

**American Railway Engineering and Maintenance of Way Association
Letter Ballot 38 21-13**

1. Committee and Subcommittee:

AREMA C&S Committee 38

2. Letter Ballot Number: 38 21-13

3. Assignment:

MP's revised at Fall 2021 meeting.

4. Ballot Item:

Ballot 38 21-13: This ballot contains the MP approved at the Fall 2021 meeting:

11.3.10 - Purpose and Meaning of Terms Used in Surge Protection and Grounding

Rationale:

Revised Manual Parts

Draft Not Yet Approved

Purpose and Meaning of Terms Used in Surge Protection and GroundingReaffirmed ~~2018-2023~~2023 (9 Pages)**ARRESTER**

See SURGE ARRESTER.

BOND

A low impedance connection to assure the required electrical conductivity between conductive parts to be ~~that are~~ electrically ~~or mechanically~~ connected ~~for this purpose~~.

BONDING

The electrical interconnecting of conductive parts designed to maintain a common electrical potential.

BREAKDOWN VOLTAGE, AC (PEAK)

The minimum peak value of a sinusoidal voltage at frequencies between 15 Hz and 105 Hz that results in a specified diversion of current or range of current through the surge protective device.

BREAKDOWN VOLTAGE, AC (RMS)

The minimum rms value of a sinusoidal voltage at frequencies between 15 Hz and 105 Hz that results in a specified current or range of current to be diverted through the surge protection device. ~~diversion of current through the surge protective device.~~

BREAKDOWN VOLTAGE, DC

The minimum slowly rising dc voltage ~~(DC)~~ that results in a specific diversion of current through the surge protective device.

BUS

A conductor(s) that serves as a common connection for the corresponding conductors of two or more circuits.

CANADIAN ELECTRICAL CODE PART THREE (CEC)

A series of standards governing the use of electric supply and communications lines, equipment and associated work practices employed by an electric supply, communications, railway, or similar utility in the exercise of its function as a utility. It is sponsored by the Canadian Standards Association (CSA C.3).

CLAMPING VOLTAGE

The maximum magnitude of voltage across a surge protective device during the passage of a specified surge current (e.g., 100 amp., 8/20 square waveshape, under specified test conditions, e.g. dynamic, static, phase angle, pulse polarity).

COMMON-MODE VOLTAGE (longitudinal)

The voltage that appears equally in amplitude and in phase from each signal conductor to ground or to a common reference.

CORONA (overhead power line corona and radio noise)

A luminous discharge due to ionization of the air surrounding an electrode caused by a voltage gradient exceeding a certain critical value. Electrodes may be conductors, hardware, accessories, or insulators.

COUPLING

Energy transfer among circuits, equipment or systems caused by electric and/or electromagnetic interaction. There are three forms of coupling: magnetic (inductive), electric (capacitive), and conductive (resistive). In addition, coupling by electromagnetic radiation exists and is associated with propagation of radiation fields, e.g., radio frequency interference (RFI).

DIELECTRIC BREAKDOWN VOLTAGE

The voltage which will result in leakage, breakdown or sparkover when impressed across a dielectric.

DIELECTRIC WITHSTAND LEVEL

The ability of insulating materials; spacing (such as components), or equipment to withstand a specified voltage for a specified time without exceeding a specified leakage, breakdown or sparkover.

DIFFERENTIAL (TRANSVERSE, METALLIC, NORMAL) MODE VOLTAGE

The voltage at a given location between two individual conductors or two conductors of in a group, (not between ends of the same conductor).

EARTH GROUNDING SYSTEM

A network of electrically interconnected rods, plates, mats, or grids installed for the purpose of establishing a low resistance contact with remote ~~earth~~Earth.

ELECTROMAGNETIC COMPATIBILITY (EMC)

The ability of a device, equipment, or system to function satisfactorily in its electromagnetic environment without while not introducing intolerable electromagnetic disturbances to anything in that environment.

ELECTROMAGNETIC INTERFERENCE (EMI)

Electromagnetic energy from sources external or internal to electrical or electronic equipment that adversely affects equipment by creating an undesirable response (degraded performance or malfunctions).

ELECTROMAGNETIC PULSE (EMP)

A transient high-intensity electromagnetic field. EMP is commonly associated with nuclear explosions in or near the Earth's atmosphere; however, electromagnetic pulses can result from other sources, such as lightning.

