

OSH INFORMATION MEMORANDUM 95 X 97

TO: OSH Managers, Supervisors, and Field Personnel

FROM: W. M. Lybrand

DATE: September 29, 1995

SUBJECT: GUIDELINES FOR ENFORCEMENT OF 1910.269, THE ELECTRIC POWER GENERATION, TRANSMISSION, AND DISTRIBUTION STANDARD

- A. PURPOSE. This guide provides inspection assistance related to 1910.269 and a glossary of industry terms to assist Compliance Officers and Industrial Hygienists (CO/IH) performing inspections at electric power generation, transmission, and distribution facilities.
- B. GLOSSARY OF INDUSTRY TERMS. See attached Appendix A (from Federal OSHA Instruction CPL 2-1.18).
- C. INSPECTION RESOURCES.

- 1. Experienced Personnel Only. The OSH Administrator shall ensure that an adequate number of appropriately trained and/or experienced CO/IHs is available for inspections at electric power generation, transmission and distribution installations.
- 2. Expert Services. When they are considered necessary, expert services shall be involved in the case at the earliest practicable date.

D. CONDUCT OF INSPECTION AND CO/IH/EMPLOYEE SAFETY AND HEALTH.

The following CO/IH and employee safety and health concerns are applicable during compliance inspections at electric power generation, transmission, and distribution facilities.

- 1. Due to the fact that electrical hazards are normally not observable, CO/IHs are reminded to take caution when approaching utility employees working with machinery or electrical equipment so as not to interrupt them prior to determining that it is safe to do so. Due to the presence of open bus bars and other energized equipment in this industry, CO/IHs should take caution not to touch or expose themselves to anything unfamiliar to them.
- 2. CO/IHs are to inquire about the presence of gases, fumes and vapors, and the location of high pressure steam lines, for their own protection as well as that of facility employees. (CO/his should have, on hand, a detector tube and a

supply of detector tubes for air contaminants they may encounter.) Examples of situations where such hazards may be present are:

- a. Furnace effluents containing particulate, coal tar pitch volatiles, sulphur dioxide and carbon monoxide may be present. The latter two may be present in lethal concentrations near furnace leaks. (A clue to the constant presence of sulphur dioxide is corroded metal structures/surfaces.) In addition, particulate from flyash contain silica, and possibly arsenic, depending on the type of coal used;
- b. Ozone is produced in some high voltage electrical operations. For example, it may be present in high concentrations in electrostatic precipitators;
- c. Enclosed spaces may contain traces of metal fumes and organic vapors emanating from energized equipment;
- d. During the chemical cleaning of boilers and pressure vessels, flammable liquids, gases, vapors or combustible materials may be used or produced during the cleaning process. Hydrazine may be used to clean boilers. Hydrazine has a PEL of 1 ppm and may be absorbed through the skin;
- e. Chlorine is likely to be present in chlorine system enclosures and may be present in the surrounding area. As a consequence of water treatment, there may be hazardous toxic or reactive chemicals in drainage trenches in the lowest levels of the power plant; and
- f. High pressure steam leaks which may be invisible are hazardous energy sources. This noise in the generation area may possibly conceal this hazard. Exposure to such hazards could cause serious harm. Caution should be exercised when traveling in these areas.
- g. Furnaces and boilers may also present confined space hazards to employees who enter them for cleaning and maintenance purposes.

3. Other Potential Hazards.

- a. Chrysotile asbestos is present in older power generation facilities. Amosite asbestos may be use in valve packing;
- b. During overhaul of boilers, inadequate scaffolding and boatswain chairs may present fall hazards; CO/IHs should inspect for such fall hazards particularly in the expansion spaces between the boilers and grating.
- c. Because of extremely high temperatures, looking in to the flame of a boiler may cause eye damage due to electromagnetic radiation in the optical range if protection is not used;
- d. Slag may be mechanically removed from fireside, for example, tube, surfaces of boilers; protection from falling slag and other objects is required by .269(v)(9)(i). Appropriate personal protective equipment must be used to supplement engineering controls and safety and healthful work practices to prevent harmful exposure to such hazards;
- e. Areas where pulverized coal is transported and stored may contain explosive coal/air mixtures. Electric equipment in such area must be approved for the hazardous location. (Note: Enforcement of

1910.269(v)(11)(xii) has been stayed until February 1, 1996.) Location of a safe means of egress must always be kept in mind;

- f. Mercury may be present in the flooring of the instrument repair area of the power plant;
- g. There are noise hazards related to induction fans;
- h. Electrical test equipment used by CO/IHs must be fully protected against the effects of electromagnetic fields;
- i. Cadmium may be used to coat fish-screens in the intake caissons and to tip blades used to propel coal; and
- j. Polychlorinated biphenyls may be present in maintenance operations involving capacitors and transformers. Dioxin may be present where these components were overheated.

