent capacitance effect between them.

Energize - Energize is the application of voltage to a device.

Fast-Operate, Fast Release Relay - A fast-operate, fast release relay is a high-speed relay specifically designed for both fast operate and fast release time.

Fast-Operate Relay - A fast-operate relay is a high-speed relay specifically designed for fast operate time but not fast release time.

Fast-Operate, Slow-Release Relay - A fast-operate, slow-release relay is a relay specifically designed for a fast operate time and slow release time.

Fast-Release Relay - A fast-release relay is a high-speed relay specifically designed for fast release time but not fast-operate time.

Fixed Contacts - Fixed contacts are the relatively immovable contacts of a relay or switch, which are engaged and disengaged by a moving contact to make or break the circuit.

Frame - The frame is the main supporting portion of a relay containing the parts of the magnetic circuit.

Frequency Relay - A frequency relay is one which functions at a predetermined value of frequency. It may be an over-frequency relay, an under-frequency relay, or a combination of both. (A.S.A defintion)

Front Contact - A front contact is a part of a relay against which, when the relay is energized, the current-carrying portion of the movable neutral member is held so as to form a continous path for current. (A.I.E.E. definition)

Gap, Contact - The contact gap is the open contact separation distance.

Gap, Magnetic - The magnetic gap is the non-magnetic portion, such as an air gap, in a magnetic circuit.

General Purpose Relay - A general-purpose relay is one which functions upon application of the operating voltage to the coil and has no special features.

Hand Reset - Hand -reset is a qualifying term applied to a relay indicating that following an operation the contacts must be reset manually to their original positions. (A.S.A. defintion)

Header - A header is the part of a hermetically sealed relay through which the electrical terminals pass. The header is designed to be completely airtight.

Heelpiece - A heelpiece is the part of a relay frame that provides a rigid support for the spring assembly and a means to mount the relay in equipment.

Hermetically Sealed Relay - A hermetically sealed relay is a sealed relay, the sealing of which involves the fusion of insulating material to metal, but does not use a gasket.

High Speed Relay - A high speed relay is a relay specifically designed for high speed operation, release, or both.

Hinge - A hinge is the means by which the armature is attached to the heelpiece.

Hold - A relay is said to hold if, the current through the relay coil is suddenly reduced from the operate to the hold value or is momentarily interrupted, and the armature does not move sufficiently to cause contacts that have been made to become unreliable or to engage contacts that have been broken.

Homing - Homing is a term referring to a stepping relay in which the wipers, upon completion of an operation cycle, are stepped around to the start position.

Housing - Housing is the enclosure for a device.

Hum - Hum is the sound caused by mechanical vibration as a result of alternating current and its fields. The sound is generally twice the alternating current frequency.

Impregnated Coils - Impregnated coils are relay coils which have been impregnated with a phenolic or similar varnish to protect the coils from mechanical vibration and moisture.

Inductive Relay Winding - Inductive Relay Winding is a relay coil consisting of a number of turns of unsulated wire wound in layers on a core. The name "inductive winding" is applied because current flowing through the winding, magnetizes the core and heelpiece of the relay.

Instrument Type Relay - An instrument type relay is a relay, the operation of which depends upon principles employed in electrical measuring instruments such as the induction disc, D'Arsonval, etc. They are sometimes referred to as "contact making meters".

Interlock - An interlock is a device actuated by the operation of some other device with which it is directly associated, to govern succeeding operations of the same or allied devices. (A.I.E.E. definition)

Interlock Relay - An interlock relay is a relay having two coils with their armatures and associated contacts so arranged that if one of the armatures is actuated, it prevents the other armature from being actuated until the first armature returns to its normal position.

Note:- Interlocks may be either electrical or mechanical.

Latch-in Relay - A latch-in relay is a relay having contacts which lock in either the energized or de-energized position until reset either manually or electrically.

Levels - When considering a stepping relay, the term "level" is used to denote one bank or series of contacts. Some stepping relays may have several levels of contacts.

Locking Relay - A locking relay is a relay which renders some other relay or device inoperative under predetermined conditions. (A.I.E.E. definition)

Make - Make is a description of two contacts when they engage or touch, thereby completing an electrical circuit.

Magnetic Freezing - Magnetic freezing is a term used to describe the sticking of a relay armature to the core, upon de-energization, due to the residual magnetism of the core. Residual pins and screws are used to overcome this.

Make-Before-Break - Make-before-break is a system of double throw contacts where the moving contact establishes a new circuit before disrupting the old one.

Marginal - A marginal relay is a relay that functions as a result of a small change in the applied voltage or current, or a marginal relay is a relay which operates and/or releases in response to predetermined changes in value of coil current or voltage.

Mechanical Latch-In - A mechanical latch-in is a device employed on a relay to hold the relay in some position which has been brought about by momentary coil excitation.

Mechanical-locking Relay - A mechanical-locking relay is a relay provided with a spring catch which latches the armature arm when it pulls up. The catch must be operated manually to release the armature. Relays of this type are used primarily for supervision purposes.

Mercury Contact Relay - A mercury contact relay is a relay equipped with contacts enclosed in glass tubes containing mercury. Relays of this type are often used in explosive atmospheres.

Minimum Operate Current - Minimum Operate Current is the minimum current required to actuate a relay armature and open or close the contacts.

Minimum Operate Voltage - The minimum operate voltage is the minimum coil voltage on a relay coil which will actuate the relay armature, thus firmly closing the front contacts.

Note: The minimum operate voltage should be considered only as an approximate value.

Mounting Covers - Mounting Covers are metal covers often provided for relays to protect them from dust, moisture, and gases.

Mounting Plates - Mounting plates are the metal mounting plates used to support large banks of relays.

Multiple Break - Multiple break is the interruption of a circuit in two or more places.

Multiple Stacks - Multiple Stacks is a term used to denote more than one stack or set of contact springs on a relay.

Non-Bridging - Non-bridging is a term referring to a stepping relay in which the wipers leave one contact before touching the next. Thus, successive contacts are not interconnected by the wiper during the stepping operation.

Non-Homing - Non-homing is a term referring to a stepping relay in which the wipers upon completion of an operation cycle, do not return to the home position, but are at rest on the last set of contacts.

Non-Inductive Windings - Non-inductive windings is a type of coil winding composed of two wires soldered together at the inner end and wound semultaneously. The outer ends of the wire form the two coil connections as usual. Since current flows in opposite directions through the two adjacent wires, the magnetic fields cancel each other and provide a non-inductive resistance.

Non-Magnetic Shim - Non-Magnetic shim is a non-magnetic material attached to the armature or core of a relay to prevent iron to iron contact when in the energized position. (Also referred to as non-freeze pin or anti-freeze pin).

Non-Operate - Non-operate is the term applied to a relay if when energized its armature does not move enough to close the front contacts or open the back contacts enough to make circuit contact unreliable.

Non-Snap Action - Non-snap action is the lack of ability of contacts to open and close speedily.

Normal Position - The normal position is theusual position, open or close, of contacts due to spring tension or gravity when the coil is not energized.

Normal Sequence of Operation - All the normally closed contacts operated by a clapper armature, rotary armature, or plunger, open before the normally open contacts of assembly directly associated with that armature, close. This is the normal sequence of operation.

Normally Open - The terms "Normally Open" and "Normally Closed" when applied to a magnetically operated switching device such as a contactor or relay, or to the contacts thereof, signify the position taken when the operating magnet is de-energized. These terms apply only to non-latching types of devices.

Normally Closed - See "Normally Open".

Operate - Operate is the term used to describe the condition of a relay if, when the coil is energized, the armature moves enough to cause the back contacts to open and the front contacts to close and causes the stop pin, or the armature itself, when no stop pins are provided, to touch the core or the separator.

Operate Time - (a) Operate time for a relay having normally open contacts is the total elapsed time from the time the relay coil is energized until the contacts are closed and all contact bounce has ceased.

(b) Operate time for relays having only normally closed contacts is the total elapsed time from the instant the relay coil is energized until the contacts have opened (i.e. the contact current is zero).

Operating Frequency - The operative frequency is the rated frequency at which the relay is designed to operate.

Operating Power - Operating power is the normal power taken by the relay coil at normal operating voltage.

The minimum operating power is the power taken by the coil at the minimum operating current. It may be expressed as a percentage of the normal operating power.

Overcurrent Relay - An overcurrent relay is a current relay which functions when the current through it reaches a predetermined value above the normal rating.

Overload Relay - An overload relay is an overcurrent relay. (A.I.E.E. definition)

Overvoltage Relay - An overvoltage relay is a voltage relay which functions when the voltage reaches a predetermined value above normal.

Pawl - A pawl is a machine element, usually consisting of a pivoted tongue, arranged to engage the teeth of a ratchet to transmit motion in one direction but not in the opposite direction.