ELECTROMAGNETIC SUSCEPTIBILITY

The level of electromagnetic interference that will cause a device, equipment, or system to malfunction or be damaged due to its electromagnetic environment.

ENERGY

~~Mathematically described as (Power) X (Time) usage or capability measured in relation to time. The unit of Energy is the Joules (Watt-seconds), is the typical unit of energy.~~

EQUALIZER (LINE-TO-LINE SURGE PROTECTIVE DEVICE)

A ~~two-two~~-terminal primary SPD(s) for railroad signal applications which incorporates an ohmic leakage path to minimize static voltage buildup. This device provides Line-to-Line protection also called differential, metallic or normal-mode protection.

EQUIPMENT GROUND

A ground connection to non-current-carrying metal parts of a wiring installation or of electric equipment, or both.

EQUIPMENT GROUNDING CONDUCTOR

The conductor used to connect the non-current carrying metal parts of equipment, raceways, and other enclosures to the service entrance panel ground~~equipment,~~ the service power source(s) ground, or a direct connection to Earth ground~~both at a particular location.~~

EQUIPOTENTIAL PLANE

A mass (or masses) of conducting material that, when bonded together, provide a low impedance to current flow over a large range of frequencies.

EQUIPOTENTIAL WORKZONE (AREA, SITE)

A work zone (area, site) where all equipment is interconnected by jumpers, grounds, ground rods, and/or grids that will provide acceptable potential differences between all parts of the zone under worst-case conditions of energization.

EXOTHERMIC WELDING

The process of joining metals by the reduction of copper oxide using aluminum. This chemical reaction produces heat along with molten copper. The molten copper flows over the conductors being welded and provides a molecular homogeneous weld for grounding and bonding.

FARADAY SHIELD

A metallic shield for the purpose of mitigating Electrostatic Fields and electromagnetic (using proper material and geometry). The shield composed can be comprised of a metallic enclosure, wire mesh, or a series of parallel wires usually connected at one end to another conductor that is grounded. Also known as Faraday Cage or Faraday Screen.

FOLLOW CURRENT (FOLLOW ON CURRENT)

The current from the connected power source that flows through or past a surge protective device during and following the passage of discharge current.

GROUND

A conducting connection, whether intentional or accidental, by which an electrical circuit or equipment is connected to the ~~earth~~Earth, or to some conducting body of relatively large extent that serves in place of the ~~earth~~Earth.

GROUND BUS

A bus to which the grounds from individual pieces of equipment are connected, and that, in turn, is connected to Earth ~~g~~Ground at one or more points.

GROUND CURRENT

Current flowing in the ~~earth~~Earth or in a grounding connection.

GROUNDED

Connected to ~~earth~~Earth or to some extended conducting body that serves instead of the ~~earth~~Earth, whether the connection is intentional or accidental.

GROUNDED CIRCUIT

1. A circuit in which one conductor or point (usually the neutral conductor or neutral point of transformer or generator windings) is intentionally grounded, either solidly or through a grounding device.
2. A circuit in which one conductor or point is accidentally grounded, either directly or through a grounding device.

GROUNDED CONDUCTOR

A system or circuit conductor that is intentionally grounded.

GROUND-FAULT CIRCUIT-INTERRUPTER (GFCI)

A device intended for the protection of personnel that functions to interrupt the electric current to the load within an established period of time when a fault current to ground exceeds some predetermined value that is less than that required to operate the over current protective device of the supply circuit.

GROUND GRID (GROUND ELECTRODE SYSTEM)

A system of grounding electrodes consisting of interconnected bare cables buried in the ~~earth~~-Earth to provide a common ground for electrical devices and metallic structures.

GROUNDING CONDUCTOR

A conductor used to connect equipment or the grounded circuit of a wiring system to the grounding electrode or electrodes.

GROUNDING ELECTRODE (EARTH ELECTRODE)

A conductor used to establish a ground, through direct contact with the soil.

GROUND POTENTIAL RISE (GPR)

The difference in ground potential between a location in proximity to a point of large current injection into the ground and any remote ground point. GPR is usually caused by a short circuit of an energized power conductor to ground and is the result of the injected current flowing through the impedance of the ground circuit. Lightning can also cause GPR.

