9. Technical Information

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Abrasion Resistance. Ability of a wire, cable or material to resist surface wear.

Accelerated Aging. A test in which voltage, temperature, etc. are increased above normal operating values to obtain observable deterioration in a relatively short period of time. The plotted results give expected service life under normal conditions.

ACM. Aluminum conductor material.

Accelerator. A chemical additive that hastens a chemical reaction under specific conditions.

Admittance. The measure of the ease with which an alternating current flows in a circuit. The reciprocal of impedance.

AEIC. Association of Edison Illuminating Companies

Aerial Cable. A cable suspended in the air on poles or another overhead structure.

Aging. The change in properties of a material with time under specific conditions.

AIA. Aluminum Interlocked Armor.

Alloy. A metal formed by combining two or more different metals to obtain desirable properties.

Alternating Current. Electric current that continually reverses its direction. It is expressed in cycles per second (hertz or Hz).

Ambient Temperature. The temperature of the medium surrounding an object. Generally a lower temperature than the temperature at which the cable is operating.

American Wire Gauge (AWG). A standard North American system for designating wire diameter.

Ampacity. See Current Carrying Capacity.

Ampere. The unit of current. One ampere is the current flowing through one ohm of resistance at one volt potential.

Analog. A data format using continuous physical variables such as voltage amplitude or frequency variations.

Anneal (Soften). Relief of mechanical stress through heat and gradual cooling. Annealing copper renders it less brittle.

Armor. A protective metal covering commonly in the form of flexible interlocking aluminum or steel tape, steel wires, or aluminum sheath.

ASTM. American Society for Testing and Materials.

Attenuation. The general term used to denote the decrease of power from one point to another. In fiber optics, the optical power loss per unit length is expressed logarithmically in decibels per kilometer (dB/km) at a specific wavelength.

Audio Frequency. The range of frequencies audible to the human ear. Usually 20-20,000 Hz.

AWM. Designation for appliance wiring material.

Balanced Circuit. One utilizing cables having two or more identical conductors with the same electromagnetic characteristics in relation to each other and to ground.

Band Marking. A continuous circumferential band applied to a conductor at regular intervals for identification.

Bandwidth. (1) The difference between the upper and lower limits of a given band of frequencies. Expressed in Hertz. (2) A measure of the maximum frequency range over which light intensity exiting a waveguide one kilometer in length can be varied before the attenuation varies 3dB from the mean. The greater the bandwidth, the greater the information carrying capacity. Bandwidth is expressed in Megahertz (MHZ)–Kilometer (km).

Bending Radius. Radius of curvature that a cable can be safely bent without any adverse effects.

Binder. A spirally served tape used for holding assembled cable components in place awaiting subsequent manufacturing operations.

Bonding Conductor. An insulated or uninsulated conductor forming part of the cable assembly which is used for the purpose of connecting non-current carrying parts of electrical equipment to a system grounding conductor.

Braid. A fibrous or metallic group of filaments interwoven in cylindrical shape to form a covering over one or more wires.

Braid Angle. The smaller of the two angles formed by the shielding strand and the axis of the cable being shielded.

Braid Carrier. A spool or bobbin on a braider that holds one group of strands or filaments consisting of a specific number of ends. The carrier revolves during braiding operations.

Braid Ends. The number of strands used to make up one carrier. The strands are wound side-by-side on the carrier bobbin and lie parallel in the finished braid.

Breakdown Voltage. The voltage at which the insulation between two conductors breaks down.

B & S Gauge. The same as American Wire Gauge (AWG).

Buffer. A protective coating over an optical fiber.

Building Wire. A general term used for light and power wiring products, 1000 volts or less.

Bunch Stranding. A group of wires of the same diameter twisted together without a predetermined pattern. Used in flexible cords and cables.

Buried Cable. A cable installed directly in the earth without use of underground conduit. Also called “direct burial cable”.

Butyl Rubber. A synthetic rubber with good insulating properties (i.e. low voltage cords).

Cable. An insulated conductor, or group of individually insulated conductors in one assembly.

Cabling. The twisting together of two or more insulated conductors to form a cable.

Capacitance. The ratio of the electrostatic charge on a conductor to the potential difference between the conductors required to maintain that charge. Units expressed in Farads.

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Capacitive Coupling. Electrical interaction between two conductors caused by the capacitance between them.

Capacitive Reactance (Xc). The opposition to alternating current due to the capacitance of the cable or circuit. Measured in ohms.

CE Code, CEC. Canadian Electrical Code

Certified Test Report (CTR). A report providing actual test data on a cable. Tests are normally conducted by the Quality Control Department to confirm that the product being shipped conforms to specifications.

Characteristic Impedance. The impedance that, when connected to the output terminals of a transmission line of any length, makes the line appear infinitely long. The ratio of voltage to current at every point along a transmission line on which there are no standing waves.

Circular Mil (cmil). The area of a circle one mil (.001") in diameter (7.854 x 10-7 sq in). Used in expressing wire cross sectional area.

Circuit Sizes. A popular term for building wire sizes 14 through 10 AWG.

Cladding. (1) A method of applying a layer of metal over another metal whereby the junction of the two metals is continuously welded. (2) A low refractive index material that surrounds the core of an optical fiber causing the transmitted light to travel down the core and protects against surface contaminant scattering.

Coaxial Cable. A cable consisting of two cylindrical conductors with a common axis, separated by a dielectric.

Cold Flow. Permanent deformation of the insulation or jacket due to mechanical force or pressure, (not due to heat softening).

Color Code. A system for circuit identification through use of solid colors and contrasting tracers.

Composite Cable. One containing more than one type or gauge size of conductors (e.g. power and control conductors in one assembly).

Compound. An insulating or jacketing material made by mixing two or more polymeric ingredients.

Concentric Stranded Conductors. Manufactured to ASTM, ICEA, and CSA standards. The most common fixed installation type conductors are: 1) Round—no diameter reduction: 2) Compressed—approximately 3% diameter reduction; 3) Compact—approximately 10% diameter reduction.

Concentric Stranding. A central wire surrounded by one or more layers of helically wound strands in a fixed round geometric arrangement.

Concentricity. The measurement of the location of the center of the conductor with respect to the geometric center of the surrounding insulation.

Conductivity. The capacity of a material to carry electrical current—usually expressed as a percentage of copper conductivity (copper being 100%).

Conductor. An uninsulated wire suitable for carrying electrical current.

Conductor Shield. An extrusion of black semi-conducting thermoses material over the conductor to provide a smooth interface with the insulation for even distribution of electrical stress.

Conduit (Electrical Raceway). A tube or pipe in which insulated wires and cables are run.

Connector. A device used to physically and electrically connect two or more conductors. Also used to physically connect cable to equipment.

Continuity Check. A test to determine whether electrical current flows continuously throughout the length of a single wire or individual wires in a cable.

Continuous Vulcanization. Simultaneous extrusion and vulcanization of rubber-like (thermoset) coating materials. Often referred to as CV.

Control Cable. A multi-conductor cable made for operation in control of signal circuits.

Copolymer. A compound resulting from the polymerization of two different monomers.

Copperweld. The trade name of Flexo Wire Division (Copperweld Steel Corp.) for its copper-clad steel conductors.

Cord. A small, flexible, insulated wire or cable.

Core. In cables, a component or assembly of components over which additional components (shield, sheath, etc.) are applied.

Corona. A discharge due to ionization of air around a conductor due to a potential gradient exceeding a certain critical value.

Coverage. The percent of completeness with which a metal serving covers the underlying surface.

CPE. Chlorinated polyethylene.

Creep. The dimensional change with time of a material under a mechanical load.

Cross-linked. Inter-molecular bonds between long chain thermoplastic polymers by chemical or electron bombardment means. The properties of the resulting thermosetting material are usually improved (e.g. XLPE).

Crosstalk. Signal interference between nearby conductors caused by pickup of stray energy.

CSA. Canadian Standards Association

Current Carrying Capacity (Ampacity). The maximum current an insulated conductor can safely carry without exceeding its insulation and jacket temperature limitations.

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Cut-Through Resistance. The ability of a material to withstand cutting from a sharp edge or small radius under pressure.

Decibel (dB). A unit to express differences of power level. Used to express power gain in amplifiers or power loss in passive circuits or cables. The units in which the ratio of two power levels, P_1 and P_2, are expressed. The ratio in dB is given as - 10 $\log_{10}$ (P_1/P_2).

$P_2 \rightarrow \square \rightarrow P_1$

Delay Line. A cable made to provide very low velocity of propagation with long electrical delay for transmitted signals.

Derating Factor. A factor used to reduce the current carrying capacity of a wire when used in environments other than that for which the value was established.

Dielectric. Any insulating material between two conductors that permits electrostatic attraction and repulsion to take place across it.

Dielectric Constant (K). The ratio of the capacitance of a condensor with dielectric between the electrodes to the capacitance when air is between the electrodes. Also called Permittivity and Specific Inductive Capacity (SIC).

Dielectric Strength. The voltage which an insulation can withstand before breakdown occurs. Usually expressed as a voltage gradient (such as volts per mil).

Dielectric Test. A test in which a voltage higher than the rated voltage is applied for a specified time to determine the adequacy of the insulation under normal conditions. Sometimes called a "Hi-Pot" test (high potential).

Digital. A data format that uses discrete or separate physical levels to contain information.

Direct Burial Cable. A cable installed directly in the earth.

Direct Current. An electric current that flows in only one direction.

Direction of Lay. The lateral direction in which the strands of a conductor run over the top of the cable conductor as they recede from an observer looking along the axis of the conductor or cable. Also applies to twisted cable.

Dissipation Factor. The tangent of the loss angle of the insulating material. (Also referred to as loss tangent, tan δ, and approximate power factor.)

Drain Wire. The uninsulated wire in contact with an electrostatic shield throughout its length, in an instrumentation or control cable, used to discharge unwanted signals. Also provides a means of terminating laminated shields. Sometimes used to describe the metallic shielding wires of a power cable insulation shield.

Drawing. In wire manufacturing, pulling the metal through a die or series of dies to reduce diameter to a specified size.

Earth. British terminology for zero-reference "ground".

Eccentricity. Like concentricity, a measure of the center of a conductor's location with respect to the circular cross section of the insulation. Expressed as a percentage of displacement of one circle within the other.

EEMAC. Electrical and Electronic Manufacturers Association of Canada (U.S. counterpart is NEMA).

Elastomer. A rubber-like substance. Any material that will return to its original dimensions after being stretched or distorted.

Electrostatic Shield. A copper or laminated aluminum/mylar tape wrap around a signal or instrumentation circuit (pair, triad, etc.) to protect from the electric field radiated by a voltage source. The grounded shield intercepts static interference and carries it off to ground.

Elongation. The fractional increase in length of material stressed in tension.

EMI. Abbreviation for electromagnetic interference.

EMRC. Energy Mines and Resources Canada

EPDM. Ethylene-propylene-diene monomer rubber. A material with good electrical insulating properties.

EPR. Ethylene-propylene copolymer rubber. A material with good electrical insulating properties.

Equal Load Sharing. An even distribution of current between the parallel cables in a power circuit.

Equilay. See Unilay. More than one layer of helically laid wires with the length of the lay the same for each layer.

Farad. A unit of electrical capacity.

Fatigue Resistance. Resistance to metal crystallization which leads to conductors or wires breaking from flexing.

Ferrous. Composed of and/or containing iron. A ferrous metal exhibits magnetic characteristics (e.g. steel armor).

FEP. Fluorinated ethylene propylene insulated wire (see Teflon).

Fiber. A single, separate optical transmission element characterized by core and cladding.

Fiber Optics. Light transmission through optical fibers for communication and signaling.

Filled Cable. Cable construction in which the cable core is filled with a material that will prevent moisture or gasses from entering or passing through the cable.

Filler. 1) A material used in multi-conductor cables to occupy large interstices formed by the assembled conductors; 2) An inert substance added to a compound to improve properties.

Flat Cable. A cable with two essentially flat surfaces (e.g. NMD90).

Flat Conductor. A wire having a rectangular cross section as opposed to round or square conductors.

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Flame Resistance. The ability of a material not to propagate flame once the heat source is removed (see FT1).

Flammability. The measure of the material's ability to support combustion.

Flex Life. The measurement of the ability of a conductor or cable to withstand repeated bending before breaking.

Flexibility. The ease with which a cable may be bent without sustaining damage.

FT1. One of several CSA flame test designations for wires and cables which pass the C22.2 No. 0.3 test requirements. (Other designations include FT2, FT4, etc.).

Fusion Splice. A splice accomplished by the application of localized heat sufficient to fuse or melt the ends of two lengths of optical fiber, forming a continuous single fiber.

Gauge. A term used to denote the physical size of a wire.

GND. Abbreviation for ground.

Graded-Index. A type of optical fiber in which the refractive index of the core is in the form of a parabolic curve, decreasing toward the cladding. This type of fiber provides high bandwidth capabilities.

Ground (GND). 1) A conducting connection between an electrical circuit and the earth, or other large conducting body, to serve as an earth thus making a complete electrical circuit; 2) Term used for non-current carrying conductor in a cable (see Bonding Conductor).

Halogen. A term used to identify any of the four elements chlorine, fluorine, bromine and iodine, grouped together because their chemical properties are similar.

Hard Drawn Copper Wire. Copper wire that has not been annealed after drawing.

Heat Shock. A test to determine stability of a material by sudden exposure to a high temperature for a short period of time.

Henry. The unit of inductance.

Hertz (Hz). A term replacing cycles-per-second as an indication of frequency.

Hi-Pot (High Potential). A test designated to determine the highest voltage that can be applied to a conductor without breaking down the insulation (see Dielectric Test).

High Voltage (HV). Generally, a wire or cable with an operating voltage of over 600 volts.

Hook-Up Wire. A wire used for low current, low voltage (under 1000 volts) applications within enclosed electronic equipment.

Hygroscopic. A material capable of absorbing moisture from the air.

Hypalon®. Dupont's trade name for their chlorosulfonated polyethylene, an ozone resistant synthetic rubber.

ICEA (formerly IPCEA). Insulated Cable Engineers Association.

IEEE. Institute of Electrical and Electronics Engineers.

Impact Strength. A test for determining the mechanical punishment a cable can withstand without physical or electrical breakdown by impacting with a given weight, dropped a given distance, in a controlled environment.

Impedance. The total opposition that a circuit offers to the flow of alternating current or any other varying current at a particular frequency. It is a combination of resistance R and reactance X, measured in ohms.

Inductance. The property of a circuit or circuit element that opposes a change in current flow, thus causing current changes to lag behind voltage changes. It is measured in henrys.

Insulation. A material having good dielectric properties permitting close assembly of conductors in cable and equipment.

Insulation Level. A designation used to identify the insulation thickness required to protect a high voltage cable under ground fault conditions. Expressed as a percentage (e.g. 100% level, 133% level).

Insulation Shield (HV Cable). A two part shield consisting of a non-metallic component and a metallic component. The first component is an extrusion of black semi-conducting thermoset material over the insulation which provides uniform radial stress distribution across the insulation. The second component is a metallic shield which is typically copper tape or wire that functions as a bonding (grounding) conductor and/or a neutral conductor. The metallic shield also serves to conduct ground fault current in the event of insulation failure. See also drain wire.

Insulation Stress. High voltage stress which causes molecular separation in the insulation at sharp projections in the conductor. Controlled by conductor and insulation shielding, called a stress relief shield. Measured in volts per mil.

Interaxial Spacing. Center to center conductor spacing.

Interstices. Voids or valleys between individual strands in a conductor or between insulated conductors in a multi-conductor cable, (interstitial spaces).

Irradiation. In insulations, the exposure of the material to high energy emissions for the purpose of favorably altering the molecular structure by crosslinking.

Jacket. An outer covering, usually non-metallic, mainly used for protection against the environment.

kcmil. One thousand circular mils (MCM).

KILO. A prefix denoting 1000 (10^3).

kV. Kilovolt (1000 volts).

Laminated Tape. A tape consisting of two or more layers of different materials bonded together (e.g. aluminum/ Mylar®).

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Lay. The length measured along the axis of a wire or cable required for a single strand (in stranded wire) or conductor (in cable) to make one complete turn about the axis of the conductor or cable.

Lay Direction. The twist in the cable as indicated by the top strands while looking along the axis of the cable away from the observer. Described as "right hand" or "left hand".

Leakage Current. The undesirable flow of current through or over the surface of an insulation.

Line Drop (Voltage Drop). A voltage loss occurring between any two points in a power circuit. Such loss, or drop, is due to the resistance, reactance, or leakage of the circuit, type of cable and configuration.

Line Voltage. The value of the potential existing on a supply or power line. Rated voltage of cables.

LOCA. Abbreviation for loss of coolant accident, a system malfunction associated with nuclear generating stations.

Longitudinal Shield. A tape shield, flat or corrugated, applied longitudinally with the axis of the core being shielded.

Loss Factor. The product of the dissipation and dielectric constant of an insulating material.

µA. Microampere. One-millionth of an ampere (10^{-6}),

mA. Milliampere. One-thousandth of an ampere (10^{-3}).

Magnetic Noise. Caused by current frequency. An AC powerline creates a magnetic field around that cable, this magnetic field causes the magnetic noise in neighboring control or instrumentation circuits.

MCM. One thousand circular mils (kcmil).

Meg or Mega. A prefix denoting 1,000,000 (10^{6}).

Megarad. A unit for measuring radiation dosage.

Messenger. The linear supporting member, usually a high strength steel wire, used as the supporting element of a suspended aerial cable. The messenger may be an integral part of the cable, or exterior to it.

Mho. The unit of conductivity. The reciprocal of an ohm.

Micro. A prefix denoting one-millionth (10^{6}).

Micron. (µ) Millionth of a meter = 10^{-6} meter.

Mil. A unit of length equal to one-thousandth of an inch (.001"). Common unit for insulation thickness.

Milli. A prefix denoting one-thousandth (10^{-3}).

Modulus of Elasticity. The ratio of stress to strain in an elastic material.

Moisture Absorption. The amount of moisture, in percentage, that a material will absorb under specified conditions.

Moisture Resistance. The ability of a material to resist absorbing moisture from the air or when immersed in water.

Multi-Conductor Cable. A cable consisting of two or more conductors, either cabled or laid in a flat parallel construction, with or without a common overall covering.

Mutual Capacitance. Capacitance between two conductors when all other conductors including ground are connected together.

Mylar®. DuPont trade name for a polyester material.

Nano. A numerical prefix denoting one-billionth (10^{-9}).

National Electrical Code (NEC). A U.S. consensus standard published by the National Fire Protection Association (NFPA) and incorporated in OSHA regulations. (Canadian Counterpart is the CE Code).

NEMA. National Electrical Manufacturers Association. (Canadian counterpart is EEMAC).

Neoprene. A synthetic rubber with good resistance to oil, chemicals, and flame. Also called polychloroprene.

Nomex®. Dupont trademark for a temperature resistant, flame-retardant nylon.

Non Hygroscopic. A material incapable of taking up or absorbing moisture from the air.

Nylon®. An abrasion-resistant thermoplastic with good chemical resistance. A DuPont registered trademark.

OHM. The electrical unit of resistance.

OSHA. Abbreviation for the U.S. Occupational Safety and Health Act.

Overlap. The amount the trailing edge laps over the leading edge of a spiral tape wrap.

Oxygen Index. Percentage of oxygen necessary to support combustion in a gas mixture. Flame retardant materials have a higher oxygen index.

Pair. Two insulated wires of a single circuit twisted together or laid parallel.

Parallel Cable. Two or more cables used to share the current in heavily loaded power circuits which permits the use of smaller conductors.

Percentage Conductivity. Conductivity of a material expressed as a percentage of that of copper. Also used to indicate ratio of conductance between the phase conductor and the neutral in power cables.

Pick. Distance between two adjacent crossover points of braid filaments. The measurement in picks per inch indicates the degree of coverage.

PICO. A prefix denoting one-millionth of one-millionth (10^{-12}).

Pitch. In flat cable, the nominal distance between the index edges of two adjacent conductors.

Pitch Diameter. Diameter of a circle passing through the center of the conductors in any layer of a multi-conductor cable.

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Plastic Deformation. Change in dimensions under load that is not recovered when the load is removed.

Plasticizer. A chemical agent added to plastics to make them softer and more pliable.

Plenum Cable. Cable approved for installation in plenums, (e.g. suspended ceiling) without the need for conduit.

Polyester. Polyethylene terephthalate which is used extensively in the production of a high strength moisture resistant film used as a cable core wrap (see Mylar).

Polyethylene (PE). A thermoplastic material having excellent electrical and physical properties.

Polymer. A material of high molecular weight formed by the chemical union of monomers.

Polyolefin. A family of thermoplastics based upon the unsaturated hydrocarbons know as olefins. When combined with butylene or styrene polymers they form compounds such as polyethylene and polypropylene.

Polypropylene (PPE). A thermoplastic similar to polyethylene but stiffer and having a higher softening point (temperature).

Polyvinyl Chloride (PVC). A general purpose thermoplastic used for low voltage wire and cable insulation, and for jackets.

Power Factor. The ratio of resistance to impedance. The ratio of the actual power of an alternating current to apparent power. Mathematically, the cosine of the angle between the voltage applied and the current resulting.

