ANSI/IEEE C37.90-1989
(Revision of ANSI/IEEE C37.90-1978)

An American National Standard

IEEE Standard for Relays and Relay Systems Associated with Electric Power Apparatus

Sponsor
**Power System Relaying Committee
of the
IEEE Power Engineering Society**

Approved August 17, 1989
Reaffirmed March 17, 1994

IEEE Standards Board

Approved December 7, 1989

American National Standards Institute

Abstract: ANSI/IEEE C37.90-1989, *IEEE Standard for Relays and Relay Systems Associated with Electric Power Apparatus*, applies to relay systems that protect and control apparatus that generate, distribute and use electrical power. This standard defines service conditions and specifies relay performance requirements and performance information that relay manufacturers shall provide.

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Foreword

(This Foreword is not a part of ANSI/IEEE C37.90-1989, IEEE Standard for Relays and Relay Systems Associated with Electric Power Apparatus.)

This revision of ANSI/IEEE C37.90-1978 (Reaffirmed 1982), IEEE Standard for Relays and Relay Systems Associated with Electric Power Apparatus contains significant changes in content and organization as described below.

1) The section on classification of relays, relay systems, and related terminology has been substantially reduced on the basis that ANSI/IEEE C37.100-1981, IEEE Standard Definitions for Power Switchgear, is now the principal reference source for definitions of relay terms in the power switchgear field. Distance relay definitions have been revised and submitted for inclusion in ANSI/IEEE C37.100.
2) Significant changes and reorganization have been made in Section 6., Ratings, and Section 8., Dielectric Tests.
3) The detailed requirements and procedures for the Surge Withstand Capability Test, called for in Section 9., have been moved to a separate document, ANSI/IEEE C37.90.1-1989, IEEE Standard Surge Withstand Capability (SWC) Tests for Protective Relays and Relay Systems.

In preparing this standard, consideration has been given to the work of other committees, and especially to international standards that have been published or that are under preparation by Technical Committee 4l of the International Electrotechnical Commission (IEC).

Related ANSI/IEEE documents are listed below, and are available individually (see footnote at bottom of page 7 for sources), or collected in IEEE Guides and Standards for Protective Relaying Systems.

C37.90.1-1989, Standard Surge Withstand Capability (SWC) Tests for Protective Relays and Relay Systems

C37.90.2-1988, Trial-Use Standard Withstand Capability of Relay Systems to Radiated Electromagnetic Interference from Transceivers

C37.91-1985, Guide for Protective Relay Applications to Power Transformers

C37.93-1987, Guide for Power System Protective Relay Applications of Audio Tones Over Telephone Channels

C37.95-1989, Guide for Protective Relaying of Utility-Consumer Interconnections

C37.96-1988, Guide for AC Motor Protection

C37.97-1979, Guide for Protective Relay Applications to Power System Buses

C37.98-1987, Standard Seismic Testing of Relays

C37.99-1980, Guide for Protection of Shunt Capacitor Banks

C37.101-1985, Guide for Generator Ground Protection

C37.102-1987, Guide for AC Generator Protection

C37.105-1987, Standard for Qualifying Class lE Protective Relays and Auxiliaries for Nuclear Power Generating Stations

C37.106-1987, Guide for Abnormal-Frequency Protection for Power Generating Plants

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C37.108-1989, Guide for the Protection of Network Transformers[1]

C37.109-1989, Guide for the Protection of Shunt Reactors[1]

C57.13.1-1981, Guide for Field Testing of Relaying Current Transformers

C57.13.2-1986, American National Standard for Conformance Test Procedures for Instrument Transformers[1]

C57.13.3-1983, Guide for the Grounding of Instrument Transformer Secondary Circuits and Cases

This standard was prepared by a working group of the Relay Standards Subcommittee of the IEEE Power System Relaying Committee. At the time this standard was approved, the working group membership was:

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[1]This document is not in the collection, IEEE Guides and Standards for Protective Relaying Systems.

