WISCONSIN STATE ELECTRICAL CODE

Volume 1

History: The Electrical Code as it existed on January 31, 1968 was repealed and a new Electrical Code was created effective February 1, 1968.

INTRODUCTION

Purpose and Structure

The legislature, by section 35.93 and chapter 227, Wis. Stats., 1955, directed the publication of the rules of administrative agencies having rule-making authority in a loose-leaf, continual revision system known as the WISCONSIN ADMINISTRATIVE CODE. The code is kept current by means of new and replacement pages. The pages are issued monthly, together with notices of hearings on proposed rules, emergency rules, new rules, instructions for insertion of new material, and other pertinent information. This monthly service is called the WISCONSIN ADMINISTRATIVE REGISTER, and comes to the subscriber after the 25th of each month.

Availability

The complete code and the upkeep service are distributed to the county law libraries; to the libraries of the University of Wisconsin Law School and Marquette University Law School; to the State Historical Society; to the Legislative Reference Bureau and to the State Law Library, and to certain designated public libraries throughout the state.

The sale and distribution of the code and of its parts is handled by Department of Administration, Document Sales and Distribution, Room B 237, State Office Building, 1 West Wilson Street, Madison, Wisconsin 53702.

History Notes

Each page of the code as it was originally filed and printed pursuant to the 1955 legislation, is dated "1–2–56". A rule which is amended or created subsequent to the original printing date is followed by a history note indicating the date and number of the REGISTER in which it was published and the date on which the amendment or the rule became effective. The absence of a history note at the end of a section indicates that the rule has remained unchanged since the original printing in 1956. The date line at the bottom of the page indicates the month in which the page was released.

In some instances an *entire* code has been repealed and recreated subsequent to the original printing date. When this occurs a history note has been placed at the beginning of the chapter to contain this information. A separate history note appears after each section indicating the date when the revision became effective.

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GENERAL REQUIREMENTS AND DEFINITIONS

Chapter E 2

SCOPE, AUTHORITY, AND STATUTORY REFERENCES

E 2.01 Scope of code. The Wisconsin State Electrical Code shall apply as minimum fire and safety requirements for the construction, installation and maintenance of all electrical power and communication circuits and equipment including signal, radio, and lightning rod equipment; and includes rules to be observed in the operation of electrical power and communication equipment and lines. In volume 1 of the Wisconsin State Electrical Code, references to NEC-71 refer to those portions of the National Electrical Code–1971 (also ANSI C1–1971—American National Standards Institute C1–1971) incorporated by reference into the Wisconsin Administrative Code according to sections E 90.01 and E 90.02, volume 2 of the Wisconsin State Electrical Code.

Note: The National Electrical Code, 1971, referred to above is on file in the offices of the Department of Industry, Labor and Human Relations, the Public Service Commission, the Secretary of State, and the Revisor of Statutes, and may be obtained for personal use from National Fire Protection Association, 60 Batterymarch Street, Boston, Massachusetts.

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

E 2.02 Authority and statutory references. (1) STATUTORY AUTHORITY. The Wisconsin State Electrical Code constitutes a general order of the Department of Industry, Labor and Human Relations and the Public Service Commission of Wisconsin authorized by sections 227.014, 101.10 and 196.74, Wis. Stats., 1959.

(2) ADMINISTRATIVE AUTHORITY. The authority for the enforcement of this code is vested in the Public Service Commission with respect to the installation and operation of circuits or equipment by public utilities and railroads in the exercise of their functions as utilities and railroads; and in the Department of Industry, Labor and Human Relations with respect to the installation and operation of circuits or equipment affecting employees, employers, or the public.

(3) STATUTORY ENFORCEMENT. (a) Compliance with the requirements of the Wisconsin State Electrical Code is required before a utility may give electric service even though some portions of the code may not be directly enforceable by state agencies. (See section 167.16, Wis. Stats.)

(b) The requirements in the code are enforceable in the same manner as other orders of the administrative authorities. (See sections

102.57, 102.58, 195.07, 196.41, 196.64, 196.66, 196.74 and chapter 227, Wis. Stats.)

(4) OTHER LEGAL REQUIREMENTS. (a) There are state statutes that refer directly to certain electrical construction. Some of these are sections 66.047, 86.16, 98.25, 134.40, 134.41, 167.16, 182.017, 182.018, 196.171, 196.58, 196.67 and 196.72, Wis. Stats., 1959.

(b) Nothing in this code shall be construed to deprive a municipality of jurisdiction over utilities, places of employment, or public buildings except that no local requirement shall be contrary to the requirements in these chapters. (See sections 101.16 and 196.58, Wis. Stats.)

(c) A utility may file with the Public Service Commission, as a condition of a rate application, requirements covering subject matter which is a part of this code but such requirements must be acceptable and not contrary to the requirements in these chapters. (See section 196.19, Wis. Stats.)