4. Personal Protective Equipment (PPE).

- a. When conducting inspections, CO/IHs shall wear clothing, in addition to standard PPE, made of 100% cotton fabric. Also, the CO/IH shall wear any clothing and PPE required by employer (i.e., fire retardant coveralls).
- b. When inspecting power generation plants, CO/IHs shall wear safety glasses with fixed side shields that meet ANSI Z87.1-1989 requirements.

5. Special Precautions When Obtaining Photographs, Recording and Using Equipment.

CO/IHs should exercise extreme caution when using cameras and any other equipment during these inspections. CO/IHs should not use equipment in locations that are hazardous (classified). Detailed sketches may be more appropriate at times.

CO/IHs are not to enter restricted areas or confined spaces. Restricted areas are areas where exposure to electric parts, chemical or steam hazards is likely to occur. Some examples of restricted areas are: electrical vaults, switch gear rooms, transformer rooms, chlorine system enclosures, and water/steam spaces.

E. ACCIDENT INVESTIGATIONS.

All significant accident, fatalities, and catastrophes will be investigated as thoroughly and expeditiously as possible. CO/IHs should request all photographs, videotapes, dispatches, records, tapes, etc. relevant to the investigations.

CO/IHs shall follow the procedures for these investigations in the OSHA Field Manual (Chapter III, Pages 22-30).

- F. EFFECTIVE DATES OF REQUIREMENTS. Paragraph (v)(11)(xii) of 1910.269 has been stayed until February 1, 1996. All other provisions of the 1910.269 are in effect.
- G. JURISDICTIONAL ISSUES AND REFERRALS. The Compliance Manager shall coordinate inspection and hazard abatement activities with MSHA and/or NRC to ensure the safety of affected employees. Referrals of hazards shall be made when appropriate.
1. MSHA. The requirements of 1910.269 are intended to apply to conditions and installations for which MSHA does not in fact “exercise statutory authority to prescribe or enforce standards or regulations”. MSHA’s jurisdiction relative to power generation plants covers the processing of coal prior to final transport of the coal into the power generation building (where the coal is burned). Processing includes activities such as mixing, breaking, crushing, sizing, washing, and mechanically assisted drying. The location of these activities whether on or off the property owned or leased by the power generation company is not an issue. The following two scenarios are provided to assist in understanding the MSHA/OSHA interfaces:
 - a. Coal is stored outdoors in piles on the property of a power generation company. Before use the coal is run through a crusher building, after which it is sized, washed, artificially dried as it is transported on a conveyor from which it is dumped into the power generation building. In this scenario, MSHA had jurisdiction up to the point where the processed coal is dumped onto the conveyor which carries it into the power generation building; and
 - b. Coal is stored outside the power generation building in silos, hoppers or outdoor piles on company property and immediately next door on property not belonging to the power generation company, which has the contractual right to transport and use the coal in its facility. The coal is not processed in any way before use. It is loaded from the various storage areas on both properties onto conveyors which deliver it directly into the power generation building. OSHA has jurisdiction over all of the activities described in this scenario, including the silos, hoppers and outdoor piles.

NOTE: Because the above information may not be sufficient to delineate jurisdictional boundaries in many situations, it is recommended that the Compliance Manager consult with the local MSHA office to determine jurisdiction during each inspection where this issue may be a factor.

2. NRC. Both the NRC and OSHA have jurisdiction over occupational safety and health at NRC-licensed facilities, many of which are electric power generation plants fueled by nuclear energy. At such facilities OSHA covers plant conditions which result in occupational hazards, but which do not affect the safety of the licensed radioactive material. For example, OSHA covers exposures to toxic non-radioactive materials and other non-radioactive related hazards throughout the facility. Specifically, 1910.269 applies throughout

such facilities except in areas directly involved in the support and/or the production of nuclear energy.