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An American National Standard

IEEE Standard for Relays and Relay Systems Associated with Electric Power Apparatus

1. Scope

This standard applies only to relays and relay systems used to protect and control power apparatus. It does not cover relays designed primarily for industrial control, for switching communication or other low-level signals, or any other equipment not intended for the control of power apparatus.

2. Purpose

The purpose of this standard is to specify standard service conditions, standard ratings, performance requirements, and requirements for testing of relays and relay systems associated with power apparatus.

3. Definition of a Relay

A relay is an electric device designed to respond to input conditions in a prescribed manner and, after specified conditions are met, to cause contact operation or similar abrupt change in associated electric control circuits.

NOTES:

1 — Inputs are usually electrical but may be mechanical, thermal, or other quantities, or a combination of quantities. Limit switches and similar simple devices are not relays.

2 — A relay may consist of several relay units, each responsive to a specified input, with the combination of units providing the desired overall performance characteristic of the relay.

4. Relay Terms and Terminology and Classification by Function

Definitions of relay terms are not included in this standard. Refer to ANSI/IEEE C37.100-1981, Definitions for Power Switchgear, for definitions of relay terms. These terms are also included in ANSI/IEEE Std 100-1988, IEEE Standard Dictionary of Electrical and Electronics Terms.[2]

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[2]ANSI/IEEE publications are available from the IEEE Service Center, 445 Hoes Lane, P.O. Box 1331, Piscataway, NJ 08855-1331; and from the Sales Department, American National Standards Institute, 1430 Broadway, New York, NY 10O18.

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Relay terminology covers a wide ares from the detailed relay structural principles through complex power system relay applications.

The following basic areas of power system relay applications provide a convenient method of classification by function:

Protective Monitoring Regulating Auxiliary

5. Service Conditions

5.1 Usual Service Conditions

Relays and relaying devices conforming to this standard shall be suitable for operation under the following conditions:

5.1.1 Ambient Temperature

This is the temperature of the air measured 30 cm from the outside surface of enclosures or covers of relay equipment. This temperature shall be within the limits of –20 °C to 55 °C.

5.1.2 Relative Humidity

The average relative humidity may be up to 55% outside of enclosures or covers for temperatures up to 40 °C, with excursions up to 95% for a maximum of 96 h, without internal condensation.

5.1.3 Altitude

The usual condition of altitude shall be less than 1500 m.

5.2 Unusual Service Conditions

The use of relays and relaying devices at conditions other than specified in 5.1 shall be considered as unusual conditions.

5.2.1 Altitude Derating

5.2.1.1 Air Insulation

Air insulation is to be derated when the relay is applied or tested at altitudes in excess of 1500 m (see Table 1).

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Table 1— Derating Factors for the Effect of Altitude on Dielectric Strength and Maximum Ambient Temperature

Altitude Above Sea Level (m)	Dielectric Strength Derating Factor	Maximum Ambient Temperature (°C)
1500	1.00	55
2000	.95	53
3000	.84	48
4000	.75	43
5000	.67	38
6000	.59	33

Table 2— Standard Current and Voltage Ratings for Relays

Voltage (V)		Current (A)
Alternating Current (rms)	Direct Current	Alternating Current (rms)
120	24	1
24O	48	5
48O	125	
	25O	

Table 3— Maximum Design Voltage for DC Control Power

Rated Volts	Maximum Design Volts
24	28
48	56
125	140
25O	28O

Table 4— Limits of Temperature Rise for Coils

Limits of Observable Temperature Rise Above 55 °C Ambient Temperature			
Method of Temperature Determination	Insulation Classs		
	105	130	180
	40	65	115
Thermometer Applied Thermocouple	45	70	120
Resistance Method	50	75	125

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5.2.1.2 Ambient Temperature

Maximum cooling air temperature for equipment that is applied or tested at an altitude greater than 1500 meters is indicated by Table 1.