(5) COMPLAINTS. If a complaint is filed with the administrative authority by any interested party to the effect that public safety requires changes in construction or methods of operation the administrative authority shall investigate and make recommendations. (See section 196.74, Wis. Stats., for procedure if changes in utility facilities are necessary.)

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68; am. (4) (b), Register, April, 1972, No. 196, eff. 5-1-72.

Chapter E 20

GENERAL REQUIREMENTS

E 20.10 Character of construction, maintenance and operation. All electrical power and communication equipment and lines shall be of such construction, and so installed, operated, and maintained as to minimize the life and fire hazard.

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

E 20.11 Use of approved materials and construction methods. (1) MATERIALS. No materials, employed in construction covered by this code, shall be used which have not been approved by the Department of Industry, Labor and Human Relations or Public Service Commission.

(a) Exception: Materials which comply with the requirements of this code are hereby approved.

Note: It is the policy of the administrative authority to approve materials, devices, and systems which are listed as standard by the Underwriters' Laboratories if they do not conflict with the requirements of this or other state codes or the laws of the state.

(2) METHODS OF INSTALLATION. No methods of installing electrical materials or devices in construction covered by this code shall be used which are not approved by the Department of Industry, Labor and Human Relations or Public Service Commission.

(a) Exception: Methods of installation which comply with the requirements of this code are hereby approved.

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

E 20.12 Construction, inspection and repairs. (1) All construction and equipment shall be cleaned when necesary and inspected at such intervals as experience has shown to be necessary. Any equipment or construction known to be defective so as to endanger life or property shall be promptly repaired, permanently disconnected, or isolated until repairs can be made. Construction, repairs, additions and changes to electrical equipment and conductors shall be made by qualified persons only. (See also sections E 121.02 and E 121.04.)

(2) Facilities installed or used in the generation, transmission, distribution and utilization of electricity shall be designed for such installation and use.

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

E 20.13 Application of rules. (1) WAIVING RULES. The rules are intended to apply to all installations except as modified or waived by the proper administrative authority. They are intended to be so modified

or waived in particular cases wherever any rules are shown for any reason to be impracticable or if equivalent or safer construction is secured in other ways.

(2) APPLICATION. The intent of the rules will be realized (a) by applying the rules in full to all new installations, reconstructions, alterations, and extensions, except where any rule is shown to be impracticable for special reasons or where the advantage of uniformity with existing construction is greater than the advantage of construction in compliance with the rules, providing the existing construction is reasonably safe; (b) by bringing existing installations into conformity with these rules as far as may be directed by the Department of Industry, Labor and Human Relations or Public Service Commission and within the time determined by them.

(3) TEMPORARY INSTALLATIONS. It will sometimes be necessary to modify or waive certain of the rules in case of temporary installations or installations which are shortly to be dismantled or reconstructed. Such temporary construction may be used for a reasonable length of time provided it is under competent supervision while it or adjoining equipment is alive or if it is protected by suitable barriers or warning signs when accessible to any person, without fully complying with this code; but all such construction shall be made reasonably safe.

(4) TESTING. Rooms which are used exclusively for routine or special electrical test work and, therefore, are under the supervision of a qualified person, need comply with this code only insofar as is practicable for the character of the testing done.

(5) EMERGENCY. In case of emergency or pending decision of the administrator, the person responsible for the installation may decide as to modification or waiver of any order, subject to review by proper authority.

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

Chapter E 101

DEFINITION OF SPECIAL TERMS

E 101.02 Definitions

E 101.02 Definitions. General guides for this chapter on definitions include: (1) for simplicity, only definitions essential to the proper use of this code are included; (2) only those terms used in 2 or more rules are defined in full in Wis. Adm. Code chapter E 101, other definitions being defined in the individual rule where they apply; (3) wherever practical the definitions conform to those of the American Standards Association.

(1) ACCESSIBLE: (As applied to wiring methods). Not permanently closed in by the structure or finish of the building; capable of being removed without disturbing the building structure or finish. (See "Concealed" and "Exposed".)

(2) ACCESSIBLE: (As applied to equipment). Admitting close approach because not guarded by locked doors, elevation or other effective means. (See "Readily accessible".)

(3) ADMINISTRATIVE AUTHORITY: The Department of Industry, Labor and Human Relations and/or the Public Service Commission.

(4) ALIVE OR LIVE: Electrically connected to a source of potential difference, or electrically charged so as to have a potential different from that of the earth.

Note: The term "live" is sometimes used in place of the term "current-carrying" where the intent is clear, to avoid repetitions of the longer term.

(5) ANTENNA CONFLICT: See "Conflict".

(6) APPLIANCE: Appliances are current-utilizing equipment, fixed or portable; for example, heating, cooking and small motor-operated equipment.

(7) APPROVED: Acceptable to the administrative authority enforcing this code. (See section E 20.11).

