

Chapter E 129

UNDERGROUND LINES

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E 129.01 Location. (1) **GENERAL LOCATION.** Underground systems of electrical conductors, whether located in ducts or buried directly in the earth, should be located so as to be subject to the least practicable disturbance. Railway tracks and underground structures, such as catch basins, water pipes, gas pipes, etc., should be avoided where practicable.

(2) **DUCTS OR BURIED CABLES.** The ducts or buried cables between adjacent manholes or other outlets should be laid as straight and direct as practicable.

(3) **ACCESS POINTS.** Manholes or handhole openings, pull boxes, above ground terminals or access points, where practicable, shall be located so as to provide safe and convenient access. At crossings under railroads, the manholes, pull boxes, and terminals should where practicable be located away from the roadbed.

(4) **SEPARATION FROM GAS FACILITIES.** The separation of gas pipes from direct buried electric and/or communication facilities shall be a minimum of 6 inches of well tamped earth when they are parallel. They may be as close as 2 inches where they cross if suitably insulated.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 129.02 Construction of duct systems. (1) **MATERIAL, SIZE, AND FINISH OF DUCTS.** Ducts shall be of such material, size, mechanical strength, and finish as to facilitate the installation and maintenance of conductors or cables. Ducts shall be freed from burrs before laying and shall have clear bores.

(2) **GRADING OF DUCTS.** Where it is necessary to drain ducts, the grade of the ducts shall be such as to permit proper and adequate drainage.

(3) **SETTLING.** Ducts should be suitably reinforced or be laid on suitable foundations of sufficient mechanical strength where necessary to protect them from settling.

(4) **CLEARANCES.** (a) *General.* The clearance between duct systems and other underground structures shall be as great as practicable. The distance between the top covering of the duct system and the

pavement surface or other surface under which the system is constructed may be varied but the duct strength must be such as to withstand the stresses induced by traffic.

(b) *Below base of rail.* The top of all duct and cable system structures shall be located at a depth not less than 30 inches, in the case of street railways, and not less than 42 inches, in the case of steam and electric railroads, below the base of rail unless the duct system is specifically designed to withstand the stresses experienced at lesser depths. In no case, however, shall the top of the duct extend higher than the bottom of the ballast section which is subject to working and cleaning.

Exception: Where physical and chemical conditions will permit conduit consisting of not more than two iron pipes, not exceeding 4 inches in diameter, or two creosoted wood ducts not exceeding 6 inches square containing communication conductors or service conductors operating at 0-750 volts may be laid in the ground beneath railroad tracks without any form of protection at a minimum depth of 18 inches below the base of the rail unless the worked ballast section of the roadbed exceeds 18 inches, in which case the conduit shall be laid below the ballast section.

(c) *Iron pipe conduit.* Where iron pipe is used as a conduit for underground cables or conductors, it shall not be laid in contact with water, gas, or steam metallic-pipe systems. Where the clearance is less than two inches, the metal conduit shall be adequately separated from other metallic-pipe systems by a barrier of suitable materials, or they shall be electrically bonded together at the point of least separation.

(5) SEPARATION BETWEEN SUPPLY AND COMMUNICATION DUCT SYSTEMS. (a) *General.* Duct systems, including laterals, to be occupied by communication conductors for public use should be separated, where practicable, from duct systems, including laterals, for supply conductors by not less than 3 inches of concrete, 4 inches of brick masonry, or 12 inches of well-tamped earth.

1. Exception 1: Extension may, however, be made to existing interconnected or jointly owned and jointly occupied duct systems used in common by municipalities, communication companies, or power companies with less effective separations than above specified.

2. Exception 2: Cables containing circuits of 550 volts or less between conductors and having a total transmitted power of not in excess of 3,200 watts, used exclusively in connection with the operation of a railway signal or supply system, may be carried in the same duct system with communication cables, if such construction is agreed to by all parties concerned, and where the communication cables are exclusively used for the operation of the railway signal or supply system, they may be carried in the same duct.

(b) *Entering manholes.* Where communication conductors and supply conductors occupy ducts terminating in the same manhole, the 2 classes of ducts should be separated as widely as practicable and where practicable should enter the manhole at opposite sides.

Note: Explanation: This requirement is made so that cables can be racked along side walls with a minimum of crosses between the 2 classes of conductors.

(6) **DUCT ENTRANCES INTO MANHOLES.** Iron pipe conduit terminating in manholes, handholes, or other permanent openings of underground systems, shall be provided with an effective shield, bushing or other smooth outlet.

(a) *Exception:* This does not apply to communication conductors, to supply conductors of less than 300 volts between conductors, or to armored cables of any voltage.

(7) **SEALING LATERALS.** Lateral ducts for service connections to buildings, through which gas or water may enter buildings or other duct systems, should be effectively plugged or cemented by the use of asphaltum, pitch, or other suitable means.