H. CONSTRUCTION vs. MAINTENANCE

1. A general definition of “construction” is given at 1910.12(b) as follows:
“For purposes of this section, Construction Work means work for construction, alteration, and/or repair, including painting and decorating.”
2. Following are some examples of situations in which the issue of construction vs. maintenance may arise.
 - a. The building of new power lines and towers, generation plants, underground distribution facilities and power stations is construction. Additions to or extensions of existing equipment or lines is also construction;
 - b. Moving an existing power line and supporting poles, without alteration or replacement of parts, a few feet to the side to allow for the widening of a roadway is covered under 1910.269. If there were violations, the company moving the power lines in this scenario would be cited under 1910.269. The contractor working on the roadway would be cited under 1926. If further down the road, longer power lines had to be installed to cross the widened span of the roadway, then this operation would be covered under the construction standards;
 - c. Generally speaking, refurbishing (replacement “in kind”) equipment and space is maintenance and covered under the general industry standards; reconfigurations of space or installation of new equipment (such as equipment capable of carrying higher voltages) is construction;
 - d. Scheduled touch-up and spot painting which is done to maintain equipment or structures is not construction; however, painting to complete newly built structures and building is construction. A complete repainting job in one room or on a major portion of a structure or building is construction. (Note: Painting is not covered by 1926, Subpart V.) Removal of lead-based paints is construction; and
 - e. The repair of specific limited portions of electrical systems to keep them in operation is covered by the general industry standards.
3. Citation in the Alternative. In cases where it is not readily obvious whether the general industry or construction standards apply, citation of standards from both general industry and construction may be issued. CO/IHs should follow procedures referenced in the OSHA Field Manual, Chapter V, Pages 4 and 5.

- I. OTHER RELATED STANDARDS. The OSHA standard at 1910.268 pertains to telecommunications work. Much of the field work related to 1910.268 is similar in nature to the type of field work performed by electric utility employees, and the

hazards faced in the performance of this type of work are frequently the same in both industries. The standard applicable would be determined by the activity being performed by the employee(s). Some activities, such as line clearance involving electrical power and telecommunications lines in the same operation, may be subject to both the 1910.268 and .269 standards.

J. Appendix E to 1910.269 provides a list of reference documents that can be helpful in understanding hazards in particular industries covered by the standard. For example, one such listing is ANSI Z133.1-1988, American National Standard Safety Requirements for Pruning, Trimming, and Repairing, Maintaining, and Removing Trees, and for Cutting Brush.

K. RELATED DIRECTIVES AND MEMORANDUMS OF UNDERSTANDING.

1. OSH Information Memorandum 90-x-86 (1/2/91).

SUBJECT: Inspection Guidelines for Enforcing the Control of Hazardous Energy Sources (Lockout/Tagout)

NOTE: With the exception of paragraph (d)(8)(v) paragraph (d) Hazardous energy control (lockout/tagout) procedures, of 1910.269 is taken nearly verbatim from 1910.147. OSHA Guidelines in OSH Information Memorandum 90-x-86 may be used to determine compliance with paragraph (d) of 1910.269 with respect to both electrical and nonelectrical hazards.

2. Memorandum of Understanding Between the Occupational Safety and Health Administration and the U.S. Nuclear Regulatory Commission (NRC) (10/21/88).

3. Interagency Agreement between MSHA and OSHA, March 29, 1979.

L. EFFECTIVE DATE.

This memorandum is effective immediately and shall remain in effect until cancelled or superseded.

APPENDIX A

GLOSSARY OF INDUSTRY TERMS

Air gap withstand voltage means a voltage which corresponds to a 1 in 1000 probability, approximately, of flashover as determined by the statistical method described in Appendix B-IV A.4. of the standard.

Ampacity means the current-carrying capacity of electric conductors expressed in amperes.

Anchorage means a secure point of attachment for personal fall arrest equipment which is independent of the means of supporting or suspending employees.

Applied loads means the working loads to which mechanical equipment are subjected when lifting and/or moving lines or other materials.

Atmospheric pressure or temperature differences means the differences between the pressure or temperature inside, relative to the temperature or pressure outside an enclosed space.

AWG stands for American Wire Gauge (Also called Brown and Sharpe gauge). AWG refers to wire size, that is the diameter of a wire.

Backfeed means energizing an otherwise deenergized circuit by a power source other than the deenergized power source.

Body belt (safety belt) means a strap with the means both for securing it about the waist and for attaching it to a lanyard, lifeline, or deceleration device.