(9) ASKAREL: A synthetic non-flammable insulating liquid which, when decomposed by the electric arc, evolves only non-flammable gaseous mixtures.

(10) AUTHORITY: See "Administrative authority."

(11) AUTOMATIC: Self-acting, operating by its own mechanism when actuated by some impersonal influence, as for example, a change in current strength, pressure, temperature, or mechanical configuration. (See "non-automatic").

(12) BRANCH CIRCUIT: That portion of a wiring system extending beyond the final overcurrent device protecting the circuit.

Note: A device not approved for branch circuit protection, such as a thermal cutout or motor overload protective device, is not considered as the overcurrent device protecting the circuit.

(13) BRANCH CIRCUIT-APPLIANCE: A branch circuit supplying energy to one or more outlets to which appliances are to be connected; such circuits to have no permanently connected lighting fixtures not a part of an appliance.

(14) BRANCH CIRCUIT—GENERAL PURPOSE: A branch circuit that supplies a number of outlets for lighting and appliances.

(15) BRANCH CIRCUIT—INDIVIDUAL: A branch circuit that supplies only one utilization equipment.

(16) BUILDING: A structure which stands alone or which is cut off from adjoining structures by fire walls with all openings therein protected by approved fire doors.

(17) CABINET: An enclosure designed either for surface or flush mounting, and provided with a frame, mat or trim in which swinging doors are hung.

(18) CABLE: A combination of conductors which are bound together and insulated from each other. It also includes single conductors having the same insulation and outside protective covering as commonly used in multi-conductor cables.

(19) CABLE VAULT: See "manhole".

(20) CIRCUIT: A conductor or system of conductors through which an electric current is intended to flow.

(21) CIRCUIT-BREAKER: A device designed to open, under abnormal conditions, a current-carrying circuit, without injury to itself. The term, as used in this code, applies only to the automatic type, designed to trip on a predetermined overload of current.

(22) CLIMBING SPACE: The vertical space reserved along the side of a pole or structure to permit ready access for linemen to equipment and conductors located thereon.

(23) COMMUNITY ANTENNA SYSTEM: A central receiving antenna together with the cables, conductors, supports and equipment used to connect the subscribers to the central antenna.

(24) COMMUNICATION LINES: See "lines".

(25) CONCEALED: Rendered inaccessible by the structure or finish of the building. Wires in concealed raceways are considered concealed, even though they may become accessible by withdrawing them.

Note: Raceways or wiring materials which are unexposed or not normally visible are considered to be concealed.

(26) CONDUCTOR: A metallic conducting material, usually in the form of a wire or cable, suitable for carrying an electric current.

(27) CONDUCTOR—BARE: A conductor having no covering or insulation whatsoever. (See "covered conductor".)

(28) CONDUCTOR CONFLICT: See "conflict".

(29) CONDUCTOR—COVERED: A conductor having one or more layers of non-conducting materials that are not recognized as insulation under the code. (See "conductor—bare").

(30) CONDUCTOR—GROUNDING: A conductor which is used to connect the equipment or the wiring system with a grounding electrode or electrodes.

(31) CONDUCTOR—LATERAL: In pole wiring work, a wire or cable extending in a general horizontal direction approximately at right angles to the general direction of the line conductors.

(32) CONDUCTOR—LINE: One of the wires or cables carrying electric current, supported by poles, towers, or other structures, but not including vertical or lateral connecting wires.

(33) CONDUCTOR—VERTICAL: In pole wiring work, a wire or cable extending in an approximately vertical direction.

(34) CONDUIT: A tube especially constructed for the purpose of enclosing electrical conductors.

(35) CONDUIT—FLEXIBLE METALLIC: A flexible raceway of circular cross-section, especially constructed for the purpose of drawing in or withdrawing of wires and cables after the conduit and its fittings are in place, and is made of metal strip, usually of steel, with metallic corrosion resistant coating, helically wound, and with interlocking edges.

(36) CONDUIT—RIGID METAL: A tubular raceway with threaded ends, for electric wires and cables; if of ferrous metal, having a corrosion resistant coating on all surfaces except threads, and if of corrosion resistant material, properly identified, and in either case with a uniformly smooth interior coating of enamel or like material. Conduit may be made of mild steel tubing of circular cross-section having walls which in the various electrical trade sizes comply with the measurements set forth in NEC-1971 chapter 9, table 4. For other materials, dimensions are to be the same.

(37) CONDUIT—THIN-WALL (ELECTRICAL METALLIC TUBING): A thin-walled steel or corrosion-resistant metal raceway of circular cross-section, constructed for the purpose of pulling in or withdrawing wires after it is installed in place, coated inside and out to be corrosion resistant, and connected by means of threadless fittings. The interior diameters should be the same as for the corresponding trade sizes of rigid conduit.

(38) CONFLICT—ANTENNA: An antenna or its guy wire is at a higher level than a supply or communication conductor and provided the breaking of the antenna or its support will be likely to result in contact between the antenna or guy wire and the supply or communication conductors.

