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An American National Standard

**IEEE Standard for
Surge Arresters
(Lightning Arresters)
for
Alternating-Current Power Circuits**

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Surge Arresters
(Lightning Arresters)
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Sponsor

Surge Protective Devices Committee
of the
IEEE Power Engineering Society

Secretariat for American National Standards Committee C62

Institute of Electrical and Electronics Engineers
National Electrical Manufacturers Association

Approved December 9, 1971

American National Standards Institute

American National Standard

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Foreword

(This foreword is not a part of American National Standard C62.1-1971 and IEEE Std 28-1972.)

The issuance of this document to supersede IEEE Std 28-1967 (ANSI C62.1-1967) revises many portions of the standard and adds two significant design tests, namely, switching-surge sparkover characteristic tests for station and intermediate arresters rated 60 kV and above, and radio-influence-voltage (RIV) and internal-ionization-voltage tests. In addition to numerous editorial corrections, clarifications, and additions, the following substantial changes have been made:

- (1) Terminology change to "surge arrester" instead of "lightning arrester."
- (2) Addition of "slow-front (switching-surge) impulse sparkover tests"
- (3) Revision of the duty-cycle test for valve arresters to incorporate "round-the-clock" timing
- (4) Addition of standard extra-high-voltage arrester ratings 312 kV to 684 kV
- (5) Addition of insulation withstand requirements for the added 312-kV rating
- (6) Revision of pressure-relief tests to permit reduced generator excitation during prospective-current measurements
- (7) Added definition of "arrester disconnecter"
- (8) Revised definition of "conformance tests"
- (9) Addition of radio-influence-voltage and internal-ionization-voltage tests, together with appropriate definitions
- (10) Addition of "year of manufacture" to standard distribution arrester nameplate information
- (11) Revision of impulse sparkover voltage-time characteristic design tests to more clearly indicate that the intent is to determine the response relationship among designated wave shapes
- (12) Revision of discharge-voltage characteristic design tests to more clearly indicate that the intent is to determine the response relationship among designated current magnitudes

IEEE representation on C62 consists of a delegation of members of the Surge Protective Devices Committee of the Power Engineering Society, which has prime responsibility for portions of this standardization within the IEEE scope. The sections indicated by a † were developed by C62 and are included in IEEE 28 to facilitate its use. The sections not marked with † have been approved by IEEE.

ANSI C62.1-1971 has been approved by the National Electrical Manufacturers Association as a NEMA Standard. ANSI C62.1-1971 constitutes, by reference only, an integral part of the NEMA Standards Publication for Surge Arresters, LA 1.

Prior to and during development of this issue of C62.1, close liaison has been maintained with the International Electrotechnical Commission's surge arrester standardizing activity, with the result that contributions have been made to the development of international specifications as well as received for the benefit of this American National Standard.

It is the policy of both the Institute of Electrical and Electronics Engineers and American National Standards Committee C62 to maintain this standard current with the state of the technology. Comments on this standard, as well as suggestions for additional material that should be included are invited. These should be addressed to the American National Standards Institute, 1430 Broadway, New York, N. Y. 10018, with copy to the Secretary, IEEE Standards Committee, Institute of Electrical and Electronics Engineers, 345 East 47th Street, New York, N. Y. 10017.

American National Standards Committee C62 on Surge Arresters is organized specifically to develop consensus standards and as such has representatives as listed below:

J. D. M. Phelps, *Chairman*

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Name of Representative

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When the IEEE Standards Committee approved this standard on June 3, 1971, it had the following membership:

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An American National Standard *IEEE Standard for* **Surge Arresters** **(Lightning Arresters)** **for** **Alternating-Current Power Circuits**

1. Scope

This standard applies to surge-protective devices designed for repeated limiting of voltage surges on 50- or 60-Hz power circuits by passing surge discharge current and subsequently automatically interrupting the flow of follow current. This standard applies to devices for separate mounting and to those supplied integrally with other equipment.

2. Definitions

The following definitions apply specifically to surge arresters and do not necessarily cover other applications.

2.1 surge arrester (lightning arrester). A protective device for limiting surge voltages on equipment by discharging or bypassing surge current; it prevents continued flow of follow current to ground, and is capable of repeating these functions as specified.

NOTE: Hereafter, the term "arrester" as used in this standard shall be understood to mean "surge arrester."

2.2 valve element. A resistor that, because of its nonlinear current-voltage characteristic, limits the voltage across the arrester terminals during the flow of discharge current and contributes to the limitation of follow current at normal power-frequency voltage.