Percentage Differential Relay - A percentage differential relay is one which functions when the difference between two quantities of the same nature exceeds a predetermined percentage of one of the quantities. (A.S.A. definition)

Pile-Ups - Pile-ups is a term used to describe a stack, or set of contact springs, placed one on top of the other. (Each spring insulated from the others)

Polarized Relay - A polarized relay is a relay in which the movement of the armature depends upon the direction of the current in the circuit controlling the armature. (A.I.E.E. definition)

Pole, Magnetic - The magnetic poles of a magnet are those portions of the magnet toward which the external magnetizing force tends to converge or diverge. The size and position of the poles of a magnet depend upon its shape and charcteristics. For a long, thin magnet, the poles occupy small regions near the ends, so that for many purposes the poles of such a magnet may be considered as concentrated at points. (A.I.E.E. definition)

Pole, Relay - A relay pole is the portion of a relay structure composing the movable contacts.

Power Relay - A relay which operates on a power greater than 100 milliwatts. Also: A power relay is a relay which functions at a predetermined value of power. It may be an overpower relay, and underpower relay or a combination of both. (A.I.E.E. definition)

Preliminary Make Contacts - Preliminary make contacts are additional relay contacts which serve to open or close certain circuits before others when the relay is operated.

Pick-Up Voltage - (a) Pick-up voltage (or current) of a relay is the minimum value of voltage (or current) at which the relay is designed to complete its function.

(b) When the coil of the relay is to be subjected to a wide temperature range (for instance, from 20°C. to 200°C.) for the purpose of definition of Pull-in or Pick-up, the current rather than voltage shall be stated or specified.

Pull-In or Pick-Up - The pick-up value of a relay is the minimum current, voltage, power, etc. at which its energized function will be completed. (A.I.E.E. definition)

Quarter-Inch Creepage - Quarter-inch creepage is a type of insulation used on relay springs to provide protection against dust and moisture, and providing a creepage path of one-quarter inch over the exposed surface of insulation.

Ratchet Relay - A ratchet relay is a relay requiring a predetermined number of separate impulses to complete its operation cycle.

Rate of Change Relay - A rate-of-change relay is one which functions in accordance with the rate of change of current, voltage, power, etc. (A.S.A definition)

Rated Coil Current - Rated coil current is the steady-state current which flows through the coil when rated voltage is applied.

Rated Voltage - Rated voltage is the voltage at which the relay is designed to operate.

Reclosing Relay - A reclosing relay is one which functions to initiate reclosing a circuit automatically. (A.S.A definition)

Relay - A relay is an electromechanical device which is operated by variation in the conditions of one electric circuit to effect the operation of other devices in the same or other electrical circuits by opening and/or closing contacts the load on which does not exceed 25 amperes at 115 volts, 60 cps, non-reactive.

Relay, Clapper - A clapper relay is a hinged armature type of relay.

Relay, Delay - A delay relay is a relay designed to allow for a time delay between the energizing instant and the time that the relay contacts open or close.

Relay, Instantaneous - An instantaneous relay is a relay which has no intentional delay between the energizing instant and the completion of its operating function.

Relay, Overload - An overload relay is a relay which is designed to operate only when an abnormal amount of current flows in the circuit in which it is placed. It is used generally for the protection of equipment.

Relay, Plunger - A plunger type relay is a relay operated by the energizing of an electromagnetic coil which in turn operates a movable core or plunger by solenoid action.

Relay, Rotary - A rotary relay is a relay employing an armature which rotates within the actuating coil, thus giving a rotary type of motion.

Release - Release is a term used to denote the operation of a relay upon a decrease of magnetic flux to a point where it assumes its normal position. A relay is said to release if, upon the decrease of the actuating current from the hold value to the release value, the armature moves sufficiently to cause the contacts which have been closed, to open and to reliably close the contacts which have been open. For relays without back contacts, the armature need not touch the back stop, but the front contact separation should be sufficient to cause a positive break.

Release Current - The release current is that value of current reached which after the relay has been in the energized position, will allow the armature to be released, causing the normally open contacts to open and the normally closed contacts, to close.

Release Factor - The release factor is the ratio of minimum to normal operating current or the analogous voltage ratio. Release factor is expressed as a percentage.

Release Time - (a) The release time for a relay having normally closed contacts is the total elapsed time between the instant that the coil is de-energized and the time that the normally closed contact closes and all contact bounce has ceased. The release time is usually taken with the same coil voltage as the operate time.

(b) Release time for relays having only normally open contacts is the total elapsed time from the instant the coil is de-energized until the contacts open (i.e. the contact current is zero).

Release Voltage - The release voltage is the voltage applied to a relay, in the operated position, which will permit the armature to start restoring, or chattering in the case of AC relay, and opening the normally open contacts.

Note: Release voltage should only be considered as approximate.

Reliable Contact - A reliable contact is one free of bouncing and fluttering which would interrupt current flow through the contact.

Residual Pins and Screws - Residual pins and screws are non-magnetic pins or screws attached to the armature of a relay to prevent its directly contacting and freezing to the magnetic core. The use of a residual screw provides a means for adjusting the spacing between the armature and the core while the spacing is generally dixed when a residual pin is used.

Residual Setting - Residual Setting is the term used todescribe the spacing adjustment between the armature and relay core for relays equipped with an adjustable residual screw.

Retractile Spring - The spring which, when the relay is de-energized, opens and holds open the armature in the normal position is the retractile spring.

Rotary (or Motor Driven) Type Relay - A rotary (or motor driven) type relay is a relay the operation of which depends upon motor action. The motor may or may not be restricted in its degree of travel. (This relay type does not refer to an armature driven ratchet type relay.)

Self-Cleaning Contacts - A self-cleaning contact is a type of spring and contact construction of such design as to cause the contacts to move through different length arcs, thus wiping against each other and making positive, self-cleaning contact.

Selector Relay - A selector relay is one which permits the selection of one or more circuits from a number of circuits.

Sensitive Contacts - Sensitive contacts are very delicate contacts such as those found in pilot or control apparatus. Sensitive contacts require special care and adjustment.

Sensitive Relay - A sensitive relay is a relay which operates on a power within the range of 1 to 100 milliwatts inclusive.

Sensitivity (Power Sensitivity) -Power sensitivity is the ability of a relay to completely operate on small quantities of power.

Sequence Control - Sequence Control is the automatic control of a series of operations in a predetermined manner.

Sequence Relay - A sequency relay is a relay which is a combination of a selector and a stepping relay, and works its contacts in some predetermined manner, or a sequence relay is one which controls two or more sets of contacts in a defintie predetermined sequence.

Shading Ring - A shading ring is a shorted coil surrounding a portion of the pole of an alternating current magnet, causing a delay of the change of the magnetic flux in that part. Shading rings are used to prevent contact chatter.

Single Break - See "Double Break" for A.I.E.E. definition.

Single Pole - One pole (abbreviated SP) (See "Pole, Relay").

Single Throw - Single throw is an arrangement of contacts providing for the closing of an electrical circuit when in one position and opening the circuit when the contacts are in the other position.

Slow-Operate, Fast-Release Relay - A slow-operate, fast-release relay is a relay specifically designed for slow operate and fast release time.

Slow-Operate Relay - A slow-operate relay is a relay of the slow-speed type, which has been specifically designed for slow operate time but not for slow release time.

Slow-Operate, Slow-Release Relay - A slow-operate, slow-release relay is a slow-speed relay specifically designed for slow operate time and slow release time.

Slow-Release Relay - A slow-release relay is a slow-speed relay specifically designed for slow release time, but not for slow operate time.

Slow-Speed Relay - A slow-speed relay is a relay specifically designed for slow speed of operation, release, or both.

Slug - The slug in a relay is the copper slug or sleeve in line with the iron flux path, to aid in retarding the establishment or decay of flux within the path.

Snap Action - Snap action is the very rapid action of contacts when a relay is energized or de-energized. Action should be rapid enough to extinguish any arc which might be formed, and provide good electrical contact.

Solder-Lug Terminal - A solder-lug terminal is a type of terminal used on some relays, consisting of a flat lug with a hole drilled through it. Wiring is attached by passing the wire through the lug hole and soldering.

Solenoid - A solenoid is an electric conductor wound as a helix with a small pitch, or as two or more coaxial helices. (A.I.E.E. definition)

Special Purpose Relay - A special purpose relay is a relay designed for a specific purpose or application that is not covered by any other type of relay defined in these definitions.

Spring Pile-Up - See "Pile-Up".

Spring Stops - Spring stops are insulated stops on a relay armature which prevent grounding of the lever spring on the frame.

Stepping Relay — (a) A stepping relay is a relay which will select one of a number of circuits as determined by predetermined actuating pulses.

(b) A stepping relay is a relay which requires a predetermined number of separate impulses to complete its cycle of operation. (The Stepping Relay is also called a Rotary Stepping Switch or a Rotary Stepping Relay.)

Switch, Magnetic - A magnetic switch is a relay or contactor.

Telephone Type Relay - A telephone type relay is an armature relay with an end-mounted coil and spring pile-up type contacts mounted parallel to the long axis of the relay coil.

Temperature Relay - A temperature relay is one which functions at a predetermined temperature in the apparatus protected. (A.S.A. definitions)

Tension Spring - A tension spring is the spring used as the retractile spring on relays.

Thermal Type Relay - A thermal type relay is a relay which is operated by the heating effect caused by electric current flow rather than magnetic or induction principles.