(39) CONFLICT—CONDUCTORS: A conductor is so situated with respect to a conductor of another line at a lower level that the horizontal distance between them is less than the sum of the following values:

(a) 5 feet, plus

(b) One-half the difference of level between the conductors concerned, plus

(c) The value required in tables 6, 7 and 8 of section E 123.06 for horizontal separation between conductors on the same support for the highest voltage carried by either conductor concerned.

(40) CONFLICT—STRUCTURE: As applied to a pole line, the line is so situated with respect to a second line that the overturning (at the ground line) of the first line will result in contact between its poles or conductors and the conductors of the second line, assuming that no conductors are broken in either line.

(a) Exceptions: Lines are not considered as conflicting under the following conditions:

1. Where one line crosses another.

2. Where 2 lines are on opposite sides of a highway, street or alley and are separated by a distance not less than 60% of the height of the taller pole and not less than 20 feet.

(41) CONNECTOR—PRESSURE (SOLDERLESS): A pressure wire connector is a device which establishes the connection between 2 or more conductors or between one or more conductors and a terminal by means of mechanical pressure and without the use of solder.

(42) CONTROLLER: A device, or group of devices, which serves to govern, in some predetermined manner, the electric power delivered to the apparatus in which it is connected.

(43) COOKING UNIT—COUNTER MOUNTED: An assembly of one or more domestic surface heating elements for cooking purposes designed for flush mounting in, or supported by, a counter, and which assembly is complete with inherent or separately mountable controls and internal wiring. (See "oven, wall-mounted.")

(44) CURRENT—CARRYING PART: A conducting part intended to be connected in an electric circuit. Non-current-carrying parts are those not intended to be so connected.

(45) CURRENT—LIMITING OVERCURRENT PROTECTIVE DEVICE: (See NEC-1971 section 240-27.)

(46) CUTOUT BOX: An enclosure designed for surface mounting and having swinging doors or covers secured directly to, and telescoping with, the walls of the box proper.

(47) DEAD: Free from any electrical connection to a source of potential difference and from electric charge; not having a potential different from that of the earth. The term is used only with reference to current-carrying parts which are sometimes alive.

(48) DEMAND FACTOR: Of any system or part of a system, the ratio of the maximum demand of the system, or part of the system, to the total connected load of the system, or part of the system under consideration.

(49) DEVICE: A unit of an electrical system which is intended to carry but not utilize electrical energy.

(50) DISCONNECTING MEANS: A device, group of devices, or other means whereby the conductors of a circuit can be disconnected from their source of supply.

(51) DISCONNECTOR: A switch which is intended to open a circuit after the load has been thrown off by some other means.

Note: Manual switches designed for opening loaded circuits are usually installed in circuit with disconnectors, to provide a safe means for opening the circuit under load.

(52) DRY: See "location—dry".

(53) DUCT: In underground work, a single tubular runway for underground cables.

(54) DUSTPROOF: So constructed or protected that dust will not interfere with its successful operation.

(55) DUST-TIGHT: So constructed that dust will not enter the enclosing case.

(56) DUTY—CONTINUOUS: A requirement of service that demands operation at a substantially constant load for an indefinitely long time.

(57) DUTY—INTERMITTENT: A requirement of service that demands operation for alternate intervals of (a) load and no load, or (b) load and rest, or (c) load, no load and rest.

(58) DUTY—PERIODIC: A type of intermittent duty in which the load conditions are regularly recurrent.

(59) DUTY—SHORT-TIME: A requirement of service that demands operation at a substantially constant load for a short and definitely specified time.

(60) DUTY—VARYING: A requirement of service that demands operation at loads, and for intervals of time, both of which may be subject to wide variation.

Note: See table in NEC-1971 section 430-21 for illustrations of various types of duty.

(61) EFFECTIVELY GROUNDED: See "grounded".

(62) ELECTRIC SIGN: A fixed or portable, self-contained electrically illuminated appliance with words or symbols designed to convey information or attract attention.

(63) ELECTRICAL METALLIC TUBING: See "conduit".

(64) ELECTRICAL SUPPLY EQUIPMENT: See "equipment".

(65) ELECTRICAL SUPPLY LINES: See "lines".

(66) ELECTRICAL SUPPLY STATION: Any building, room, or separate space within which electrical supply equipment is located and the interior of which is accessible, as a rule, only to properly qualified persons.

Note: This includes generating stations and substations and generator, storage battery, and transformer rooms, but excludes manholes and isolated transformer vaults on private premises. (See "transformer vault".)

(67) ENCLOSED: Surrounded by a case which will prevent a person from accidentally contacting live parts.

(68) EQUIPMENT: A general term including materials, fittings, devices, appliances, fixtures, apparatus, and the like, used as a part of, or in connection with, an electrical installation.