IMPULSE

A surge of unidirectional polarity.

IMPULSE DISCHARGE CURRENT

The amount of current shunted or absorbed by a surge protective device.

IMPULSE SPARKOVER (FLASHOVER) VOLTAGE

The highest magnitude of voltage attained by an impulse of a designated wave shape and polarity applied across the terminals of a surge arrester prior to the flow of discharge current. Sometimes referred to as "surge" or "impulse breakdown voltage".

IMPULSE WITHSTAND VOLTAGE

The crest value of an applied impulse voltage that, under specified conditions, does not cause a flashover, puncture, or disruptive discharge on the test specimen.

ISOLATION

Physical and electrical arrangement of the parts of ~~an~~-equipment, system, or facility to prevent uncontrolled electrical contact within or between the parts.

ISOLATION TRANSFORMER

A transformer of the multiple-winding type, with the primary and secondary windings physically separated. This isolation separates grounded ac circuits from floating/ungrounded ac circuits.

JOULE

A unit measure of energy. The work done when the point of application of a force of one Newton is displaced a distance of one meter in the direction of the force (1 Joule = 1 Watt-second).

LET-THROUGH VOLTAGE

The current and ~~time-time~~-dependant voltage present at the equipment side terminals of a surge protective device.

LIGHTNING ARRESTER/PROTECTOR

See SURGE ARRESTER.

LIGHTNING SURGE

A transient electrical disturbance in an electric circuit caused by lightning.

LONGITUDINAL (COMMON MODE) VOLTAGE

The voltage common to all conductors of a group as measured between that group at a given location and an arbitrary reference (usually ~~earth~~Earth), but not between conductors at each individual end.

MADE GROUND

An intentional connection between an electrical conductor and ground.

MAXIMUM CONTINUOUS OPERATING VOLTAGE (MCOV)

The maximum designated rms value of power frequency that may be applied continuously between the terminals of the surge protective device without degradation of the device.

MULTIPOINT GROUND

More than one path to ground.

NATIONAL ELECTRICAL SAFETY CODE (NEC)

A standard governing the use of electric supply and communications lines, equipment, and associated work practices employed by an electric supply, communications, railway, or similar utility in the exercise of its function as a utility. It also covers similar systems under the control of qualified persons, such as those associated with an industrial complex or ~~utility-utility~~-interactive system (ANSI C2).

NEUTRAL

The ac power system conductor that is intentionally grounded on the supply side of the first service disconnecting means. It is the low potential (white) side of a single-phase ac circuit or the low potential fourth wire of a three-phase wye distribution system. The neutral (grounded conductor) provides a current return path for ac power currents.

whereas the grounding (or green, safety ground) conductor does not, except during fault conditions.

NORMAL MODE

See DIFFERENTIAL (TRANSVERSE, METALLIC, NORMAL) MODE VOLTAGE.

PRIME GROUND TERMINAL

A terminal electrically common to a metallic electrical equipment enclosure to which all internal grounding conductors are routed, and which in turn is externally connected to the made ground for the installation (not applied to modern railroad practices).

RADIO FREQUENCY INTERFERENCE (RFI)

RFI is intentional or unintentional electromagnetic energy that results in unintentional and undesirable responses from or performance degradation or malfunction of electronic equipment.

SERVICE BOX (SERVICE EQUIPMENT)

The necessary equipment, usually consisting of a circuit breaker or switch or fuses, and their accessories, located near the point of entrance of supply conductors to a building or other structure, or an otherwise defined area. It is intended to constitute the main control and means of cutoff of the supply and is constructed so that it may be effectively locked or sealed.

SHIELD

A housing, screen, or cover which substantially reduces the coupling of electric and/or magnetic fields into or out of circuits or prevents the accidental contact of objects or persons with parts or components operating at hazardous voltage levels.

SPARKOVER

A disruptive discharge between electrodes of a measuring gap, voltage-control gap, or surge protective device.

STEP POTENTIAL

The potential difference between two points on the ~~earth's~~Earth's surface separated by a distance of one pace (assumed to be one meter) in the direction of maximum potential gradient. This potential difference could be dangerous when current flows through the ~~earth~~Earth or material upon which a worker is standing, particularly under fault conditions or lightning strikes to ~~earth~~Earth.