Time Delay Relay - A time delay relay is a relay equipped with a retarding means to provide a slow operated or release time, or a time delay relay is one in which a delayed action is purposely introduced.

Timer, Repeating - A repeating timer is a timing device which upon completion of one operating cycle continues to repeat automatically until excitation is removed.

Timing Relay - A timing relay is a form of auxiliary relay used to introduce a definite time delay in the performance of a function. (A.I.E.E. definition)

Totalizing - Totalizing is generally accomplished by a set of one or more switches making individual counts and a totalizing switch. Each individual counting switch upon reaching a predetermined count will send an impulse to the totalizing switch and associated number wheel which iniicated the grand total.

Undercurrent Relay - An undercurrent relay is a relay specifically designed to function when the current through it falls below a predetermined value.

Undervoltage - Undervoltage is less than normal rated voltage. Undervoltage is also used to describe equipment designed to operate when the applied voltage decreases.

Undervolatge relay - An undervoltage relay is a relay designed to function when the voltage falls below a predetermined value.

Very Sensitive Relay - A very sensitive relay is a relay which operates on a power less than 1 milliwatt.

Winding - A relay winding is a coil consisting of turns of wire which provide the relay magnetic field.

Wiper - A wiper or brush is that portion of a moving member of a selector, or other similar device, which makes contact with the terminals of a bank. (A.I.E.E. definition)
When applied to relays, wipers are generally associated with relay operated stepping switches.

TEST CODE FOR RELAYS

Purpose

This code contains instructions for conducting the more generally applicable and acceptable tests to determine the performance characteristics by conforming with the relay Standards of NARM. It is not intended that the code shall cover all possible tests, or tests of a research nature, but only those more general methods which may be used to obtain performance data.

Scope

This code covers Performance Tests for relays, as defined in the Relay Standards of NARM.

Sampling Procedure

The samples used for Relay Test Code approval shall be representative of the manufacturer's normal production and shall be taken, preferably, from the production lines. If more than 100 relays of the same general construction are produced during a week, the manufacturer shall take one (1) relay from each 100 until a sufficient number has been obtained for tests described herein and, if approved, only one relay shall be tested per additional 1000 relays produced, to insure uniformity of production. In event the maker wishes to have approved relays in stock, but not in current production, he shall provide only the necessary number of samples, provided that he presents satisfactory proof that these samples are truly representative of the entire stock. In case of production in very small quantities, the maker shall provide only sufficient relays required for tests.

1. STANDARD TEST CONDITIONS

Unless other wise specified, the ambient temperature shall be 25°C ± 5°C (25°C being used as reference). Where phrase "room temperature" is used in connection with relay test conditions, 25°C is intended.

1.2 Elevation - The standard elevation shall be taken as sea level. For other elevations the following applies: "The reduced air density at high altitudes gives an increased temperature rise for self-ventilated machines, which should be allowed for when machines are to be operated at altitudes more than 3300 feet above sea level...For machines cooled principally by radiation, the additional rise may be as low as 0.2 percent for each 330 feet of additional altitude." Standards of the AIEE, No. 1, Jn., '40.

1.3 Relative Humidity - Unless otherwise specified, the relative humidity shall be taken as 40 to 60 per cent.

2. INSPECTION

2.1 Visual and Mechanical Inspection - The relay shall be inspected for completeness of construction and marking and to verify that the workmanship, weight, dimensions and finish are in accordance with the makers' claims and that the relay is in good mechanical working order.

3.1 Contact Bounce - The relay shall be tested to determine duration of contact bounce by comparison with a timing wave on a recorded chart of a Dumont Type 304-H Cathode Ray Oscillograph, or equivalent means.

MIL-R-5757B
Par. 4.6.5.4 Contact Bounce - Relays shall be tested to determine contact bounce. The method of test may be by comparing the number of makesand breaks with the timing wave on the recorded chart of a G.E. Model PM-10-A1 oscillograph or equivalent means.

Remarks

General discussion of above subject was held. Mr. K.B, Austin and Mr. R.D. Bean agreed to submit a general discussion in writing based on their recent experiences with military applications.

It was pointed out that the term "Contact Bounce" was much too general and loosely defined. For instance, some cases arise where contacts never actually separate but variations in contact pressure cause fluctuations in contact resistance. The question then arises as to whether this is or is not contact bounce.

It was felt by some that use of term "equivalent means" should be more definite, i.e., instruments should have equivalent sensitivity, frequency response, sweep frequency, etc. The opinion was expressed that a record of the test was unnecessary except where it was specifically requested.

The duration of contact bounce, in many instances, is not the important factor. It has been the experience of some manufacturers who have worked out various relay application (primarily on military equipment) problems, that at least four items need to be considered. These are:

1. Total bounce time
2. The time duration of the maximum closed period during bounce
3. Actual integration of (2) with succeeding bounces
4. Integration to determine area under curve where contact is never broken but the resistance varies.

The foregoing were the main points discussed in addition to other relatively minor items such as use of terms "chatter" and "hash" in connection with contact bounce.

It was agreed the subject was much more complex and required more consideration than it had been given in the past.

3.2 Contact Pressure - Contact pressure shall be measured by means of a gram gage or comparable means at a position in line with the center and normal to the length of the arm. Where this is not practical, measure the contact pressure as near the contact as possible, or under a tab or projection provided for that prupose. In some instances the use of a gram gage is impossible. The contact pressure may then be determined by measuring the contact deflection and, by knowing spring constants for the contact-arm material, the contact pressure may be calculated.

Indication of opening of contacts may be obtained by use of any suitable indicator such as a 6 volt light in series with the contact.

3.3 Contact Millivolt Drop - The millivolt drop shall be measured at the contact terminals while the contacts are carrying rated non-reactive current. The millivolt drop shall conform with Relay Standards.

MIL - R-5757B
par 4.6.5.3 Contact resistance - Contact resistance shall be determined at rated current of the contacts, using the voltmeter - ammeter method, Kelvin bridge, or other equivalent means. The maximum circuit voltage shall not exceed 6 volts D.C. except when a higher voltage is necessary to pass rated current through the contacts.

* The millivolt drop shall be measured at the contact terminals with one ampere current flow through the contacts. Care should be exercised to not measure the resistances of current carrying leads.

Remarks

Some resistance-measuring devices such as bridges (as an example, Kelvin Double Bridge) and ohmmeters use very low values of voltage. Very often insufficient potential exists to penetrate contact surface film. Therefore, results of successive measurements may be inconsistent.

There are certain low level relay applications where the contact millivolt drop or resistance needs to be determined at current values less than one ampere. Data are not available at this time to establish any definite limits on operation levels which necessitate such special measurements. The vast majority of relay applications are such that measurements made with a one ampere current flow will be satisfactory.

3.4 Inter-Contact and Contact-to-Ground Capacitance- The capacitance between contacts and from contacts to ground shall be measured by means of a capacitance bridge such as General Radio, R.F. Capacitance Meter, Type 1612-AL or its equivalent.

4. INSULATION

4.1 Dielectric Strength - The dielectric strength shall be determined by applying a voltage which is increased at a uniform rate from zero to the breakdown value. The frequency of test voltage shall be 60 c.p.s. The potential shall be applied between mutually insulated terminals, between coil and core, and between contacts and relay frame (or case).

MIL-R-6106

4.5.2 Insulation - A potential of 1000 volts rms at commercial frequency shall be applied between terminals and between terminals and grounded metal posts for a period of 60 seconds. There shall be no failure as a result of this test.

MIL-R-5757B

4.6.3 Dielectric strength. The relay shall be subjected as specified in 4.6.3.1 and 4.6.3.2, to a potential of commercial line frequency for 1 minute ± 5 seconds during the qualification testing, and for not less than 5 seconds nor more than 1 minute during inspection testing. The specified potential shall be applied to mutually insulated terminals, between coil and core, and between contacts and case or frame. For qualification tests, test voltages shall be applied gradually at a rate not exceeding 700 volts per second. For inspection tests, the test voltage may be applied instantaneously at the option of the manufacturer.

Remarks

Disagreement exists amoung manufacturers as to the value of testing to break-down values. Some feel that simply determining the insulation will withstand a reasonable voltage is sufficient while others hold it is very difficult to know what voltages may be encountered. As an example, take the case of contacts operating in an inductive circuit. When the circuit is opened, exceptionaly high voltages may appear across the contacts. If relays are tested to break-down this value may be given to relay users and the responsibility of determining a relays suitability rests entirely with circuit designers.

Other factors are of primary importance, such as, wave shape of applied voltage, sensitivity of detector, and regulation of source.

The idea was advanced that two tests might be the answer, one a destructive test and the other simply a proof test the relay insulation will withstand a reasonable voltage.

General agreement was reached that a solution of this problem might rest on simply selecting one of the commercially available test sets which has desirable characteristics to use in performing this test. Other test sets which are equivalent to the named test device in all the above mentioned pertinent features may also be used.

4.2 Insulation Resistance - The insulation resistance shall be measured between mutually insulated parts by use of a megohm bridge or equivalent means. The results shall comply with Relay Standards.