5.2.2 Other Conditions

Other conditions may require special construction, treatment, or operation, and these shall be brought to the attention of those responsible for the application, manufacture, and operation of relays and relaying devices. Among such conditions are exposure to:

1) Damaging fumes or vapors
2) Moisture or dripping water
3) Dust, (abrassive, magnetic, conductive, etc.)
4) Explosive mixtures of dust or gases
5) Steam
6) Salt air
7) Shock, vibration, and seismic disturbances
8) Transportation or storage conditions
9) Extreme temperature or sudden change in temperature
10) Extreme variations of supply voltage
11) Excessive electrical wave distortion
12) Excessive electrical noise
13) Electromagnetic radiation
14) Nuclear radiation

6. Electrical Ratings

6.1 Standard Current and Voltage Ratings for Relays

The standard current and voltage ratings for relays shall be as shown in Table 2.

6.2 Maximum Design Voltage and Current for Relays

6.2.1

Maximum design voltage is the highest rms alternating voltage or direct voltage at which apparatus is designed to be energized continuously.

6.2.2

Maximum design current is the highest rms alternating current or direct current at which apparatus is designed to be energized continuously.

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6.3 Allowable Variation from Rated Voltage for Voltage Operated Auxiliary Relays

6.3.1 DC Auxiliary Relays

Direct current auxiliary relays that may be continuously energized for indefinite periods shall be able to withstand the maximum design voltage shown in Table 3 without exceeding the temperature rises shown in Table 4. These relays shall operate over a range from 80% of rated voltage to the maximum design voltage.

NOTE — Typically, electromechanical auxiliary relays that pick up at 80% or less of rated voltage when hot will pick up at 72% or less of rated voltage when cold.

6.3.2 AC Auxiliary Relays

Alternating current auxiliary relays that may be continuously energized for indefinite periods should be able to withstand 110% of rated voltage without exceeding the temperature rises shown in Table 4. These relays shall operate over a range of 85–110% of rated voltage.

6.3.3 Test for Operation at Minimum Voltage—Auxiliary Relays

For successful operation at the minimum voltage for continuous duty, the auxiliary relay coil should be subjected to the normal line voltage until constant temperature is reached, and then tested for successful operation at the minimum voltage.

Relays may be tested cold with proper allowance for the increase in impedance due to temperature rise as established by temperature tests on duplicate relays.

6.4 Allowable Variation from Rated Voltage and Current for Protective Relays

6.4.1 Measuring Input

The maximum design voltage or current for protective relays shall be equal to or greater than the rated voltage or current of the relay.

6.4.1.1 Measuring Input with AC Voltage Rating

Protective relays that are designed to be energized with ac voltage shall operate without damage at rated frequency with voltage not more than 10% above the rated voltage, but not necessarily in accordance with the temperature rise limits established for operation at rated voltage in Section 7.

6.4.1.2 Measuring Input with Current Rating

The manufacturer shall state the highest rms value that the relay can carry continuously while satisfying the temperature rise requirements of Section 7.

6.4.2 Protective Relay Control Power Inputs

6.4.2.1 DC Rated Control Power Inputs

DC power supplies and auxiliary circuits with dc voltage rating shall be able to continuously withstand the maximum design voltage shown in Table 3. They shall be capable of operating successfully over a range from 80% of rated voltage to the maximum design voltage.

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6.4.2.2 AC Rated Control Power Inputs

AC power supplies and auxiliary circuits with ac voltage rating shall be capable of operating successfully over a range of 85–110% of rated voltage.

6.5 Allowable AC Component in DC Control Voltage Supply

An alternating component (ripple) of 5% peak or less in the dc control voltage supply to protective or auxiliary relays shall be permitted, provided the minimum instantaneous voltage is not less than 80% of rated voltage. The ripple content of a dc supply expressed as a percentage is defined as follows:

$$\frac{(\text{peak value} - \text{dc component})}{(\text{dc component})} \times 100$$

NOTE — The above refers to law frequency ripple as might typically be introduced on the dc control power bus by a battery charger. Higher frequency effects, such as might be introduced by a dc/dc converter within the relay itself, are not sufficiently defined at this time to be included in this standard.

6.6 Short Time Thermal Withstand

The limiting short time thermal withstand is the highest value of an energizing quantity that the relay can withstand for a specified time without permanent degradation of its operating characteristics, but possibly with some loss of life.