(8) **DUCT ARRANGEMENT FOR DISSIPATION OF HEAT.** Duct systems intended to carry supply cables of large current capacity should be arranged where practicable, so that ducts carrying such cables will not dissipate their heat solely through other ducts.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 129.03 Construction of manholes. (1) **MINIMUM STRENGTH.** The design and construction of manholes and handholes shall provide sufficient strength to sustain, with a suitable margin of safety, the loads which may reasonably be imposed on them.

(2) **DIMENSIONS.** Manholes should meet the following requirements where practicable:

(a) *Width.* The least horizontal inside dimension should be not less than 3 feet, 6 inches.

(b) *Working space.* A clear working space should be provided. The horizontal dimension should be not less than 3 feet. The vertical dimension should be not less than 6 feet except in manholes where the opening is within 1 foot on each side of the full size of the manhole.

1. *Exception:* The dimensions specified in subsection (2) (a) and (b) are not necessary in service boxes, handholes, or in manholes serving a small number of ducts, or in manholes used exclusively for communication-system equipment and cables.

(3) **DRAINAGE.** Where drainage is into sewers, suitable traps shall be provided to prevent entrance of sewer gas into manholes.

(4) **VENTILATION.** Adequate ventilation to open air shall be provided for manholes from which any openings exist into subways entered by the public. Where such manholes house transformers, sectionalizing switches, or regulators, etc., the ventilator ducts shall be cleaned at necessary intervals.

(a) *Exception:* Subways under water or in other locations where it is impracticable to comply.

(5) **MANHOLE OPENINGS.** Round openings to any manhole should be not less than 24 inches in diameter. Rectangular openings should have dimensions not less than 24 by 20 inches.

(a) *Exception:* The dimensions specified above are not necessary in service boxes and handholes or in manholes serving a small number of ducts.

(6) **MANHOLE COVERS.** Manholes and handholes, while not being worked in, shall be securely closed by covers of sufficient strength to sustain such loads as reasonably may be imposed upon them.

(7) **SUPPORTS FOR CABLES.** Cables should be adequately supported at each manhole.

(8) **MANHOLE LOCATION.** Manhole openings shall, where practicable, be located so that barriers or other suitable guards can be placed to protect the opening effectively when uncovered.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 129.04 Location of cables. (1) **ACCESSIBILITY.** Cables in manholes shall be reasonably accessible to workmen and clear working space shall be maintained at all times.

(2) **CABLES CARRYING LARGE CURRENTS.** Cables intended to carry large currents should be located, where practicable, in outside ducts so that they will not necessarily dissipate heat solely through adjacent ducts.

(3) **SEPARATION BETWEEN CONDUCTORS.** (a) *Cables of different voltages.* Cables shall be arranged and supported in ducts and manholes so that those operating at higher voltages will be separated as far as practicable from those operating at lower voltages.

(b) *Cables of different systems.* Cables belonging to different systems, particularly supply-distribution and communication systems, shall not be installed in the same duct.

1. Exception: This does not apply to the installation of railway-signal supply and communication cables in the same duct, as permitted by exception 2 in section E 129.02(5)(a)✓

(c) *Cables of supply and communication systems.* 1. General. Supply cables and communication cables for public use should, in general, be maintained in separate duct systems, and particularly in separate manholes.

a. *Exception 1:* Cable extensions may be made to existing inter-connected or jointly owned and jointly occupied duct systems used in common by municipalities, communication companies or supply companies.

b. *Exception 2:* This does not apply where railway-signal supply and communication cables are carried in the same duct system as permitted in exception 2, section E 129.02(5)(a)✓

2. In the same manhole. Supply cables and communication cables for public use occupying the same manhole should, where practicable, be maintained at opposite sides of the manhole. Where supply and communication cables must cross, a separation of at least 1 foot shall be maintained where practicable.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 129.05 Direct burial of cables and conductors. (1) **GENERAL.** Cables and conductors designed for the purpose may be buried directly in the earth. This type of cable also may be installed in flexible or rigid duct. If metal duct is used it shall be tied to the neutral if one is used at the termination of each duct section.

(2) **CONCENTRIC NEUTRAL-TYPE UNDERGROUND CABLE WHEN USED IN GROUNDED WYE DISTRIBUTION WHERE NEUTRAL IS DESIGNED TO CARRY LOAD CURRENT.** A concentric neutral type of direct burial multiple or single conductor cable is one designed for the purpose which has tinned copper bare multiple ground wires individually not smaller

than No. 14 AWG, approximately totaling the conductivity of the phase wire, spiralled about the cable with average spacing between wires not exceeding 0.3 inch and with a lay not exceeding 8 times the diameter of the cable over the concentric wires, or with a continuous or spiral metal sheath of equal conductivity. The required conductivity when using the continuous or spiral sheath may be obtained with a separate neutral laid not more than 3 inches from the cable and be not smaller than #4 AWG. The separate neutral or the sheath shall be in direct contact with the earth and the two shall be interconnected. Such type of cable shall be installed as in (a), (b), (c), (d), and (e) below.