(69) EQUIPMENT—ELECTRICAL SUPPLY: Equipment which produces, modifies, regulates, controls, or safeguards a supply of electrical energy.

(70) EQUIPMENT—UTILIZATION: Equipment which utilizes electrical energy for mechanical, chemical, heating, lighting, testing, or similar

purposes and is not a part of supply equipment, supply lines or communication lines.

(71) EXPLOSION-PROOF APPARATUS: Enclosed in a case which is capable of withstanding an explosion of a specified gas or vapor which may occur within it, and of preventing the ignition of a specified gas or vapor surrounding the enclosure by sparks, flashes, or explosions of the gas or vapor within, and which operates at such an external temperature that a surrounding flammable atmosphere will not be ignited thereby.

(72) EXPOSED: (As applied to circuits or lines). In such a position that in case of failure of supports or insulation contact with another circuit or line may result.

(73) EXPOSED: (As applied to live parts). A live part can be inadvertently touched or approached nearer than a safe distance by any person. It is applied to parts not suitably guarded or isolated. (See "accessible" and "concealed".)

(74) EXPOSED: (As applied to wiring method). Not concealed.

(75) EXTERNALLY OPERABLE: (As applied to equipment in a case or cabinet). Capable of being operated without exposing the operator to contact with live parts.

(76) FEEDER: A feeder is the circuit conductors between the service equipment, or the generator switchboard of an isolated plant, and the branch circuit overcurrent device.

(77) FITTING: An accessory such as a locknut, bushing or other part of a wiring system which is intended primarily to perform a mechanical rather than an electrical function.

(78) FLEXIBLE METALLIC TUBING: See "conduit".

(79) GARAGE: A building, or part of a building, which accommodates or houses self-propelled vehicles. For the purpose of this code the term vehicle includes land, air and water vehicles.

(80) GENERAL-USE SWITCH: See "switch".

(81) GROUND: A conducting connection, whether intentional or accidental, between an electrical circuit or equipment and earth, or to some conducting body which serves in place of the earth.

(82) GROUNDED: Connected to earth or to some conducting body which serves in place of the earth.

(83) GROUNDED CONDUCTOR: A conductor which is intentionally grounded, either solidly or through a current limiting device.

(84) GROUNDED-EFFECTIVELY: Permanently connected to earth through a ground connection or connections of sufficiently low impedance and having sufficient current-carrying capacity to prevent the building up of voltages which may result in undue hazard to connected equipment or to persons. Where the term "effectively grounded" is used in conjunction with cables, sheaths, messengers, or conductors it means effectively grounded throughout their lengths. (See section E 103.02(2)(e)).

(85) GROUNDED SYSTEM: A system of conductors in which at least one conductor or point (usually the middle wire, or neutral point of

transformer or generator windings) is intentionally grounded, either solidly or through a current limiting device. This ground connection may be at one or more points.

(86) GROUNDING CONDUCTOR: See "conductor".

(87) GUARDED: Covered, shielded, enclosed or otherwise protected, by means of suitable covers, casings, barriers, rails, or screens, or by means of mats or platforms, to remove the liability of dangerous contact or approach by persons or objects to a point of danger. Wires which are insulated, but not otherwise protected, are not considered as guarded. (See "insulated".)

(88) GUARD ZONE: The space at minimum clearance from guards to electrical parts where guards may be installed by workmen without definite engineering design. (See section E 112.05).

(89) HANDHOLE: An opening in an underground system into which workmen reach, but do not enter.

(90) HAZARDOUS LOCATIONS: See NEC-1971 Article 500.

(91) HOISTWAY: Any shaftway, hatchway, wellhole, or other vertical opening or space in which an elevator or dumbwaiter is designed to operate.

(92) IDENTIFIED: As used in NEC-1971 Article 200, the conductor or terminal to which it refers is to be recognized as grounded.

(93) INSULATED: Separated from other conducting surfaces by a dielectric substance or air space permanently offering a high resistance to the passage of current and to disruptive discharge through the substance or space.

Note: When any object is said to be insulated, it is understood to be insulated in a suitable manner for the conditions to which it is subjected. Otherwise, it is, within the purpose of these rules, uninsulated. Insulating covering of conductors is one means of making the conductors insulated. Wires which are insulated, but not otherwise protected, are not considered guarded.

(94) INSULATING: Where applied to the covering of a conductor or to clothing, guards, rods, and other safety devices, a device, when interposed between a person and current-carrying parts, protects the person making use of it against electric shock from the current-carrying parts with which the device is intended to be used. (The opposite of conducting.)

(95) ISOLATED: Not readily accessible to persons unless special means for access are used. (See "exposed".)

(96) ISOLATED PLANT: A private electrical installation deriving energy from its own generator driven by a prime mover.

(97) ISOLATING SWITCH: See "switch".

(98) ISOLATION BY ELEVATION: Elevated sufficiently so that persons may safely walk underneath. (See "exposed".)