Primary Insulation. The first layer of non-conductive material applied over a conductor, whose prime function is to act as electrical insulation.

Pulling Eye. A device fastened to a cable to which a hook may be attached in order to pull the cable.

Quad. Four insulated wires of a single circuit.

REA. Rural Electrification Administration. A branch of the U.S. Department of Agriculture.

Reactance. The opposition offered to the flow of alternating current by inductance or capacitance of a component or circuit.

Reel Drum Diameter. Diameter of the drum (or hub) of the reel.

Reel Flange Diameter (Reel Height). Diameter of the reel flanges

Reel Traverse. Width of space between reel flanges.

Reel Width. Overall width of reel.

Ridge Marker. One or more ridges running laterally along the outer surface of a insulated wire or cable for purposes of identification.

Root Mean Square (RMS). The effective value of an alternating current or voltage.

Rope Lay Conductor. A conductor composed of a central core surrounded by one or more layers of helically laid groups of wires used in portable cables.

Rubber. A general term used to describe wire insulation and jackets made of thermosetting elastomers, such as natural or synthetic rubbers, EPR, neoprene, Hypalon, butyl rubber, and others.

SBR. A copolymer of styrene and butadiene. Also GR-S or Buna-S. Most commonly used type of synthetic rubber.

Self Extinguishing. The characteristic of a material whose flame is extinguished after the igniting flame is removed.

Semi-Conductor. In wire industry terminology, a material possessing electrical conductivity that falls somewhere between that of conductors and insulators. Usually made by adding carbon particles to an insulator (e.g. conductor shield and insulation shield). Not the same as semi-conductor materials such as silicon, germanium, etc. used for making transistors and diodes.

Separator. Pertaining to wire and cable, a layer of insulating material such as textile paper, Mylar, etc. which is placed between a conductor and its dielectric, between a cable jacket and the components it covers, or between various components of a multi-conductor cable. It can be utilized to improve stripping qualities, flexibility, or can offer additional mechanical or electrical protection to the components it separates.

Served Wire Armor (SWA). Spiral wrap of galvanized steel wires applied around a cable to afford mechanical protection and increase the cable pulling tension characteristics, (mineshaft, submarine cable, etc.). Also used to denote steel wire armor.

Sheath. The outer covering or jacket of a multi-conductor cable. Usually non-metallic.

Shield (Electrostatic). In cables, a metallic layer placed around a conductor or group of conductors to prevent electrostatic interference between the enclosed wires and external fields. Also see Insulation Shield.

Shrink Tubing. Tubing which has been extruded, crosslinked, and mechanically expanded which when reheated will return to its original diameter.

SIA. Steel Interlocked Armor.

Side Wall Bearing Pressure (SWBP). A term used in reference to the pressure on a cable which is being pulled around a curved surface under tension. If excessive, SWBP can damage cable components and reduce the life of the cable.

Signal Cable. A cable designed to carry current of usually less than one ampere per conductor to operate signal circuit devices.

Silicone. A material made from silicone and oxygen.Can be in thermosetting elastomer or liquid form. The thermosetting elastomer form is noted for high heat resistance.

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Skin Effect. The tendency of alternating current to concentrate and to travel only on the surface of a conductor. Tendency increases with increase in frequency.

Sleeving. An extruded tube.

Spark Test. A test designed to locate imperfections (usually pin-holes) in the insulation of a wire or cable by application of voltage for a very short period of time while the wire is being drawn through the electrode field.

Specific Gravity. The ratio of the density (mass per unit volume) of a material to that of water.

Specific Inductive Capacity (SIC). Same as dielectric constant (See Dielectric Constant).

Tank Test. A voltage insulation test in which the insulated wire or cable is submerged in water and voltage is applied between the conductor and water serving as ground. Shielded cables are generally not tank tested due to the possibility of introducing contaminants on the outer surface of the insulation.

Teflon®. DuPont Company trademark for fluorocarbon resins. (See FEP and TFE).

Temperature Rating. The maximum temperature at which an insulating material may be used in continuous operation without loss of its basic properties (i.e. operating, overload, short circuit). The minimum temperature for safe handling.

Tensile Strength. The pull stress required to break a given specimen. Measured in pounds per square inch. Also referred to as "Ultimate Tensile Strength".

TFE. Tetrafluoroethylene. A thermoplastic material with good electrical insulating properties and chemical and heat resistance.

Thermoplastic. A material that can be softened repeatedly by heating and hardened by cooling through a temperature range characteristic of the plastic, and that in the softened state can be shaped by molding or extrusion.

Thermoset. A material that has been vulcanized by heat or other means and is substantially infusible and insoluble.

Three Conductor Cable. Three insulated conductors assembled with other necessary cable components (shield, filler, etc.) to form a core, protected by an overall jacket.

Tinned Copper. Tin coating added to copper to aid in soldering and inhibit corrosion.

Tray. A cable tray system is a unit or assembly of units or sections, and associated fittings, made of non-combustible materials forming a rigid structural system used to support cables. Cable tray systems (previously termed continuous rigid cable supports) include ladders, troughs, channels, solid bottom trays, and similar structures.

Tray Cable. A factory assembled multi-conductor or multi-pair control, signal or power cable specifically approved under the Canadian Electrical Code for installation in trays.

Triad. Three insulated wires of a single circuit forming a unit. (Two or more units are cabled to form a multi-triad cable.)

Triplexed Cable. Three individual cables twisted together.

UL. Underwriters Laboratories. A non-profit independent organization, which operates a listing service for electrical and electronic materials and equipment. (Canadian counterpart is CSA).

UHF. Abbreviation for ultra high frequency, 300 to 3,000 MHZ.

Unilay. A conductor with more than one layer of helically laid wires with the direction of lay and length of lay the same for all layers.

Velocity of Propagation. The speed of an electrical signal down a length of cable compared to speed in free space expressed as a percent. It is the reciprocal of the square root of the dielectric constant of the cable insulation.

VHF. Abbreviation for very high frequency, 30 to 300 MHZ.

Voltage. The term most often used in place of electromotive force, potential, potential difference or voltage drop to designate the electric pressure that exists between two points and is capable of producing a current when a closed circuit is connected between two points.

Voltage Rating. 1) The highest voltage that can be continuously applied to a wire in conformance with the standard or specification; 2) The "system" voltage printed on the wire or cable.

Volume Resistivity. The electrical resistance between opposite faces of a one cm. cube of insulating material, commonly expressed in ohms-centimeter.

Vulcanization. An irreversible process during which a compound, through a change in its chemical structure (e.g. cross-linking), becomes less plastic and more resistant to swelling by organic liquids and elastic properties are conferred, improved or extended over a greater range of temperatures.

VW-1. A flammability rating established by Underwriters Laboratories for wires and cables that pass a specially designed vertical flame test, formerly designated FR-1. Similar to CSA designation FT1.

Watt. A unit of electric power.

Wicking. The longitudinal flow of a liquid in a wire or cable due to capillary action.

Wire. A conductor; bare or insulated.

Yield Strength. The minimum stress at which a material will start to physically deform without further increase in load.

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AAR S-501: Specification for Wire & Cables

AAR 581.3: Specification for Single Conductor, Clean Stripping Rubber Insulated, 0–600 Volts, Neoprene Jacketed Cable for Locomotive and Car Equipment

AAR 589: Specification for Single Conductor Chloro-sulfonated Polyethylene Integral Insulated-Jacketed, 0-300V, 0-600V Cable for Locomotive and Car Equipment

AEIC CS 1: Specifications for Solid-Type Impregnated-Paper-Insulated Metallic Sheathed Cable

AEIC CS2: Specifications for Impregnated-Paper and Laminated Paper-Polypropylene Insulated Cable, High-Pressure Pipe-Type

AEIC CS3: Specifications for Impregnated-Paper-Insulated, Metallic Sheathed Cable, Low Pressure Gas-Filled Type

AEIC CS4: Specifications for Impregnated-Paper-Insulated Low and Medium Pressure Self Contained Liquid Filled Cable

AEIC CS5: Specifications for Thermoplastic and Crosslinked Polyethylene Insulated Shielded Power Cables Rated 5 Through 69 kV

AEIC CS6: Specifications for Ethylene Propylene Rubber Insulated Shielded Power Cables Rated 5 Through 69 kV

AEIC CS7: Specifications for Crosslinked Polyethylene Insulated Shielded Power Cables Rated 46 Through 138 kV

ANSI C2: National Electrical Safety Code

ANSI MC96.1: Thermocouple Extension Wire Calibration

ANSI N45.2: Packaging, Shipping, Receiving, Storage and Handling of Items for Nuclear Power Plants

ASTM B 1: Standard Specification for Hard-Drawn Copper Wire

ASTM B 2: Standard Specification for Medium-Hard-Drawn Copper Wire

ASTM B 3: Standard Specification for Soft or Annealed Copper Wire

ASTM B 8: Standard Specification for Concentric-Lay Stranded Copper Conductors, Hard, Medium-Hard, or Soft

ASTM B 33: Standard Specification for Tinned Soft or Annealed Copper Wire for Electrical Purposes

ASTM B 105: Standard Specification for Hard-Drawn Copper Alloy Wires for Electrical Conductors

ASTM B 170: Standard Specification for Oxygen-Free Electrolytic Copper

ASTM B 172: Standard Specification for Rope-Lay-Stranded Copper Conductors Having Bunch-Stranded Members, for Electrical Conductors

ASTM B 173: Standard Specification for Rope-Lay-Stranded Copper Conductors Having Concentric-Stranded Members, for Electrical Conductors

ASTM B 174: Standard Specification for Bunch-Stranded Copper Conductors for Electrical Conductors

ASTM B 189: Standard Specification for Lead-Coated and Lead-Alloy-Coated Soft Copper Wire for Electrical Purposes

ASTM B 193: Standard Test Method for Resistivity of Electrical Conductor Materials

ASTM B 226: Standard Specification for Cored, Annular, Concentric-Lay-Stranded Copper Conductors

ASTM B 227: Standard Specification for Hard-Drawn Copper-Clad Steel Wire

ASTM B 228: Standard Specification for Concentric-Lay-Stranded Copper-Clad Steel Conductors

ASTM B 229: Standard Specification for Concentric-Lay-Stranded Copper and Copper-Clad Steel Composite Conductors

ASTM B 230: Standard Specification for Aluminum 1350-H19 Wire for Electrical Purposes

ASTM B 230M: Standard Specification for Aluminum 1350-H19 Wire for Electrical Purposes [Metric]

ASTM B 231: Standard Specification for Concentric-Lay-Stranded Aluminum 1350 Conductors

ASTM B 231 M: Standard Specification for Concentric-Lay-Stranded Aluminum 1350 Conductors [Metric]

ASTM B 232: Standard Specification for Concentric-Lay-Stranded Aluminum Conductors, Coated Steel-Reinforced (ACACARSR)

ASTM B 232M: Standard Specification for Concentric-Lay-Stranded Aluminum Conductors, Coated Steel-Reinforced (ACSR) [Metric]

ASTM B 233: Standard Specification for Aluminum 1350 Drawing Stock for Electrical Purposes

ASTM B 246: Standard Specification for Tinned Hard-Drawn and Medium-Hard-Drawn Copper Wire for Electrical Purposes

ASTM B 258: Standard Specification for Standard Nominal Diameters and Cross-Sectional Areas of AWG Sizes of Solid Round Wires Used as Electrical Conductors

ASTM B 263: Standard Test Method for Determination of Cross-Sectional Area of Stranded Conductors

ASTM B 286: Standard Specification for Copper Conductors for Use in Hookup Wire for Electronic Equipment

ASTM B 298: Standard Specification for Silver-Coated Soft or Annealed Copper Wire

ASTM B 324: Standard Specification for Nickel-Coated Soft or Annealed Copper Wire

ASTM B 341: Standard Specification for Aluminum-Coated (Aluminized) Steel Core Wire for Aluminum Conductors, Steel-Reinforced (ACSR/AZ)

ASTM B 341M: Standard Specification for Aluminum-Coated (Aluminized) Steel Core Wire for Aluminum Conductors, Steel-Reinforced (ACSR/AZ) [Metric]

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ASTM B 355: Standard Specification for Nickel-Coated Soft or Annealed Copper Wire

ASTM B 397: Standard Specification for Concentric-Lay-Stranded Aluminum-Alloy 5005-H19 Conductors

ASTM B 398: Standard Specification for Aluminum-Alloy 6201-T81 Wire for Electrical Purposes

ASTM B 398M: Standard Specification for Aluminum-Alloy 6201-T81 Wire for Electrical Purposes [Metric]

ASTM B 399: Standard Specification for Concentric-Lay-Stranded Aluminum-Alloy 6201-T81 Conductors

ASTM B 399M: Standard Specification for Concentric-Lay-Stranded Aluminum-Alloy 6201-T81 Conductors [Metric]

ASTM B 400: Standard Specification for Compact Round Concentric-Lay-Stranded Aluminum 1350 Conductors

ASTM B 401: Standard Specification for Compact Round Concentric-Lay-Stranded Aluminum Conductors, Steel-Reinforced (ACSR/COMP)

ASTM B 416: Standard Specification for Concentric-Lay-Stranded Aluminum-Clad Steel Conductors

ASTM B 452: Standard Specification for Copper-Clad Steel Wire for Electronic Application

ASTM B 470: Standard Specification for Bonded Copper Conductors for Use in Hookup Wires for Electronic Equipment

ASTM B 496: Standard Specification for Compact Round Concentric-Lay-Stranded Copper Conductors

ASTM B 498: Standard Specification for Zinc-Coated (Galvanized) Steel Core Wire for Aluminum Conductors, Steel-Reinforced (ACSR)

ASTM B 498M: Standard Specification for Zinc-Coated (Galvanized) Steel Core Wire for Aluminum Conductors, Steel-Reinforced (ACSR) [Metric]

ASTM B 500: Standard Specification for Zinc-Coated (Galvanized), Zinc-5% Aluminum Mischmetal Alloy-Coated, and Aluminum-Coated (Aluminized) Stranded Steel Core for Aluminum Conductors, Steel-Reinforced (ACSR)

ASTM B 501: Standard Specification for Silver-Coated, Copper-Clad Steel Wire for Electronic Application

ASTM B 502: Standard Specification for Aluminum-Clad Steel Core Wire for Aluminum Conductors, Aluminum-Clad Steel Reinforced

ASTM B 520: Standard Specification for Tin-Coated, Copper-Clad Steel Wire for Electronic Application

ASTM B 524: Standard Specification for Concentric-Lay-Stranded Aluminum Conductors, Aluminum-Alloy Reinforced (ACAR, 1350/6201)

ASTM B 524M: Standard Specification for Concentric-Lay-Stranded Aluminum Conductors, Aluminum-Alloy Reinforced (ACAR, 1350/6201) [Metric]

ASTM B 549: Standard Specification for Concentric-Lay-Stranded Aluminum Conductors, Aluminum-Clad Steel Reinforced (ACSR/AW)

ASTM B 559: Standard Specification for Nickel-Coated, Copper-Clad Steel Wire for Electronic Application

ASTM B 606: Standard Specification for High-Strength Zinc-Coated (Galvanized) Steel Core Wire for Aluminum and Aluminum Alloy Conductors, Steel Reinforced

ASTM B 609: Standard Specification for Aluminum 1350 Round Wire, Annealed and Intermediate Tempers, for Electrical Purposes

ASTM B 609M: Standard Specification for Aluminum 1350 Round Wire, Annealed and Intermediate Tempers, for Electrical Purposes [Metric]

ASTM B 624: Standard Specification for High-Strength, High-Conductivity Copper-Alloy Wire for Electronic Application

ASTM B 682: Standard Specification for Standard Metric Sizes of Electrical Conductors

ASTM B 701: Standard Specification for Concentric-Lay-Stranded Self-Damping Aluminum Conductors, Steel-Reinforced (ACSR/SD)

ASTM B 711: Standard Specification for Concentric-Lay-Stranded Aluminum-Alloy Conductors, Steel Reinforced (AACSR) (6201)

ASTM B 738: Standard Specification for Fine-Wire Bunch-Stranded and Rope-Lay Bunch Stranded Copper Conductors for Use as Electrical Conductors

ASTM B 778: Standard Specification for Shaped Wire Compact Concentric-Lay-Stranded Aluminum Conductors (AAC/TW)

ASTM B 779: Standard Specification for Shaped Wire Compact Concentric-Lay-Stranded Aluminum Conductors, Steel Reinforced (ACSR/TW)

ASTM B 784: Standard Specification for Modified Concentric-Lay-Stranded Copper Conductors for Use in Insulated Electrical Cables

ASTM B 785: Standard Specification for Compact Round Modified Concentric-Lay-Stranded Copper Conductors for Use in Insulated Electrical Cables

ASTM B 786: Standard Specification for 19 Wire Combination Unilay-Stranded Aluminum 1350 Conductors for Subsequent Insulation

ASTM B 787: Standard Specification for 19 Wire Combination Unilay-Stranded Copper Conductors for Subsequent Insulation

ASTM B 801: Standard Specification for Concentric-Lay-Stranded Conductors of 8000 Series Aluminum Alloy for Subsequent Covering or Insulation

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ASTM B 802: Standard Specification for Zinc-5% Aluminum-Mischmetal Alloy-Coated Steel Core Wire for Aluminum Conductors, Steel Reinforced (ACSR)

ASTM B 803: Standard Specification for High-Strength Zinc-5 % Aluminum-Mischmetal Alloy Coated Steel Core Wire for Aluminum and Aluminum-Alloy Conductors, Steel Reinforced

ASTM D 149: Standard Test Method for Dielectric Breakdown Voltage and Dielectric Strength of Solid Electrical Insulating Materials at Commercial Power Frequencies

ASTM D 470: Method of Testing Crosslinked Insulations and Jackets for Wire and Cable

ASTM D 866: Specification for Styrene-Butadiene (SBR) Synthetic Rubber Jacket for Wire and Cable

ASTM D 1047: Specification for Polyvinyl Chloride (PVC) Jacket for Wire and Cable

ASTM D 1351: Specification for Polyethylene Insulation for Wire and Cable

ASTM D 1352: Specification for Ozone-Resisting Butyl Rubber Insulation for Wire and Cable

ASTM D 1523: Method for Synthetic Rubber Insulation for Wire and Cable, 90° Operation

ASTM D 1679: Specification for Synthetic Rubber Heat and Moisture-Resisting Insulation for Wire and Cable, 75°C Operation

ASTM D 2219: Specification for Polyvinyl Chloride (PVC) Insulation for Wire and Cable, 60° Operation

ASTM D 2220: Specification for Polyvinyl Chloride (PVC) Insulation for Wire and Cable, 75° Operation

ASTM D 2308: Specification for Polyethylene Jacket for Electrical Insulated Wire and Cable

ASTM D 2526: Specification for Ozone-Resisting Silicone Rubber Insulation for Wire and Cable

ASTM D 2655: Specification for Crosslinked Polyethylene Insulation for Wire and Cable Rated 0 to 2000V

ASTM D 2656: Specification for Crosslinked Polyethylene Insulation for Wire and Cable Rated 2001 to 35000V

ASTM D 2768: Specification for General-Purpose Ethylene-Propylene Rubber Jacket for Wire and Cable

ASTM D 2770: Specification for Ozone-Resisting Ethylene-Propylene Rubber Integral Insulation and Jacket for Wire and Cable

ASTM D 2802: Specification for Ozone-Resistant Ethylene-Propylene Rubber Insulation for Wire and Cable

ASTM D 3004: Specification for Extruded Thermosetting and Thermoplastic Semi-Conducting Conductor and Insulation Shields

ASTM D 3485: Specification for Smooth-Wall Coilable Polyethylene (PE) Conduit (Duct) for Preassembled Wire and Cable

ASTM D 3554: Specification for Track-Resistant Black Thermoplastic High Density Polyethylene Insulation for Wire and Cable

ASTM D 3555: Specification for Track-Resistant Black Crosslinked Thermosetting Polyethylene Insulation for Wire and Cable

ASTM D 4244: Specification for General-Purpose, Heavy-Duty and Extra-Heavy Duty Acrylonitrile-Butadiene/ Polyvinyl Chloride (NBR/PVC) Jackets for Wire and Cable

ASTM D 4245: Specification for Ozone-Resistant Thermoplastic Elastomer Insulation for Wire and Cable, 90°C Dry - 75°C Wet Operation

ASTM D 4246: Specification for Ozone-Resistant Thermoplastic Elastomer Insulation for Wire and Cable, 90°C Operation

ASTM D 4247: Specification for General-Purpose Black Heavy-Duty and Black Extra-Heavy Duty Polychloroprene Jackets for Wire and Cable

ASTM D 4313: Specification for General Purpose Heavy-Duty and Extra-Heavy-Duty Crosslinked Chlorinated Polyethylene Jackets for Wire and Cable

ASTM D 4314: Specification for General Purpose Heavy-Duty and Extra-Heavy-Duty Crosslinked Chlorosulfonated Polyethylene Jackets for Wire and Cable

ASTM D 4363: Specification for Thermoplastic Chlorinated Polyethylene Jacket for Wire and Cable

ASTM D 4496: Test Method of DC Resistance or Conductance of Moderately Conductive Materials

ASTM D 4568: Test Methods for Evaluating Compatibility Between Cable Filling and Flooding Compounds and Polyolefin Cable Materials

