

**ASA**  
**C62.1-1944**

**AIEE**  
**No. 28**  
**May-1944**

IEEE STANDARDS  
**ARCHIVES**  
DO NOT REMOVE

*American Standards*

*for*

**LIGHTNING ARRESTERS**  
**FOR ALTERNATING-CURRENT POWER CIRCUITS**

**APPROVED**

**American Standards Association**

**April 28, 1944**



**SPONSOR**

**American Institute of Electrical Engineers**

**Published by**

**THE AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS**

**33 West Thirty-ninth Street, New York**

## ACKNOWLEDGEMENT

The American Institute of Electrical Engineers wishes to acknowledge its indebtedness to those who have so freely given their time and knowledge and have conducted experimental work on which these standards are based.

### Sectional Committee—C62

K. B. McEACHRON, Chairman  
General Electric Co., Pittsfield, Mass.

|                 |                |
|-----------------|----------------|
| Edwark Beck     | J. R. McFarlin |
| J. O'R. Coleman | A. C. Monteith |
| H. W. Collins   | E. G. Newton   |
| F. M. Defandorf | J. R. North    |
| R. H. Earle     | A. H. Schirmer |
| I. W. Gross     | H. R. Stewart  |

## TABLE OF CONTENTS

|                                       |    |
|---------------------------------------|----|
| Scope .....                           | 5  |
| Service Conditions .....              | 5  |
| Definitions .....                     | 5  |
| Classification .....                  | 8  |
| Rating .....                          | 8  |
| Performance Characteristics .....     | 8  |
| Design Tests .....                    | 9  |
| Alternating Voltage Design Tests..... | 9  |
| Impulse Design Tests .....            | 10 |
| Operating Duty Design Tests .....     | 11 |
| Routine Tests .....                   | 12 |
| Acceptance Tests .....                | 12 |
| Other Tests .....                     | 13 |
| Nameplate Data .....                  | 13 |

# AMERICAN STANDARDS

## For

### Lightning Arresters for Alternating-Current Power Circuits

(Approved by ASA as American Standard Jan. 30, 1936—Revision approved April 28, 1944)

#### SCOPE

These standards apply to all types of lightning arresters which are designed for the protection of alternating-current power circuits, and which have an element with non-linear volt-ampere characteristic to limit the follow current.

#### SERVICE CONDITIONS

**28-1 Usual Service Conditions.**—Apparatus conforming to these standards shall possess its specified characteristics and be capable of successful operation:

- (a) When and where the temperature of the cooling medium does not exceed 40 C.
- (b) Where the altitude does not exceed 3,300 feet (1,000 meters).

**28-2 Considerations Affecting Lightning Arrester Applications.** — There are conditions which, where they exist, should be considered by those responsible for the manufacture, application, and operation of lightning arresters. Among such conditions are:

##### 1. System Conditions

- (a) Whether the system neutral is isolated or grounded; and if grounded, the effect under the most severe fault conditions, of zero sequence and positive (or negative) sequence impedances on the voltages to be expected on unfaulted phases at the arrester locations.
- (b) Over-voltages such as may occur during a line-to-ground fault on an ungrounded system for which the ratio of zero sequence reactance to positive or negative sequence reactance is negative in sign.
- (c) Possible loss of neutral connection to ground on a system or part of system where arrester is located, the system having been regarded as effectively grounded.

- (d) Temporary overvoltage (such as may occur due to apparatus or line regulation, generator overspeed following sudden loss of load, harmonic over-voltages on systems fed by generators without damper windings, etc.)
- (e) Sustained overvoltage (such as may occur on ungrounded circuits by induction from unbalanced parallel higher voltage circuits in close proximity, or by contact with circuits of higher voltage).
- (f) Order of magnitude of expected arrester ground resistance.
- (g) Impulse insulation level of the equipment to be protected.
- (h) Unusual operating duty.

##### 2. Physical Conditions:

- (a) Temperature of cooling medium exceeding 40 C.
- (b) Altitude exceeding 3,300 feet.
- (c) Exposure to damaging fumes or vapors; excessive dirt, moisture or dripping water; explosive mixtures of dust, gases or fumes; or exposure to steam or salt spray.
- (d) Exposure to abnormal vibrations or shocks.
- (e) Limitation of weight, or space, including proximity to conducting objects.

#### DEFINITIONS

Definitions given herein apply specifically to the apparatus treated in this section.