MIL-R-5757-B

4.6.4 Insulation Resistance - The insulation resistance shall be measured between mutually insulated parts by means of a megohm bridge or other approved method, at a direct-current potential of 100 volts.

* The insulation resistance shall be measured between mutually insulated parts by use of megohm bridge or equivalent means.

Remarks

In paragraphs 4.2 and 4.1 it seemed desirable to specify a commercially available instrument for conducting the test. In this particular case (4.2) the General Radio Type 544-B Megohm Bridge seemed to fit the requirements.

5. SEALING (Applicable to Sealed Relays only)

5.1 Leakage Test - Sealed relays shall be immersed in tap water for a period of one (1) hour with the pressure of the enclosure above the solution equal to 2.5 inches of mercury, absolute pressure. During this period (1 hour) the relay shall be observed for evidence of leakage indicated by bubbles emanating from the relay case. The relay shall then be subjected to the Dielectric Stress tests, the results of which shall meet Relay Standards requirements.

MIL-E-5272

6.2.3 Hermetically Sealed - Hermetically sealed enclosure is one, the walls of which are glass, glazed ceramic, or metal and the closure of which is a fused joint of the appropriate material which so seals the enclosure that it shall not breathe under any combination of environmental conditions.

MIL-R-6106

3.2.3.2 Sealed - When specified in the detail specification or drawing, the relay mechanism shall be filled with a suitable gas or blend of gases and sealed, at existing atmospheric pressure or greater, in such a manner that no leakage shall occur when tested as specified herein.

MIL-R-6518

4.3.2.5 Gas leakage. - The leakage of the pressurizing gas from the sealed container of each relay shall be determined by the Mass Spectrometer method of leak detection. The leakage shall not exceed the value specified herein.

MIL-R-6518

3.13 Container - The entire relay assembly shall be enclosed in a leak proof corrosion-resistant metal container and pressurized with an inert gas or blend of gases containing not less than 10 percent heluim by volume to a pressure greater than sea level atmospheric. Leakage of the pressurizing gas shall not exceed one micron cubic foot perhour. The exterior of the sealed container shall be suitably protected from corrosion in a salt fog atmosphere by painting and/or plating as required.

MIL-R-5757B

1.2.1.4 Enclosure - The enclosure is identified by a single number in accordance with table III

Table III.- Enclosure

Symbol	Type of Enclosure
1.	.Open.
2.	.Enclosed (but not sealed).
3.	.Sealed.

3.3 Material. - The material for each part shall be as specified herein. When a definite material is not specified, a suitable material shall be used. Only noncombustible, nongassing, and low-vapor pressure materials

Sealing, Cont'd.

shall be used in the construction of sealed relays. Acceptance or approval of any constitutent material shall not be construed as a guaranty of acceptance of the finished product.

3.5 Sealing (applicable to sealed relays only). - The term "sealed" is construed to cover all methods of sealing; namely, vacuum, atmospheric, and pressurized with air or inert gas. When tested as specified in 4.6.2, the sealed relays shall show no evidence of leakage.

4.6.2.1.1.1 Nondestructive - Relays shall be immersed in a saturated solution of sodiom chloride and shall be subjected to an absolute pressure equal to 2.5 inches of mercury for 4 hours. The immersed relay shall be observed for evidence of leakage indicated by bubbles emanating from the case.

4.6.2.1.1.2 Destructive - Relays shall be immersed in a saturated solution of sodium chloride and shall be subjected to an absolute pressure equal to 2.5 inches of mercury for 4 hours and then returned to normal. After 4 hours at normal pressure, relays shall be removed from the case and examined for any evidence of leakage.

Remarks

It was agreed that this section should be deferred for study at a later time.

6. OPERATE AND RELEASE VALUES

6.1 By means of an auto-transformer or potentiometer a low voltage of rated frequency (or D.C.) shall be applied to the relay and the voltage slowly and continuously increased until the armature pulls-in, and in the case of an AC relay, all chatter has ceased. The average of five such successive measured values of voltage (or current) shall be termed the minimum operate voltage (or current). The relay should be cycled several times, at rated voltage, prior to the test in order to eliminate any effects due to residual magnetizm.

6.2 Maximum Release Voltage - This test shall be conducted in a similar fashion to (6.1) with drop-out values of voltage (or current) substituted for pull-in values.

Maximum operating voltage should be applied to the relay coil by means of an auto-transformer or potentiomenter and the voltage slowly and continuously reduced until the armature drops-out to its de-energized position, and in the case of an AC relay, all chatter has ceased. The relay should be cycled several times, at rated voltage, prior to the test in order to eliminate any effects due to residual magnetism.

7. RELAY COIL TESTS

7.1 Cold Coil Current - The rated operating voltage at rated frequency (or DC) shall be applied and the r.m.s. value of coil current measured by ammeter of proper range within thirty seconds.

Hot Coil Current - The rated operating voltage at rated frequency (or DC) shall be applied and the r.m.s. value of coil current measured while the relay is at its maximum operating temperature.

Repeat the Cold Coil Current and Hot Coil Current Test using maximum operating voltage instead of rated voltage.

7.2 Coil Resistance - Direct-current coil resistance. The coil resistance shall be measured by any suitable means.

7.3 Rated Operate Power or V.A.- The value of resistance as determined in (7.2) multiplied by the square of the hot coil current as determined in (7.1) shall constitute the rated operate power.

The product of rated voltage and hot coil current as determined in (7.1) shall constitute the rated volt-amperes.

7.4 Temperature Rise - In any continuous-duty relay the maximum temperature experienced in operation shall not exceed the maximum allowable temperature rises as in Relay Standards.

MIL-R-6106

4.5.9.1 Coil Temperature Rise and Contact Drop. - The relay shall be suspended in still air by a non-heat-conducting material attached to the mounting base so that the relay is no closer than one foot from any heat-conducting surfaces. The relay shall be subjected to rated resistive load with the applicable size cable of 6-foot lengths, in accordance with Specification AN-J-C-48 and applicable terminals conforming to Drawing AN659. The maximum operating voltage shall be applied to the coil terminals for a period of 3 hours on the continuous duty coils and 1-1/2 minutes on the intermittent duty coils. The temperature rise of the coil shall not exceed 95°C as measured by the resistance method, and the drop across the contacts shall not exceed 0.1 volt during this period with maximum operating voltage on the coil and rated resistive load through the contacts. Immediately after this test, the relay shall be subjected to the tests specified for "Pick-Up Voltage" and "Drop-Out Voltage," and shall meet the requirements specified therein.

* Temperature Rise - The relay shall be suspended in still air by a non-heat-conducting material attached to the mounting base so the relay is no closer than one foot from any heat conducting surface. The relay contacts shall be subjected to rated resistive load, and maximum operating voltage shall be applied to the coil terminals for a period of three hours on the continuous duty coils. The coil temperature rise shall then be measured by the resistance method.

Remarks

Discussion was held on advisability of having two temperature rise tests; one using rated voltage and the other using maximum voltage. No conclusions were reached.

Intermittent and continuous duty relays must be clearly defined.

Provision in the above is made for finding the coil temperature rise and in many instances the contact temperature rise and the terminal temperature rise should also be determined.

8. OPERATE AND RELEASE TIME

8.1 Operate Time - The operate time may be determined by the same test as contact bounce (3.1). An oscilloscope with suitable fast camera or other equivalent means may be used. The operate time shall include time of contact bounce.

MIL-R-5757B
4.6.5.7 Operating and releasing time. Relays shall be tested for operating and releasing time. The circuit shown on figure 2 or other suitable methods may be used.

Remarks

Complete and specific understanding of this item hinges upon nomenclature and terms used in test for contact bounce. A satisfactory test circuit and equipment list should be given. Illustrations might possibly be included. Be specific about items that are of prime importance when "an equivalent means" is used.

8.2 Release Time - The release time shall be determined by the same procedure as for operate time, except that the voltage recording galvanometer element shall be disconnected because the coil would discharge through this circuit.

MIL-R-5757B
par. 4.6.5.7 Operating and releasing time.- Relays shall be tested for operating and releasing time. The circuit shown on figure 2 or other suitable methods may be used.

Remarks

Ideas expressed for operate-time test apply here.

9. VIBRATION

9.1 Operated Vibration Test - With the relay energized, the NO contacts closed and the NC contacts open, it shall be subjected to a simple harmonic motion with an amplitude of 0.03 inches (total excursion 0.06 inches) at a frequency which is varied uniformly from 10 to 55 cycles per second. The test shall be conducted with the direction of vibration on successive tests being parallel with three mutually perpendicular axes. The number of g's acceleration shall be calculated for the minimum frequency at which the closed contacts open or the open contacts close, either permanently or momentarily, according to the equation $g = .0511\ DF^2$, where D is the total excursion in inches and F is the frequency in cycles per second.