ASTM D 4967: Guide for Selecting Materials to Be Used for Insulation, Jacketing, and Strength Components in Fiber Optic Cables

CAN3-Z299.0: Guide for Selecting and Implementing the CAN3-Z299 Quality Assurance Program Standards

CAN3-Z299.1: Standard for Quality Assurance Program - Category 1

CAN3-Z299.2: Standard for Quality Assurance Program - Category 2

CAN3-Z299.3: Standard for Quality Assurance Program - Category 3

CAN3-Z299.4: Standard for Quality Assurance Program - Category 4

CSA C22.1: Canadian Electrical Code, Part 1, Safety Standard for Electrical Installations

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CSA C22.2 No. 0.3: Standard for Test Methods for Electrical Wires and Cables

CSA C22.2 No. 16: Standard for Insulated Conductors for Power-Operated Electronic Devices

CAN/CSA C22.2 No. 211: Standard for Cord Sets and Power-Supply Cords

CSA C22.2 No. 35: Standard for Extra-Low-Voltage Control Circuit Cables, Low-Energy Control Cable, and Extra-Low-Voltage Control Cable

CSA C22.2 No. 38: Standard for Thermoset Insulated Wires and Cables

CAN/CSA C22.2 No. 48: Standard for Nonmetallic Sheathed Cable

CAN/CSA C22.2 No. 49: Standard for Flexible Cords and Cables

CAN/CSA C22.2 No. 51: Standard for Armoured Cable

CSA C22.2 No. 52: Standard for Service-Entrance Cables

CSA C22.2 No. 75: Standard for Thermoplastic-Insulated Wires and Cables

CAN/CSA C22.2 No. 96: Standard for Portable Power Cables

CSA C22.2 No. 116: Standard for Coil-Lead Wires

CSA C22.2 No. 123: Standard for Aluminum Sheathed Cables

CSA C22.2 No. 124: Standard for Mineral-Insulated Cable

CSA C22.2 No. 127: Standard for Equipment Wires

CSA C22.2 No. 129: Standard for Neutral Supported Cable

CSA C22.2 No. 130: Standard for Heating Cables and Heating Cable Sets

CAN/CSA C22.2 No. 130.1: Standard for Heat-Tracing Cable Systems for Use in Industrial Locations

CAN/CSA C22.2 No. 131: Standard for Type TECK 90 Cable

CSA C22.2 No. 138: Standard for Heat Tracing Cable and Cable Sets for Use in Hazardous Locations

CSA C22.2 No. 174: Standard for Cables and Cable Glands for Use in Hazardous Locations

CSA C22.2 No. 179: Standard for Airport Series Lighting Cables

CSA C22.2 No.188: Standard for Splicing Wire and Cable Connectors

CSA C22.2 No. 198.2: Standard for Underground Cable Splicing Kits

CAN/CSA C22.2 No. 203: Standard for Modular Wiring Systems for Office Furniture

CSA C22.2 No. 208: Standard for Fire Alarm and Signal Cable

CAN/CSA C22.2 No. 210.2: Standard for Appliance Wiring Material Products

CAN/CSA C22.2 No. 214: Standard for Communications Cables

CSA C22.2 No. 222: Standard for Type FCC Under-Carpet Wiring System

CSA C22.2 No. 230: Standard for Tray Cable

CSA C22.2 No. 232: Standard for Optical Fiber Cables

CAN/CSA C22.2 No. 233: Standard for Cords and Cord Sets for Communication Systems

CAN/CSA C22.2 No. 239: Standard for Control and Instrumentation Cables

CAN/CSA C22.2 No. 241: IEEE Standard for Cable Joints for Use with Extruded Dielectric Cable Rated 5,000V Through 46,000V, and Cable Joints for Use with Laminated Dielectric Cable Rated 2,500V Through 500,000V (Adopted IEEE 404-1986)

CAN/CSA C22.3 No. 1: Standard for Overhead Systems

CSA/CAN3 C22.3 No. 7: Standard for Underground Systems

CAN/CSA C22.3 No. 8: Standard for Railway Electrification Guidelines

CAN/CSA C49.1: Standard for Round Wire, Concentric Lay, Overhead Electrical Conductors

CSA C49.2: Standard for Compact Aluminum Conductors Steel Reinforced (ACSR)

CSA C49.3: Standard for Aluminum Alloy 1350 Round Wire, All Tempers, for Electrical Purposes

CSA C49.4: Standard for Concentric-Lay Aluminum Stranded Conductors (ASC)

CSA C49.5: Standard for Compact Round Concentric-Lay Aluminum Stranded Conductors (Compact ASC)

CSA CAN3-C49.6: Standard for Zinc-Coated Steel Wires for Use in Overhead Electrical Conductors

CSA CAN3-C49.7: Standard for Aluminum Round Wires for Use in Overhead Electrical Conductors

CSA C68.1: Standard Specifications for Impregnated Paper-Insulated, Metallic-Sheathed Cable, Solid-Type

CAN/CSA C68.3: Standard for Shielded and Concentric Neutral Power Cables Rated 5-46 kV

CSA C170.2: Standard for Polyethylene Protective Covering on Paper-Insulated Metallic Sheathed Power Cable

CSA C170.3: Standard for Polyvinyl-Chloride (PVC) Protective Covering on Paper-Insulated Metallic-Sheathed Power Cable

CSA M421: Standard for Use of Electricity in Mines

CAN/CSA T529: Standard Design Guide for Telecommunications Wiring Systems in Commercial Buildings

EIA/TIA-568: Commercial Building Telecommunications Wiring Standard

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EIA/TIA-569: Commercial Building Standard for Telecommunications Pathways and Spaces

EIA/TIA-606: Administration Standard for the Telecommunications Infrastructure of Commercial Buildings

EIA/TIA TSB-36: Additional Cable Specifications for Unshielded Twisted Pair Cables (Technical Systems Bulletin 36)

EIA/TIA TSB-40: Additional Transmission Specifications for Unshielded Twisted Pair Connecting Hardware (Technical Systems Bulletin 40)

FP-4: TM-4 CSA CBC and UL CMR (Riser) Cable

FP-16: TD-16 Plastic Insulated, Two Parallel Conductor, Telephone Drop Wire

FP-28: Air Core, Solid PIC, ALPETH-DCAS Cable & PAP-DCAS Cable

FP-67: PHD Plastic Insulated and Jacketed, Four Conductor, Telephone Drop Wire

FP-68: TM-68 CSA PCC FT4, Shielded Inside Wiring Cable

FP-71: TM-28 CSA PCC FT4, Inside Wiring Cable

FP-75: PHILPLAST CSA PCC FT4, PVC Insulated and Jacketed, Switchboard Cable

FP-81: TM-81 CSA ZSW FT1, Telephone Station Wire

FP-90: CONCEL Cellular Polyethylene Insulated, Air Core, ALPETH-DCAS Sheathed, Telephone Cable

FP-93: TM-91, TM-92, TM-93 & TM-97, Filled, Buried Wire

FP-95: Quasi-Solid Polyethylene Insulated, Filled, Regular & Twin Core, ALPETH-DCAS Sheathed Cable

FP-98: CELSEAL Cellular Polyethylene Insulated, Filled, ALPETH-DCAS Sheathed Cable

FP-99: DUCTCEL Cellular Polyethylene Insulated, Air Core, ALPETH-DCAS Sheathed Telephone Cable

FP-8859: PHILSYM UL 444 CMR & CSA PCC FT4 Switchboard Cable

HP: See NEMA listing

ICEA P-32-382: ICEA Standards Publication for Short Circuit Characteristics of Insulated Cable

ICEA P-45-482: ICEA Standards Publication for Short-Circuit Performance of Metallic Shields and Sheaths of Insulated Cable

ICEA P-53-426: ICEA/NEMA Standards Publication for Ampacities, Including Effect of Shield Losses for Single-Conductor Solid-Dielectric Power Cable 15 kV through 69 kV (NEMA WC 50)

ICEA P-54-440: ICEA/NEMA Standards Publication for Ampacities of Cables in Open-Top Cable Trays (NEMA WC 51)

ICEA P-79-561: ICEA Guide for Selecting Aerial Cable Messengers & Lashing Wires

ICEA P-81-570: ICEA Standards Publication for Direct Burial 600 Volt Cable with Ruggedized Extruded Insulation

ICEA S-19-81: ICEA/NEMA Standards Publication for Rubber-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy (NEMA WC 3)

ICEA S-56-434: ICEA/ANSI Standards Publication for Polyolefin Insulated Communications Cables for Outdoor Use

ICEA S-61-402: ICEA/NEMA Standards Publication for Thermoplastic-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy (NEMA WC 5)

ICEA S-66-524: ICEA/NEMA Standards Publication for Cross-Linked-Thermosetting Polyethylene-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy (NEMA WC 7)

ICEA S-67-401: ICEA/NEMA Standards Publication for Steel Armor and Associated Coverings for Impregnated-Paper-Insulated Cables (NEMA WC 2)

ICEA S-68-516: ICEA/NEMA Standards Publication for Ethylene-Propylene-Rubber-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy (NEMA WC 8)

ICEA S-70-547: ICEA/ANSI Standards Publication for Weather-Resistant Polyolefin-Covered Wire and Cable

ICEA S-73-532: ICEA/NEMA/ANSI Standards Publication for Control Cables (NEMA WC 57)

ICEA S-75-381: ICEA/NEMA/ANSI Standards Publication for Portable and Power Feeder Cables for Use in Mines and Similar Applications (NEMA WC 58)

ICEA S-76-474: ICEA/ANSI Standards Publication for Neutral-Supported Power Cable Assemblies with Weather-Resistant Extruded Insulation, 600 Volts

ICEA S-77-528: ICEA/ANSI Standards Publication for Outside Plant Communications Cables, Specifying Metric Wire Sizes

ICEA S-80-576: ICEA/ANSI Standards Publication for Communications Wire and Cable for Wiring of Premises

ICEA S-82-552: ICEA/NEMA Standards Publication for Instrumentation Cables and Thermocouple Wire (NEMA WC 55)

ICEA S-83-596: ICEA/ANSI Standards Publication for Fiber Optic Premises Distribution Cable

ICEA S-84-608: ICEA/ANSI Standards Publication for Telecommunications Cable, Filled Polyolefin Insulated, Copper Conductor

ICEA S-85-625: ICEA/ANSI Standards Publication for Aircore, Polyolefin Insulated, Copper Conductor Telecommunications Cable

ICEA S-86-634: ICEA/ANSI Standards Publication for Buried Distribution & Service Wire, Filled Polyolefin Insulated, Copper Conductor

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ICEA S-87-640: ICEA/ANSI Standards Publication for Fiber Optic Outside Plant Communication Cable

ICEA T-22-294: ICEA Standard Test Procedures for Extended Time-Testing of Wire and Cable Insulations for Service in Wet Locations

ICEA T-25-425: ICEA Guide for Establishing Stability of Volume Resistivity for Conducting Polymeric Components of Power Cables

ICEA T-26-465: ICEA/NEMA Guide for Frequency of Sampling Extruded Dielectric Power, Control, Instrumentation, and Portable Cables for Test (NEMA WC 54)

ICEA T-27-581: ICEA/NEMA Standard Test Methods for Extruded Dielectric Power, Control, Instrumentation, and Portable Cables (NEMA WC 53)

ICEA T-28-562: ICEA Standard Test Method for Measurement of Hot Creep of Polymeric Insulations

ICEA T-29-520: ICEA Standard for Vertical Tray Flame Tests at 210,000 Btu

ICEA T-30-520: ICEA Standard for Vertical Tray Flame Tests at 70,000 Btu

ICEA T-31-610: ICEA Standard for Water Penetration Resistance Test, Sealed Conductor

ICEA T-32-645: ICEA Standards Publication for Compatibility of Sealed Conductor Filer Compounds

IEC 92-3: International Electrotechnical Commission Electrical Installation in Ships - Part 3 Cables (Constructions, Testing, and Installations)

IEEE 45: IEEE Recommended Practice for Electric Installations on Shipboard

IEEE 48: IEEE Standard Test Procedures and Requirements for High-Voltage Alternating Current Cable Terminations

IEEE 100: IEEE Standard Dictionary of Electrical and Electronics Terms

IEEE 141: IEEE Recommended Practice for Electric Power Distribution for Industrial Plants ("IEEE Red Book")

IEEE 142: IEEE Recommended Practice for Grounding of Industrial and Commercial Power Systems ("IEEE Green Book")

IEEE 241: IEEE Recommended Practice for Electric Power Systems in Commercial Buildings ("IEEE Gray Book")

IEEE 242: IEEE Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems ("IEEE Buff Book")

IEEE 323: IEEE Standard for Qualifying Class 1E Equipment for Nuclear Power Generating Stations

IEEE 383: IEEE Standard for Type Test of Class 1E Electric Cables, Field Splices and Connections for Nuclear Power Generating Stations

IEEE 400: IEEE Guide for Making High-Direct-Voltage Tests on Power Cable Systems in the Field

IEEE 404: IEEE Standard for Cable Joints for Use with Extruded Dielectric Cable Rated 5,000V Through 46,000V, and Cable Joints for Use with Laminated Dielectric Cable Rated 2,500V Through 500,000V (Adopted as a National Standard of Canada, CAN/CSA-C22.2 No. 241)

IEEE 446: IEEE Recommended Practice for Emergency and Standby Power Systems for Industrial and Commercial Applications ("IEEE Orange Book")

IEEE 493: IEEE Recommended Practice for the Design of Reliable Industrial and Commercial Power Systems ("IEEE Gold Book")

IEEE 515: IEEE Recommended Practice for the Testing, Design, Installation, and Maintenance of Electrical Resistance Heat Tracing for Industrial Applications

IEEE 524: IEEE Guide to the Installation of Overhead Transmission Line Conductors

IEEE 525: IEEE Guide for the Design and Installation of Cable Systems in Substations

IEEE 575: IEEE Guide for the Application of Sheath-Bonding Methods for Single-Conductor Cables and the Calculation of Induced Voltages and Currents in Cable Sheaths

IEEE 576: IEEE Recommended Practice for Installation, Termination, and Testing of Insulated Power Cable as Used in the Petroleum and Chemical Industry

IEEE 590: IEEE Cable Plowing Guide

IEEE 602: IEEE Recommended Practice for Electric Systems in Health Care Facilities ("IEEE White Book")

IEEE 635: IEEE Guide for Selection and Design of Aluminum Sheaths for Power Cables

IEEE 644: IEEE Standard Procedures for Measurement of Power Frequency Electric and Magnetic Fields from AC Power Lines

IEEE 738: IEEE Standard for Calculation of Bare Overhead Conductor Temperature and Ampacity Under Steady-State Conditions

IEEE 789: IEEE Standard Performance Requirements for Communications and Control Cables for Application in High Voltage Environments

IEEE 802.3: IEEE Standard for Information Processing Systems - Local and Metropolitan Area Networks - Part 3: Carrier Sense Multiple Access with Collision Detection (CSMA/CD) Access Method and Physical Layer Specifications (ISO/IEC) (ANSI/IEEE Std 802.3)

IEEE 802.5: IEEE Standard for Information Technology - Local and Metropolitan Area Networks - Part 5: Token Ring Access Method and Physical Layer Specifications (ISO/IEC) (ANSI/IEEE Std 802.5)

IEEE 816: IEEE Guide for Determining the Smoke Generation of Solid Materials Used for Insulations and Coverings of Electric Wire and Cable

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IEEE 844: IEEE Recommended Practice for Electrical Impedance, Induction, and Skin Effect Heating of Pipelines and Vessels

IEEE 1017: IEEE Recommended Practice for Field Testing Electric Submersible Pump Cable

IEEE 1018: IEEE Recommended Practice for Specifying Electric Submersible Pump Cable – Ethylene-Propylene Rubber Insulation

IEEE 1019: IEEE Recommended Practice for Specifying Electric Submersible Pump Cable – Polypropylene Insulation

IEEE 1120: IEEE Guide to the Factors to Be Considered in the Planning, Design, and Installation of Submarine Power and Communications Cables

IEEE 1202: IEEE Standard for Flame Testing of Cables for Use in Cable Tray in Industrial and Commercial Occupancies

IEEE/ICEA S-135: Power Cable Ampacities

Mil-C-17: General Specifications for Flexible and Semirigid Radio Frequency Cables

Mil-C-915F: General Specification for Electrical Cable and Conductors for Shipboard Use

Mil-C-13777: General Specification for Special Purpose Electrical Cable

Mil-C-24640: General Specification for Lightweight Electrical Cable for Shipboard Use

Mil-C-24643: General Specification for Low Smoke Electrical Cable and Conductors for Shipboard Use

Mil-C-27500: General Specification for Shielded and Unshielded Electrical Power Cable and Special Purpose Cable

Mil-C-85045: General Specification for Fiber Optic Cables [Metric]

Mil-W-16878: General Specification for Insulated Electrical Wire

Mil-W-22759: General Specification for Copper or Copper Alloy Fluoropolymer-Insulated Electrical Wire

Mil-W-81044: General Specification for Copper or Copper Alloy, Crosslinked Polyalkene, Crosslinked Alkane-Imide Polymer or Polyalkene Insulated Electrical Wire

Mil-W-81381: General Specification for Replacement Wire

Mil-W-85485: General Specification for Radio Frequency Absorptive Filter Line Electrical Cable

NAVSEA 6710782: Fiber Optic & Multimode Cable

NEMA HP 3: Electrical and Electronic PTFE (Polytetra-fluoro-ethylene) Insulated High Temperature Hook-Up Wire; Types (600 Volt), EE (1000 Volt), and ET (250 Volt)

NEMA HP 4: Electrical and Electronic FEP Insulated High Temperature Hook-Up Wire; Types K, KK, and KT

NEMA HP 100: High Temperature Instrumentation and Control Cables

NEMA HP 100.1: High Temperature Instrumentation and Control Cables Insulated and Jacketed with FEP Fluorocarbons

NEMA HP 100.2: High Temperature Instrumentation and Control Cables Insulated and Jacketed with ETFE Fluoropolymers

NEMA HP 100.3: High Temperature Instrumentation and Control Cables Insulated and Jacketed with Cross-Linked (Thermoset) Polyolefin (XLPO)

NEMA HP 100.4: High Temperature Instrumentation and Control Cables Insulated and Jacketed with ECTFE Fluoropolymers

NEMA WC 2: Steel Armor and Associated Coverings for Impregnated-Paper-Insulated Cables (ICEA S-67-401)

NEMA WC 3: Rubber-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy (ICEA S-19-81)

NEMA WC 5: Thermoplastic-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy (ICEA S-61-402)

NEMA WC 7: Cross-Linked-Thermosetting-Polyethylene-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy (ICEA S-66-524)

NEMA WC 8: Ethylene-Propylene-Rubber-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy (ICEA S-68-516)

NEMA WC 26: Wire and Cable Packaging

NEMA WC 50: Ampacities, Including Effect of Shield Losses for Single-Conductor Solid Dielectric Power Cable 15 kV through 69 kV (ICEA P-53-426)

NEMA WC 51: Ampacities of Cables in Open-Top Cable Trays (ICEA P-54-440)

NEMA WC 52: High Temperature and Electronic Insulated Wire-Impulse Dielectric Testing

NEMA WC 53: Standard Test Methods for Extruded Dielectric Power, Control, Instrumentation, and Portable Cables (ICEA T-27-581)

NEMA WC 54: Guide for Frequency of Sampling Extruded Dielectric Power, Control, Instrumentation, and Portable Cables for Test (ICEA T26-465)

NEMA WC 55: Instrumentation Cables and Thermocouple Wire (ICEA S-82-552)

NEMA WC 56: 3.0 kHz Insulation Continuity Proof Testing of Hook-Up Wire

NEMA WC 57: Standard for Control Cables (ICEA S-73-532)

NEMA WC 58: Standard for Portable and Power Feeder Cables for Use in Mines and Similar Applications

NEMA WC 61: Transfer Impedance Testing

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NEMA WC 62: Repeated Spark/Impulse Dielectric Testing

NFPA 70: National Electrical Code

NFPA 70HB: National Electrical Code Handbook

NFPA 262: Test for Fire and Smoke Characteristics of Wires and Cables

ONT M-302-84: Cable, Secondary, for Direct Burial

ONT M-355-82: Cable, Primary Submarine

ONT M-538-84: Cable, For Use in Generating Stations (5 kV and Above)

ONT M-570-84: Cable, For Use in Generating Stations (600V)

ONT M-695-88: Cable, Primary and Subtransmission Submarine, Concentric Neutral

SAE 1560: Low Tension Thin Wall Primary Cable

SAE J1127: Battery Cable

SAE J1128: Low Tension Primary Cable

TIA: See EIA/TIA

UL 4: Standard for Armored Cable

UL 13: Standard for Power-Limited Circuit Cables

UL 44: Standard for Rubber-Insulated Wires and Cables

UL 62: Standard for Flexible Cord and Fixture Wire

UL 83: Standard for Thermoplastic-Insulated Wires and Cables

UL 183: Standard for Manufactured Wiring Systems

UL 444: Standard for Communications Cables

UL 486A: Standard for Wire Connectors and Soldering Lugs for Use With Copper Conductors

