

Revised Report On Standards
for
VALVE and EXPULSION TYPE
LIGHTNING ARRESTERS

**This report supersedes AIEE Numbers 24, 28A, and 47
and is published for comment and criticism as a proposed revision of
AIEE Standard No. 28 (ASA C62.1-1944)**

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Revised Report on Standard of the American Institute of Electrical Engineers

VALVE and EXPULSION TYPE LIGHTNING ARRESTERS

SCOPE

These standards apply to lightning protective devices designed to limit repeatedly voltage surges on power circuits¹ by passing surge discharge current and subsequently automatically interrupting the flow of power follow current. Arresters claimed to be in accordance with these standards, including those supplied integrally with equipment, must meet the tests specified herein.

DEFINITIONS²

- 28.10 A **lightning arrester** is a protective device for limiting surge voltages on equipment by discharging surge current. It prevents continued flow of follow current and is capable of repeating these functions as specified in these standards. (Hereafter the term "arrester" as used in these standards shall be understood to mean "lightning arrester.")
- 28.11 A **valve type arrester** is an arrester having a characteristic element consisting of a resistor with a nonlinear volt-ampere characteristic which limits the follow current to a value the series gap can interrupt. If the arrester has no series gap, the characteristic element limits the follow current to a magnitude that is tolerable for both the arrester and the system.
- 28.12 An **expulsion type arrester** is an arrester having a characteristic element in which the arc is brought into contact with gas evolving or other arc extinguishing material in a manner which enables it to interrupt follow current. The term expulsion arrester includes any external series gap used as a part of the complete device as installed for service.

NOTE 1: In these standards a frequency of 50 or 60 cycles per second is assumed as the system power frequency. For test purposes either 50 or 60 cps, whichever is available, may be used where power frequency is specified. The required tests, when properly interpreted, are also useful in making lightning arrester applications to 25 cps systems.

NOTE 2: These definitions include changes proposed for use in revising Ameri-

can Standard Definitions of Electrical Terms ASA C42-1941.

- 28.13 The term **protector tube** refers to an expulsion type arrester used primarily for protection of line and switch insulation.
- 28.14 The **characteristic element** of an arrester is that component which primarily determines both the discharge voltage and the follow current. It is the nonlinear resistor of a valve type arrester or the arc interrupting portion of an expulsion type arrester.
- 28.15 A **prorated section** of a valve type arrester is a complete suitably housed section including series gaps and characteristic elements in the same proportion as in the complete arrester.
- 28.16 The **series gap** (or gaps) of an arrester is an intentional gap between spaced electrodes and is in series with the characteristic element of the arrester.
- 28.17 The **line and ground terminals** of an arrester are the conducting parts provided for connecting the arrester in parallel with the insulation to be protected. When the series gap is not an integral part of the arrester, the line terminal is the line electrode of the prescribed series gap.
- 28.18 **Lightning** is an electric discharge which occurs in the atmosphere between clouds or between clouds and ground.
- 28.19 A **lightning surge** is a transient electric disturbance in an electric circuit caused by lightning
- 28.20 A **wave** in an electric circuit is the variation of current or potential at a point in the electric circuit.
- 28.21 A **surge** in an electric circuit is a transient variation in the current or potential at a point in the circuit
- 28.22 An **impulse** is a surge of unidirectional polarity
- 28.23 An **oscillatory surge** is a surge which includes both positive and negative polarity values.
- 28.24 The **crest value** of a wave is the maximum value which it attains.
- 28.25 The **wave front** of a surge or impulse is that

- part which occurs prior to the crest value.
- 28.26 The **wave tail** of an impulse is that part between the crest value and the end of the impulse.
- 28.27 **Virtual zero** for a surge or impulse is the point on the zero axis at which the zero axis is intersected by a straight line drawn through two points on the front of the wave as follows:
- A. For voltage waves the two points shall be 30 percent and 90 percent of the crest value.
 - B. For current waves the two points shall be 10 percent and 90 percent of the crest value.
- 28.28 The **nominal rate of rise of a wave front** is the slope of the line that determines the virtual zero. It is usually expressed in volts or amperes per microsecond.
- 28.29 The **wave shape** of an impulse is the variation of voltage or current with time. For test purposes it is expressed as a combination of two numbers. The first is the microseconds from virtual zero to the wave crest. The second is the microseconds from virtual zero to one half crest value on the wave tail. Examples are 1.5 x 40 and 10 x 20 waves.
- 28.30 A **flashover** is a disruptive discharge around or over the surface of a solid or liquid insulator.
- 28.31 A **sparkover** is a disruptive discharge between electrodes of a measuring gap, voltage control gap, or protective device.
- 28.32 **Fault current** is the power-frequency current from the connected power system which flows in a short circuit at a specified location.
- 28.33 **Recovery voltage** is the transient voltage which occurs across the terminals of an arrester as a result of interruption of the follow current.
- 28.34 **Discharge current** of an arrester is the surge current which flows through the arrester.
- 28.35 **Follow current** of an arrester is the power-frequency current from the connected power source which flows through an arrester during and following the passage of discharge current.
- 28.36 The **power-frequency sparkover voltage** of an arrester is the root-mean-square value of the lowest power-frequency sine-wave voltage that will cause sparkover when applied between its line and ground terminals.
- 28.37 The **power-frequency withstand voltage** is the root-mean-square voltage which when applied to the specimen does not cause a disruptive discharge.
- 28.38 The **impulse withstand voltage** is the crest value of the impulse voltage of a given wave shape and polarity which when applied to the specimen does not cause a disruptive discharge.
- 28.39 **Impulse sparkover voltage** of an arrester is the highest value of voltage attained prior to the flow of discharge current when an impulse of given wave shape and polarity is applied across its line and ground terminals.
- 28.40 The **time to impulse sparkover** is the time between virtual zero and the sparkover point on the voltage wave.
- 28.41 The **impulse sparkover volt-time characteristic** of a device is a graph plotted between impulse sparkover voltage and time to impulse sparkover obtained by varying the crest value of voltage impulses of specified wave shape and polarity.
- 28.42 The **discharge voltage** of an arrester is the voltage that appears across its terminals during the passage of discharge current.
- 28.43 **Circuit voltage** is the root-mean-square voltage from line to line as distinguished from the voltage from line to neutral.
- 28.44 A **rating** of a device is the designation of an operating limit.
- 28.45 The **voltage rating** of an arrester is the designated maximum permissible root-mean-square voltage between its line and ground terminals at which it is designed to perform its duty cycle. It is the voltage rating specified on the nameplate.
- 28.46 The **power-frequency current rating** of an expulsion arrester is a designation of the range of the symmetrical root-mean-square system fault currents for which the arrester is designed. An expulsion arrester is given a maximum current rating and many also have a minimum current rating.
- 28.47 The term **decrement factor** describes the damping of the major natural-frequency component of voltage of the test circuit which is superimposed on the power-frequency voltage in the event of any abrupt change in voltage or current. It represents the ratio of amplitudes of any half wave of the major natural-frequency component of voltage to the immediately preceding half wave of opposite polarity. In general the device affects the amplitude of the first half cycle so the use of the first half cycle should be avoided in determining the decrement factor.
- 28.48 A **unit operation** of an arrester consists of discharging a surge through the arrester so as to initiate follow current.