Note: Cables used in a grounded wye distribution system where neutral is designed to carry load current and operating at 300 volts to ground or less need not be of the concentric neutral type described above. Such cables designed for direct burial use with or without an insulated or separate bare neutral shall be installed as in (a), (b), (c), (d) and (e) below.

(a) *Depth.* This cable shall be buried to a minimum depth of 30 inches except under railroad tracks where they shall be buried with a minimum cover of 42 inches.

1. Exception: Except at railroad and street railway crossings a lesser depth of 24 inches is permissible for conductors of 300 volts to ground or less.

2. Exception: Where rock formation is encountered the depth may be reduced to 24 inches except at railroad and street railway crossings.

3. Exception: Except at railroad and street railway crossings, a lesser depth is permissible where the conductors supply utilization equipment such as signals or street, area, or yard lighting.

4. Exception: Temporary installations of secondary underground cables, operating at less than 300 volts, may be laid on the ground, provided they are suitably mechanically protected. This will permit placing underground cables on the ground during winter periods.

(b) *Separation.* No separation is required between this type of cable and any other.

(c) *Protection.* 1. In an underground distribution system operating at more than 300 volts to ground the cable if random laid with communication cables shall be protected by fuses or devices capable of clearing a phase-to-neutral fault. The total clearing time shall not exceed the melting time of a 140K or 100T fuse as specified in American Standards Association specification ASA C-37.43-1962 plus 6 cycles. Such protection shall not reclose; however, reclosing type protection may be used on the overhead portions of the same circuit.

2. This protection is not required where the cable is used as a customer service or as a short length of underground in a general overhead system.

(d) *Interconnection.* At each transformer and/or pedestal installation all existing grounds should be interconnected. These include primary neutral, secondary neutral, power cable shield, metal duct, or sheath and telephone cable sheath.

(e) *Common grounding.* Telephone protectors, telephone service cable shields and secondary neutrals shall be connected to a common ground at each customer's service entrance when telephone circuits are underground without separation from power conductors.

(3) UNDERGROUND CABLE USED IN NON-WYE DISTRIBUTION OR WHERE GROUND WIRE, SHEATH OR CONCENTRIC WIRE IS NOT DESIGNED TO CARRY

LOAD CURRENT. A cable designed for direct burial with or without an insulated or separate bare neutral shall be installed as in (a), (b), (c), (d), and (e) below.

(a) *Depth.* This cable shall be buried to a minimum depth of 36 inches except under railroad tracks where they shall be buried with a minimum cover of 42 inches.

1. Exception: Except at railroad and railway crossings a lesser depth of 24 inches is permissible for conductors of 300 volts to ground or less.

2. Exception: Where rock formation is encountered the depth may be reduced to 24 inches except at railroad and street railway crossings.

3. Exception: Except at railroad and street railway crossings, a lesser depth is permissible where the conductors supply utilization equipment such as signals or street, area, or yard lighting.

4. Exception: Temporary installations of secondary underground cables, operating at less than 300 volts, may be laid on the ground, provided they are suitably mechanically protected. This will permit placing underground cables on the ground during winter periods.

(b) *Separation.* The separation between buried communication and buried supply conductors or cables shall consist of not less than 12 inches of well tamped earth, 4 inches of brick, or 3 inches of concrete.

1. This separation is not required where the supply voltage does not exceed 300 volts to ground.

2. This separation is not required for circuits having a potential of 550 volts or less and having a transmitted power of 3,200 watts are laid adjacent to communication cables, if all cables are used exclusively for the operation of railway-signal or supply system and are maintained by the same company.

3. No separation is required between power and communication cables located below transformers or their supporting pads or structures.

(c) *Protection.* 1. At all crossings where buried supply conductors or cables are above communication conductors or cables the supply conductors shall be protected from digging operations by concrete or treated wood plank or equivalent mechanical protective coating extending at least 2 feet in each direction from the point of crossing.

Exception. a. This protection is not required where supply circuits having a potential of 550 volts or less between conductors and having a total transmitted power of not in excess of 3,200 watts are laid adjacent to communication cables, if all cables are used exclusively for the operation of a railway-signal or supply system, and are maintained by the same company.

2. Where buried communication and buried supply conductors or cables are installed in the same trench generally parallel to each other, the buried supply conductors or cables shall be covered with concrete or treated wood plank or equivalent mechanical protection.

Exception a. This protection may be omitted where the voltage of the supply conductors does not exceed 300 volts to ground.