UL 486B: Standard for Wire Connectors and Soldering Lugs for Use With Aluminum Conductors

UL 486C: Standard for Splicing Wire Connectors

UL 486D: Standard for Insulated Wire Connectors for Use With Underground Conductors

UL 486E: Standard for Equipment Wiring Terminals for Use With Aluminum and/or Copper Conductors

UL 493: Standard for Thermoplastic-Insulated Underground Feeder and Branch-Circuit Cables

UL 498: Standard for Attachment Plugs and Receptacles

UL 514B: Standard for Fittings for Conduit and Outlet Boxes

UL 719: Standard for Nonmetallic-Sheathed Cables

UL 758: Standard for Appliance Wiring Material - Component

UL 814: Standard for Gas-Tube-Sign and Ignition Cable

UL 817: Standard for Cord Sets and Power-Supply Cords

UL 854: Standard for Service-Entrance Cables

UL 910: Standard for Test for Flame-Propagation and Smoke-Density Values for Electrical and Optical-Fiber Cables Used in Spaces Transporting Environmental Air

UL 1023: Standard for Household Burglar-Alarm System Units

UL 1063: Standard for Machine-Tool Wires and Cables

UL 1072: Standard for Medium-Voltage Power Cables

UL 1084: Standard for Hoistway Cables

UL 1263: Standard for Irrigation Cables

UL 1277: Standard for Electrical Power and Control Tray Cables With Optional Optical Fiber Members

UL 1309: Standard for Marine Shipboard Cable

UL 1424: Standard for Cables for Power-Limited Fire-Protective-Signaling Circuits

UL 1426: Standard for Cables for Boats

UL 1446: Standard for Systems of Insulating Materials - General

UL 1462: Standard for Mobile Home Pipe Heating Cable

UL 1569: Standard for Metal-Clad Cables

UL 1581: Reference Standard for Electrical Wires, Cables, and Flexible Cords

UL 1588: Standard for Roof and Gutter De-Icing Cable Units

UL 1666: Standard Test for Flame Propagation Height of Electrical and Optical-Fiber Cables Installed Vertically in Shafts

UL 1673: Standard for Electric Space Heating Cables

UL 1685: Standard for Vertical-Tray Fire-Propagation and Smoke-Release Test for Electrical and Optical-Fiber Cables

UL 1690: Standard for Data Processing (DP) Cables

UL 1712: Standard Tests for Ampacity of Insulated Electrical Conductors Installed in the Fire Protective System

UL 1807: Standard for Fire Resistant Cable Coating Materials

UL 2023: Standard Test Method for Flame and Smoke Characteristics of Nonmetallic Wiring Systems (Raceway and Conductors) for Environmental Air-Handling Spaces

UL 2029: Standard for Gas/Vapor-Blocked Cable Classified for Use in Class 1 Hazardous (Classified) Locations

UL 2049: Standard for Residential Pipe Heating Cable

WC: See NEMA listing

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Washington, DC, USA 20001
(202) 639-2100

Association of Edison Illuminating Companies (AEIC)
Publication Department
600 North 18th Street
Birmingham, AL 35203, USA

American National Standards Institute (ANSI)
Sales Department
11 West 42nd Street - 13th Floor
New York, NY 10036, USA
(212) 642-4900
Fax: (212) 302-1286

American Society for Testing and Materials (ASTM)
Customer Services
1916 Race Street
Philadelphia, PA 19103, USA
(215) 299-5454

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Standards Sales
178 Rexdale Boulevard
Rexdale, ON M9W lR3, Canada
(416) 747-4044
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Engineering Publications Office
2001 Pennsylvania Ave., NW
Washington, DC, USA
(202) 457-4963

FP STANDARDS ARE AVAILABLE FROM:

Insulated Cable Engineers Association (ICEA)
PO Box P
South Yarmouth, MA 02664, USA

IEC STANDARDS ARE AVAILABLE FROM ANSI:

Institute of Electrical and Electronic Engineers (IEEE)
Customer Service Center
445 Hoes Lane
Piscataway, NJ 08855-1331, USA
(800) 678-IEEE
(in the U.S. and Canada)
(908) 981-1392
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700 University Avenue
Toronto, Ontario M56 lX6, Canada

Rural Electrification Administration (REA)
U.S . Department of Agriculture
Washington, DC 20250
(202) 447-3827

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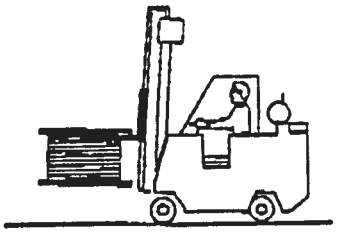
RECOMMENDED CABLE HANDLING PROCEDURES

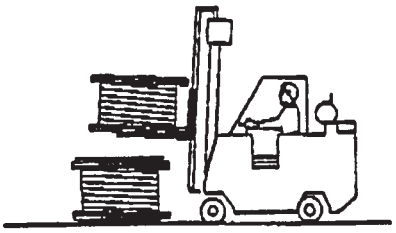
Wire and Cable Reel Handling and Storage

If cable reels must be pancaked or stored in vertical racks, do not lift the reel by the top flange. Spacers placed under the bottom flange and between reels (two 2x4's placed wide side up) create a space to insert the forks and lift the reel without damaging the cable. *If nails are used to secure the spacers, make sure the nails do not go through the flange and into the cable.*



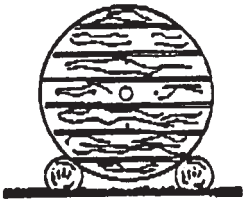
DON'T

END VIEW OF SPACERS



DO

For extended storage of bare or insulated cables (spare cable, etc.) reels should be stored cradled between railroad ties, power poles or crossarms. Size and spacing of the supports should raise the flange above the ground.



This helps keep the flanges from decaying and prevents the reels from rolling. At temporary storage sites where soil may be soft, preservative treated plywood sheets may be used to keep reel flanges from sinking into the ground.

When possible, the reel wrap or lagging supplied on the reels should be replaced to help protect the cable from inadvertent damage. Under extreme environmental conditions, other measures may be necessary. To prevent entrance of water, insulated cable ends should be sealed with plastic end caps. Electrical tape does not offer a sufficient seal. When lengths are cut, cable ends should be immediately resealed and secured.

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RECOMMENDED CABLE HANDLING PROCEDURES

Wire and Cable Reel Handling and Storage

DON'T

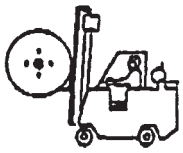
When off loading reels from a truck, lower reels carefully using a hydraulic gate, hoist or fork lift truck. *Never drop reels.* If reels must be rolled, roll in opposite direction of the cable wraps to keep cable from loosening on the reel.

When using a hoist, install a mandrel through the reel arbor holes and attach a sling. Use a spreader bar approximately 6 inches longer than the overall reel width placed between the sling ends just above the reel flanges. This will prevent bending the reel flanges and mashing the cable

DO

DON'T

DO

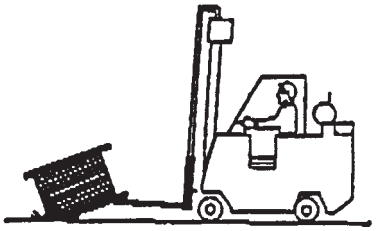


DON'T

If a fork lift is used, approach the reel from the flange side. Position the forks such that the reel is lifted by *both* reel flanges. *Do not allow the lift forks to contact the cable.* Care must be taken by the fork lift operator not to make sudden turns or stops.

Cable shipped on pallets should be stored indoors if possible. Cable shipped on wooden or metal reels may be stored outdoors. When selecting a storage site, consideration should be given to:

- Traffic patterns during off-loading
- Grade and condition of the soil or pavement
- Protection from vehicle damage during the time in storage
- Environmental conditions such as exposure to heat, corrosive chemicals, etc.



DON'T

Cable reels should be stored on hard surfaces resting on the flanges edge (flanges vertical). Align reels flange to flange and, if possible, arrange so that first in is first out. Multiple reels stacked on top of each other ("Pancake" storage), or storing reels flat (flanges horizontal) is not recommended for bare conductor or medium voltage cable. The weight of the stack can total thousands of pounds creating an enormous load on the bottom reel. Also, damage to the reel and/or cable will likely occur when the reel is flipped for transit. A concentration of stress on the reel flange may cause it to break and subsequently damage the cable.

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MAXIMUM PULLING TENSION

BICC Cables

Multiconductor cables having equal conductors; without subassemblies.
Soft drawn copper.

The following maximum tensions are for direct attachment to the conductor.
However, the pulling force must not exceed the smallest value of 1) conductor tension;
or 2) pulling device tension; or 3) sidewall load.

MAXIMUM ALLOWABLE CONDUCTOR TENSION (LBS)

	AWG/kcmil							
#CDR	**20**	**18**	**16**	**14**	**12**	**11**	**10**	**9**
2	16	26	41	66	100	130	160	200
3	24	39	62	99	150	190	240	310
4	33	52	83	130	200	260	330	410
5	41	65	100	160	260	320	410	520
6	49	78	120	190	310	390	490	620
7	49	78	120	190	310	390	490	620
8	52	83	130	210	330	420	530	670
9	59	93	140	230	370	470	590	750
10	65	100	160	260	410	520	660	830
11	72	110	180	280	460	570	730	920
12	78	120	190	310	500	630	790	1000
13	85	130	210	340	540	680	860	1000
14	91	140	230	360	580	730	930	1000
15	98	150	240	390	620	790	990	1000
16	100	160	260	420	660	840	1000	1000
17	110	170	280	440	710	890	1000	1000
18	110	180	290	470	750	940	1000	1000
19	120	190	310	500	790	1000	1000	1000
20	130	200	330	520	830	1000	1000	1000
22	140	220	360	570	910	1000	1000	1000
24	150	240	390	630	1000	1000	1000	1000
26	170	270	420	680	1000	1000	1000	1000
28	180	290	460	730	1000	1000	1000	1000
30	190	310	490	780	1000	1000	1000	1000
32	200	330	520	840	1000	1000	1000	1000
34	220	350	560	890	1000	1000	1000	1000
36	230	370	590	940	1000	1000	1000	1000
38	240	390	620	1000	1000	1000	1000	1000
40	260	410	660	1000	1000	1000	1000	1000
42	270	430	690	1000	1000	1000	1000	1000
44	280	450	720	1000	1000	1000	1000	1000
46	300	470	760	1000	1000	1000	1000	1000
48	310	490	790	1000	1000	1000	1000	1000
50	320	510	820	1000	1000	1000	1000	1000

$T = 0.008 \times CM \times N$, if $N \leq 6$.
$T = 0.008 \times CM \times N \times 0.8$, if $N > 6$.
$T = 0.008 \times CM \times N \times 0.6$, if twisted subassemblies.

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In general, the requirements for cable storage are quite straight forward. Maintain the cable dry, at a temperature that will not cause degradation, and protect the cable from damage.

In order to maintain cable dryness, it is mandatory that the following steps be taken:

1. Maintain cable and end cap moisture seal integrity.
2. Do not store in locations where standing water is likely.
3. Maintain cable ends fixed to reel flanges without puncturing jackets of end caps.

In order to keep the cable from degrading and ready for use, it is necessary to:

1. Maintain, as far as practicable, a covering over the cable on the reel.
2. Maintain storage temperatures between -20°C (-4°F) and 50°C (122°F). Excursions beyond these temperatures are permissible for certain materials. Consult cable manufacturer.
3. It is recommended to avoid storing cables immediately prior to installation in direct sunlight when ambient temperatures are in excess of 122°F. Some jackets will soften and this may lead to physical damage during installation.
4. When cable is stored at temperatures colder than -20°C (-4°F), it is necessary to move the reel(s) into a heated area before installation, maintained at a minimum temperature of 32°F. The cable must reside in this heated area for at least 8 hours before it is installed.

In order to protect the cable from damage, it is necessary to:

1. Store cable, especially long term storage, in relatively inactive areas.
2. Maintain a covering on the cable reels so that any cable damaging instrument will damage the covering also.
3. In areas of extreme rodent infestation, cables should be protected with full lagging, steel plates over flange penetrations or other suitable means.
4. Store cable reels standing on flange rims. DO NOT, except in special circumstances, store cable reels on their sides; i.e., laying on one or the other flange.

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PREINSTALLATION

Overview

To ensure safety during cable installation and reliability once the cable is installed, you should confirm the following prior to installation.

- The cable selected is proper for your application.
- The cable has not been damaged in transit or storage.

Review all applicable state and national codes to verify that the cable chosen is appropriate for the job. Also, consult your local building authority.

Next, you must identify any existing cable damage and prevent any further damage from occurring. This is done through proper cable inspection, handling and storage.

Cable Inspection

Inspect every cable reel for damage before accepting the shipment. Be particularly alert for cable damage if:

- A reel is laying flat on its side
- Several reels are stacked
- Other freight is stacked on a reel
- Nails have been driven into reel flanges to secure shipping blocks
- A reel flange is damaged
- A cable covering is removed, stained or damaged
- A cable end seal is removed or damaged
- A reel has been dropped (hidden damage likely)

Cabling Handling

Remove all nails and staples from the reel flanges before moving a reel, and avoid all objects that could crush, gouge or impact the cable when moving. NEVER use the cable as a means to move a reel.

When unreeling, observe recommended bending radii, use swivels to prevent twisting and avoid overruns.

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INSTALLATION

Overview

A survey of customer complaints revealed that 92% of the cables in question failed due to mechanical damage. When does mechanical damage usually occur? During installation.

In fact, most cables are subjected to more mechanical stress during installation than they ever experience in actual operation. Needless to say, handling and pulling your cable according to manufacturer's recommendations is extremely important.

There are five main considerations in any cable installation:

- Ambient temperature
- Equipment
- Conduit fill
- Mechanical fit in raceway
- Physical limitations

These considerations were developed and refined by installers of paper-lead cables. Two excellent references are the "Underground Systems Reference Book" and "Pipeline Design for Pipe Type Feeders." The former was published by Edison Electric Institute in 1931 and was last revised in 1957. The latter was an AIEE paper (#53-389) by R.C. Rifenburg, published in *Power Apparatus & Systems* in December, 1953.

Ambient Temperature

Low temperatures are a cause for concern when installing cable. The following are temperatures below which cable should not be installed.

- CP/EP - 1/C.....-31°F
- CPE Jacket.....-31°F
- CPE/EP - 1/C .....-31°F
- FREP, PE, XLPE - 1/C.....-58°F
- PVC .....+14°F

CP = Chlorosulfonated Polyethylene (Hypalon®)
CPE = Chlorinated Polyethylene
EP = Ethylene Propylene
FREP = Flame Retardant EP
PVC = Polyvinyl Chloride

During cold weather installation, cable should be pulled more slowly and trained in place the same day it is removed from storage. Do not impact, drop, kink or bend cable sharply in low temperatures.

Equipment

The proper use of appropriate equipment is crucial to a successful cable installation. The equipment needed for most installations is detailed in the following checklist:

- □ Portable electric generator
- □ Extension cords & GFCI
- □ Pump, diaphragm
- □ Make-up air blower & hose
- □ Manhole cover hooks
- □ Warning flags, signs
- □ Electrostatic kV tester
- □ Electric safety blankets and clamps
- □ Radios or telephones
- □ Gloves
- □ Flood lamps
- □ Fishtape or string blower/vacuum
- □ Hand line
- □ Duct cleaning mandrels
- □ Duct testing mandrels
- □ Capstan type puller
- □ Snatch blocks
- □ Short ropes for temp tie-offs
- □ Guide-in flexible tubing (elephant trunks)
- □ Several wire rope slings of various lengths
- □ Shackles/clevis
- □ Gang rollers; with at least 4 ft. effective radius
- □ Hand winches (come-a-long)
- □ Manhole edge sheave
- □ Pulling rope
- □ Swivels
- □ Basket grip pullers
- □ 0-1/5/10 kip dynamometer
- □ Reel arbor
- □ Reel jacks
- □ Reel brakes
- □ Cable cutter
- □ Lint free rags
- □ Cable pulling lubricant
- □ Prelubing devices
- □ Plywood sheets
- □ Diameter tape
- □ 50 ft. measuring tape
- □ Silicone caulking (to seal cable ends)

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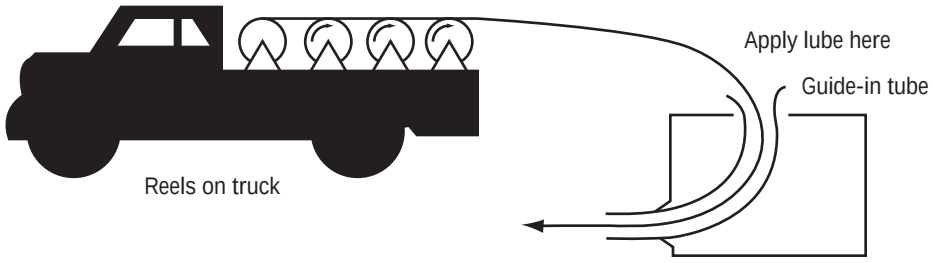
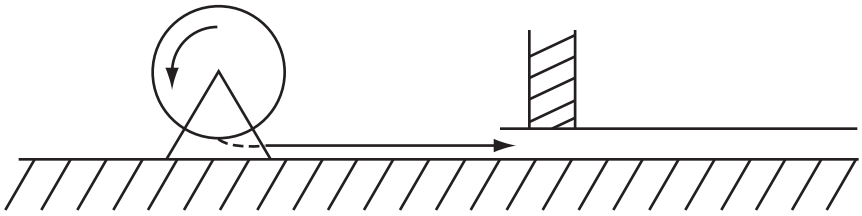
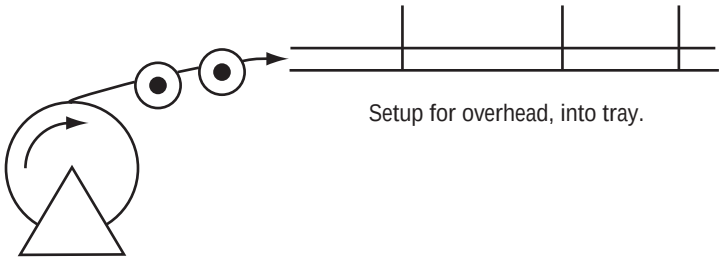
CABLE FEED-IN SETUPS

The following diagrams illustrate various cable feed-in setups.





Setup for duct close to floor.



Setup for overhead, into tray.

The feed-in setup should unreel the cable with a natural curvature (Figure 1) as opposed to a reverse "S" curvature (Figure 2).

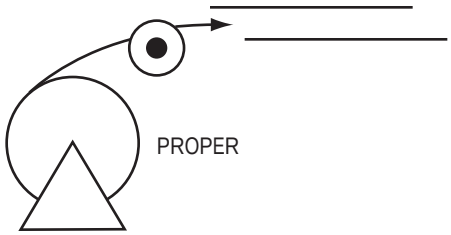


Figure 1

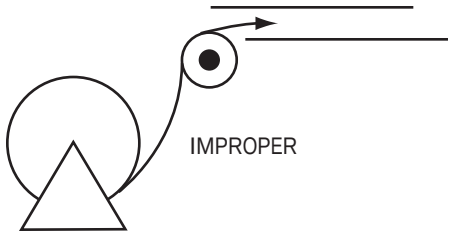


Figure 2

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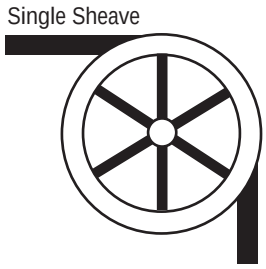
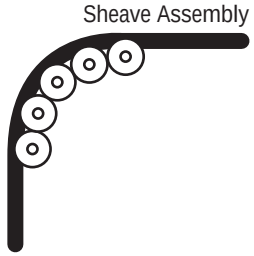
CABLE FEED-IN SETUPS (CONT.)

Single Sheaves may be used only for GUIDING cables. Arrange multiple blocks to hold bending radii whenever cable is deflected.



For pulling around bends, use conveyor sheave assemblies of the appropriate radius series.



The pulleys must be positioned to ensure that the effective curvature is smooth and deflected evenly at each pulley. Never allow a polygon curvature to occur (Figure 3).

The fit of a pulley around the cable is also important when pulling heavy weights (i.e. pulleys at th top of a vertical drop).

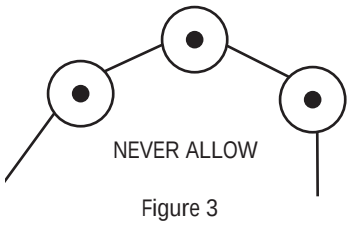
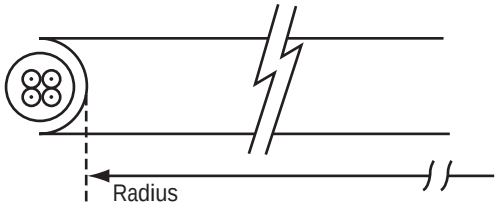


Figure 3

Remember to use the radius of the surface over which the cable is bent, not the outside flange diameter of the pulley. A “10 inch” cable sheave typically has an inside (bending) radius of 3 inches!