Body harness means a design of straps which may be secured about the employee in a manner to distribute the fall arrest forces over at least the thighs, pelvis, waist, chest and shoulders with means of attaching it to other components of a personal fall arrest system.

Bonding means the joining of conductive parts to form an electrically conductive path designed to maintain a common electrical potential.

Breakdown voltage means the voltage at which a disruptive discharge takes place through or over the surface of insulation.

Brush means a conductor, usually composed, in part, of some form of the element carbon, serving to maintain an electric connection between stationary and moving parts of a machine or apparatus.

Buckling means a lateral deflection. For example a power or telephone pole which deflects in a horizontal direction, that is perpendicular to the length of the pole, such that the pole is bowed relative to its ends.

Bushing means an insulating structure including a central conductor, or providing a passageway for such a conductor, with provision for mounting on a barrier, conducting or otherwise, for the purpose of insulating the conductor from the barrier and conducting current from one side of the barrier to the other. (See ANSI/IEEE Std. 100-1988, IEEE Standard Dictionary of Electrical and Electronic Terms for other definitions of bushings used in electric power generation, transmission and distribution).

Capacitor is an electrical device which stores an electrical charge. It consists of two conducting plates of metal separated by an insulating material called a dielectric. Capacitance (C) is the ability to store an electrical charge where $C=Q/V$ and Q is the amount of charge and V is voltage. The unit for capacitance is the Farad (F).

Capacitor bank is a group of electrically connected capacitors. A capacitor bank is used to raise the power factor that is, it tends to bring the voltage and current in phase. When the voltage and current are perfectly in phase, the power factor is unity (one).

Catch-off point means an attachment point on supporting structures to which load bearing hardware and accessories, rigging and hoists are attached to install or remove line conductors.

Circuit transient means a change in the steady state condition of voltage or current or both. It is the transition period during which the current and voltage change from their former value to new ones. This transition interval is called the transient; before and after which, the circuits are said to be in the steady state condition. Transients may be caused by lightning, by faults, or by switching operations and may be transferred readily from one conductor to another by means of electrostatic or electromagnetic coupling.

Climbers are a pair of hooked shaped devices which are used by an employee to ascend, maintain working positions and descend wooden poles. Climbers are worn over the work shoes such that the curved part of the hook fits under the shoe between the heel and lower leg. Climbers are strapped on the leg below the knee and on the foot at the ankle.

Closed circuit means an unbroken conductive path for current to flow from the electromotive force (emf) through loads and back to the emf source.

Coal bunker means an open bin in which coal is stored. A bunker has a four sided cross section; whereas a coal silo, also used to store coal, has a circular cross section.

Cogeneration means two or more power generating stations supplying electrical energy to the same distribution transmission system.

Condenser means a heat exchange where latent heat is removed from, for example, turbine exhaust steam without changing the steam temperature. The steam passes over tube bundles through which water flows. Heat from the steam is conducted through the tubes to the water which carries the heat away.

Conductor grip means a device designed to permit the pulling of conductor without splicing on fittings, eyes, etc. It permits the pulling of a continuous conductor where threading is not possible. The design of these grips vary considerably.

Current transformer means an instrument transformer intended to have its primary winding connected in series with the conductor carrying the current to be measured or controlled.

Dead end is the end of an electric wire or cable which may or may not be energized.

Dielectric means a medium in which it is possible to maintain an electric field with little or no supply of energy. Examples of dielectric materials are air, teflon, paper, Bakelite and ceramic (electrolyte type).

Dielectric Strength means the maximum potential gradient a dielectric material can withstand without breakdown, that is, becoming a conductor.

Drawhead means the body of an automatic coupler used to connect railroad (coal and ash carrying) cars and locomotives. (See Knuckle.)

Dropline means a vertical lifeline.

Drop starting means starting a portable saw by holding the saw away from the body in one hand and with no other means of support, pulling the starting cord (rope) with the other hand.

Elasticity of synthetic rope means the ratio of ["A" minus "B"] to "B" where:

1. "A" equals the elongated length of the rope when fully supporting the load.
2. "B" equals the stretched full length of the rope before supporting any of the load
3. Rope length is measured from the anchor connection to the safety belt or harness connection.
4. The load is the combined tool and body weight of the climber.

Electric generators are machines which convert mechanical power into electric power; whereas, electric motors are machines which convert electric power into mechanical power.

Electromagnetic radiation means the flow of energy consisting of orthogonally vibrating electric and magnetic fields lying transverse to the direction of propagation. X-rays,

ultraviolet, visible, infrared, and radio waves occupy various portions of the electromagnetic spectrum and differ only in frequency and wavelength.