2.3 expulsion element. A chamber in which an arc is confined and brought into contact with gas-evolving material.

2.4 series gap. An intentional gap(s) between spaced electrodes; it is in series with the valve or expulsion element of the arrester, substantially isolating the element from line or

ground or both under normal line voltage conditions.

2.5 valve arrester. An arrester that includes a valve element.

2.6 expulsion arrester. An arrester that includes an expulsion element.

2.7 protector tube. An expulsion arrester used primarily for the protection of line and switch insulation.

2.8 indoor arrester. An arrester that, because of its construction, must be protected from the weather.

2.9 outdoor arrester. An arrester that is designed for outdoor use.

2.10 classification of arresters. Arrester classification is determined by prescribed test requirements. These classifications are:

- station valve arrester
- intermediate valve arrester
- distribution valve arrester
- distribution expulsion arrester
- secondary valve arrester
- protector tube

NOTE: See 4.2 for the test requirements.

2.11 terminals. The conducting parts provided for connecting the arrester across the insulation to be protected.

2.11.1 ground terminal. The conducting part provided for connecting the arrester to ground.

2.11.2 line terminal. The conducting part provided for connecting the arrester to the circuit conductor.

NOTE: When a line terminal is not supplied as an integral part of the arrester, and the series gap is obtained by providing a specified air clearance between the line end

of the arrester and a conductor, or arcing electrode, etc. the words "line terminal" used in the definition refer to the conducting part that is at line potential and that is used as the line electrode of the series gap.

2.12 grading or control ring. A metal part, usually circular or oval in shape, mounted to modify electrostatically the voltage gradient or distribution.

2.13 vent. An intentional opening for the escape of gases to the outside.

2.14 deflector. A means for directing the flow of the gas discharge from the vent of the arrester.

2.15 discharge indicator. A means for indicating that the arrester has discharged.

2.16 discharge counter. A means for recording the number of arrester discharge operations.

2.17 arrester disconnecter. A means for disconnecting an arrester in anticipation of, or after, a failure in order to prevent a permanent fault on the circuit and to give indication of a failed arrester.

NOTE: Clearing of the power current through the arrester during disconnection generally is a function of the nearest source-side overcurrent-protective device.

2.18 prorated section. In a valve arrester, a complete, suitably housed section including series-gap and valve-element components in the same proportion as in the complete arrester.

2.19 lightning. An electric discharge that occurs in the atmosphere between clouds or between clouds and ground.

2.20 lightning surge. A transient electric disturbance in an electric circuit caused by lightning.

2.21 wave. The variation with time of current, potential, or power at any point in an electric circuit.

2.22 surge. A transient wave of current, potential, or power in an electric circuit.

2.23 impulse. A surge of unidirectional polarity.

2.24 oscillatory surge. A surge that includes both positive and negative polarity values.

2.25 crest (peak) value (of a wave, surge, or impulse). The maximum value that it attains.

2.26 wave front (of a surge or impulse). That part which occurs prior to the crest value.

2.27 wave tail (of an impulse). That part between the crest value and the end of the impulse.

2.28 wave shape (of an impulse test wave). The graph of the wave as a function of time.

2.29 wave shape designation (of an impulse).

2.29.1 The wave shape of an impulse (other than rectangular) of a current or voltage is designated by a combination of two numbers. The first, an index of the wave front, is the virtual duration of the wave front in microseconds as defined in 2.31. The second, an index of the wave tail, is the time in microseconds from virtual zero to the instant at which one-half of the crest value is reached on the wave tail. Examples are 1.2×50 and 8×20 waves.

2.29.2 The wave shape of a rectangular impulse of current or voltage is designated by two numbers. The first designates the minimum value of current or voltage which is sustained for the time in microseconds designated by the second number. An example is the $75A \times 1000$ wave.

2.30 virtual zero point (of an impulse). The intersection with the zero axis of a straight line drawn through points on the front of the current wave at 10 percent and 90 percent crest value, or through points on the front of the voltage wave at 30 percent and 90 percent crest value.

2.31 virtual duration of wave front (of an impulse). The virtual value for the duration of the wave front is as follows.

(1) For voltage waves with wave front durations less than $30 \mu s$, either full or chopped on the front, crest, or tail, 1.67 times the time for the voltage to increase from 30 to 90 percent of its crest value.

(2) For voltage waves with wave front durations of 30 or more μs , the time taken by the voltage to increase from actual zero to maximum crest value.