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CONDUCTORS IN PARALLEL OR AS ASSEMBLIES. SOFT DRAWN COPPER OR HARD DRAWN ALUMINUM.

The following maximum tensions are for direct attachment to the conductor. However, the pulling force must not exceed the smallest value of 1) conductor tension; or 2) pulling device tension; or 3) sidewall load.

MAXIMUM ALLOWABLE CONDUCTOR TENSION (LBS)

	#CDR					
AWG/kcmil	**1**	**2**	**3**	**4**	**5**	**6**
20	8	16	24	26	33	39
18	13	26	39	41	52	62
16	21	41	62	66	83	99
14	33	66	99	100	130	150
12	52	100	150	160	200	250
11	66	130	190	210	260	310
10	83	160	240	260	330	390
9	100	200	310	330	410	500
8	130	260	390	420	520	630
6	210	420	630	670	840	1000
4	330	660	1000	1060	1330	1600
3	420	840	1260	1340	1680	2020
2	530	1060	1590	1690	2120	2540
1	670	1330	2000	2140	2670	3210
1/0	840	1690	2530	2700	3370	4050
2/0	1060	2130	3190	3400	4250	5110
3/0	1340	2680	4020	4290	5370	6440
4/0	1690	3380	5070	5410	6500	6500
250	2000	4000	6000	6400	6500	6500
300	2400	4800	6500	6500	6500	6500
350	2800	5600	6500	6500	6500	6500
400	3200	6400	6500	6500	6500	6500
450	3600	6500	6500	6500	6500	6500
500	4000	6500	6500	6500	6500	6500
600	4800	6500	6500	6500	6500	6500
700	5000	6500	6500	6500	6500	6500
750	5000	6500	6500	6500	6500	6500
800	5000	6500	6500	6500	6500	6500
900	5000	6500	6500	6500	6500	6500
1000	5000	6500	6500	6500	6500	6500

$T = 0.008 \times CM \times N$, if $N \leq 3$.

$T = 0.008 \times CM \times N \times 0.8$, if $N > 3$.

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MULTICONDUCTOR CABLES HAVING EQUAL SIZED CONDUCTORS; WITHOUT SUBASSEMBLIES. SOFT DRAWN COPPER.

The following maximum tensions are for direct attachment to the conductor. However, the pulling force must not exceed the smallest value of 1) conductor tension; or 2) pulling device tension; or 3) sidewall load.

MAXIMUM ALLOWABLE CONDUCTOR TENSION (LBS)

	AWG							
#CDR	20	18	16	14	12	11	10	9
2	16	26	41	66	100	130	160	200
3	24	39	62	99	150	190	240	310
4	33	52	83	130	200	260	330	410
5	41	65	100	160	260	320	410	520
6	49	78	120	190	310	390	490	620
7	49	78	120	190	310	390	490	620
8	52	83	130	210	330	420	530	670
9	59	93	140	230	370	470	590	750
10	65	100	160	260	410	520	660	830
11	72	110	180	280	460	570	730	920
12	78	120	190	310	500	630	790	1000
13	85	130	210	340	540	680	860	1000
14	91	140	230	360	580	730	930	1000
15	98	150	240	390	620	790	990	1000
16	100	160	260	420	660	840	1000	1000
17	110	170	280	440	710	890	1000	1000
18	110	180	290	470	750	940	1000	1000
19	120	190	310	500	790	1000	1000	1000
20	130	200	330	520	830	1000	1000	1000
22	140	220	360	570	910	1000	1000	1000
24	150	240	390	630	1000	1000	1000	1000
26	170	270	420	680	1000	1000	1000	1000
28	180	290	460	730	1000	1000	1000	1000
30	190	310	490	780	1000	1000	1000	1000
32	200	330	520	840	1000	1000	1000	1000
34	220	350	560	890	1000	1000	1000	1000
36	230	370	590	940	1000	1000	1000	1000
38	240	390	620	1000	1000	1000	1000	1000
40	260	410	660	1000	1000	1000	1000	1000
42	270	430	690	1000	1000	1000	1000	1000
44	280	450	720	1000	1000	1000	1000	1000
46	300	470	760	1000	1000	1000	1000	1000
48	310	490	790	1000	1000	1000	1000	1000
50	320	510	820	1000	1000	1000	1000	1000

The maximum limit is 1000 lbs.

$T = 0.008 \times CM \times N$, if $N \leq 6$.
$T = 0.008 \times CM \times N \times 0.8$, if $N > 6$.
$T = 0.008 \times CM \times N \times 0.6$, if twisted subassemblies.

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PHYSICAL LIMITATIONS TRAINING AND BENDING

Overview

Training is the positioning of cable which is not under tension. Bending is the positioning of cable which is under tension. When installing cable, the object is to limit these forces so that the cable's physical and electrical characteristics are maintained for the expected service life. The recommended limits are:

- Tables per National Electric Code (see tables at right)
- Tables per ICEA/NEMA
- A nonshielded cable can tolerate a sharper bend than a shielded cable can. This is especially true for cables having helical metal tapes which, when bent too sharply, can separate, buckle and cut into the insulation.

The problem is compounded by the fact that most tapes are under jackets which conceal such damage. The shielding bedding tapes or extruded polymers have sufficient conductivity and coverage initially to pass acceptance testing, then fail prematurely due to corona at the shield/insulation interface.

Remember that offsets are bends.

Applications in Accordance with the National Electrical Code.

TABLE 1

Shielded or Lead-Covered Cable (Non-Armored)
Single and Multiple Conductor – All Voltages Over 600 Volt Nominal
12 x Overall Diameter

TABLE 2

Non-Shielded and Non-Armored
Single and Multiple Conductor – All Voltages Over 600 Volt Nominal
8 x Overall Diameter

TABLE 3

Armored Cable - Type MC
Interlocked or Corrugated Sheath
Multiple Conductors – Non Shielded
7 x External Diameter of Armor
Multiple Conductors – Shielded
12 x Diameter of One Shielded Conductor
or
7 x External Diameter of Armor
Whichever is greater

In all cases the minimum bending radius specified refers to the inner surface of the cable and not to axis of the cable.

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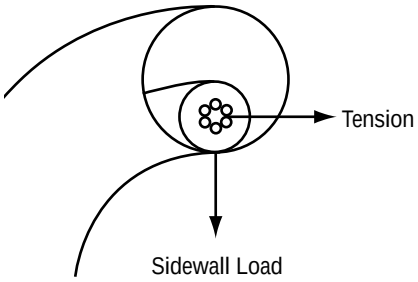
MAXIMUM SIDEWALL PRESSURE

Sidewall Loading (Sidewall Bearing Pressure)

Overview

Sidewall load is the radial force exerted on a cable being pulled around a conduit bend or sheave. Excessive sidewall loading can crush a cable and is, therefore, one of the most restrictive factors in installations having bends or high tensions. Sidewall loading is reduced by increasing the radius of the bends.



The maximum tension that can be safely applied to the cable during installation can be derived using the maximum sidewall loading limit of the cable and the radius of the bend it is traversing. For example, a cable having a maximum SWL of 300 lb/ft that is being pulled around a bend having a radius of 2 feet should have no greater than 300 lbs/ft x 2 ft or 600 lbs tension applied to it as the cable exits the bend.

Laboratory tests conducted on standard cables after they had been subjected to conduit pull tests through 90° elbows of appropriate radii, indicate no significant change in the cable's electrical parameters at the following sidewall loads:

Cable type	SWL lbs/ft
600V nonshielded control	300
600V and 1 kV nonshielded EP power	500
5 and 35 kV UniShield® & Uniblend®, 5 kV Durasheath® EP	500
Interlocked armored cable (All Voltage Classes)	300

BICC CABLES APPROVAL LIST
CABLE PULLING LUBRICANTS

Name of Lubricant	Manufacturer
Polywater® A, G, and J	American Polywater Corporation, Stillwater, MN
Polywater® Plus Silicone, Types NN, WNN, FS	American Polywater Corporation, Stillwater, MN
Wire Lube® and Aqua-Gel®	Ideal Industries, Sycamore, IL
Dyna-Blue® Cable Lubricant	American Polywater Corporation, Stillwater, MN
Wirepull	Mac Products, Kearney, NJ

Other lubricants may be suitable for use with BICC Cable designs.
Contact the lubricant manufacturer about the compatibility of their products with specific cables.
Cable lubricants should be currently UL listed.
Contact lubricant manufacturers for proof of approval.

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DC HIGH POTENTIAL (HIPOT) TESTING OF MEDIUM VOLTAGE POWER CABLES

Overview

This procedure is intended to provide general guidelines for high potential dc testing of power cables.

All tests made after cable installation and during the guarantee period shall be made in accordance with applicable specifications.

All safety precautions must be observed during testing at high voltage.

Read and understand and follow the Operator's Manual for the particular test set being used!

Test Equipment

Direct current test equipment is available commercially with a wide range of voltages. Accessory equipment is necessary to safely conduct high voltage tests such as safety barriers, rubber gloves and nonconducting hard hats must be used; consult appropriate safety officer.

Test Procedures

See IEEE Standard 400. Acceptable procedures, although varying slightly in technique, have more or less been standardized as either a "withstand test" or a "time-leaking current test."

Before performing any dc over-potential tests:

- All equipment must be disconnected from the cable circuit, i.e. disconnect transformers, switch taps, motors, circuit breakers, surge arrestors, etc. This will preclude damage to such equipment and will prevent test interruptions due to flashovers and/or trip-outs resulting from excessive leakage current.
- Establish adequate clearance between the circuit test ends and any grounded object, and to other equipment not under test (about 2.5 feet).
- Ground all circuit conductors not under test with *all* cable shields including nearby equipment.
- Consult termination manufacturers for maximum test voltage recommendations and time limitations.

The direct current test voltage may be applied either continuously or in predetermined steps to the maximum value in accordance with applicable specifications.

- **Continuous Method –** Apply test voltage at an approximate rise rate of 1 kV per second or 75% of the rated current output of the equipment, whichever is less. Some equipment will take longer to reach the maximum test voltage because of the amount of charging current.
- **Step Method –** Apply test voltage slowly in 5 to 7 increments of equal value, to the maximum specified. Allow sufficient time at each stop for the leakage current to stabilize.

Hi-Pot Testing Procedures

Normally this requires only a few seconds unless cable circuits of high capacitance are involved.

Record leakage current at each step.

Maintain the test voltage at the prescribed value for the time designated in applicable specifications. The following times are usually considered adequate: at the end of the test period, set the test set voltage control to zero; allow the residual voltage on the circuit to decay then ground the conductor just tested.

CAUTION

It should be recognized that dc charges on cable can build up to potentially dangerous levels if grounds are removed too quickly. **Maintain solid grounds after the test on the cable for at least 4 times the duration of the test.** On exceptionally long cable lengths it may be necessary to increase the grounding time. It is advantageous to maintain these grounds longer and while reconnecting circuit components.

- **Acceptance Testing –** After installation and before the cable is placed in regular service the specified test voltage shall be applied for **15 consecutive minutes.**
- **Proof Testing –** At any time during the period of guarantee the cable circuit may be removed from service and tested at a reduced voltage (normally 65 percent of the original acceptance value) for **5 consecutive minutes.**
- Record the leakage current, at one minute intervals for the duration of the test time involved.

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DC HIGH POTENTIAL (HIPOT) TESTING OF MEDIUM VOLTAGE POWER CABLES

Comments

DC overpotential testing of medium voltage power cables is usually performed with negative polarity connected to the conductor.

DC overpotential testing is a tool only for determining insulation resistance at higher voltages. Effective insulation resistance of the cable system may be calculated by means of Ohms Law: R = V/I. The relation is:

$$\text{Megohms} = \frac{\text{Kilovolts}}{\text{Microamperes}} \times 1000$$

Insulation resistance may also be measured with standard instruments which give a direct reading at 500 volts (or higher, depending on the model). IR in general has little or no direct relationship to dielectric or breakdown strength.

The significance of conducting dc High Voltage tests on nonshielded, nonmetallic-sheathed cable is dependent upon the environment in which it is installed because the characteristics of the return circuits are unknown. The environment must be carefully considered or test results may not be significant. In fact, these tests can result in damage to the cable insulation.

Humidity, condensation and actual precipitation on the surface of a cable termination can increase the leakage current by several orders of magnitude. Humidity also increases the corona current, which indication is included in the total leakage current. Wind prevents the accumulation of space charges at all bare energized terminals. This results in an increase of corona. It is most desirable to reduce or eliminate corona current at the bare metal extremities of cable or terminations. This may be accomplished by covering these areas with plastic envelopes, plastic or glass containers, plastic wrap (e.g. "Saran" or "Handiwrap®") or suitable electrical putty.

Routine periodic dc maintenance testing of cable for the evaluation of the insulation strength is not a common practice. Some power cable users have adopted a program of testing circuits during planned outages, preferring possible breakdowns during testing rather than experiencing a service outage. It is nearly impossible to recommend test voltage values for those maintenance tests with the history of the cable circuit. An arbitrary test voltage level could break down a cable circuit that would otherwise render long trouble-free service at normal operating ac voltage.

The main usefulness of dc high voltage testing is to detect conducting particles left on the creepage surface during splicing or termination.

Test equipment should be supplied from a stable, constant voltage source. Do not use the same source that is supplying arc welders or other equipment causing line voltage fluctuations. The output voltage of the test set must be filtered and regulated. Consider using a portable motor driven alternator to energize test set.

The gradual decrease or nonincrease of leakage current with respect to time at maximum test voltage is the acceptance criteria for dc hipot testing.

Testing Problems

Extra Leakage Current:
- Failure to guard against corona
- Failure to clean insulation surface
- Failure to keep cable ends dry
- Failure to provide adequate clearance to ground
- Improper shield termination

Erratic Readings:
- Fluctuating voltage to test set
- Improper test leads

Environmental influences:
- High relative humidity
- Dampness, dew, fog
- Wind, snow

Results vs. Cable Life

To date there is no bases for correlation between dc test results and cable life expectancy.

Partial Listing of Equipment Suppliers

J.G. Biddle Company
Blue Bell, PA 19422

Hipotronics
Brewster, NY 10519

Associated Research Inc.
Chicago, IL 60648

Von Corporation
Birmingham, AL 35211

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MAXIMUM DC TEST VOLTAGES FOR SHIELDED CABLES

National Electrical Manufacturers' Association & IEEE Standard 400

EPR = NEMA WC-8, ICEA S-68-516
XLP = NEMA WC-7, ICEA S-66-524
PE = NEMA WC-5, ICEA S-61-402

Rated Circuit Voltage Phase to Phase Volts	Conductor Size AWG-kcmil	ACCEPTANCE 100% (For Grounded) kV	ACCEPTANCE 133% (For Ungrounded) kV
2001-5000	8-1000	25	25
5001-8000	6-1000	35	35
8001-15000	2-1000 (1)	55	–
	1-1000 (1)	–	65 (2)
15001-25000	1-1000	80	100 (2)
25001-28000	1-1000	85	–
28001-35000	1/0-1000	100	–

(1) Combined in S-61-402, S-68-516

(2) Not in IEEE-400

BICC Cables does not make any recommendations for maintenance testing.

Test to be made immediately after installation.

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TESTS DURING AND AFTER INSTALLATION

(Excerpt from AEIC CS6)

During Installation

At any time during installation, a dc proof test may be made at a voltage not exceeding the dc test voltage specified in the table below, under the "During Installation" column, applied for 5 consecutive minutes.

In Service

After the cable has been completely installed and placed in service, a dc proof test may be made at any time within the first 5 years of service at a voltage not exceeding the dc test voltage specified in the table below under the "First 5 Years" column, applied for 5 consecutive minutes.*

DC test voltages are applied to discover gross problems such as improperly installed accessories or mechanical damage. DC testing is not expected to reveal deterioration due to aging during the first five years of service.

Rated Voltage Phase to Phase	Conductor Size AWG or kcmil (mm²)	Insulation Thickness Mils (mm)		Maximum DC Field Test Voltages kV			
				During Installation		First 5 Years	
		100%	133%	100%	133%	100%	133%
5	8-1000 (8.4-507) Above 1000 (507)	90 (2.92) 140 (3.56)	115 (2.92) 140 (3.56)	28 28	36 36	22 22	29 29
8	6-1000 (13.3-507) Above 1000 (507)	115 (2.92) 175 (2.92)	140 (3.56) 140 (3.56)	36 36	44 44	29 29	35 35
15	2-1000 (33.6-507) Above 1000 (507)	175 (4.45) 220 (5.59)	220 (5.59) 220 (5.59)	56 56	64 64	45 45	51 51
25	1-2000 (42.4-1013)	260 (6.60)	320 (8.13)	80	96	64	77
28	1-2000 (42.4-1013)	280 (7.11)	345 (8.76)	84	100	67	80
35	1/0-2000 (53.5-1013)	345 (8.76)	420 (10.7)	100	124	80	99
46	4/0-2000 (107.2-1013)	445 (11.3)	580 (14.7)	132	172	106	138
69	500-2000 (153.4-1013)	650 (16.5)	–	192	–	154	–

* These test voltages are for all EPR circuits. Other values may be dictated by mixed cable circuits with other insulations or thinner insulation walls.

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COMMON COLOR SEQUENCE

Conductor Number	Background or Base Color	Tracer Color	Conductor Number	Background or Base Color	Tracer Color
SEQUENCE DESIGNATION K-1					
1	Black	—	12	Black	White
2	White	—	13	Red	White
3	Red	—	14	Green	White
4	Green	—	15	Blue	White
5	Orange	—	16	Black	Red
6	Blue	—	17	White	Red
7	White	Black	18	Orange	Red
8	Red	Black	19	Blue	Red
9	Green	Black	20	Red	Green
10	Orange	Black	21	Orange	Green
11	Blue	Black			
SEQUENCE DESIGNATION K-2 (NEC)					
1	Black	—	19	Orange	Blue
2	Red	—	20	Yellow	Blue
3	Blue	—	21	Brown	Blue
4	Orange	—	22	Black	Orange
5	Yellow	—	23	Red	Orange
6	Brown	—	24	Blue	Orange
7	Red	Black	25	Yellow	Orange
8	Blue	Black	26	Brown	Orange
9	Orange	Black	27	Black	Yellow
10	Yellow	Black	28	Red	Yellow
11	Brown	Black	29	Blue	Yellow
12	Black	Red	30	Orange	Yellow
13	Blue	Red	31	Brown	Yellow
14	Orange	Red	32	Black	Brown
15	Yellow	Red	33	Red	Brown
16	Brown	Red	34	Blue	Brown
17	Black	Blue	35	Orange	Brown
18	Red	Blue	36	Yellow	Brown

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METRIC CONVERSION

	To Convert From	To	Multiply By
Length	Inches	Millimeters	25.4
	Millimeters	Inches	0.03937
	Inches	Centimeters	2.54
	Centimeters	Inches	0.3937
	Feet	Meters	0.3048
	Meters	Feet	3.2808
	Kilofeet (1000 ft)	Kilometers	0.3048
	Kilometers	Kilofeet (1000 ft)	3.2808
Area	Square Inches	Square Millimeters	645.16
	Square Millimeters	Square Inches	0.00155
	Square Inches	Square Centimeters	6.4516
	Square Centimeters	Square Inches	0.155
	Square Inches	Circular Mils	1,273,240
	Circular Mils	Square Inches	7.854×10^{-7}
	Circular Mils	Square Millimeters	5.066×10^{4}
	Square Millimeters	Circular Mils	1973.51
	Square Feet	Square Meters	0.0929
	Square Meters	Square Feet	10.764
Weight	Pounds	Kilograms	0.4536
	Kilograms	Pounds	2.2046
	Pound/Kilofeet	Kilograms/Kilometer	1.4882
	Kilograms/Kilometer	Pounds/Kilofeet	0.6720
Electrical	Ohms/Kilofeet	Ohms/Kilometer	3.2808
	Ohms/Kilometer	Ohms/Kilofeet	0.3048
	Microfarads/Kilofeet	Microfarads/Kilometer	3.2808
	Microfarads/Kilometer	Microfarads/Kilofeet	0.3048
	Insulation Resistance:		
	Megohms—Kilofeet	Megohms—Kilometer	0.3048
	Megohms—Kilometer	Megohms—Kilofeet	3.2808
Mechanical	Pounds/Square Inch	Kilo Pascal*	6.895
	Kilo Pascal*	Pounds/Square Inch	0.1432
	Pounds (force)	Newtons	4.448
	Newtons	Pounds (force)	0.2248