(99) JOINT USE: The simultaneous use of facilities by two or more agencies not furnishing like services but having use for similar facilities.

(100) LATERAL CONDUCTOR: See "conductor".

(101) LATERAL WORKING SPACE: The space reserved for working between conductor levels outside the climbing space, and to its right and left.

(102) LIGHTING OUTLET: An outlet intended for the direct connection of a lampholder, a lighting fixture or a pendent cord terminating in a lampholder.

(103) LIGHTNING ARRESTER: As applied to supply circuits, a device which has the property of reducing the voltage of a surge applied to its terminals, is capable of interrupting follow current if present, and restores itself to its original operating condition.

(104) LINE CONDUCTOR: See "conductor".

(105) LINES—COMMUNICATION: The conductors and their supporting or containing structures which are located outside of buildings and are used for public or private signal or communication service and which operate at not exceeding 400 volts to ground or 750 volts between any two points of the circuit, and the transmitted power of which does not exceed 150 watts. When operating at less than 150 volts no limit is placed on the capacity of the system.

(a) Telephone, telegraph, railroad-signal, messenger-call, clock, fire, police alarm, community antenna, and other systems conforming with the above are included.

(b) Lines used for signalling purposes, but not included under the above definition are considered as supply lines of the same voltage and are to be so run.

1. Exception is made under certain conditions for communication circuits used in the operation of supply lines. (See section E 128.09 (1)).

(106) LINES; ELECTRICAL SUPPLY: Those conductors and their necessary supporting or containing structures which are located entirely outside of buildings and are used for transmitting a supply of electrical energy. Electrical supply lines do not include communication lines as defined in subsection (105) above.

(a) Does not include open wiring on buildings, in yard or similar locations where spans are less than 20 feet and all the precautions required for stations or utilization equipment, as the case may be, are observed.

(b) Railway-signal lines of more than 400 volts to ground are always supply lines within the meaning of these rules, and those of less than 400 volts may be considered as supply lines, if so run and operated throughout.

(107) LOCATION; DAMP: A location subject to a moderate degree of moisture, such as some basements, some barns, some cold storage warehouses, and the like.

(108) LOCATION; DRY: A location not normally subject to dampness or wetness. A location classified as dry may be temporarily subject to dampness or wetness, as in the case of a building under construction.

(109) LOCATION; WET: A location subject to saturation with water or other liquids, such as locations exposed to the weather, wash rooms in garages, and like locations. Installations underground or in concrete slabs or masonry in direct contact with the earth, shall be considered as wet locations.

(110) LOW-ENERGY POWER CIRCUIT: A circuit which is not a remote-control or signal circuit but which has the power supply limited in

accordance with the requirements of class 2 remote-control circuits. (See NEC-1971 Article 725.)

(a) Such circuits include electric door openers and circuits used in the operation of coin-operated phonographs.

(111) LOW VOLTAGE PROTECTION: The effect of a device operative on the reduction or failure of voltage to cause and maintain the interruption of power supply to the equipment protected.

(112) LOW VOLTAGE RELEASE: The effect of a device operative on the reduction or failure of voltage to cause the interruption of power supply to the equipment, but not preventing the re-establishment of the power supply on return of voltage.

(113) MANHOLE: (More accurately termed splicing chamber or cable vault). An opening in an underground system which workmen or others may enter for the purpose of installing cables, transformers, junction boxes, and other devices, and for making connections and tests.

(114) MANUAL: Capable of being operated by personal intervention.

(115) MOTOR CIRCUIT SWITCH: See "switch".

(116) MULTI-OUTLET ASSEMBLY: A type of surface or flush raceway, designed to hold conductors and attachment plug receptacles, assembled in the field or at the factory.

(117) NEW CONSTRUCTION: All new electrical installations and all extensions and renewals which constitute a substantial portion of the installation.

(118) NON-AUTOMATIC: The implied action requires personal intervention for its control. (See "automatic")

Note: As applied to an electric controller, non-automatic control does not necessarily imply a manual controller, but only that personal intervention is necessary.

(119) OPEN WIRE: A conductor or pair of conductors separately supported above the surface of the ground.

(120) OUTLET: A point on the wiring system at which current is taken to supply utilization equipment.

(121) OUTLINE LIGHTING: An arrangement of incandescent lamps or gaseous tubes to outline and call attention to certain features such as the shape of a building or the decoration of a window.

(122) OVEN, WALL-MOUNTED: A domestic oven for cooking purposes designed for mounting in or on a wall or other surface.

(123) PANELBOARD: A single panel, or group of panel units, designed for assembly in the form of a single panel; including busses and with or without switches and/or automatic overcurrent protective devices for the control of light, heat, or power circuits of small individual as well as aggregate capacity; designed to be placed in a cabinet or cutout box placed in or against a wall, or partition, and accessible only from the front. (See definition of "switchboard").