MIL-R-5757-B - Preliminary superceding MIL-R-5757-A superceding MIL-R-5757

4.6.8 Vibration.- Relays shall be rigidly mounted in normal orientation on the vibration platform. A simple harmonic motion having an amplitude of 0.03 inch (0.06-inch maximum total excursion) shall be applied, the frequency being varied uniformly between the approximate limit of 10 and 55 cycles per second. The entire range of frequencies and return shall be traversed in not less than 1 minute but not more than 2 minutes. The vibration shall be for 2 hours in each of three mutually perpendicular directions. An oscillograph shall be used to check opening or closing of contacts during the test. Measurements of millivolt drop and contact resistance, d.c. coil resistance, and contact alinement shall be made at the end of the test. (See 3.11.)

3.11 Vibration.- When tested as specified in 4.6.8 the normally open contacts shall close and remain closed when the coil is energized, but shall remain open when the coil is deenergized. Normally closed contacts shall open and remain open when the coil is energized but shall remain closed when the coil is deenergized. Momentary opening or closing of contacts during this test will be permissible. Following the vibration test the requirements for millivolt drop and contact resistance, and d.c. coil resistance shall be met as specified in 3.8.5 and 3.8.8, respectively. There shall be no misalinement of contacts or loosening of parts as a result of this test.

MIL-R-6466

Refer to par. 4.3.3.2.5, also Procedure III of MIL-E-5272, par. 4.7.3

MIL-R-6742

F-5e (2). Vibration. - The relay shall be subjected to vibration consisting of simple harmonic motion, having an amplitude of approximately 0.03 of an inch (maximum total excursion of 0.06 of an inch) and a frequency varied uniformly between the approximate limits of 10 to 55 cycles per second. The entire cycle of frequencies shall be accomplished in approximately 1 to 10 minutes. The relay shall be mounted in the position most likely to cause malfunctioning and vibrated continuously for a period of three hours. If mounting in more than one position is considered likely to cause malfunctioning, the relay shall be vibrated for three hours in each likely position. A test lamp or other suitable indicating device shall be connected across the contacts during the test. During this test, the relay shall operate with the specified pick-up voltage across the coil and shall remain in the energized position when the voltage is reduced to 1/2 of the pick-up voltage. The contacts shall remain in the de-energized position with no voltage across the coil. There shall be no mechanical failure.

No. 41065-B (USAF)
Refer to par. 4.8

MIL-E-5272
Refer to par. 4.7, 4.7.1-4.7.9

MIL-R-6518
4.2.3.5 Vibration. - The relay assembly shall be subjected to vibration frequencies from 6000 to 15,000 cpm and amplitudes not to exceed 0.002 inch total excursion. During this vibration range, there shall be no malfunctioning, inadvertent operation, other signs of failure of the relay assembly. The relay shall then be subjected to vibration frequencies of 9000 cpm and amplitude of 0.002 inch for 6 hours. Following this test the relay shall be shock mounted with appropriate sized vibration dampers. The shock mounted relays shall be subjected to a vibration frequency varying 5 to 55 cps at an amplitude of 0.60 inch for a period of 6 hours. Following these tests, the relay assembly shall be operated for 100 cycles as specified for Life cycle.

MIL-R-6106
4.5.10.2 - Same as par. F-5e (2) of MIL-R-6742

Remarks

It was agreed that this section should be deferred for study at a later date.

9.2 Unoperated Vibration Test - This test shall be identical to the operated test, except the relay shall be deenergized with the NC contacts closed and the NO contacts open. The minimum number of g's acceleration shall be calculated for the frequency at which the NC contacts open or the NO contacts close, either permanently or momentarily.

Remarks

It was agreed that this section should be deferred for study at a later time.

9.3 Performance Rating - The relay vibration performance rating in g's shall be the lesser of the two values determined from the operated and unoperated test (9.1 and 9.2), and shall conform with requirements of Relay Standards. In addition, the relay shall show no visible signs of electrical or mechanical failure.

Remarks

It was agreed that this section should be deferred for study at a later time.

10. SHOCK

10.1 Operated Shock Test - With the relay energized and its NO contacts closed and its NC contacts open, it shall be mounted on the carriage of a standard drop-type shock testing machine and dropped from successively higher elevations, beginning with a low value and increasing in small steps until the drop height is reached at which the NO contacts open or the NC contacts close, either permanently or momentarily. The test shall be performed with the relay mounted by its normal method of mounting in each of two mutually perpendicular planes.

MIL-R5757 (USAF) -

4.5.2.2.2 Shock. The relay shall be mounted by the normal method in each of the three mutually perpendicular planes, in turn, and sugjected to a transient decelerating force produced by dropping the assembly through a sufficient height such that when decelerated by resilient impact, a deceleration of 50 gravity units shall be obtained for 10 milliseconds. The relay shall be subjected to a total of 30 impact shocks, 10 in each plane. The reference operating voltage shall be applied across the coil of the relay to close the normally open contacts. During impact, the contacts shall remain sufficiently closed so that a sensitive relay having a drop-out time of two milliseconds will remain energized and so that the sensitive relay contacts do not open when placed in series with the contacts of the relay on test. This test shall be repeated for the normally closed contact relay with no voltage across the coil. The relay with normally open contacts shall remain sufficiently open with no voltage across the coil, or the relay with normally closed contacts shall remain sufficiently closed with maximum operating voltage across the coil so that a sensitive relay with a 10-millisecond pick-up value will not be energized during impact or the relay on test, under the same conditions. Shock test as covered by Specification No. 7201 is a suitable test method. Measurements for direct-current resistance and dielectric stress of the coil shall be made at the end of this test.

MIL-R-5757A (USAF)

4.3.3.15 Shock. - The relay shall be mounted by the normal method in each of the three mutually perpendicular planes and subjected to an accelerating force produced by dropping the assembly through a sufficient height such that when decelerated by a resilient impact, a deceleration will occur equivalent to 30 Gravity units for 10 milliseconds; 40 gravity units for 10 milliseconds or 50 gravity units for 10 milliseconds depending on the class for which the relay is designed. An oscilloscope shall be used to indicate chattering or bouncing of contacts. The relay shall be tested with coil energized with rated coil voltage and with no voltage applied. The normally open contacts shall be connected in parallel, and the normally closed contacts connected in series when the coil is de-energized and vice versa when coil is energized. The relay shall be subjected to 5 impact shocks test method. The relay shall not chatter during this test. Measurements for insulation resistance and dielectric strength shall be made at the end of this test. Three shock tests of 175G at 3 milliseconds duration shall be applied, one in each plane to determine mechanical failure of relay. No electrical or mechanical damage shall occur as a result of this test.

MIL-E-5272 - ENVIRONMENTAL TESTING
Refer to: par. 4.15 Shock Tests

MIL-R-5757-B Preliminary
Refers to MIL-S-901

MIL-R-6742

F-5e (1). Shock.- The relay shall be secured to a sufficient mass in each one of its rectangular positions, in turn, and subjected to a transient decelerating force produced by dropping the assembly through a sufficient height such that when decelerated by resilient impact, a deceleration of 25 gravity units shall be obtained. The relay shall be checked, first with no voltage across the coil and then with the maximum operating voltage across the coil to determine the ability of the contacts to remain in the proper position under impact. When the contacts of the relay being tested are in the open position they shall remain sufficiently open so that a sensitive relay with a 10 millisecond pick-up value will not be energized. When the contacts of the relay being tested are in the closed position they shall remain sufficiently closed so that a Sensitive relay with a 2 millisecond drop-out time will remain in the energized position. The shock mechanism in accordance with Specification JAN-S-44, altered for relay mounting, is suitable for conducting the test.

MIL-R-6518 (USAF)
par. 4.2.3.6
Refers to MIL-E-5272

MIL-R-6106

4.5.10.1 Shock.- The relay shall be secured to a sufficient mass in each one of its rectangular positions, in turn, and subjected to a transient decelerating force produced by dropping the assembly through a sufficient height such that when decelerated by resilient impact, a deceleration of 25g shall be obtained. The relay shall be checked, first with no voltage across the coil and then with the maximum operating voltage across the coil, to determine the ability of the contacts to remain in the proper position under impact. When the contacts of the relay being tested are in the open position, they shall remain sufficiently open so that a sensitive relay with a 10 millisecond pick-up value will not be energized. When the contacts of the relay being tested are in the closed position, they shall remain sufficiently closed so that a sensitive relay with a 2 millisecond drop-out time will remain in the energized position. The shock mechanism in accordance with Specification JAN-S-44, altered for relay mounting, is suitable for conducting the test.

Remarks

It was agreed that this section should be deferred for study at a later time.

10.2 Unoperated Shock Test - The unoperated test method shall be identical with the operated test method except the relay shall be de-energized, the NO contacts being open and the NC contacts being closed.

Remarks

It was agreed that this section should be deferred for study at a later time.

10.3 Shock Rating - Both the operated test (10.1) and the unoperated test (10.2) shall be repeated four times. The miniumu value of drop-distance from these tests converted into g's at which faulty contact opening or closing occurs shall be the relay shock performance rating and shall conform to minimum limits as stated in Relay Standards.

Remarks

It was agreed that this section should be deferred for study at a later time.