6.6.1

Relays designed to be energized continuously shall withstand the application of the limiting short time thermal withstand stated by the manufacturer for the following times:

Current relays: one second

Voltage relays: ten seconds

6.6.2

Relays designed for intermittent duty shall withstand the application of the limiting short time thermal withstand value. The manufacturer shall state this value and also the duration.

6.7 Make and Carry Ratings for Tripping Output Circuits

A tripping output consists of relay contacts or a relay output circuit designed for the purpose of energizing power circuit breaker trip coils.

6.7.1 Tripping Output Performance Requirements

Tripping output circuits shall meet the following specification for performance: The contacts or output circuit shall make and carry 30 A for at least 2000 operations in a duty cycle as described below. The load shall be resistive for both dc and ac and the current shall be interrupted by independent means. The voltage value applied will be one of the standard voltage ratings. Design tests to prove this rating shall be made at room ambient temperature (not less than 20 °C) with the relay in its case and with its cover (if any) in position. One duty cycle shall consist of the following sequence: 200 ms on, 15 s off. (Current is interrupted by independent means at the end of each “on” interval.)

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6.7.2 Holding Current

If a tripping output requires a certain value of holding current to remain conducting, as is generally the case with thyristor circuits, the manufacturer shall state this requirement.

6.8 Make and Carry Ratings for Output Circuits Not Rated for Tripping

For output circuits not rated for tripping, the manufacturer shall state their capability.

6.9 Published Data for Auxiliary Relays

Tables 5, 6, and 7 show the performance information concerning contact ratings, operating time, pickup and dropout values, etc., which shall be provided by the manufacturer in literature describing these relays. The format shown in these tables shall be used as a guide when publishing this information. Manufacturers of solid-state auxiliary relays shall provide similar data as is appropriate to their devices.

7. Heating-Limits of Temperature Rise for Coils

The temperature rise of relay coils as installed in a relay case or other enclosure and tested at the maximum design voltage or current per usual service conditions (see 5.1) shall not exceed the value given in Table 4.

8. Dielectric Tests

8.1 Dielectric Tests at the Point of Manufacture

Dielectric tests between circuits, and dielectric tests between circuits and relay frame or ground reference terminal shall be considered as routine tests, and shall be made at the point of manufacture in accordance with this standard.

8.2 Dielectric Tests by Users

8.2.1

Dielectric tests, in accordance with this standard, maybe made by the user only on new relays to determine whether specifications are fulfilled. New relays, for the purpose of this test, are defined as those which have not been in service, which are not more than one year old from the date of shipment, and which have been suitably stored to prevent deterioration.

8.2.2

Additional dielectric tests may be made, using 75% of the test voltage determined in accordance with 8.4.1, at the point of installation to determine the practicality of placing or continuing equipment in service.

8.3 Dielectric Tests Across Open Contacts

Dielectric tests across open contacts shall be considered as design tests. Dielectric tests are not required across contacts with surge-suppression components, nor across solid-state output circuits; when these are used, the Surge Withstand Capability (SWC) test (Section 9.) should be substituted for the dielectric test.

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8.4 Dielectric Test Methods

8.4.1 Standard Test Voltages

Relays rated 600 V and below shall withstand a low-frequency test of the following values:

1) Insulation to ground and between circuits: twice rated voltage plus 1000 Vrms, with a minimum of 1500 Vrms.
2) Across open contacts rated for tripping: twice rated voltage plus 1000 Vrms with a minimum of 1500 Vrms.
3) Across open contacts not rated for tripping: 1000 Vrms, minimum.

The test source shall be substantially sinusoidal and at a frequency between 45 and 65 Hz.

Dielectric tests may be conducted using a dc source. For dc testing, the test voltages shall be 1.41 times the values given for ac tests.

8.4.2 Points of Application of Test Voltage

The test voltage for insulation to ground and between circuits shall be applied successively between each electric circuit and all other electric circuits, and between each electric c ircuit and the metal frame of the relay. All the terminals of a given circuit shall be connected together. The test voltage across open contacts shall be applied to the relay terminals that connect to the contacts. For relays with adjustable contact gap, the contact spacing shall be not less than that recommended by the manufacturer.