Electromagnetic wave means a wave characterized by variations of electric and magnetic fields.

Electrostatic shielding is a ground wire or static wire mounted above and strung along the line conductors, in similar fashion to the line conductors, to protect or shield the circuit from lightning.

Empirically determined means determined by "...experience or observation alone often without due regard for system and theory."

Employee proficiency means that the employee, through training required by 1910.269(a)(2), has the knowledge and skills necessary to perform work practices mandated by 1910.269 in a safe manner.

Energized means connected to an energy source or containing residual or stored energy when used in 1910.269(d); otherwise the definition of energized in 1910.269(x) applies.

Equipotential zone means a three dimensional space in which temporary protective grounds are placed (located and arranged) to eliminate hazardous step potentials and touch potentials (See definitions in Appendix C II B of the standard).

Exciter means the source of all or part of the field current for the excitation of an electric machine. Note: Familiar sources include direct-current commutator machines; alternating-current generators whose output is rectified; and batteries. (See ANSI/IEEE Std. 100-1988, IEEE Standard Dictionary of Electrical and Electronic Terms for other definitions of exciter).

Exothermic means a chemical reaction that releases energy, for example, heat. Oxidation and Reduction Chemical reactions are exothermic. For example, Sodium (Na) atoms combined with Chlorine (Cl₂) molecules react to form salt (NaCl) and emit heat by the following equation: $2\text{Na} + \text{Cl}_2 \rightarrow 2\text{Na}^+ (\text{reducing agent}) + 2\text{Cl}^-$.

Expulsion-type fuse means a vented fuse in which the expulsive effect of gases produced by the arc or burning of the fuse holder, either alone or aided by a spring, extinguishes the arc. The arc erodes the tube of the fuse holder, producing a gas that ignites causing an explosion that blasts the arc out through the fuse tube vent(s) and thereby opens the circuit.

Extra high voltage (EHV) is defined as voltage levels higher than 240,000 volts.

Fault means a partial or total local failure in the insulation or continuity of a conductor. (See ANSI/IEEE Std. 100-1988, Standard Dictionary of Electrical and Electronic Terms for other definitions used in electric power generation, transmission and distribution.)

Flashover (gap sparkover) voltage means a disruptive discharge through air around or over the surface of solid or liquid insulation, between parts of different potential or polarity, produced by the application of voltage wherein the breakdown path becomes sufficiently ionized to maintain an electric arc.

Flume means an artificial channel or chute which transports and directs the flow of water, for example, to the hydroelectric turbine. Flumes may be open or closed. A canal is an example of an open flume and a penstock is an example of a closed flume.

Forced air ventilation means mechanical ventilation such as a permanent or portable blower (as opposed to natural ventilation).

Forebay is an open basin, that is, a small reservoir to take care of variations in water flow demand at the turbine. A forebay is located between the canal on the upper end and the penstock on the lower end of a hydroelectric power plant installation which directs water from the upper reservoir to the hydraulic turbine below.

Free-fall means the act of falling before the personal fall arrest system begins to apply force to arrest the fall.

Gaff means the metal spur part of climbers. The gaff is attached to the bottom of the hook stem and protrudes toward the other foot. (See climbers.)

Gap means the clear air space between objects.

Hazardous energy means a voltage at which there is sufficient energy to cause injury. If no precautions are taken to protect employees from hazards associated with involuntary reactions from electric shock, a hazard is presumed to exist if the induced voltage is sufficient to pass a current of 1 milliamperes through a 500 ohm resistor. (The 500 ohm resistor represents the resistance of an employee.) If employees are protected from injury due to involuntary reactions from electric shock, a hazard is presumed to exist if the resultant current would be more than 6 milliamperes (the let-go threshold for women).

Hazardous (induced) voltage means 50 (rms) volts or more.

High power testing involves sources where fault currents, load currents, magnetizing currents, or line dropping currents are used for testing, either at the rated voltage of the equipment under test or at lower voltages.

Impedance (Z) is the ratio of voltage to current expressed in complex terms. It represents the opposition that a circuit offers to A.C. current. $Z=v/i$ measured in ohms where v =voltage and i =current. (See ANSI/IEEE Std. 100-1988, IEEE Standard Dictionary of Electrical and Electronic Terms for other definitions used in electric power generation, transmission and distribution).