10.4 ACCELERATION

MIL-E-5272
Refer to par. 4.16, 4.16.1, 4.16.2

MIL-R-6742
F-5e (3). Acceleration.- The relay shall be subjected to an acceleration force of 10 gravity units. The time required to attain the 10 gravity units acceleration shall not be more than two seconds. The relay shall be mounted in the position most likely to cause malfunctioning and shall be accelerated for a minimum of one minute. During this test, the contacts of the relay shall remain in the de-energized position with no voltage across the coil and shall remain in the energized position when the coil voltage is reduced from the specified pick-up voltage to 1/2 of the specified pick-up voltage. A test lamp or other indicating device shall be connected across the contacts while the relay is undergoing this test to determine the ability of the contacts to remain in the proper position.

No. 41065-B (USAF)
Refer to par. 4.16

MIL-R-6518
par 4.2.3.7 Refers to MIL-E-5272 - Procedure II

MIL-R-6106
par. 4.5.10.3 Same as MIL-R-6742 - par F-5e (3)

Remarks

It was agreed that this section should be deferred for study at a later time.

11. TERMINAL STRENGTH

11.1 Plug-In (socket type) Terminals - Each pin of the relay shall be subjected to a five pound pull along the longitudinal axis of the pin. This applied pull shall be started at zero and increased uniformly to five pounds in a time not in excess of thirty seconds. This five pound pull shall then be held constant for not less than ten additional seconds and not more than thirty additional seconds.

11.2 Solder Terminals - Each solder terminal shall be given a five pound pull in any direction. Loading procedure and duration of maximum load shall be in accordance with 11.1

11.3 Screw Terminals - For No. 8 screw sizes or larger, a twenty-five pound pull shall be applied to each terminal in any direction. For screw sizes smaller than No.8, a five pound pull shall be applied to each terminal in any direction. The application and duration of load shall be in accordance with 11.1.

MIL-R-5757B

4.6.6.2 Torque - Terminals with external screw threads shall be subjected to the torque listed below, as applicable:

Screw Size	Torque (pound-inches)
4-40	4.4
6-32	8.5
8-32	16.5
10-32	32
10-24	35

Remarks

Combine 11.3 and MIL-R-5757B, para. 4.6.6.2.

12. CONTACT OVERLOAD

12.1 Continuous Duty Relays - A non-reactive load current at 60 c.p.s. frequency or DC of 125 percent rated contact load current shall be passed through the relay contacts. The relay shall be energized 0.2 seconds and deenergized 0.3 seconds. The relay shall be operated a total of one per cent of total operations as determined from life test; the minimum number of test operations shall not be less than 100. The contact voltage shall be the rated value. This test shall then be repeated with direct current as contact current. An incandescent lamp load is not a proper load to use for non-reactive load tests because the current inrush to the lamps may be from ten to twenty times the steady-state current.

12.1.1 Overload - Relays shall be actuated by maximum operating voltage for 100 cycles. At the completion of this cycling, contact resistance shall be measured.

12.1.2 Resistive - When the load is specified as resistive the contact shall make and break four times their rated resistive load current at a rate of 20 to 30 cycles per minute.

12.1.3 Inductive - When the load is specified as inductive the contact shall make and break three times rated inductive load current, at a rate of 20 to 30 cycles per minute.

12.1.4 Lamp Load - When the load is specified as tungsten lamp load, the contacts shall make and break the rated load current at a rate of two to three times a minute.

12.2 Intermittent Duty Relays - This test shall be the same as 12.1, except the cycle of energization shall follow the rated duty cycle of the relay.

13. CORROSION AND HUMIDITY

13.1 Corrosion Resistance - The relay shall be immersed in a saturated solution of solium chloride (NaCl) for a period of one hour. The relay shall then be removed and without drying, let it stand for an additional time of eleven hours.

13.2 Humidity Resistance

MIL-R-6106

4.5.7.4 Humidity Cycling. - Humidity cycling shall be in accordance with method 31 of Specification 41065 for a period of 10 cycles. During the cycling test a potential of 150 volts rms at commercial frequency shall be applied between the terminals and other exposed metal parts. The current leakage shall not be in excess of 0.1 amp 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 57°C. Immediately after drying, the relay shall be subjected to and shall satisfactorily meet the requirements for "Pick-Up Voltage," "Drop-Out Voltage," and "Insulation" and shall satisfactorily operate for 1/10 of the minimum operating cycles specified at rated resistive load and maximum operating voltage without sticking or welding of the contacts. This test is not applicable to sealed relays.

Remarks

This test was considered to be unsatisfactory and further material should be submitted.

14. LIFE TEST

14.1 Test Procedure - With rated voltage at rated frequency (or DC) applied to the relay, the relay shall be operated on a cycle of energization as in 12.1 or 12.2, depending on the rated duty cycle of the relay. The test shall be terminated when the contacts and armature cease to operate properly, whichever occurs first.

MIL-R-5757B

4.6.14 Life - All contacts of the relays shall be subjected to the operating voltage specified at rated contact load for at least 100,000 operations (see 3.20) at a rate of 10 to 12 cycles per minute. On and off periods shall be approximately the same. Circuits shall simulate normal application characteristics insofar as practicable with respect to impedance of the voltage source and surges produced in relay coils. Following the test, insulation resistance and electrical characteristics shall be determined. (see 3.17).

Remarks

14.1 Cannot be used in view of opinions expressed concerning 12.1 and 12.2.

General opinions were expressed that in the past life test procedures were not detailed and specific. An exact specification as in 4.6.14 above has some merit. Such facts as procedure, what determines end point of life tests, etc. need to be included.

15. HIGH TEMPERATURE

MIL-R-6106

4.5.7.1 High Temperature - The relay shall be subjected to a temperature of 70°C or hotter for a minimum period of 16 hours. At the completion of the 16-hour period and with the relay at this temperature, the relay shall be subjected to the tests specified for "Pick-Up Voltage," "Drop-Out Voltage", and "Insulation", and shall meet the requirements specified therein. The relay shall then be tested intermittently for pick-up and drop-out voltage, until it attains a temperature of 20° to 30°C. The voltage characteristics during this test shall be in accordance with the applicable voltages specified for "Pick-Up Voltage" and "Drop-Out Voltage."

Remarks

It was suggested that more complete details should be specified or made available on the type of oven or enclosure which could be used to perform the above test. The question of constant temperature in all parts of the enclosure (or oven) was discussed.

16. LOW TEMPERATURE

MIL-R-6106

4.5.7.2 Low Temperature.- The relay shall be subjected to a temperature of -55°C or colder for a minimum period of 16 hours. At the end of the 16-hour period and with the relay at this temperature, the relay shall be subjected to the tests specified for "Pick-Up Voltage," "Drop-Out Voltage," and "Coil Current." The relay shall meet the requirements specified for "Pick-Up Voltage" and "drop-Out Voltage." The "Coil Current" shall not exceed 1-1/2 times the actual coil current, at maximum operating voltage. (These tests shall be accomplished in the sequence listed in a minimum amount of time to prevent excessive heating of the coil). The relay shall then be tested intermittently for pick-up and drop-out voltages until it attains room temperature. The voltage characteristics after this test shall be in accordance with the applicable voltages specified for "Pick-Up Voltage" and "Drop-Out Voltage."

Remarks

As with the previous section, the type of enclosure for making the test should be more fully outlined.

End of discussion at meeting in N.Y.C. Nov. 1952

17. CORONA

MIL-R-5757A

4.3.3.7 Corona.- Relays having coils or contacts rated at 400 peak volts or higher shall be tested for corona. The relay case shall be isolated from ground by an r-f inductor of at least 20 millihenries inductance for test power at 60 cps or correspondingly lower inductance at higher test frequencies. Voltage across the r-f Inductor shall be coupled to a corona detector which shall be either an oscilloscope having a sensitivity of not over 0.1 peak volt per inch up to at least 200 kilocycles per second, or a radio receiver having a sensitivity of not over 25 microvolts in the 500-1500 kc/sec band. Noise limiting and narrow band filtering circuits in the receiver shall be disabled. A corona-free power frequency test voltage of approximately 150 percent of reference value shall be applied to the relay. A suitable noise-free source of voltage and test location shall be used. There shall be no corona indicated for pressure altitudes from room ambient to 1.3 inches of mercury.

18. TEMPERATURE CYCLING

MIL-R-5757A

4.3.3.14 Temperature Cycling.- Relays shall be subjected to the temperature cycle shown in Table II for a total of five cycles performed continuously. The relays may be transferred from one chamber to another for the temperature changes. During the last cycle, pull-in voltage and drop-out voltage shall be measured upon completion of the high-temperature step and upon completion of the cold-temperature step. The temperature of the chamber shall stay within ±5 degrees Centigrade. The test can be interrupted for 24 hours after step 4 but not in between steps 1 and 4.

TABLE II

TEMPERATURE CYCLE

Step	Time	Temperature of Test Chamber
1.	Not less than 30 minutes	At +85°C, +125°C or 200°C whichever temperature the relay is designed for, non-operating.
2.	Not more than 5 minutes	At room conditions, non-operating.
3.	Not less than 30 minutes	At -55°C or -65°C whichever temperature range the relay is designed for, non-operating.
4.	Not more than 5 minutes	At room conditions non-operating. End of one cycle.