**28-50 Lightning.** — Lightning is an electric discharge\* occurring in the atmosphere, one terminal of which is a cloud.

\*When a discharge between cloud and earth terminates on an overhead line, apparatus, or other objects, it is called a "direct stroke" of lightning.

**28-51 Lightning Surge.\*\***—A lightning surge is a transient electric disturbance in an electric circuit caused by lightning.

**28-52 Wave** (In an electric circuit).—A wave in an electric circuit is the variation of current and/or potential at any point in the electric circuit.

**28-53 Traveling Wave.**—A traveling wave is the resulting wave when the electric variation in a circuit takes the form of translation of energy along a conductor, such energy being always equally divided between current and potential forms.

**28-54 Surge** (In an electric circuit).—A surge in an electric circuit is a transient variation in the current and/or potential at a point in the circuit.

**28-55 Oscillatory Surge.**—An oscillatory surge is a surge which includes both positive and negative polarity values.

**28-56 Impulse.**—An impulse is a surge of unidirectional polarity.

**28-57 Crest Value** (of a Wave, Surge, or Impulse). The crest value of a wave, surge, or impulse is the maximum value which the current and/or potential attains at any time during a period, or during the transient.

**28-58 Wave Front†** (of a Surge or Impulse).—The wave front of a surge or impulse is that part, in distance or time, between the virtual zero time and the point at which the surge or impulse reaches its crest value, where the virtual zero time is determined by 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, and through points on the front of the voltage wave at 30 percent and 90 percent crest value.

**28-59 Wave Tail‡** (of an Impulse).—The wave tail of an impulse is that part, in time or distance, between the point of crest value and the end of the impulse.

**28-60 Wave Shape\*** (of an Impulse).—The wave shape of an impulse is the graph of the wave as a function of time or distance.

**28-61 Disruptive Discharge.**—Disruptive discharge is the sudden and large increase in current through an insulating medium due to the complete failure of the medium under the electrostatic stress.

**28-62 Flashover.**—A flashover is a disruptive discharge around or over the surface of a solid or liquid insulator.

**28-63 Sparkover.**—A sparkover is a disruptive discharge between electrodes of a measuring gap, such as a sphere gap or oil testing gap.

**28-64 Breakdown.**—A breakdown is a disruptive discharge through insulation (as between electrodes of a lightning arrester gap).

**28-65 Lightning Arrester.\*\***—A lightning arrester is a device which has the property of reducing the voltage of a surge applied to its terminals, is capable of interrupting follow current, if present, and restores itself to its original operating conditions.

**28-66 Station, Line, and Distribution Type Arresters.**—A station type arrester is distinguished from the line and distribution type arresters as one having a higher discharge current capacity and better overall protective characteristics for a given rating; it is also characterized by heavier construction. The discharge capacity of a station type arrester will exceed 100,000 amperes, and that of the line and distribution type arrest-

\*\*In relation to the circuit as a whole, a lightning surge usually takes the form of a traveling wave or a transient in space. In relation to any given point of the circuit, however, such a surge manifests itself as a transient in time. A lightning surge manifesting itself in such a time transient at a point in a circuit may be caused by:

- A direct stroke of lightning at or near the point.
- A traveling wave caused by a direct stroke elsewhere on the circuit.
- Release of bound induced charge at the point (as by nearby discharge of a cloud).
- A traveling wave resulting from release of bound charge elsewhere on the circuit.
- Any combination of a, b, c, or d.

†The wave front is described in terms of its steepness and duration. The nominal steepness of the wave front of a surge or impulse is the rate of rise of current (or potential) in amperes (or kilovolts) per microsecond, measured as the slope of a straight line passing through the points on the wave front at which the instantaneous value of current, or potential, is the percent of crest value given in section 28-58. The nominal duration of the wave front is equal to 1.5 or two times, respectively, the length of time elapsing between the points on the wave front at which the instantaneous value of current, or potential, is 10 and 90 percent, or 30 and 90 percent, respectively, of the crest value.

‡The nominal value of the wave tail of an impulse is the time from virtual zero time of the impulse to the instant at which one-half crest value is reached on the wave tail.

\*It is customary in practice to express the wave shape by a combination of two numbers the first part of which represents the nominal duration of the wave front and the second the nominal value of the wave tail, both values being expressed in microseconds such as a 1x5 wave or a 1.5x40 wave.

\*\*This definition does not apply to communication circuits.