* 1 Pascal = 1 newton/m^2

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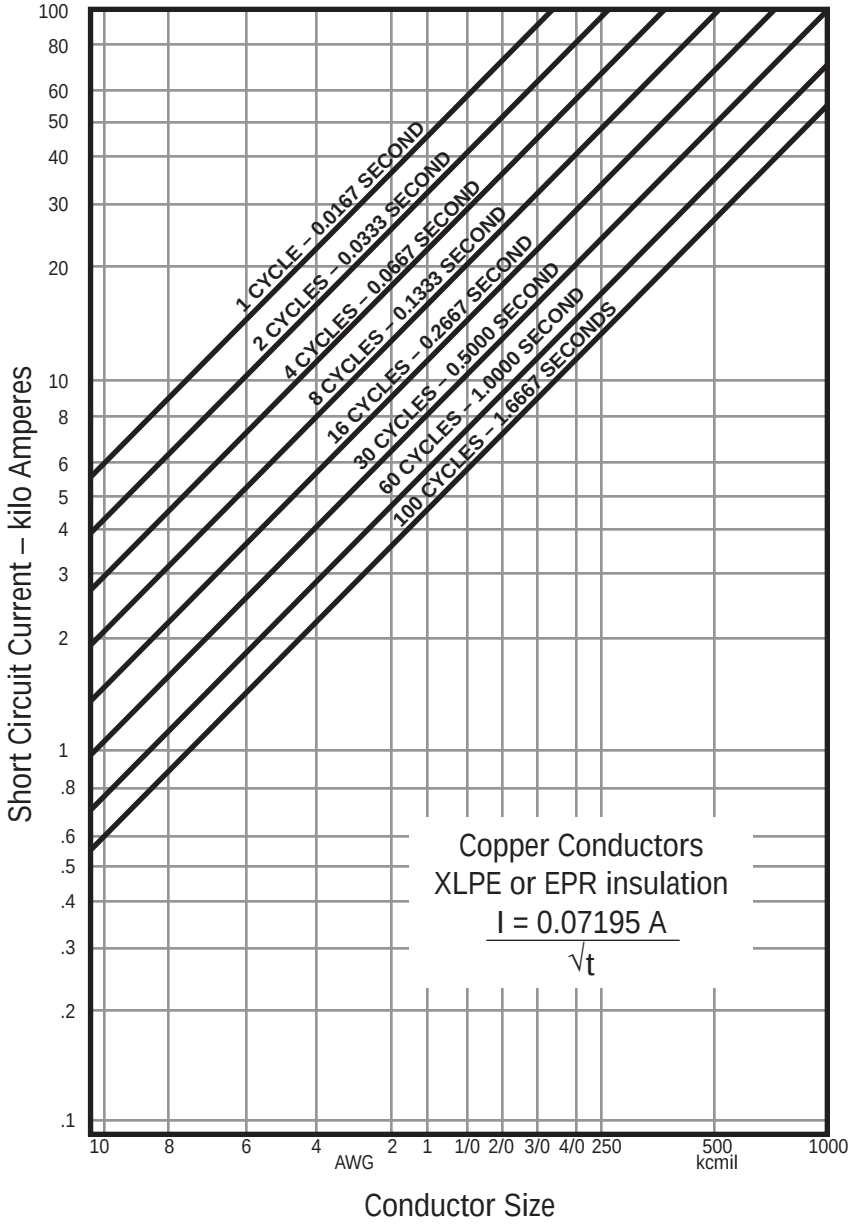
ALLOWABLE SHORT CIRCUIT CURRENTS FOR INSULATED COPPER CONDUCTORS



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CONDUCTOR DATA

Size		Diameter (Inches)					Weight (lb/ft)		Area
AWG	kcmil	Solid	Class B			Class H	Copper	Aluminum	[4]Circumscribed in^2
			[1]Conc	[2]Combination	[3]Anapact™				
22	640	0.0253					0.00194	0.000589	0.000503
20	1020	0.0320	0.036				0.003154	0.000942	0.00103
18	1620	0.0403	0.046				0.005015	0.00149	0.00163
16	2580	0.0508	0.058				0.007974	0.00238	0.00261
14	4110	0.0641	0.073				0.01268	0.00378	0.00414
12	6530	0.0808	0.092				0.02016	0.00601	0.00658
10	10380	0.1019	0.116				0.03206	0.009556	0.0106
9	13090	0.1144	0.130				0.04042	0.01204	0.0133
8	16510	0.1285	0.146		0.137	0.167	0.05097	0.0152	0.0167
6	26240	0.1620	0.184		0.172	0.210	0.08105	0.0246	0.0266
4	41740	0.2043	0.232		0.217	0.266	0.1289	0.0392	0.0423
3	52620	0.2294	0.260		0.240	0.299	0.1625	0.04843	0.0531
2	66360	0.2576	0.292		0.271	0.335	0.2049	0.0623	0.0670
1	83690	0.2893	0.332	0.328	0.303	0.378	0.2584	0.0785	0.0865
1/0	105600	0.3249	0.373	0.369	0.342	0.424	0.3258	0.0991	0.109
2/0	133100	0.3648	0.419	0.413	0.384	0.477	0.4109	0.1249	0.138
3/0	167800	0.4096	0.470	0.464	0.429	0.536	0.5181	0.1575	0.173
4/0	211600	0.4600	0.528	0.521	0.480	0.601	0.6533	0.1986	0.219
	250		0.575	0.570	0.525	0.653	0.7719	0.2347	0.260
	300		0.630		0.574	0.716	0.9263	0.2816	0.312
	350		0.681	0.674	0.619	0.772	1.081	0.3286	0.364
	400		0.728			0.826	1.235	0.3755	0.416
	500		0.813	0.807	0.740	0.923	1.544	0.4694	0.519
	550		0.855			0.980	1.698	0.5163	0.574
	600		0.893			1.022	1.853	0.5632	0.626
	700		0.964			1.106	2.161	0.6571	0.730
	750		0.998	0.989	0.911	1.145	2.316	0.7040	0.782
	900		1.094			1.253	2.779	0.8449	0.940
	1000		1.152	1.142	1.064	1.320	3.088	0.9387	1.04

[1]ASTM B 8 (Conc. = Concentric)
[2]Combination Stranding, having smoother configuration than Class B.
[3]Anapact is BICC Cables version of compact stranding.
[4]Circumscribed Area = $(\pi/4)$ $(OD)^2$, using Class B OD's, or OD of solid when Class B OD not given.

Use Circumscribed Area for computing conduit fill. Use in^2 $(\pi/4)(CM)(10^6)$ for finding conductor area. Values at 20°C (68°F)

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SI UNITS/METRIC

Size		Diameter (Inches)					Weight (lb/ft)		Area
AWG/kcmil	mm^2	Solid	Class B			Class H	Copper	Aluminum	[4]Circumscribed in^2
			[1]Conc	[2]Combination	[3]Anapact™				
22	0.32	0.64					2.89	0.877	
20	0.52	0.81	0.92				4.69	1.40	See Column 2
18	0.82	1.02	1.16				7.46	2.22	for sizes
16	1.31	1.29	1.46				11.9	3.54	under 250
14	2.08	1.63	1.84				18.9	5.63	kcmil.
12	3.31	2.05	2.32				30.0	8.94	
10	5.26	2.59	2.95				47.7	14.2	
9	6.63	2.91	3.30				60.2	17.9	
8	8.37	3.26	3.71		3.48	4.24	75.8	22.6	
6	13.2	4.12	4.67		4.37	5.33	120	36.6	
4	21.2	5.19	5.89		5.51	6.76	192	58.3	
3	26.7	5.83	6.60		6.10	7.59	242	72.1	
2	33.6	6.54	7.42		6.88	8.51	305	92.7	
1	42.4	7.35	8.43	8.33	7.63	9.8	384	117	
1/0	53.5	8.25	9.47	9.37	8.69	10.8	485	147	
2/0	67.4	9.27	10.6	10.5	9.75	12.1	611	186	
3/0	85	10.4	11.9	11.6	10.9	13.6	771	234	
4/0	107	11.7	13.4	13.2	12.2	15.3	972	296	
250	126		14.6	14.5	13.3	16.6	1150	349	168
300	152		16.0		14.6	18.2	1380	419	201
350	177		17.3	17.1	15.7	19.6	1610	489	235
400	202		18.5			21.0	1840	559	269
500	253		20.6	20.5	18.8	23.4	2300	698	335
550	278		21.7			24.9	2530	768	371
600	304		22.7			26.0	2760	838	404
700	354		24.5			28.1	3220	978	471
750	380		25.3	25.1	23.1	29.1	3450	1050	505
900	456		27.8			31.6	4140	1280	607
1000	506		29.3	29	27	33.5	4600	1400	672

[1](ASTM B 8) x (25.4) (Conc. = Concentric)
[2]Combination Stranding, having smoother configuration than Class B.
[3]Anapact is BICC Cables version of compact stranding.
[4]Circumscribed Area = $(\pi/4)\ (25.4)^2$, using Class B OD's, or OD of solid when Class B OD not given.

Use Circumscribed Area for computing conduit fill. Values at 20°C (68°F)

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THERMOPLASTIC PROPERTIES

Insulation or Jacket Material	CPE	PVC Polyvinyl Chloride	Low Density Polyethylene	Cellular Polyethylene	High Density Polyethylene	Poly-Urethane	Poly-Propylene	Nylon	Teflon	TPE
Oxidation Resistance	E	E	E	E	E	E	E	E	0	E
Heat Resistance	G-E	G-E	G	G-E	E	E	G	E	0	G
Oil Resistance	E	E	G-E	G-E	G-E	E	E	E	0	P
Low Temp. Flexibility	G	P-G	G-E	E	E	E	G	G	0	E
Weather, Sun Resistance	E	G-E	E	E	E	E	F-G	E	0	
Ozone Resistance	E	E	E	E	E	E	E	E	E	E
Abrasion Resistance	E	F-G	F-G	G	E	F-G	0	E	G-E	F
Electrical Properties	F	F-G	E	E	E	E	P-F	F	E	G
Flame Resistance	F	E	P	P	P	P	P	P	0	F
Nuclear Radiation Resistance	G-E	P-F	G	G	G	F	G	F-G	P-F	F
Water Resistance	G	E	E	E	E	E	P	P-F	E	E
Acid Resistance	G-E	G-E	G-E	G-E	G-E	E	F	P-F	E	G
Alkali Resistance	G-E	G-E	G-E	G-E	G-E	E	F	E	E	G
Gasoline, Kerosene, Etc. (Alaphatic Hydrocarbons Resistance)	F	G-E	P-F	P-F	P-F	P-F	F	G	E	P
Benzol, Toluol Etc. (Aromatic Hydrocarbons Resistance)	F	P-F	P	P	P	P-F	P	G	E	P
Degreaser Solvents (Halogenated Hydrocarbons) Resistance	P	P-F	P	P	P	P	P	G	E	P
Alcohol Resistance	G	G-E	E	E	E	E	P	P	E	E

P = Poor
F = Fair
G = Good
E = Excellent
O = Outstanding

Any given property can usually be improved by the use of selective compounding.

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THERMOSET PROPERTIES

Insulation or Jacket Material	SBR (Styrene Butadiene Rubber	Natural Rubber	Synthetic Rubber	Poly Butadiene	Neoprene	Hypalon (Chloro-Sulphonated Polyethylene	NBR (Nitrile or Rubber Butadiene Nitrile	NBR/ PVC	EPR (Ethylene Propylene Rubber	XLPE	CPE	Silicone Rubber
Oxidation Resistance	F	F	G	G	G	E	F	E	G	E	E	E
Heat Resistance	F-G	F	F	F	G	E	G	G	E	G	E	G
Oil Resistance	P	P	P	P	G	G	G-E	G	F	G	G-E	F-G
Low Temp. Flexibility	F-G	G	E	E	F-G	F	F	F	G-E	0	F	0
Weather, Sun Resistance	F	F	F	F	G	E	F-G	G	E	G	E	0
Ozone Resistance	P	P	P	P	G	E	P	G	E	E	G-E	0
Abrasion Resistance	G-E	E	E	E	G-E	G	G-E	E	G	F-G	G-E	F
Electrical Properties	E	E	E	E	F	G	P	F	E	E	F-G	0
Flame Resistance	P	P	P	P	G	G	P	G	P	F-G	G	F-G
Nuclear Radiation Resistance	F-G	F-G	F-G	P	F-G	G	F-G	P	G	E	G	E
Water Resistance	G-E	G-E	E	E	G	G-E	G-E	E	G-E	G-E	G-E	G-E
Acid Resistance	F-G	F-G	F-G	F-G	G	E	G	G	G-E	G-E	E	F-G
Alkali Resistance	F-G	F-G	F-G	F-G	G	E	F-G	G	G-E	G-E	E	F-G
Gasoline, Kerosene, Etc. (Alaphatic Hydrocarbons Resistance)	P	P	P	P	G	F	E	G-E	P	F	F	P-F
Benzol, Toluol Etc. (Aromatic Hydrocarbons Resistance)	P	P	P	P	P-F	F	G	G	F	F	F	P
Degreaser Solvents (Halogenated Hydrocarbons) Resistance	P	P	P	P	P	P-F	P	G	P	F	P	P-G
Alcohol Resistance	F	G	G	F-G	F	G	E	G	P	E	G-E	G

P = Poor
F = Fair
G = Good
E = Excellent
O = Outstanding

Any given property can usually be improved by the use of selective compounding.

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Power Cable

- □ Size, AWG or kcmil
- □ Conductor Type (metal)
- □ Stranding
  - ___ Class B, concentric
  - ___ Class B, compact
  - ___ Class C
  - ___ Other
- □ Bare/Coated ___
- □ Conductor Shielding
  - ___ Extruded
  - ___ Tape
- □ Insulation
  - ___ EPR
  - ___ XLP
  - ___ PVC
  - ___ FR-EP
  - ___ Paper
  - ___ Other
- □ Insulation Level
  - ___ 100%
  - ___ 133%
  - ___ 173%
- □ Insulation Shielding
  - ___ Extruded
  - ___ Tape
- □ Metallic Shielding
  - ___ Helical copper tapes
  - ___ Helical wires
  - ___ Longitudinal drain wires
  - ___ Bare/Coated ___
  - ___ Other
- □ Jacket
  - ___ Neoprene
  - ___ CSPE
  - ___ PVC
  - ___ CPE
  - ___ Other
- □ Cable Assembly
  - ___ Cabled
  - ___ Multiconductor
  - ___ Other
- □ Grounding Conductors
  - ___ Quantity
  - ___ Insulated
  - ___ Size
  - ___ Bare/Coated ___
- □ Neutral Conductors
  - ___ Quantity
  - ___ Insulated
  - ___ Size
  - ___ Bare/Coated ___ Fillers
  - ___ Paper
  - ___ Flame retardant
  - ___ Fiber
  - ___ Other
- □ Covering
  - ___ Nonmetallic
  - ___ Interlocked armor
  - ___ Corrugated continuous welded armor
  - ___ Lead
  - ___ Other
- □ Color
- □ Voltage rating
- □ Temperature rating
- □ Approvals

Control Cable

- □ Conductor tape
- □ AWG
- □ Solid
  - ___ Class B, concentric
  - ___ Flexible
- □ Bare/Coated ___
- □ Insulation
- □ Jacket
- □ Temperature rating
- □ Voltage rating
- □ Individual Conductor Listings
- □ Number of Conductors
- □ Identification Method
  - ___ Color code
  - ___ Numbering
  - ___ Tags
- □ Grounding
  - ___ Bare/Coated ___
  - ___ Size
  - ___ Insulated

General Checklist

- □ Standards
  - ___ UL
  - ___ ICEA
  - ___ AEIC
  - ___ IEEE
  - ___ Other
- □ Testing Procedures
  - ___ UL
  - ___ ICEA
  - ___ AEIC
  - ___ IEEE
  - ___ Other
- □ Special Requirements
  - ___ Flame retardant
  - ___ Sunlight resistant
  - ___ Oil resistant
  - ___ Direct burial
  - ___ Cold bend
  - ___ Other
- □ Documentation
  - ___ Certificates of Compliance
  - ___ Certified Test Reports
  - ___ Drawings
  - ___ Warranties
  - ___ Other
- □ System Characteristics
- □ Shipping Details
  - ___ Cut lengths
  - ___ Returnable reels
  - ___ Lagging
  - ___ Installation recommendation
  - ___ Other
- □ Identification
  - ___ Cable
  - ___ Reel
  - ___ Circuit

NOTE: This checklist must be accompanied by exact system details about the environment and electrical characteristics.

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AMPACITIES FOR PORTABLE POWER CABLES, AMPERES PER CONDUCTOR

Power Conductor Size AWG or kcmil	Single Conductor				Two Conductor	Three Conductor	Three Conductor Round			Four Conductor	Five Conductor	Six Conductor
	0-2000 Volts Unshielded	2001-8000 Volts* Shielded	8001-15000 Volts* Shielded	15001-25000 Volts* Shielded	Round and Flat 0-2000 Volts	Round and Flat 0-5000 Volts Unshielded	0-8000 Volts Shielded	8001-15000 Volts Shielded	15001-25000 Volts Shielded	0-2000 Volts	0-2000 Volts	0-2000 Volts
8	63	—	—	—	72	59	—	—	—	54	50	48
6	109	112	—	—	95	79	93	—	—	72	68	64
4	145	148	—	—	127	104	122	—	—	93	88	83
3	167	171	—	—	145	120	140	—	—	106	100	95
2	192	195	195	—	167	138	159	164	178	122	166	110
1	223	225	225	222	191	161	184	187	191	143	136	129
1/0	258	260	259	255	217	186	211	215	218	165	—	—
2/0	298	299	296	293	250	215	243	246	249	192	—	—
3/0	345	345	343	337	286	249	279	283	286	221	—	—
4/0	400	400	397	389	328	287	321	325	327	255	—	—
250	445	444	440	430	363	320	355	359	360	280	—	—
300	500	496	491	480	400	357	396	—	—	310	—	—
350	552	549	543	529	436	394	435	—	—	335	—	—
400	600	596	590	572	470	430	470	—	—	356	—	—
450	650	640	633	615	497	460	503	—	—	377	—	—
500	695	688	678	659	524	487	536	—	—	395	—	—
550	737	732	—	—	—	—	—	—	—	—	—	—
600	780	779	—	—	—	—	—	—	—	—	—	—
650	820	817	—	—	—	—	—	—	—	—	—	—
700	855	845	—	—	—	—	—	—	—	—	—	—
750	898	889	—	—	—	—	—	—	—	—	—	—
800	925	925	—	—	—	—	—	—	—	—	—	—
900	1010	996	—	—	—	—	—	—	—	—	—	—
1000	1076	1061	—	—	—	—	—	—	—	—	—	—

* These ampacities are based on single isolated cable in air operated with open-circuit shield.

NOTE: These ampacities are based on a conductor temperature of 90°C and an ambient air temperature of 40°C.

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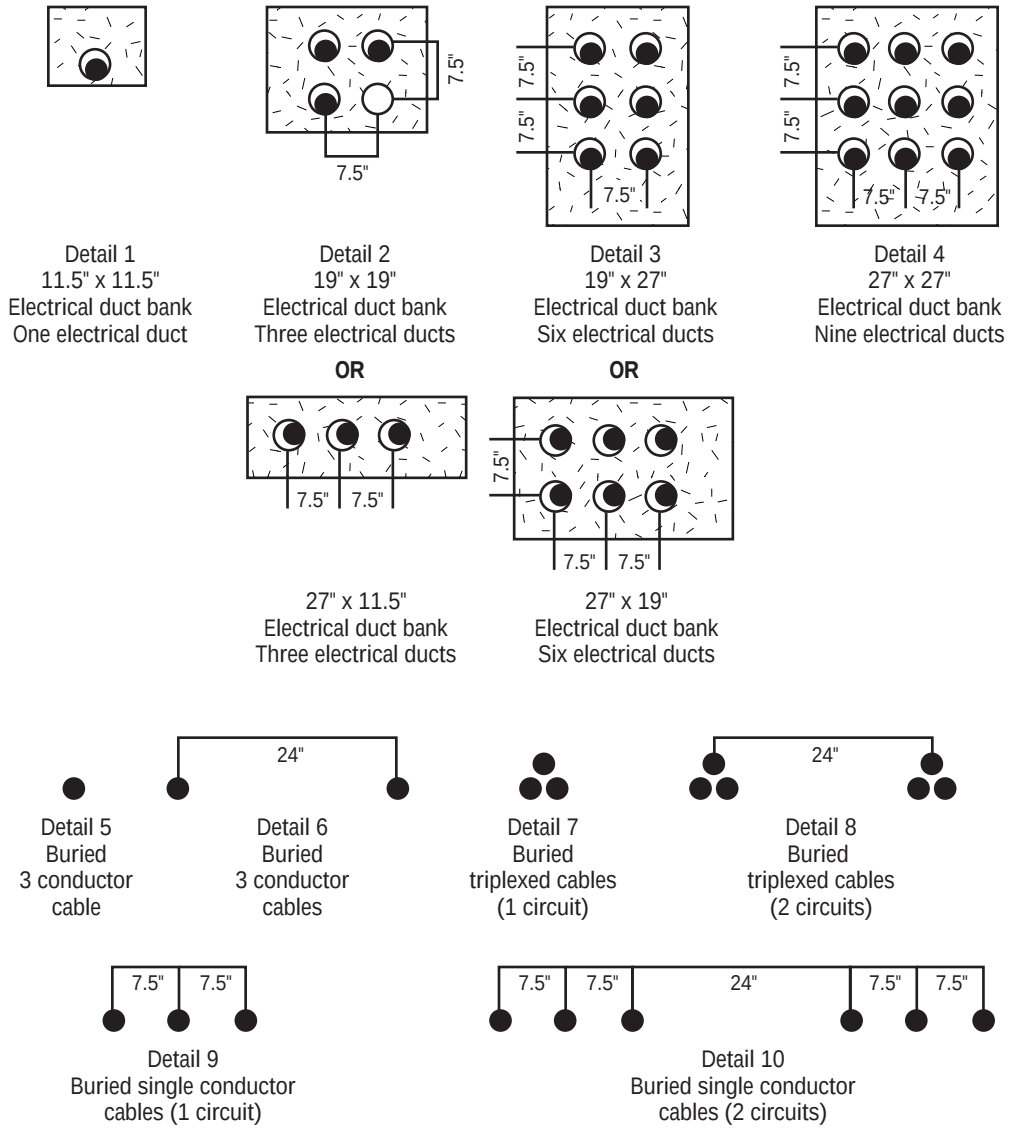
ARTICLE 310

Figure 310-1. Cable Installation Dimensions for Use with Tables 310-77 through 310-84.