Table 5— Contact Rating for All Auxilliary Relays

Contact Circuit (V)	Interrupting Rating (A) (1)				Contact Rating (A) (4)	
	Resistive		Inductive (2)			
	Single Contact	Double (3) Contacts	Single Contact	Double (3) Contacts	Short Time (1 min)	Continuous
dc						
24						
48						
125						
250						
60 Hz						
120						
240						
480						

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Table 6— Operating Data for Continuously Rated Auxiliary Relays

Coil Circuit Voltage (10)	Coil Circuit Resistance (ω) DC 25 °C		Typical Operating Time (ms) (5) (6)		Operating (V) (6) (7) (10)	
			Pickup	Dropout	Must Pickup	Must Dropout
dc						
24						
48						
125						
250						
	60 Hz (Ω) (8)					
	Armature	Armature				
60Hz	Open	Closed				
120						
240						
480						

Table 7— Operating Data for Auxiliary Relays with Intermittent Ratings

DC Circuit (V)	Coil Rated (V)	Coil Resistance (ω) 25 °C	Series Resistor (if used)	Withstand (s) (9)	Operating Time (ms) (9)

NOTES TO TABLES 5, 6, AND 7:

1 — Interrupting rating should be based on at least 100 operations at rated value, with n significant burning of contacts, using suddenly applied (o removed) rated voltage on coil.

2 — Inductive rating should be based on tests using an impedance with L/R = 0.04 for dc and power factor equals 0.4 for ac.

3 — “Double Contacts” means two contacts in series.

4 — Short-time and continuous ratings are based on temperature rise in contact members and supporting parts. Limiting temperatures are to be determined by the manufacturer.

5 — All operating times are measured with rated voltage suddenly applied or removed.

6 — Operating time values and pickup/dropout values in Table 6 are measured with relay “hot” (i.e., energized at rated voltage until thermal equilibrium has been reached at room ambient temperature (20–25 °C)).

7 — Operating voltage data columns in Table 6 have the following meanings: (a) “Must Pickup” means that actual pickup is less than the value given, and applied voltage should be greater than this value for reliable operation; and (b) “Must Dropout” means that actual dropout is greater than value given, and applied voltage should be less than this value for reliable dropout.

8 — Impedance data for ac relays should include ohms and power factor.

9 — Operating time and withstand values in Table 7 are measured with relay "old" (i.e., coil at room ambient temperature (20–25 °C) before measurement is made).

10 — For current operated auxiliary relays, substitute amperes for volts in the tables.

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8.4.3 Duration and Method of Application of Test Voltage

The open circuit voltage of the testing equipment is initially set to not more than 50% of the specified voltage. It is then applied to the relay under test. From this initial value, the test voltage shall be raised to the specified value, in such a manner that no appreciable transients occur, and then maintained for one minute. It shall then be reduced smoothly to zero as rapidly as possible.

As an alternate, to be used at the point of manufacture only, it is permissible to test any relay for one second at a value 20% higher than the standard 60 s test voltage.

8.4.4 Accuracy of Test Voltage

The source voltage shall be verified with an error of no more than 5%.

8.4.5 Temperature at Which Dielectric Tests Are to be Made

Dielectric tests shall be made at the temperature assumed under normal operation or at the temperature attained under the condition of commercial testing.

8.4.6 Requirements for Conformance

During the dielectric test, no breakdown or flash over shall occur.

9. Surge Withstand Capability Tests

9.1 General

Surge withstand tests are design tests for protectiv relays and relay systems. Standardized test waveforms that ar representative of surges observed and measured in actua installations are applied to the terminals of the system. Th relay or relay system must be able to withstand the applied surge without damage to components and without operating incorrectly.

9.2 Surge Tests

Surge tests shall be conducted in accordance with ANSI/IEEE C37.90.1-1989, Surge Withstand Capability (SWC) Tests for Protective Relays and Relay Systems.

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