19. ALTITUDE TEST

MIL-R 6742

F-5d (3) Altitude Operation.- The relay shall be subjected to the Maximum Operating Voltage across the coil with Rated Load through the contacts at a pressure equivalent of 50,000 feet, ±2,000 feet, for the Minimum Operating Period. Immediately after this period and with the relay at the specified pressure, it shall be subjected to the test specified for "Insulation", except that the voltage shall be 750 volts root mean square. There shall be no failure as a result of this test.

20. INDUCTIVE LOAD

MIL-R-6742

F-5d (5). Inductive Load - (120 Volt D.C. Relays Only). - The relay shall be subjected to 1/10 of the Minimum Operating Cycles at a pressure equivalent of 50,000 feet ± 2,000 feet, at Maximum Operating Voltage and Rated Inductive Load consisting of the proper inductor or inductors shown on AN3179. The minimum "on" period shall be 1/2 second and the maximum "off"period shall be 2-1/2 seconds. The complete test shall be conducted without mechanical or electrical failure of the relay and at the completion of the test, the relay shall be subjected to and shall satisfactorily pass the test specified for "Insulation".

21. SAND AND DUST

MIL-R-6742

F-5b (3). Sand and Dust.- The relay shall be subjected to a sand laden air stream test in accordance with the following conditions:

1. The sand used shall be 4 pounds of foundry moulding sand which passes through a 150-mesh screen.

2. The sand streams shall not impinge directly upon the relay and the flow of sand shall be approximately 2.5 pounds per hour. The duration of the test shall be 5 hours.

3. The ambient temperature in the chamber shall be maintained within the range of 50 to 60°C (122 to 140°F)

F-5b (3)a. After being subjected to the sand and dust test and immediately after the relay has attained a room temperature of 20 to 30°C (68 to 86°F) it shall satisfactorily pass the tests specified herein for "Pick-UP Voltage" and "Drop-Out Voltage" and shall satisfactorily operate for 1/10 of the Minimum Operating Cycles at rated resistive load. There shall be no welding of the contacts.

22. RUPTURE

MIL-R-6742

F-5e (4) Rupture.- The relay shall be made to make and break, instantaneously, 10 times its Rated Load at approximately Maximum Operating Voltage, for a miniumu of 50 operations. The lapse of time between operations shall be 30 seconds. There shall be no welding of the contacts.

REVISIONS OF PROPOSED MILITARY STANDARD SHEETS

The following pages present a proposal for revised Military Standard Sheets to accompany relay specifications. The Military Standard Sheets as proposed in previous reports were an attempt to adapt a form for other components to use in relay Military Standard drawings.

The revised form presented here serves the same purpose as the original, but the form is altered to conform to the needs of a relay specification and to the order of items as they appear in MIL-R-5757B.

NOMINAL RATING

Coil voltage & frequency
Rated coil current
Coil resistance
Coil impedance
Coil power or VA
Rated contact current (voltage and type of load)

DESIGN AND CONSTRUCTION

Cover
Contact Arrangement
Terminal Type
Dimensions
Mounting
Weight

PERFORMANCE REQUIREMENTS

Test	Requirements
Visual & Mechanical	
Seal Test I Nondestructive	
Seal Test I Destructive	
Seal Test II	
Dielectric Strength	
Sea level	
High Altitude	
Insulation Resistance	
Electrical Characteristics	
Pick-up voltage or current	
Drop out voltage or current	
Contact resistance	
Contact Bounce	
Coil Current	
Coil resistance	
Operating & Releasing time	
Corona	
Terminal Strength	
Pull	
Torque	
Temperature Cycling	
Vibration	
Contact Overload	
Resistive	
Inductive	
Lamp Load	
Corrosion	

PART NO. MS

Custodian: Navy-Bureau of Ships	**MILITARY STANDARD**	MS
Procurement Specification	General Form For Military Standard Drawings For Relays	Sheet 1 of 3

PERFORMANCE REQUIREMENTS (con't)

Shock Test I
Shock Test II
Moisture Resistance
High & low temperature
Life

ADDITIONAL REQUIREMENTS

1. Test, sampling and inspections shall be in accordance with Military Specification MIL-R-5757B
2. Reference specification shall be of issue in effect on date of invitation for bids.
3. Qualification approval required.

PART NO. MS

Custodian: Navy-Bureau of Ships	**MILITARY STANDARD**	**MS**
Procurement Specification	General Form For Military Standard Drawings For Relays	Sheet 2 of 3

DIMENSIONAL DRAWING AND MOUNTING

NOTES:

MINIMUM CHASSIS CUTOUT

TERMINAL WIRING - BOTTOM VIEW

PART NO.MS

Custodian: Navy-Bureau of Ships	**MILITARY STANDARD**	**MS**
Procurement Specification	General Form For Military Standard Drawings For Relays	Sheet 3 of 3

NOMINAL RATING

Coil voltage & frequency: 28 volts dc	Coil impedance:
Rated coil current: 0.175 amp.	Coil power or VA:
Coil resistance: 160 ohm	Rated contact current (voltage and type of load): 3 amp. for 28 volts dc, or 115 volts, 400 cps ac, with resistive load.

DESIGN AND CONSTRUCTION

Cover	Hermetically Sealed
Contact Arrangement	4 Pole Double Throw
Terminal Type	Solder ( ) AWG
Dimensions	See dw'g sheet 3
Mounting	Not specified
Weight	3.2 oz.

PERFORMANCE REQUIREMENTS

Test	Requirements
Visual & Mechanical	Pass
Seal Test I Nondestructive	Pass
Seal Test I Destructive	
Seal Test II	
Dielectric Strength	
Sea level	1000 volts
High Altitude	
Insulation Resistance	100 megohms
Electrical Characteristics	
Pick-up voltage or current	Not specified
Drop out voltage or current	Not specified
Contact resistance	0.015 ohms
Contact Bounce	Not specified
Coil Current	0.175 amp
Coil resistance	160 ohms
Operating & Releasing time	Not specified
Corona	Not specified
Terminal Strength	
Pull	Not specified
Torque	Not specified
Temperature Cycling	-67°F to +185°F
Vibration	125 G
Contact Overload	
Resistive	Not specified
Inductive	Not specified
Lamp Load	Not specified
Corrosion	Not specified

PART NO. MS

Custodian: Navy-Bureau of Ships	**MILITARY STANDARD**	**MS**
Procurement Specification	Relay - Armature Connecticut Valley Enterprise No. S-1854	Sheet 1 of 3

PERFORMANCE REQUIREMENTS (con't)

Shock Test I	250 G
Shock Test II	
Moisture Resistance	Not specified
High & low temperature	-67°F to +185°F
Life	Not specified

ADDITIONAL REQUIREMENTS

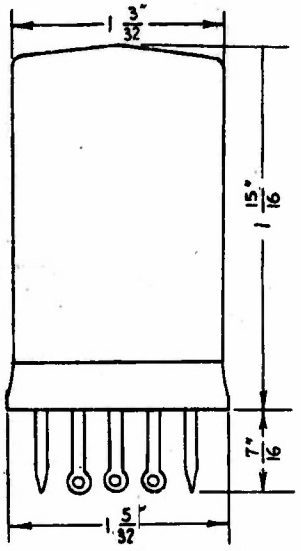
1. Tests, sampling and inspections shall be in accordance with Military Specification MIL-R-5757B.
2. Reference specification shall be of issue in effect on date of invitation for bids.
3. Qualification approval required.

PART NO. MS

Custodian: Navy-Bureau of Ships	**MILITARY STANDARD**	**MS**
Procurement Specification	Relay - Armature Connecticut Valley Enerprise No. 1854	Sheet 2 of 3

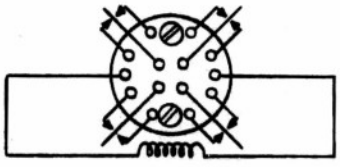
DIMENSIONAL DRAWING AND MOUNTING

NOTES:



MINIMUM CHASSIS CUTOUT

TERMINAL WIRING - BOTTOM VIEW



PART NO. MS

Custodian: Navy-Bureau of Ships	**MILITARY STANDARD**	**MS**
Procurement Spceification	Relay - Armature Connecticut Valley Enterprise No. 1854	Sheet 3 of 3

NOMINAL RATING

Coil voltage & frequency: 265 D.C.	Coil impedance:
Rated coil current:	Coil power or VA:
Coil resistance: 240ohms ± 10%	Rated contact current: 2 amps at 29 volts d.c. resistive load.
Continuous Duty	

DESIGN AND CONSTRUCTION

Cover	Hermetically Sealed
Contact Arrangement	6 form C
Terminal Type	Solder
Dimensions	See Drawing Sheet 3
Mounting	See Drawing Sheet 3
Weight	4.2 oz.