Notes for all details:

1. Minimum burial depths to top electrical ducts or cables shall be in accordance with Section 300-5. Maximum depth to the top of electrical duct banks shall be 30 inches and maximum depth to top of direct buried cables shall be 36 inches.
2. Burial depths shall be permitted to be increased in part(s) of the duct run to avoid underground obstructions without decreasing the rated ampacity of the conductors. The total length of parts of the duct run increased in depth to avoid obstructions must be less than 25 percent of the total run length, or else the ampacity reduction factor of Note 4 of Tables 310-69 through 310-84 shall be applied.
3. For SI units: one inch = 25.4 millimeters; one foot = 305 millimeters.

LEGEND

- Backfill (earth or concrete)
- Electrical duct
- Cable or cables

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TABLE 310-16

Allowable Ampacities of Insulated Conductors Rated 0 through 2000 Volts, 60° to 90°C (140° to 194°F) Not More Than Three Current-Carrying Conductors in Raceway or Cable or Earth (Directly Buried) Based on Ambient Temperature of 30°C (86°F)

Size	Temperature Rating of Conductor						Size
	60°C (140°F)	75°C (167°F)	90°C (194°F)	60°C (140°F)	75°C (167°F)	90°C (194°F)	
AWG kcmil	Types TW†, UF†	Types FEPW†, RH† RHW†, THHW†, THW†, THWN†, XHHW†, USE†, ZW†	Types TBS, SA, SIS, FEP†, FEPB†, MI, RHH†, RHW-2, THHN†, THHW†, THW-2†, THWN-2†, USE-2, XHH, XHHW†, XHHW-2, ZW-2	Types TW†, UF†	Types RH†, RHW†, THHW†, THW†, THWN†, XHHW†, USE†	Types TBS, SA, SIS, THHN†, THHW†, THW-2, THWN-2, RHH†, RHW-2, USE-2, XHH XHHW, XHHW-2, ZW-2	AWG kcmil
	Copper			Aluminum or Copper-Clad Aluminum			
18	—	—	14	—	—	—	—
16	—	—	18	—	—	—	—
14	20†	20†	25†	—	—	—	—
12	25†	25†	30†	20†	20†	25†	12
10	30	35†	40†	25	30†	35†	10
8	40	50	55	30	40	45	8
6	55	65	75	40	50	60	6
4	70	85	95	55	65	75	4
3	85	100	110	65	75	85	3
2	95	115	130	75	90	100	2
1	110	130	150	85	100	115	1
1/0	125	150	170	100	120	135	1/0
2/0	145	175	195	115	135	150	2/0
3/0	165	200	225	130	155	175	3/0
4/0	195	230	260	150	180	205	4/0
250	215	255	290	170	205	230	250
300	240	285	320	190	230	255	300
350	260	310	350	210	250	280	350
400	280	335	380	225	270	305	400
500	320	380	430	260	310	350	500
600	355	420	475	285	340	385	600
700	385	460	520	310	375	420	700
750	400	475	535	320	385	435	750
800	410	490	555	330	395	450	800
900	435	520	585	355	425	480	900
1000	455	545	615	375	445	500	1000
1250	495	590	665	405	485	545	1250
1500	520	625	705	435	520	585	1500
1750	545	650	735	455	545	615	1750
2000	560	665	750	470	560	630	2000

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EFFECTIVE 1998-09-30

TABLE 310-16 (CONT.)

Correction Factors							
Ambient Temp. °C	**For ambient temperatures other than 30°C (86°F), multiply the allowable ampacities shown above by the appropriate factor shown below.**						**Ambient Temp. °F**
21-25	1.08	1.05	1.04	1.08	1.05	1.04	70-77
26-30	1.00	1.00	1.00	1.00	1.00	1.00	78-86
31-35	0.91	0.94	0.96	0.91	0.94	0.96	87-95
36-40	0.82	0.88	0.91	0.82	0.88	0.91	96-104
41-45	0.71	0.82	0.87	0.71	0.82	0.87	105-113
46-50	0.58	0.75	0.82	0.58	0.75	0.82	114-122
51-55	0.41	0.67	0.76	0.41	0.67	0.76	123-131
56-60	—	0.58	0.71	—	0.58	0.71	132-140
61-70	—	0.33	0.58	—	0.33	0.58	141-158
71-80	—	—	0.41	—	—	0.41	159-176

† Unless otherwise specifically permitted elsewhere in this Code, the overcurrent protection for conductor types marked with an obelisk (†) shall not exceed 15 amperes for No. 14, 20 amperes for No. 12, and 30 amperes for No. 10 copper; or 15 amperes for No. 12 and 25 amperes for No. 10 aluminum and copper-clad aluminum after any correction factors for ambient temperatures and number of conductors have been applied.

Adjustment Factors

More than Three Current-Carrying Conductors in a Raceway or Cable.

Where the number of current-carrying conductors in a raceway or cable exceeds three, the allowable ampacities shall be reduced as shown in the table below:

Number of Current-Carrying Conductors	Percent of Values in Tables asAdjusted for Ambient Temperature If Necessary
4 through 6	80
7 through 9	70
10 through 20	50
21 through 31	45
31 through 40	40
41 and above	35

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TABLE 310-17

Allowable Ampacities of Single Insulated Conductors, Rated 0 through 2000 Volts in Free Air Based on Ambient Air Temperature of 30°C (86°F)

Size	Temperature Rating of Conductor						Size
AWG kcmil	60°C (140°F) Types TW†, UF†	75°C (167°F) Types FEPW†, RH† RHW†, THHW†, THW†, THWN†, XHHW†, ZW†	90°C (194°F) Types TBS, SA, SIS, FEP†, FEPB†, MI, RHH†, RHW-2, THHN†, THHW†, THW-2†, THWN-2†, USE-2, XHH, XHHW†, XHHW-2, ZW-2	60°C (140°F) Types TW†, UF†	75°C (167°F) Types RH†, RHW†, THHW†, THW†, THWN†, XHHW†	90°C (194°F) Types TBS, SA, SIS, THHN†, THHW†, THW-2, THWN-2, RHH†, RHW-2, USE-2, XHH, XHHW†, XHHW-2, ZW-2	AWG kcmil
	Copper			Aluminum or Copper-Clad Aluminum			
18	—	—	18	—	—	—	—
16	—	—	24	—	—	—	—
14	25†	30†	35†	—	—	—	—
12	30†	35†	40†	25†	30†	35†	12
10	40†	50†	55†	35	40†	40†	10
8	60	70	80	45	55	60	8
6	80	95	105	60	75	80	6
4	105	125	140	80	100	110	4
3	120	145	165	95	115	130	3
2	140	170	190	110	135	150	2
1	165	195	220	130	155	175	1
1/0	195	230	260	150	180	205	1/0
2/0	225	265	300	175	210	235	2/0
3/0	260	310	350	200	240	275	3/0
4/0	300	360	405	235	280	315	4/0
250	340	405	455	265	315	355	250
300	375	445	505	290	350	395	300
350	420	505	570	330	395	445	350
400	455	545	615	355	425	480	400
500	515	620	700	405	485	545	500
600	575	690	780	455	540	615	600
700	630	755	855	500	595	675	700
750	655	785	885	515	620	700	750
800	680	815	920	535	645	725	800
900	730	870	985	580	700	785	900
1000	780	935	1055	625	750	845	1000
1250	890	1065	1200	710	855	960	1250
1500	980	1175	1325	795	950	1075	1500
1750	1070	1280	1445	875	1050	1185	1750
2000	1155	1385	1560	960	1150	1335	2000
Correction Factors							
Ambient Temp. °C	For ambient temperatures other than 30°C (86°F), multiply the allowable ampacities shown above by the appropriate factor shown below.						Ambient Temp. °F
21-25	1.08	1.05	1.04	1.08	1.05	1.04	70-77
26-30	1.00	1.00	1.00	1.00	1.00	1.00	78-86
31-35	0.91	0.94	0.96	0.91	0.94	0.96	87-95
36-40	0.82	0.88	0.91	0.82	0.88	0.91	96-104
41-45	0.71	0.82	0.87	0.71	0.82	0.87	105-113
46-50	0.58	0.75	0.82	0.58	0.75	0.82	114-122
51-55	0.41	0.67	0.76	0.41	0.67	0.76	123-131
56-60	—	0.58	0.71	—	0.58	0.71	132-140
61-70	—	0.33	0.58	—	0.33	0.58	141-158
71-80	—	—	0.41	—	—	0.41	159-176

† Unless otherwise specifically permitted elsewhere in this Code, the overcurrent protection for conductor types marked with an obelisk (†) shall not exceed 15 amperes for No. 14, 20 amperes for No. 12, and 30 amperes for No. 10 copper; or 15 amperes for No. 12 and 25 amperes for No. 10 aluminum and copper-clad aluminum.

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TABLE 310-67

Ampacities of Insulated Single Copper Conductor Cables Triplexed in Air
Based on Conductor Temperature of 90°C (194°F) and 105°C (221°F) and Ambient Air Temperature of 40°C (104°F)

Conductor Size AWG-kcmil	Temperature Rating of Conductor			
	2001-5000 Volts Ampacity		5001-35,000 Volts Ampacity	
	90°C (194°F)	105°C (221°F)	90°C (194°F)	105°C (221°F)
	Type MV-90	Type MV-105	Type MV-90	Type MV-105
8	65	74	—	—
6	90	99	100	110
4	120	130	130	140
2	160	175	170	195
1	185	205	195	225
1/0	215	240	225	255
2/0	250	275	260	295
3/0	290	320	300	340
4/0	335	375	345	390
250	375	415	380	430
350	465	515	470	525
500	580	645	580	650
750	750	835	730	820
1000	880	980	850	950

TABLE 310-69

Ampacities of Insulated Single Copper Conductor Isolated in Air
Based on Conductor Temperature of 90°C (194°F) and 105°C (221°F) and Ambient Air Temperature of 40°C (104°F)

Conductor Size AWG-kcmil	Temperature Rating of Conductor					
	2001-5000 Volts Ampacity		5001-15,000 Volts Ampacity		15,001-35,000 Volts Ampacity	
	90°C (194°F)	105°C (221°F)	90°C (194°F)	105°C (221°F)	90°C (194°F)	105°C (221°F)
	Type MV-90	Type MV-105	Type MV-90	Type MV-105	Type MV-90	Type MV-105
8	83	93	—	—	—	—
6	110	120	110	125	—	—
4	145	160	150	165	—	—
2	190	215	195	215	—	—
1	225	250	225	250	225	250
1/0	260	290	260	290	260	290
2/0	300	330	300	335	300	330
3/0	345	385	345	385	345	380
4/0	400	445	400	445	395	445
250	445	495	445	495	440	490
350	550	615	550	610	545	605
500	695	775	685	765	680	755
750	900	1000	885	990	870	970
1000	1075	1200	1060	1185	1040	1160
1250	1230	1370	1210	1350	1185	1320
1500	1365	1525	1345	1500	1315	1465
1750	1495	1665	1470	1640	1430	1595
2000	1605	1790	1575	1755	1535	1710

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TABLE 310-71

Ampacities of an Insulated Three-Conductor Copper Cable Isolated in Air Based on Conductor Temperature of 90°C (194°F) and 105°C (221°F) and Ambient Air Temperature of 40°C (104°F)

Conductor Size AWG-kcmil	Temperature Rating of Conductor			
	2001-5000 Volts Ampacity		5001-35,000 Volts Ampacity	
	90°C (194°F)	105°C (221°F)	90°C (194°F)	105°C (221°F)
	Type MV-90	Type MV-105	Type MV-90	Type MV-105
8	59	66	—	—
6	79	88	93	105
4	105	115	120	135
2	140	154	165	185
1	160	180	185	210
1/0	185	205	215	240
2/0	215	240	245	275
3/0	250	280	285	315
4/0	285	320	325	360
250	320	355	360	400
350	395	440	435	490
500	485	545	535	600
750	615	685	670	745
1000	705	790	770	860

TABLE 310-73

Ampacities of an Insulated Triplexed or Three Single Conductor Copper Cables in Isolated Conduit in Air Based on Conductor Temperature of 90°C (194°F) and 105°C (221°F) and Ambient Air Temperature of 40°C (104°F)

Conductor Size AWG-kcmil	Temperature Rating of Conductor			
	2001-5000 Volts Ampacity		5001-35,000 Volts Ampacity	
	90°C (194°F)	105°C (221°F)	90°C (194°F)	105°C (221°F)
	Type MV-90	Type MV-105	Type MV-90	Type MV-105
8	55	61	—	—
6	75	84	83	93
4	97	110	110	120
2	130	145	150	165
1	155	175	170	190
1/0	180	200	195	215
2/0	205	225	225	255
3/0	240	270	260	290
4/0	280	305	295	330
250	315	355	330	365
350	385	430	395	440
500	475	530	480	535
750	600	665	585	655
1000	690	770	675	755

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TABLE 310-75

Ampacities of an Insulated Three-Conductor Copper Cable in Isolated Conduit in Air Based on Conductor Temperature of 90°C (194°F) and 105°C (221°F) and Ambient Air Temperature of 40°C (104°F)

Conductor Size AWG-kcmil	Temperature Rating of Conductor			
	2001-5000 Volts Ampacity		5001-35,000 Volts Ampacity	
	90°C (194°F)	105°C (221°F)	90°C (194°F)	105°C (221°F)
	Type MV-90	Type MV-105	Type MV-90	Type MV-105
8	52	58	—	—
6	69	77	83	92
4	91	100	105	120
2	125	135	145	165
1	140	155	165	185
1/0	165	185	195	215
2/0	190	210	220	245
3/0	220	245	250	280
4/0	255	285	290	320
250	280	315	315	350
350	350	390	385	430
500	425	475	470	525
750	525	585	570	635
1000	590	660	650	725

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TABLE 310-77

Ampacities of Three Single Insulated Copper Conductors in Underground Electrical Ducts (Three Conductors per Electrical Duct) Based on Ambient Earth Temperature of 20°C (68°F), Electrical Duct Arrangement per Figure 310-1, 100 Percent Load Factor Thermal Resistance (RHO) of 90, Conductor Temperature of 90°C (194°F) and 105°C (221°F)

Conductor Size AWG-kcmil	Temperature Rating of Conductor			
	2001-5000 Volts Ampacity		5001-35,000 Volts Ampacity	
	90°C (194°F)	105°C (221°F)	90°C (194°F)	105°C (221°F)
	Type MV-90	Type MV-105	Type MV-90	Type MV-105
One Circuit (See Figure 310-1, Detail 1)				
8	64	69	—	—
6	85	92	90	97
4	110	120	115	125
2	145	155	155	165
1	170	180	175	185
1/0	195	210	200	215
2/0	220	235	230	245
3/0	250	270	260	275
4/0	290	310	295	315
250	320	345	325	345
350	385	415	390	415
500	470	505	465	500
750	585	630	565	610
1000	670	720	640	690
Three Circuit (See Figure 310-1, Detail 2)				
8	56	60	—	—
6	73	79	77	83
4	95	100	99	105
2	125	130	130	135
1	140	150	145	155
1/0	160	175	165	175
2/0	185	195	185	200
3/0	210	225	210	225
4/0	235	255	240	255
250	260	280	260	280
350	315	335	310	330
500	375	405	370	395
750	460	495	440	475
1000	525	565	495	535
Six Circuit (See Figure 310-1, Detail 3)				
8	48	52	—	—
6	62	67	64	68
4	80	86	82	88
2	105	110	105	115
1	115	125	120	125
1/0	135	145	135	145
2/0	150	160	150	165
3/0	170	185	170	185
4/0	195	210	190	205
250	210	225	210	225
350	250	270	245	265
500	300	325	290	310
750	365	395	350	375
1000	410	445	390	415

For SI units: 1 in. = 25.4 mm.

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TABLE 310-79

Ampacities of Three Single Insulated Copper Conductors Cabled within an Overall Covering (three-Conductor Cable) in Underground Electrical Ducts (One Cable per Electrical Duct) Based on Ambient Earth Temperature of 20°C (68°F) Electrical Duct Arrangement per Figure 310-1, 100 Percent Load Factor, Thermal Resistance (RHO) of 90 Conductor Temperature of 90°C (194°F) and 105°C (221°F)

Conductor Size AWG-kcmil	Temperature Rating of Conductor			
	2001-5000 Volts Ampacity		5001-35,000 Volts Ampacity	
	90°C (194°F)	105°C (221°F)	90°C (194°F)	105°C (221°F)
	Type MV-90	Type MV-105	Type MV-90	Type MV-105
One Circuit (See Figure 310-1, Detail 1)				
8	59	64	—	—
6	78	84	88	95
4	100	110	115	125
2	135	145	150	160
1	155	165	170	185
1/0	175	190	195	210
2/0	200	220	220	235
3/0	230	250	250	270
4/0	265	285	285	305
250	290	315	310	335
350	355	380	375	400
500	430	460	450	485
750	530	570	545	585
1000	600	645	615	660
Three Circuit (See Figure 310-1, Detail 2)				
8	53	57	—	—
6	69	74	75	81
4	89	96	97	105
2	115	125	125	135
1	135	145	140	155
1/0	150	165	160	175
2/0	170	185	185	195
3/0	195	210	205	220
4/0	225	240	230	250
250	245	265	255	270
350	295	315	305	325
500	355	380	360	385
750	430	465	430	465
1000	485	520	485	515
Six Circuit (See Figure 310-1, Detail 3)				
8	46	50	—	—
6	60	65	63	68
4	77	83	81	87
2	98	105	105	110
1	110	120	115	125
1/0	125	135	130	145
2/0	145	155	150	160
3/0	165	175	170	180
4/0	185	200	190	200
250	200	220	205	220
350	240	270	245	275
500	290	310	290	305
750	350	375	340	365
1000	390	420	380	405

For SI units: 1 in. = 25.4 mm.

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TABLE 310-81

Ampacities of Single Insulated Copper Conductors Directly Buried in Earth
Based on Ambient Earth Temperature of 20°C (68°F), Arrangement per Figure 310-1, 100 Percent Load Factor
Thermal Resistance (RHO) of 90, Conductor Temperature of 90°C (194°F) and 105°C (221°F)

Conductor Size AWG-kcmil	Temperature Rating of Conductor			
	2001-5000 Volts Ampacity		5001-35,000 Volts Ampacity	
	90°C (194°F)	105°C (221°F)	90°C (194°F)	105°C (221°F)
	Type MV-90	Type MV-105	Type MV-90	Type MV-105
One Circuit — 3 Conductors (See Figure 310-1, Detail 9)				
8	110	115	—	—
6	140	150	130	140
4	180	195	170	180
2	230	250	210	225
1	260	280	240	260
1/0	295	320	275	295
2/0	335	365	310	335
3/0	385	415	355	380
4/0	435	465	405	435
250	470	510	440	475
350	570	615	535	575
500	690	745	650	700
750	845	910	805	865
1000	980	1055	930	1005
Two Circuits — 6 Conductors (See Figure 310-1, Detail 10)				
8	100	110	—	—
6	130	140	120	130
4	165	180	160	170
2	215	230	195	210
1	240	260	225	240
1/0	275	295	255	275
2/0	310	335	290	315
3/0	355	380	330	355
4/0	400	430	375	405
250	435	470	410	440
350	520	560	495	530
500	630	680	600	645
750	775	835	740	795
1000	890	960	855	920

For SI units: 1 in. = 25.4 mm.

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TABLE 310-83

Ampacities of Three Insulated Copper Conductors Cabled within an Overall Covering (Three-Conductor Cable) Directly Buried in Earth, Based on Ambient Earth Temperature of 20°C (68°F), Electrical Duct Arrangement per Figure 310-1 100 Percent Load Factor, Thermal Resistance (RHO) of 90, Conductor Temperature of 90°C (194°F) and 105°C (221°F)

Conductor Size AWG-kcmil	Temperature Rating of Conductor			
	2001-5000 Volts Ampacity		5001-35,000 Volts Ampacity	
	90°C (194°F)	105°C (221°F)	90°C (194°F)	105°C (221°F)
	Type MV-90	Type MV-105	Type MV-90	Type MV-105
One Circuit— (See Figure 310-1, Detail 5)				
8	85	89	—	—
6	105	115	115	120
4	135	150	145	155
2	180	190	185	200
1	200	215	210	225
1/0	230	245	240	255
2/0	260	280	270	290
3/0	295	320	305	330
4/0	335	360	350	375
250	365	395	380	410
350	440	475	460	495
500	530	570	550	590
750	650	700	665	720
1000	730	785	750	810
Two Circuits— (See Figure 310-1, Detail 10)				
8	80	84	—	—
6	100	105	105	115
4	130	140	135	145
2	165	180	170	185
1	185	200	195	210
1/0	215	230	220	235
2/0	240	260	250	270
3/0	275	295	280	305
4/0	310	335	320	345
250	340	365	350	375
350	410	440	420	450
500	490	525	500	535
750	595	640	605	650
1000	665	715	675	730

For SI units: 1 in. = 25.4 mm.