(124) PERMANENTLY GROUNDED: See "grounded, effectively".

(125) POLE FACE: That side of a pole on which cross arms are attached, or which is so designated by the companies owning or operating the pole.

(126) PORTABLE APPLIANCE: An appliance capable of being readily moved where established practice or the conditions of use make it necessary or convenient for it to be detached from its source of current by means of a flexible cord and attachment plug.

(127) QUALIFIED PERSON: One familiar with the construction and operation of the apparatus and the hazards involved for over 600 volts.

(128) RACEWAY: Any channel for holding wires, cables or bus bars, which is designed expressly for, and used solely for, this purpose.

Note: Raceways may be of metal or insulating material and the term includes rigid metal conduit, rigid non-metallic conduit, flexible metal conduit, electrical metallic tubing, underfloor raceways, cellular concrete floor raceways, cellular metal floor raceways, surface metal raceways, structural raceways, wireways, and busways.

(129) RAINTIGHT: So constructed or protected that exposure to a beating rain will not result in the entrance of water.

(130) READILY ACCESSIBLE: Capable of being reached quickly for operation, renewal or inspection, without requiring those to whom ready access is requisite to climb over or remove obstacles or to resort to portable ladders, chairs, etc. (See "accessible".)

(131) RECEPTACLE OUTLET: An outlet where one or more receptacles are installed.

(132) RECONSTRUCTION: Replacement of a substantial portion of an existing installation by new equipment or construction. Does not include ordinary maintenance replacements.

(133) REMOTE-CONTROL CIRCUIT: Any electrical circuit which controls any other circuit through a relay or an equivalent device.

(134) RURAL DISTRICTS: All places not urban, usually in the country, but in some cases within city limits. (See definition of "urban districts".)

(135) SAG: (a) *Apparent sag at any point:* The departure of the wire at the particular point in the span from the straight line between the 2 points of support of the span, at 60° F., with no wind.

(b) *Apparent sag of a span:* The maximum departure of the wire in a given span from the straight line between the 2 points of support of the span, at 60° F., with no wind loading.

(c) *Final unloaded sag:* The sag of a conductor after it has been subjected for an appreciable period to the loading prescribed, or equivalent loading, and the loading removed.

(d) *Initial unloaded sag:* The sag of a conductor prior to the application of any external load.

(e) *Maximum total sag:* The total sag at the midpoint of the straight line joining the 2 points of support of the conductor.

(f) *Total sag:* The distance, measured vertically, from any point of a conductor to the straight line joining its 2 points of support, under conditions of ice loading equivalent to the total resultant loading.

(g) *Unloaded sag:* (Of a conductor at any point in a span). The distance, measured vertically, from the particular point in the conductor to a straight line between its 2 points of support, without any external load.

(136) SEALABLE EQUIPMENT: Equipment enclosed in a case or cabinet that is provided with means for sealing or locking so that live parts cannot be made accessible without opening the enclosure. The equipment may or may not be operable without opening the enclosure.

(137) SEALED (HERMETIC TYPE) REFRIGERATION COMPRESSOR: A mechanical compressor consisting of a compressor and a motor, both of which are enclosed in the same sealed housing, with no external shafts nor shaft seals, the motor operating in the refrigerant atmosphere.

(138) SERVICE: The conductors and equipment for delivering energy from the electricity supply system to the wiring system of the premises served.

(139) SERVICE CABLE: Service conductors made up in the form of cable.

(140) SERVICE CONDUCTORS: The supply conductors which extend from the street main, or from transformers to the service equipment of the premises supplied.

(141) SERVICE DROP: The overhead service conductors between the last pole or other aerial support and the first point of attachment to the building.

(142) SERVICE ENTRANCE CONDUCTORS, OVERHEAD SYSTEM: The service conductors between the terminals of the service equipment and a point usually outside the building, clear of building walls, where joined by tap or splice to the service drop.

(143) SERVICE ENTRANCE CONDUCTORS, UNDERGROUND SYSTEM: The service conductors between the terminals of the service equipment and the point of connection to the service lateral.

(a) Where service equipment is located outside the building walls, there may be no service-entrance conductors, or they may be entirely outside the building.

(144) SERVICE EQUIPMENT: The necessary equipment, usually consisting of circuit-breaker or switch and fuses, and their accessories, located near point of entrance of supply conductors to a building and intended to constitute the main control and means of cut-off for the supply to that building.

(145) SERVICE LATERAL: The underground service conductors between the street main, including any risers at a pole or other structure or from transformers, and the first point of connection to the service entrance conductors in a terminal box inside or outside the building wall. Where there is no terminal box, the point of connection shall be considered to be the point of entrance of the service conductors into the building.

(146) SERVICE RACEWAY: The rigid metal conduit, electrical metallic tubing, or other raceway, that encloses service entrance conductors.

(147) SETTING: (of circuit-breaker). The value of the current at which it is set to trip.