PERFORMANCE REQUIREMENTS

Test	Requirements
Visual & Mechanical	Pass
Seal Test I Nondestructive	Pass
Seal Test I Destructive	Pass
Seal Test II	Not Required
Dielectric Strength	
Sea level	1000 volts, r.m.s.
High Altitude	450 volts, at 70,000ft.
Insulation Resistance	100 megohms
Electrical Characteristics	
Pick-up voltage or current	Not Specified
Drop out voltage or current	Not Specified
Contact resistance	.020 Ohms, maximum
Contact Bounce	Not Specified
Coil Current	Not Specified
Coil resistance	240 Ohms ± 10%
Operating & Releasing time	8 milliseconds operate
Corona	Not Specified
Terminal Strength	
Pull	Pass
Torque	Pass
Temperature Cycling	Pass
Vibration	10 G
Contact Overload	
Resistive	Not Specified
Inductive	Not Specified
Lamp Load	Not Specified
Corrosion	Pass

PART NO. MS

Custodian: Navy-Bureau of Ships	**MILITARY STANDARD**	**MS**
Procurement Specification	Relay Armature Allied Control Co. Type MH-18	Sheet 1 of 3

PERFORMANCE REQUIREMENTS (con't)

Shock Test I	50 G for 10 milliseconds
Shock Test II	Not required
Moisture Resistance	Pass
High & low temperature	-55°C to +85°C
Life	Not specified

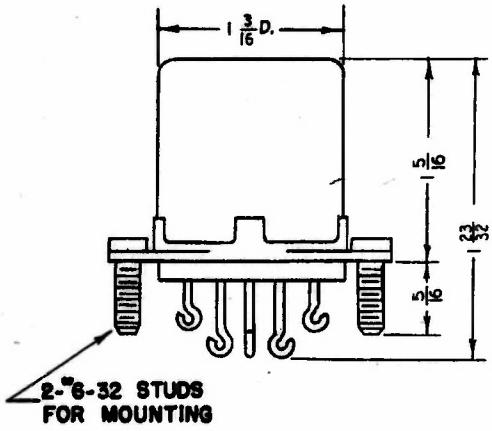
ADDITIONAL REQUIREMENTS

1. Tests, sampling and inspections shall be in accordance with Military Specification MIL-R-5757B
2. Reference specification shall be of issue in effect on date of invitation for bids.
3. Qualification approval required.

PART NO. MS

Custodian: Navy-Bureau of Ships	**MILITARY STANDARD**	**MS**
Procurement Specification	Relay Armature Allied Control Co. Type MH-18	Sheet 2 of 3

DIMENSIONAL DRAWING AND MOUNTING



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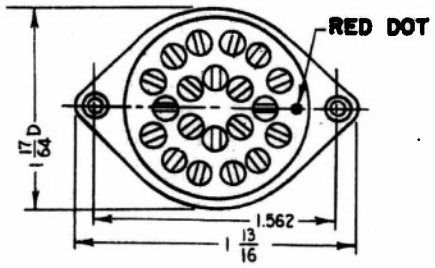
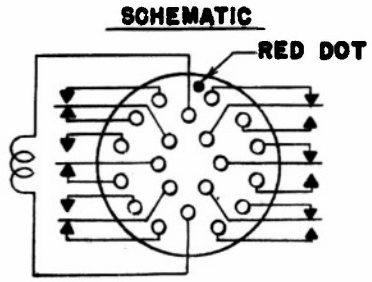


MINIMUM CHASSIS CUTOUT

TERMINAL WIRING - BOTTOM VIEW



UNENERGIZED POSITION

PART NO. MS

Custodian: Navy-Bureau of Ships	**MILITARY STANDARD**	**MS**
Procurement Specification	Relay Armature Allied Control Co. Type MH-18	Sheet 3 of 3

GENERAL FACTUAL DATA

Engineers directly involved in carrying out the subject program are listed below with the number of man-hours applied during the twenty-first interim period.

D. L. Johnson ----------120 man-hours
C. W. Jiles ----------120 man-hours
J. E. Tompkins ----------120 man-hours
C. F. Cameron
Director of Project---139 man-hours
A. Naeter ---------- 40 man-hours
L. A. Barnes ---------- 53 man-hours

Technicians directly involved in carrying out the subject program are listed below with the number of man-hours applied during the twenty-first interim period.

M. J. Reynolds ----------160 man-hours
A. B. Franks ----------100 man-hours
C. B. Wadsworth ----------160 man-hours

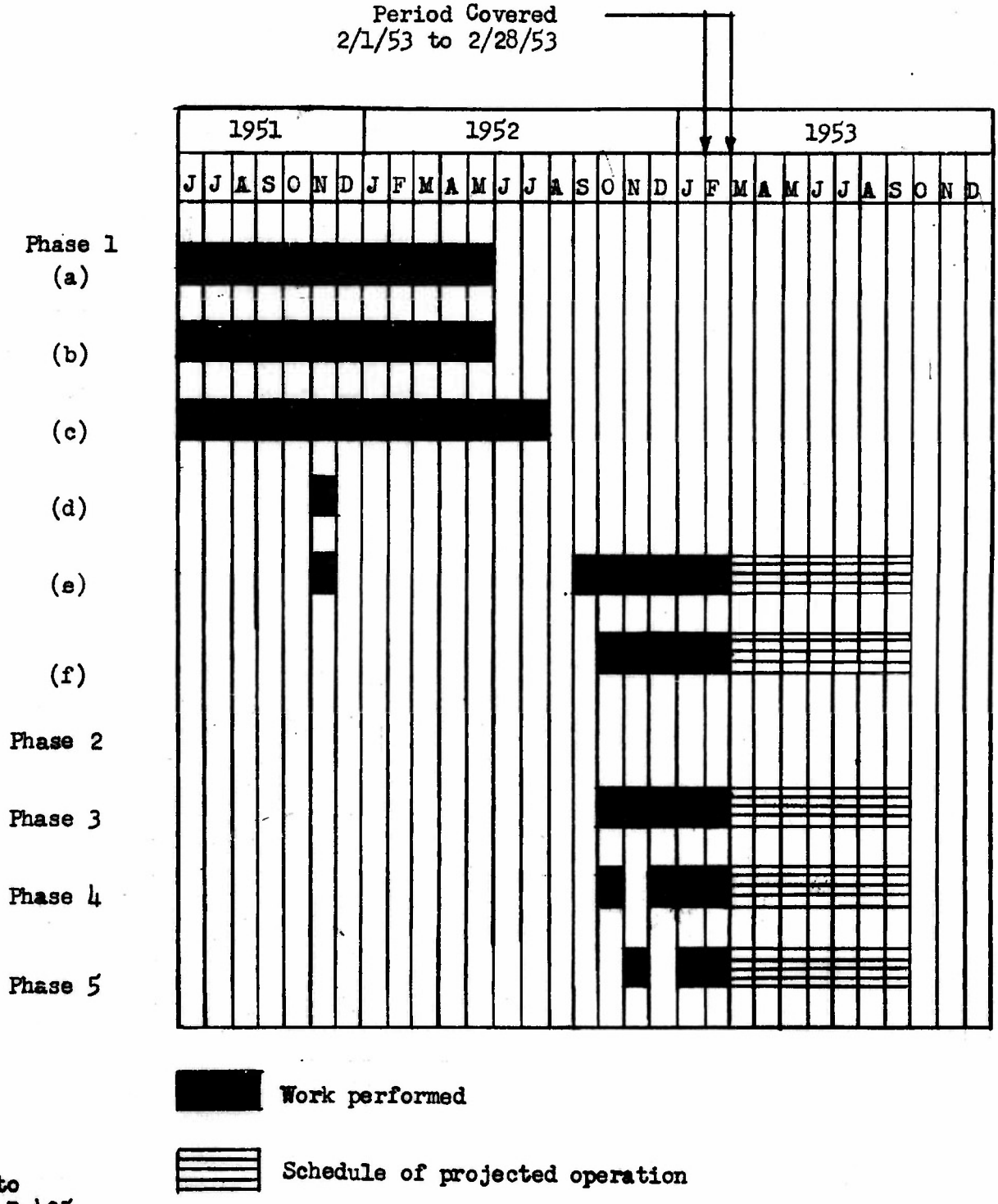
OKLAHOMA A & M COLLEGE

PROJECT PERFORMANCE AND SCHEDULE

Index No. NE-111615

Contract NObsr-52423

Report Date 28 Feb. 1953



Legend
Refer to
(SHIPS-R-405
3.1 to 3.1.5)

CONCLUSIONS

I. An effort is being made to keep the work on various phases of the project progressing on an even front. The parts relating to relay testing and developing relay tests are falling far behind. This can be remedied only by having some test equipment with which experiments may be performed.

II. As an alternative method of attack, since test equipment is not available, the opinions of relay manufacturers and relay users have been solicited. Thus, the revised Relay Standards and Relay Test Code have been published in workbook form in an effort to stimulate the receipt of such comments. The effectiveness of this method of obtaining ideas and information is dwindling.

III. A proposal for revising specifications is being drafted and will be submitted in a later report.

IV. If progress is to be made on revising tests and test procedure, test equipment is vital.

PROGRAM FOR NEXT INTERVAL

I. Work on Relay Standards, Test Code and Specifications will continue.

II. It is proposed to visit more relay manufacturers and relay users.

III. Work will be continued on a proposal for revising the relay specifications.

IV. Relay Standards and Relay Test Code (in workbook form) will be distributed to relay manufacturers and relay users.