Exception b. This protection may be omitted where the supply conductors or cables are encased in a continuous metallic sheath effectively grounded.

Exception c. This protection is not required where the supply conductors or cables are installed more than 2 feet horizontally from communication conductors.

Exception d. This protection is not required where supply circuits having a potential of 550 volts or less between conductors and having a total transmitted power of not in excess of 3,200 watts are laid adjacent to communication cables, if all cables are used exclusively for the operation of a railway-signal or supply system, and are maintained by the same company.

(d) *Interconnection.* At each transformer and/or pedestal installation all existing grounds should be interconnected. These include multiple ground primary neutral (if one is present), secondary neutral, power cable shield, metal duct or sheath, and telephone cable sheath.

(e) *Common grounding.* Telephone protectors, telephone service cable shields and secondary neutrals should be connected to a common ground at each customer's service entrance.

(4) **SEPARATION FROM GAS FACILITIES.** The separation of gas pipes from direct buried electric and/or communication facilities shall be a minimum of 6 inches of well tamped earth when they are parallel. They may be as close as 2 inches where they cross if suitably insulated.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 129.06 Protection of conductors in duct systems and manholes.

(1) **PROTECTION AGAINST ARCING.** A suitable fire-resisting covering should be placed on the following cables to prevent injury from arcing:

(a) Closely grouped lead-sheathed supply cables of more than 8,700 volts or of large current capacity operating at more than 750 volts a.c. or 300 volts d.c.

(b) Communication cables and supply cables of large current capacity, if occupying the same side of the manhole, or if they cross each other.

(2) **BONDING.** Exposed metallic cable sheaths shall be bonded at suitable intervals with a conductor of suitable size, electrolysis conditions permitting. Supply cable sheaths need not be bonded to communication cable sheaths.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 129.07 Guarding of live parts in manholes. (1) **CONDUCTOR JOINTS OR TERMINALS.** Joints or terminals of conductors or cables of supply systems shall be arranged so that there are no bare ungrounded current-carrying metal parts exposed to accidental contact within manholes or handholes.

(2) **APPARATUS.** (a) *General.* Live parts of protective, control, or other apparatus installed and maintained in manholes should be enclosed in suitable grounded cases or in cases having no exposed metallic parts.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 129.08 Construction at risers from underground. (1) **SEPARATION BETWEEN RISERS OF COMMUNICATION AND SUPPLY SYSTEMS.** The placing of risers for communication systems and risers for supply systems

on the same pole should be avoided where practicable. If it is necessary to use the same pole for the risers of both systems, they shall be placed on opposite semicircumferences of the pole where practicable. Where located on streets or highways, risers should where practicable be placed on poles so as to be in the safest available location from the point of view of traffic damage.

(2) **MECHANICAL PROTECTION OF CONDUCTORS.** See subsection E 103.06(3).

(3) **GROUNDING OF RISER PIPES.** Exposed metal riser pipes containing supply conductors shall be grounded unless such conductors are covered with a grounded metal sheath or are themselves grounded.

(4) **CONDUCTOR TERMINAL CONSTRUCTION.** The terminals of underground cables operating at more than 750 volts and connecting to overhead open-wire systems shall meet the following requirements:

(a) *Protection against moisture.* Protection shall be provided so that moisture will not enter the cable.

(b) *Insulation of conductors.* Conductors shall be properly insulated from the grounded metal sheath. In addition, the conductors of multiple conductor cable shall be properly separated and insulated from each other.

Note: These requirements may be fulfilled by the use of potheads or other equivalent devices, such as oil switches, if incidentally they accomplish the same purpose.

(5) **CLEARANCE ABOVE GROUND FOR OPEN SUPPLY WIRING.** For supply wires connecting to underground systems see section E 123.03 (3).

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 129.09 Identification of conductors. Cables shall be permanently identified by tags or otherwise at each manhole or other permanent opening of the underground system. Where the duct formation on opposite sides of the manhole is the same, the cables where practicable should be installed in corresponding ducts.

(1) **Exception:** This requirement does not apply where the position of a cable, in conjunction with diagrams supplied to workmen, gives sufficient identification, or where the manhole is occupied solely by the communication cables of one utility, or of 2 utility companies agreeing thereto.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 129.10 Identification of apparatus connected in multiple. Where transformers, regulators, or other similar apparatus not located in the same manhole operate in multiple, special tags, diagrams, or other suitable means shall be used to indicate that fact.

Exception: This requirement does not apply where disconnecting devices are provided to permit cutting such equipment completely off the system.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 129.11 Underground services. Underground services shall comply with NEC-1971 sections 230-30 through 230-33 except as changed in volume 2 (see section E 230.31) and except as otherwise provided in volume No. 1.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68; am. Register, April, 1972, No. 196, eff. 5-1-72.