Induced voltage means a voltage produced around a closed path or circuit by a change in magnetic flux linking that path. (See ANSI/IEEE Std. 100-1988, IEEE Standard Dictionary of Electrical and Electronic Terms for other definitions used in electric power generation, transmission and distribution.)

Inextricably commingled refers to electrical components of the power generation, distribution and transmission systems and the utilization systems in an electric power generation, substation or other facility such that the components are mixed (interconnected) so that they are indistinguishably tied together.

Jumper means a short length of cable used to make electric connections within, between, among, and around circuits and their associated equipment. Note: It is usually a temporary connection.

Knuckle means the movable arm which connects with the drawhead to form the coupling on cars and locomotives. (See Drawhead.)

Laser means Light Amplification by Simulated Emission of Radiation. Any of several devices that convert incident electromagnetic radiation of mixed frequencies to one or more discrete frequencies of highly amplified and coherent radiation may be called a laser.

Line Insulator is a device which prevents the flow of an electric current by direct contact or flashover and is used to support electrical conductors. A function of an insulator is to separate the energized conductors from the poles or towers. Insulators are fabricated from porcelain, glass, clay and fiberglass. (See ANSI/IEEE Std. 100-1988, IEEE Standard Dictionary of Electrical and Electronic Terms for other descriptions and definitions of “insulator”).

Live-line bare-hand work (technique) means work performed by a qualified employee or person in an equipotential zone established at the potential of a line conductor.

Live-line tool rods, tubes, and poles (hot sticks) are insulating tools used by employees to perform live line servicing and maintenance. These tools insulate the employee from an energized part and enable the employee to work a safe distance from an energized part.

Loadline means a rope or line which bears the weight of a mass, for example, a tower or a tower section during erection or removal.

Maximum rated operating pressure means the maximum operating pressure for which a hydraulic and pneumatic tool is designed and built by the manufacturer and identified on the nameplates of these tools.

Maximum rated load (or load rating) means the maximum applied load for which the mechanical equipment is designed and built by the manufacturer and identified on the nameplate of the equipment.

Metering (meter installation inspection): Examination of the meter, auxiliary devices, connections, and surrounding conditions, for the purpose of discovering mechanical defects or conditions that are likely to be detrimental to the accuracy of the installation. Such an examination may or may not include an approximate determination of the percentage registration of the meter.

Microwave (data transmission). A term used rather loosely to signify radio waves in the frequency range from about 1000 megahertz (mHz) upwards. Microwave radio signals are used for point to point communication between substations and other power-system facilities and specifically, for communication channels, protective relaying, supervisory control and remote metering.

Normal (Gaussian) distribution is a continuous probability distribution which is defined by

$$f(x) = \frac{1}{\sigma\sqrt{2\pi}} e^{-1/2(x-\mu)^2/\sigma^2}$$

The standard normal distribution or curve is obtained by substituting $t = x - \mu$ into $f(x)$ above or

$$\Phi(t) = \frac{1}{\sqrt{2\pi}} e^{-1/2t^2}$$

Which has a mean, $\mu = 0$ and a variance, $\text{Var} = \sigma^2 = 1$

The above normal (Gaussian) distribution curve is a bell-shaped curve which is symmetrical about the positive y-axis (at which $\Phi(t)$ has its maximum value) of an x-y graph. The ends of the curve approach the x-axis as x increases and as $-x$ decreases.

In one standard deviation ($\sigma = 1$), there is 68.2% of the area under the curve, that is, there is a 68.2% probability that the random variable lies within one standard deviation. Likewise, there is a 95.4% and 99.6% probability within $\sigma = 2$ and $\sigma = 3$, respectively.

Open circuit means a break in the circuit so that a complete conductive path is not provided for current to flow.

Overhead lines means electric transmission or distribution line conductors installed overhead either underground or above ground inside or outside of a building.

Overvoltage means a voltage above the normal rated voltage or the maximum operating voltage of a device or circuit. (See ANSI/IEEE Std. 100-1988, IEEE Standard Dictionary of Electrical and Electronic Terms for other definitions of overvoltage used in electric power generation, transmission and distribution.

Parallel circuit means a circuit in which two or more (for example, resistor) components are connected across the same voltage source.

Partial vacuum means the pressure inside a vessel is less than the atmospheric pressure surrounding the vessel.