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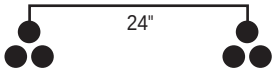
TABLE 310-85

Ampacities of Three Triplexed Single Insulated Copper Conductors Directly Buried in Earth, Based on Ambient Earth Temperature of 20°C (68°F), Arrangement per Figure 310-1, 100 Percent Load Factor, Thermal Resistance (RHO) of 90, Conductor Temperature of 90°C (194°F)

Detail 7
Buried
triplexed cables
(1 circuit)



Detail 8
Buried
triplexed cables
(2 circuits)

Conductor Size AWG-kcmil	2001-5000 Volts Ampacity	5001-35,000 Volts Ampacity
One Circuit — Three Conductors (See Figure 310-1, Detail 7)		
8	90	—
6	120	115
4	150	150
2	195	190
1	225	215
1/0	255	245
2/0	290	275
3/0	330	315
4/0	375	360
250	410	390
350	490	470
500	590	565
750	725	685
1000	825	770
Two Circuits — Six Conductors (See Figure 310-1, Detail 8)		
8	85	—
6	110	105
4	140	140
2	180	175
1	205	200
1/0	235	225
2/0	265	255
3/0	300	290
4/0	340	325
250	370	355
350	445	426
500	535	510
750	650	615
1000	740	690

For SI units: 1 in. = 25.4 mm.

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TABLE B-310-1

Ampacities of Two or Three Insulated Conductors, Rated 0 through 2000 Volts within an Overall Covering (Multiconductor Cable), in Raceway, in Free Air, Based on Ambient Air Temperature of 30°C (86°F)

Size	Temperature Rating of Conductor						Size
	60°C (140°F)	75°C (167°F)	90°C (194°F)	60°C (140°F)	75°C (167°F)	90°C (194°F)	
AWG kcmil	Types TW, UF	Types RH, RHW THHW, THW THWN, XHHW, ZW	Types THHN, THHW, THW-2, THWN-2, RHH, RWH-2, USE-2, XHHW XHHW-2, ZW-2	Types TW	Types RH, RHW, THHW, THW, THWN, XHHW	Types THHN, THHW, THW-2, THWN-2, RHH†, RWH-2, USE-2, XHHW, XHHW-2, ZW-2	AWG kcmil
	Copper			Aluminum or Copper-Clad Aluminum			
14	16†	18†	21†	—	—	—	—
12	20†	24†	27†	16†	18†	21†	12
10	27†	33†	36†	21†	25†	28†	10
8	36	43	48	28	33	37	8
6	48	58	65	38	45	51	6
4	66	79	89	51	61	69	4
3	76	90	102	59	70	79	3
2	88	105	119	69	83	93	2
1	102	121	137	80	95	106	1
1/0	121	145	163	94	113	127	1/0
2/0	138	166	186	108	129	146	2/0
3/0	158	189	214	124	147	167	3/0
4/0	187	223	253	147	176	197	4/0
250	205	245	276	160	192	217	250
300	234	281	317	185	221	250	300
350	255	305	345	202	242	273	350
400	274	328	371	218	261	295	400
500	315	378	427	254	303	342	500
600	343	413	468	279	335	378	600
700	376	452	514	310	371	420	700
750	387	466	529	321	384	435	750
800	397	479	543	331	397	450	800
900	415	500	570	350	421	477	900
1000	448	542	617	382	460	521	1000
Correction Factors							
Ambient Temp. °C	For ambient temperatures other than 30°C (86°F), multiply the allowable ampacities shown above by the appropriate factor shown below.						Ambient Temp. °F
21-25	1.08	1.05	1.04	1.08	1.05	1.04	70-77
26-30	1.00	1.00	1.00	1.00	1.00	1.00	79-86
31-35	0.91	0.94	0.96	0.91	0.94	0.96	88-95
36-40	0.82	0.88	0.91	0.82	0.88	0.91	97-104
41-45	0.71	0.82	0.87	0.71	0.82	0.87	106-113
46-50	0.58	0.75	0.82	0.58	0.75	0.82	115-122
51-55	0.41	0.67	0.76	0.41	0.67	0.76	124-131
56-60	—	0.58	0.71	—	0.58	0.71	133-140
61-70	—	0.33	0.58	—	0.33	0.58	142-158
71-80	—	—	0.41	—	—	0.41	160-176

† Unless otherwise specifically permitted elsewhere in this Code, the overcurrent protection for conductor types marked with an obelisk (†) shall not exceed 15 amperes for No. 14, 20 amperes for No. 12, and 30 amperes for No. 10 copper; or 15 amperes for No. 12 and 25 amperes for No. 10 aluminum and copper-clad aluminum.

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TABLE B-310-2

Ampacities of Two or Three Single Insulated Conductors, Rated 0 through 2000 Volts Supported on a Messenger, Based on Ambient Air Temperature of 40°C (104°F)

Size	Temperature Rating of Conductor				Size
	75°C (167°F)	90°C (194°F)	75°C (167°F)	90°C (194°F)	
AWG kcmil	TYPES RH, RHW THHW, THW THWN, XHHW, ZW	TYPES THHN, THHW THW-2, THWN-2, RHH, RWH-2, USE-2, XHHW, XHHW-2, ZW-2	TYPES RH, RHW THW, THWN, THHW, XHHW	TYPES THHN, THHW RHH, XHHW RHW-2, XHHW-2, THW-2, THWN-2, USE-2, ZW-2	AWG kcmil
8	57	66	44	51	8
6	76	89	59	69	6
4	101	117	78	91	4
3	118	138	92	107	3
2	135	158	106	123	2
1	158	185	123	144	1
1/0	183	214	143	167	1/0
2/0	212	247	165	193	2/0
3/0	245	287	192	224	3/0
4/0	287	335	224	262	4/0
250	320	374	251	292	250
300	359	419	282	328	300
350	397	464	312	364	350
400	430	503	339	395	400
500	496	580	392	458	500
600	553	647	440	514	600
700	610	714	488	570	700
750	638	747	512	598	750
800	660	773	532	622	800
900	704	826	572	669	900
1000	748	879	612	716	1000
Ambient Temp. °C	For ambient temperatures other than 40°C (104°F), multiply the ampacities show above by the appropriate factor shown below.				Ambient Temp °F
21-25	1.20	1.14	1.20	1.14	70-77
26-30	1.13	1.10	1.13	1.10	79-86
31-35	1.07	1.05	1.07	1.05	88-95
36-40	1.00	1.00	1.00	1.00	97-104
41-45	0.93	0.95	0.93	0.95	106-113
46-50	0.85	0.89	0.85	0.89	115-122
51-55	0.76	0.84	0.76	0.84	124-131
56-60	0.65	0.77	0.65	0.77	133-140
61-70	0.38	0.63	0.38	0.63	142-158
71-80	—	0.45	—	0.45	160-176

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TABLE B-310-3

Ampacities of Multiconductor Cables with Not More than Three Insulated Conductors, Rated 0 through 2000 Volts in Free Air Based on Ambient Air Temperature of 40°C (104°F) (For TC, MC, MI, UF, and USE Cables)

Size	Temperature Rating of Conductor								Size
AWG kcmil	60°C (140°F)	75°C (167°F)	85°C (185°F)	90°C (194°F)	60°C (140°F)	75°C (167°F)	85°C (185°F)	90°C (194°F)	AWG kcmil
	Copper				Aluminum or Copper-Clad Aluminum				
18				11†					18
16				16†					16
14	18†	21†	24†	25†					14
12	21†	28†	30†	32†	18†	21†	24†	25†	12
10	28†	36†	41†	43†	21†	28†	30†	32†	10
8	39	50	56	59	30	39	44	46	8
6	52	68	75	79	41	53	59	61	6
4	69	89	100	104	54	70	78	81	4
3	81	104	116	121	63	81	91	95	3
2	92	118	132	138	72	92	103	108	2
1	107	138	154	161	84	108	120	126	1
1/0	124	160	178	186	97	125	139	145	1/0
2/0	143	184	206	215	111	144	160	168	2/0
3/0	165	213	238	249	129	166	185	194	3/0
4/0	190	245	274	287	149	192	214	224	4/0
250	212	274	305	320	166	214	239	250	250
300	237	306	341	357	186	240	268	280	300
350	261	337	377	394	205	265	296	309	350
400	281	363	406	425	222	287	317	334	400
500	321	416	465	487	255	330	368	385	500
600	354	459	513	538	284	368	410	429	600
700	387	502	562	589	306	405	462	473	700
750	404	523	586	615	328	424	473	495	750
800	415	539	604	633	339	439	490	513	800
900	438	570	639	670	362	469	514	548	900
1000	461	601	674	707	385	499	558	584	1000
Ambient Temp. °C	For ambient temperatures other than 30°C (86°F), multiply the ampacities shown above by the appropriate factor shown below.								Ambient Temp °F
21-25	1.32	1.20	1.15	1.14	1.32	1.20	1.15	1.14	70-77
26-30	1.22	1.13	1.11	1.10	1.22	1.13	1.11	1.10	79-86
31-35	1.12	1.07	1.05	1.05	1.12	1.07	1.05	1.05	88-95
36-40	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	97-104
41-45	0.87	0.93	0.94	0.95	0.87	0.93	0.94	0.95	106-113
46-50	0.71	0.85	0.88	0.89	0.71	0.85	0.88	0.89	115-122
51-55	0.50	0.76	0.82	0.84	0.50	0.76	0.82	0.84	124-131
56-60	—	0.65	0.75	0.77	—	0.65	0.75	0.77	133-140
61-70	—	0.38	0.58	0.63	—	0.38	0.58	0.63	142-158
71-80	—	—	0.33	0.44	—	—	0.33	0.44	160-176

† Unless otherwise specifically permitted elsewhere in this Code, the overcurrent protection for conductor types marked with an obelisk (†) shall not exceed 15 amperes for No. 14, 20 amperes for No. 12, and 30 amperes for No. 10 copper; or 15 amperes for No. 12 and 25 amperes for No. 10 aluminum and copper-clad aluminum.

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TABLE B-310-8

Ampacities of Two or Three Insulated Conductors, Rated 0 through 2000 Volts, Cabled within an Overall (Two- or Three-Conductor) Covering, Directly Buried in Earth, Based on Ambient Air Temperature of 20°C (68°F) Arrangement per Figure B-310-2, 100 Percent Load Factor, Thermal Resistance (Rho) of 90.

Size	Temperature Rating of Conductor								Size
	1 Cable (Fig. B310-2, Detail 5)		2 Cables (Fig. B310-2, Detail 6)		1 Cable (Fig. B310-2, Detail 5)		2 Cables (Fig. B310-2, Detail 6)		
	60°C (140°F)	75°C (167°F)	60°C (140°F)	75°C (167°F)	60°C (140°F)	75°C (167°F)	60°C (140°F)	75°C (167°F)	
AWG kcmil	Types				Types				AWG kcmil
	UF	RHW, THHW, THW, THWN, XHHW, USE	UF	RHW THHW, THW THWN, SHHW, USE	UF	RHW, THHW, THW, THWN, XHHW, USE	UF	RHW, THHW THW, THWN, XHHW, USE	
	Copper				Aluminum or Copper-Clad Aluminum				
8	64	75	60	70	51	59	47	55	8
6	85	100	81	95	68	75	60	70	6
4	107	125	100	117	83	97	78	91	4
2	137	161	128	150	107	126	110	117	2
1	155	182	145	170	121	142	113	132	1
1/0	177	208	165	193	138	162	129	151	1/0
2/0	201	236	188	220	157	184	146	171	2/0
3/0	229	269	213	250	179	210	166	195	3/0
4/0	259	304	241	282	203	238	188	220	4/0
250		333		308		261		241	250
350		401		370		315		290	350
500		481		442		381		350	500
750		585		535		473		433	750
1000		657		600		545		497	1000
Ambient Temp. °C	For ambient temperatures other than 20°C (68°F), multiply the ampacities shown above by the appropriate factor shown below.								Ambient Temp °F
6-10	1.12	1.09	1.12	1.09	1.12	1.09	1.12	1.09	43-50
11-15	1.06	1.04	1.04	1.04	1.06	1.04	1.06	1.04	52-59
16-20	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	61-68
21-25	0.94	0.95	0.94	0.95	0.94	0.95	0.94	0.95	70-77
26-30	0.87	0.90	0.87	0.90	0.87	0.90	0.87	0.90	79-86

For ampacities of UF cable in underground electrical ducts, multiply the ampacities shown in the table by 0.74.

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TABLE B-310-9

Ampacities of Three Triplexed Single Insulated Conductors, Rated 0 through 2000 Volts, Directly Buried in Earth Based on Ambient Earth Temperature of 20°C (68°F), Arrangement per Figure B-310-2, 100 Percent Load Factor, Thermal Resistance (Rho) of 90.

Size	Temperature Rating of Conductor								Size
	See (Fig. B310-2, Detail 7)		See (Fig. B310-2, Detail 8)		See (Fig. B310-2, Detail 7)		See (Fig. B310-2, Detail 8)		
AWG kcmil	60°C (140°F)	75°C (167°F)	60°C (140°F)	75°C (167°F)	60°C (140°F)	75°C (167°F)	60°C (140°F)	75°C (167°F)	AWG kcmil
	Types				Types				
	UF	USE	UF	USE	UF	USE	UF	USE	
	Copper				Aluminum or Copper-Clad Aluminum				
8	72	84	66	77	55	65	51	60	8
6	91	107	84	99	72	84	66	77	6
4	119	139	109	128	92	108	85	100	4
2	153	179	140	164	119	139	109	128	2
1	173	203	159	186	135	158	124	145	1
1/0	197	231	181	212	154	180	141	165	1/0
2/0	223	262	205	240	175	205	159	187	2/0
3/0	254	298	232	272	199	233	181	212	3/0
4/0	289	339	263	308	226	265	206	241	4/0
250		370		336		289		263	250
350		445		403		349		316	350
500		536		483		424		382	500
750		654		587		525		471	750
1000		744		665		608		544	1000
Ambient Temp. °C	For ambient temperatures other than 20°C (68°F), multiply the ampacities shown above by the appropriate factor shown below.								Ambient Temp °F
6-10	1.12	1.09	1.12	1.09	1.12	1.09	1.12	1.09	43-50
11-15	1.06	1.04	1.06	1.04	1.06	1.04	1.06	1.04	52-59
16-20	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	61-68
21-25	0.94	0.95	0.94	0.95	0.94	0.95	0.94	0.95	70-77
26-30	0.87	0.90	0.87	0.90	0.87	0.90	0.87	0.90	79-86

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TABLE B-310-10

Ampacities of Three Single Insulated Conductors, Rated 0 through 2000 Volts, Directly Buried in Earth Based on Ambient Earth Temperature of 20°C (68°F) Arrangement per Figure B-310-2, 100 Percent Load Factor Thermal Resistance (Rho) of 90.

Size	Temperature Rating of Conductor								Size
	Detail 9		Detail 10		Detail 9		Detail 10		
AWG kcmil	60°C (140°F)	75°C (167°F)	60°C (140°F)	75°C (167°F)	60°C (140°F)	75°C (167°F)	60°C (140°F)	75°C (167°F)	AWG kcmil
	Types				Types				
	UF	USE	UF	USE	UF	USE	UF	USE	
	Copper				Aluminum or Copper-Clad Aluminum				
8	84	98	78	92	66	77	61	72	8
6	107	126	101	118	84	98	78	92	6
4	139	163	130	152	108	127	101	118	4
2	178	209	165	194	139	163	129	151	2
1	201	236	187	219	157	184	146	171	1
1/0	230	270	212	249	179	210	165	194	1/0
2/0	261	306	241	283	204	239	188	220	2/0
3/0	297	348	274	321	232	272	213	250	3/0
4/0	336	394	309	362	262	307	241	283	4/0
250		429		394		335		308	250
350		516		474		403		370	350
500		626		572		490		448	500
750		767		700		605		552	750
1000		887		808		706		642	1000
1250		979		891		787		716	1250
1500		1063		965		862		783	1500
1750		1133		1027		930		843	1750
2000		1195		1082		990		897	2000
Ambient Temp. °C	For ambient temperatures other than 20°C (68°F), multiply the ampacities shown above by the appropriate factor shown below.								Ambient Temp °F
6-10	1.12	1.09	1.12	1.09	1.12	1.09	1.12	1.09	43-50
11-15	1.06	1.04	1.06	1.04	1.06	1.04	1.06	1.04	52-59
16-20	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	61-68
21-25	.94	.95	.94	.95	.94	.95	.94	.95	70-77
26-30	.87	.90	.87	.90	.87	.90	.87	.90	79-86

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HIGH TEMP LEAD WIRE AMPACITIES

TYPE TGGT & TKGT

The following Ampacity data is based on IPCEA P-46-426 criteria for appropriately designed cables for use at elevated temperatures. These values were extrapolated from the appropriate 90°C maximum conductor temperature tables to cover the designated, higher conductor temperature that appears below.

Conditions:

1. Conductor – 27% NCC (Nickel Clad Copper)
2. Single or multi-conductor cable in free air
3. Maximum conductor temperature of 250°C
4. Ambient temperature of 30°C

Wire Size, AWG or MCM	Number of Conductors			
	1	2 to 3	4 to 6	7 to 24
16	40	29	23	20
14	53	39	31	27
12	70	49	39	34
10	93	66	53	46
8	121	86	69	60
6	160	114	92	80
4	210	153	122	107
2	279	200	160	140
1	326	234	188	164
1/0	375	270	215	189
2/0	434	313	250	219
3/0	503	362	290	254
4/0	583	420	335	294
250	648	467	374	327
350	805	574	458	402
500	1012	708	566	495
750	1310	894	715	625
1000	1563	1030	825	721

Other Conditions:

1) For single and multi-conductor cables in single conduit, in air:
New Ampacity = 0.89 X **any** Ampacity in Table

2) For duplexed or triplexed single conductor cables in air:
New Ampacity = 0.82 X **single** conductor Ampacity from Table

3) For duplexed or triplexed single conductor cables in single conduit, in air:
New Ampacity = 0.68 X **single** conductor from Table

4) For randomly spaced cables in trays, use the Ampacity from above Table corresponding to the number of loaded conductors in the tray

For more than 24 conductors in a tray:

- 24 to 42 conductors
  New Ampacity = 0.60 X **2 or 3** conductor Ampacity from Table

- 43 and up
  New Ampacity = 0.50 X **2 or 3** conductor Ampacity from Table

5) Correction factors from ambients other than 30°C, when the maximum conductor temperature is 250°C

60°C	.93	Times Ampacity in Table
80°C	.88	
100°C	.82	
125°C	.75	
150°C	.67	
200°C	.48	
255°C	.33	

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EFFECTIVE 1998-09-30

TYPE MG

The ampacity table below applies to appropriately designed 450°C rated Type MG Appliance Wires, and Integraflame Control Cables.

Conditions:

1. 27 percent nickel plated copper conductors per ASTM B355
2. Single conductor in free air, sufficiently removed from any heat source
3. Maximum conductor temperature of 450°C
4. Ambient temperature of 30°C

Correction factors for ambient temperatures over 30°C:

80°C	0.94
125°C	0.88
150°C	0.84
200°C	0.77
250°C	0.69
300°C	0.60
350°C	0.49

Wire Size, AWG	Number of Conductors		
	1	2 to 3	4 to 6
18	26	20	15
16	34	25	20
14	45	30	25
12	65	45	40
10	85	60	45
8	110	75	55
6	135	90	79
4	185	120	95
2	245	160	125
1	285	190	150
1/0	330	220	180
2/0	385	255	200
3/0	440	290	230
4/0	525	345	275

TYPES SRG, SRK, AND SR

The ampacity table below applies to appropriately designed 200°C rated Types SRG, SRK, and Type SR Appliance & Motor lead wires.

Conditions:

1. Tinned, annealed copper conductor per ASTM B33, B8 or B173
2. Cables installed in free air, sufficiently removed from any heat source
3. Maximum conductor temperature of 200°C
4. Ambient temperature of 30°C

Correction factors for ambient temperatures over 30°C:

40°C	0.91
50°C	0.90
60°C	0.88
70°C	0.87
90°C	0.80
100°C	0.76
120°C	0.69
140°C	0.59
150°C	0.54

Additional derating factor if installed in a conduit - 0.89

Wire Size, AWG or kcmil	Number of Conductors			
	1	2 to 3	4 to 6	7 to 24
18	32	20	16	13
16	35	22	18	15
14	45	30	24	21
12	55	40	32	28
10	75	55	45	40
8	100	70	55	50
6	135	95	75	65
4	180	120	95	85
2	240	165	130	115
1	280	190	150	130
1/0	325	225	180	155
2/0	370	250	200	175
3/0	430	285	230	200
4/0	510	340	270	240
250 kcmil	560	375	300	260
350 kcmil	700	460	370	320
500 kcmil	850	550	440	385
750 kcmil	1250	800	635	560

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