SURGE

A transient voltage or current, which usually rises rapidly to a peak value and then falls more slowly to zero, occurring in electrical equipment or networks in service. Surges are generally distinguished from transients based on their duration (i.e., > 8.3 milli-sec.).

SURGE ARRESTER

A protective spark gap device for limiting surge voltages on equipment by discharging or bypassing surge current that is capable of repeating these functions as specified.

Note: Historically, the term arrester has been used interchangeably with the term lightning arrester. In railroad signaling applications, the term arrester was typically applied to air-gapped silicon carbide protective devices applied on low voltage circuits (track and line circuits) in a line-ground orientation at their point of entry to a facility.

SURGE ARRESTER GAS-TUBE

A gap or series of gaps in an enclosed discharge medium designed to protect apparatus or personnel or both from high transient voltages.

SURGE LET-THROUGH

The peak voltage level of the surge that passes by a surge protective device.

SURGE PROTECTION, TERTIARY

Components integrated into the design of the device they are intended to protect. Operating parameters of tertiary protection need to compliment the characteristics of any upstream surge protective devices (*i.e. primary and secondary*).

SURGE PROTECTIVE DEVICE MODE(S) OF OPERATION

A mode of operation for an SPD identified as having a protective element or elements connected in the following manner:

1. Across pairs of **energized** (non-grounded) lines identified as Line-Line.
2. Between a non-grounded conductor and a neutral conductor, identified as Line-Neutral.
3. Between a neutral conductor and grounded conductor, identified as Neutral-Ground.
4. Between a **signal** conductor and ground, identified as Line-Ground.

Note: A surge let-through voltage level, maximum continuous operating voltage level, and maximum surge current level shall be identified by each mode of operation of the SPD. Follow through current performance levels shall also be identified for all operational modes of arrester gas and air gap type SPD's. One may also want to identify maximum (utility) fault current levels for each mode of operation of a **series** series-operated SPD.

SURGE PROTECTIVE DEVICE, PRIMARY

A surge protective device applied on a circuit at its entrance to a facility and rated to withstand the severest category of impressed surges for that environment.

SURGE PROTECTIVE DEVICE, SECONDARY

A surge protective device applied on a circuit usually protected by a primary surge protective device and rated to withstand the severest category of impressed surges for that environment. Typically located away from the circuit's entrance to the facility. (Note: In areas of low exposure, a secondary surge protective device might be used in lieu of a primary surge protective device).

SURGE PROTECTIVE DEVICE, SIGNAL

A surge protective device specifically designed for circuits used in railroad signal systems.

SURGE PROTECTIVE DEVICE (SPD) (SURGE PROTECTOR)

The generic term used to describe a device by its protective function, regardless of technology, uses, ratings, packaging, point of application, etc.

SURGE PROTECTIVE DEVICE, VITAL

A primary surge protective device intended for use in railroad signal circuits that cannot be grounded without reducing safety.

SURGE PROTECTOR

See SURGE PROTECTIVE DEVICE (SPD).

SURGE WITHSTAND CAPABILITY

The maximum dc, ac rms, or impulse voltage and energy which can be applied between terminals of a circuit, or between a circuit and metallic chassis of the equipment, without resulting in functional, electrical, or mechanical damage to the equipment.

TOUCH POTENTIAL (refer to STEP POTENTIAL)

The voltage potential difference between a conductive structure and a point on the ~~earth's~~ Earth's surface separated by a distance equal to the normal maximum horizontal reach, approximately one meter. This voltage potential difference could be dangerous and could result from induction, lightning, or fault conditions. -Touch potential can also exist between two close proximity conductive structures.

TRANSIENT

A change in the steady-state condition of voltage or current, or both. Transients may be caused by lightning, a fault, or by power line switching operations, and may readily be transferred from one conductor to another by electrostatic or electromagnetic coupling. The time duration of a "transient" is often recognized as an event with a duration of less than 8.3 milliseconds, as differentiated from a "surge" which is an event with a duration greater than 8.3 milliseconds.

TRANSIENT VOLTAGE SURGE SUPPRESSOR (TVSS)

See SURGE PROTECTIVE DEVICE.

TRANSVERSE (DIFFERENTIAL, METALLIC, NORMAL) MODE VOLTAGE

See DIFFERENTIAL (TRANSVERSE, METALLIC, NORMAL) MODE VOLTAGE.

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