Penstock is the closed conduit which transports water at the upper reservoir level to the (tail-water reservoir) level below at a hydroelectric power plant. A penstock is located between a forebay at the end of the canal on the upper level and a hydraulic turbine in the powerhouse on the lower level.

Personal fall arrest equipment consists of a body belt or body harness, connectors and may include a lanyard, deceleration device, lifeline or suitable combination.

Personal fall arrest system means a system used to arrest an employee in a fall from a working level. It consists of an anchorage and personal fall arrest equipment.

Phase-to-ground voltage means the voltage measured by a voltmeter between a conducting transmission line and a ground wire, for example the electrostatic shielding conductor to the ground (earth).

Phase-to-phase voltage means the voltage measured by a voltmeter between conducting transmission lines.

Phasing out means live-line maintenance to determine whether the phase of a given electric line (or apparatus) corresponds with the phases of another line (or apparatus) when a new line is to be paralleled with another line, new or old, and after repairs or changes have been made on either of two lines which have previously operated in parallel. When a phasing out voltmeter, connected across corresponding lines or phases reads zero voltage, the phases of the two lines are properly installed in-phase.

Power line carrier means the use of radio frequency energy, generally below 600 kHz, to transmit information over transmission lines whose primary purpose is the transmission of electric power.

Pull rig means a rig used to install or remove a line conductor. The pull rig consists of a take-up reel and carriage, a pulling rope and a puller.

Relaying means remote operation of electric control relays by a microwave radio signals, by power line carrier signal, or by pilot wire communications.

Resistance (r) means that physical property of an element, device, branch, network, or system that is the factor by which the mean-square conduction current must be multiplied to give the corresponding power lost by dissipation as heat or as other permanent radiation or loss of electromagnetic energy from the circuit. In short, resistance means the opposition to current flow.

RMS stands for root mean square and is the square root of the average square of the instantaneous magnitude of the voltage or current taken throughout one period. A RMS value is the effective value. Effective values are specific values of voltages and current to which time varying, periodic (alternating) voltages and currents (AC) are associated. By definition, the effective value of a periodic direct voltage and current, V_{eff} and I_{eff} respectively, is the positive direct voltage and current (DC) that produces the same average power (P_{av}) in a resistor (R) or $P_{\text{av}} = V_{\text{eff}}^2/R$ and $P_{\text{av}} = I_{\text{eff}}^2 R$.

Note: Electric appliances are rated in effective (RMS) values. Also, most AC ammeters and voltmeters give readings in effective values.

Example of how to calculate RMS values

For a sinusoidal voltage, the average power loss is

$$P_{\text{av}} = V_m^2/2R \text{ where } V_m \text{ is the peak value of the sinusoidal voltage.}$$

$$\text{Then } P_{\text{av}} = V_{\text{eff}}^2/R = V_m^2/2R \text{ and } V_{\text{eff}} = V_m/\sqrt{2} = .707 V_m$$

Summarizing, the effective voltage (V_{eff}) equals 0.707 times the peak voltage: (V_m) of the sinusoidal at voltage.

A similar calculation yields: $I_{\text{eff}} = I_m = 0.707 I_m$

Note: Different periodic (alternating) voltages and currents have different effective values. For example, a saw tooth (or triangular wave) has effective values equal to the peak values divided by $\sqrt{3}$. Effective values must be calculated (using calculus) for each different periodic wave configuration.

Safety (climber's) saddle means a body sling to which the climbing rope is secured. The safety saddle fits around the lower buttock of the climber and is secured by a taut-line hitch to a snap, front and center on the safety saddle approximately opposite the climber's belly button.

Safety strap means a strap used to support employees in a working position on poles, towers and platforms. Integral snaphooks on each end of the strap connect to different D-rings of a body belt. The strap is adjustable for length by means of a buckle in the strap to suit the workman and the support, for example, the pole, it fits around.

Series circuit means a circuit in which there is only one path for current to flow along.

Short circuit is an abnormal connection (including an arc) of relatively low impedance, whether made accidentally or intentionally, between two points of different potential. (See ANSI/IEEE Std. 100-1988, IEEE Standard Dictionary of Electrical and Electronic Terms for more specific definitions.)

Skirt (petticoat) means the outer skirt-like portion of a line insulator.

Snaphook means a connector comprised of a hook-shaped member with a normally closed keeper, or similar arrangement, which may be opened to permit the hook to receive an object and when released, automatically closes to retain the object. Snaphooks are generally one of two types:

1. The locking type with a self-closing, self locking keeper which remains closed and locked until unlocked and pressed open for connection or disconnection, or
2. The non-locking type with a self-closing keeper, which remains closed until pressed open for connection or disconnection.

Standard deviation (σ) means the square root of variance (Var) which measures the spread of dispersion of a random variable (x) with respect to the mean (μ) or expected value. Where,

$$\mu = \sum_{-\infty}^{\infty} xf(x)dx$$

Stored energy means a residual mechanical, thermal or electrical energy possessed by a machine or equipment after powering and controlling energy source(s) have been isolated. Also, electrical stored energy (W) mean the electromagnetic energy and the electrostatic energy stored in a transmission line at any instant or $W=1/2Li^2 + 1/2Ce^2$ where, C is capacitance, L is inductance and i and e are instantaneous current and voltage, respectively.

Stringing (pilot line) means a light weight rope used to pull the pulling rope to which a line conductor is attached typically for pole installation through the stringing blocks of travelers.

Stringing sheave means a sheave which is used to redirect the travel of a line conductor during its installation or removal. The sheave is mounted on a string block attached to a supporting (pole, tower) structure.

Stringing sock or board means a device which is used to pull multiple line conductors simultaneously by one pulling line.

String insulators means multiple insulators mounted one upon the other to provide the required spread distance between the line conductors and pole or tower supporting components. The number of insulator units in a string depend largely on the voltage of the line, that is, the higher the voltage the more insulator units in a string.

Substation means a high-voltage electric system facility used to switch generators, equipment, and circuits or lines in and out of the system, change a.c. voltages from one level to another, and/or change a.c. to d.c. or d.c. to a.c. (See ANSI/IEEE Std. 100-1988, IEEE Standard Dictionary of Electrical and Electronic Terms for other specific substation definitions.)

Surge arrester means a device that prevents high voltages (overvoltages) from building up on a circuit by discharging or by passing surge current from lightning or transient voltages and then restores normal circuit conditions. (See ANSI/IEEE Std. 100-1988, IEEE Standard Dictionary of Electrical and Electronic Terms for specific application definitions.)

Surge (transients) means a transient wave of current, potential, or power in an electric circuit. Surges can be caused by direct lightning strokes or induced charges as a result of lightning strokes to ground or can be caused by circuit-switching operations as well as the operation of devices connected to the lines.

Switching surge means transient voltage (overvoltage) caused by opening, closing or short circuiting an electrical system. (See ANSI/IEEE Std. 100-1988, IEEE Standard Dictionary of Electrical and Electronic Terms for specific application definitions.)

Taps means connecting deenergized conductors to live lines by special live (hot) line tapping clamps. (See ANSI/IEEE Std. 100-1988, IEEE Standard Dictionary of Electrical and Electronic Terms.)

Tension stringing means the use of pullers and tensioners to keep the conductor under tension and positive control during the stringing phase, thus keeping it clear of the earth and other obstacles which could cause damage.

Test observer means an employee who guards a high-voltage or high-power testing area to prevent unauthorized entry.

Tied-in means an employee wearing a body belt or safety strap is connected to the work positioning equipment including a climbing rope and safety saddle.

Transformer is an electromagnetic device having two or more stationary coils coupled through a mutual flux. Basic components of a transformer are the core and primary and secondary coils (windings). These coils are electrically insulated from each other. Electric energy is transferred from one coil to the other coil using magnetic coupling. The coil receiving energy from an A. C. source is called the primary and the coil delivering energy to the A. C. load is called the secondary. (See ANSI/IEEE Std. 100-1988, IEEE Standard Dictionary of Electrical and Electronic Terms for specific application definitions.)

Transient voltage means overvoltage or undervoltage with respect to steady state voltage.

Voltage Regulator means a device which maintains constant voltage. A voltage regulator is used to vary alternating current (AC) supply or source voltage to keep the voltage within the limits desired.

Waveguide means a system of material boundaries or structures, for example, a hollow cylinder (circular cross section) made of a good conducting material, for guiding electromagnetic waves. Waveguides are used to transfer very high frequency energy at high power levels from place to place. Energy conveyed by the waveguide is contained in the electric and magnetic fields established within the guide.

Web-type lanyard means a strap of woven synthetic fibers.

Work-positioning equipment means equipment used in a positioning device system which is used by an employee for support in an elevated position on a vertical object, for example, a power pole, or a vertical surface, for example the side of a building, so that both hands are free to perform work.