(148) SHALL: Is used to indicate requirements.

(149) SHOULD: Is used to indicate recommendations, or that which is advised but not required. In general, recommendations have the

form of fine-print notes or paragraphs supplementing the preceding text.

(150) SHOW WINDOW: Any window used or designed to be used for the display of goods or advertising material, whether it is fully or partly enclosed or entirely open at the rear, and whether or not it has a platform raised higher than the street floor level.

(151) SIGN: See "electric sign".

(152) SIGNAL CIRCUIT: Any electrical circuit which supplies energy to an appliance which gives a recognizable signal.

(a) Such circuits include circuits for door bells, buzzers, code-calling systems, signal lights, and the like.

(153) SPAN LENGTH: The horizontal distance between two adjacent supporting points of a conductor.

(154) SPECIAL PERMISSION: The written consent of the Department of Industry, Labor and Human Relations or Public Service Commission.

(155) STRUCTURE CONFLICT: See "conflict".

(156) SUBSTANTIAL: So constructed and arranged as to be of adequate strength and durability for the service to be performed under the prevailing conditions.

(157) SWITCHES: (a) *Switches:* A device for opening and closing or for changing connection of a circuit. A switch will always be understood to be manually operated, unless otherwise stated.

(b) *General use switch:* A switch intended for use as a switch in general distribution and branch circuits. It is rated in amperes and is capable of interrupting its rated current at its rated voltage.

(c) *General use snap switch:* A form of general use switch so constructed that it can be installed in flush device boxes, or on outlet box covers, or otherwise used in conjunction with wiring systems recognized by this code.

(d) *AC general use snap switch:* A form of general use snap switch suitable only for use on alternating current circuits for controlling the following:

1. Resistive and inductive loads (including electric discharge lamps) not exceeding the ampere rating at the voltage involved.
2. Tungsten filament lamp loads not exceeding the ampere rating at 120 volts.
3. Motor loads not exceeding 80% of the ampere rating of the switches at the rated voltage.

Note: All AC general use snap switches are marked "AC" in addition to their electrical rating.

(e) *AC-DC general use snap switch:* A form of general use snap switch suitable for use on either direct or alternating current circuits for controlling the following:

1. Resistive loads not exceeding the ampere rating at the voltage involved.
2. Inductive loads not exceeding one-half the ampere rating at the voltage involved, except that switches having a marked horsepower rating are suitable for controlling motors not exceeding the horsepower rating of the switch at the voltage involved.

3. Tungsten filament lamp loads not exceeding the ampere rating at 125 volts, when marked with the letter "T".

Note: AC-DC general use snap switches are not generally marked AC-DC, but are always marked with their electrical rating.

(f) *Isolating switch:* A switch intended for isolating an electric circuit from its source of power. It has no interrupting rating and is intended to be operated only after the circuit has been opened by some other means.

(g) *Motor circuit switch:* A switch, rated in horsepower, capable of interrupting the maximum operating overload current of a motor of the same horsepower rating as the switch at the rated voltage.

(158) SWITCHBOARD: When referred to in connection with the supply of electricity is a large single panel, frame, or assembly of panels on which are mounted, on the face or back or both, switches, overcurrent and other protective devices, buses, and usually instruments. Switchboards are generally accessible from the rear as well as from the front and are not intended to be installed in cabinets. (See "panelboard").

(159) TAGS: Tags or other markers of distinctive appearance, indicating that men are at work on the equipment or lines so designated.

(160) TENSION: (a) *Final unloaded conductor tension:* The longitudinal tension in a conductor after the conductor has been stretched by the application for an appreciable period, and subsequent release, of the heavy loading of ice and wind, and temperature decrease, specified in these rules (or equivalent loading).

(b) *Initial conductor tension:* The longitudinal tension in a conductor prior to the application of any external load.

(161) THERMAL CUTOUT: An overcurrent protective device which contains a heater element in addition to and affecting a renewable fusible member which opens the circuit. It is not designed to interrupt short circuits.

(162) THERMAL PROTECTION: (As applied to motors). The words "thermal protection" appearing on the name plate of a motor indicate that the motor is provided with a thermal protector.

(163) THERMAL PROTECTOR: (As applied to motors). An inherent overheating protective device which is responsive to motor current and temperature and which, when properly applied to a motor, protects the motor against dangerous overheating due to overload or failure to start.

(164) TRANSFORMER VAULT: An isolated fire-resistant enclosure, either above or below ground, in which transformers and related equipment are installed and which is not continuously attended during operation.

(165) URBAN DISTRICT: Thickly settled area, whether in cities or not, or where congested traffic often occurs. A highway, even though in the country, on which the traffic is often heavy, is considered as urban.

(166) UTILIZATION EQUIPMENT: See "equipment".

(167) VAPOR-TIGHT: So enclosed that vapor will not enter the enclosure.

(168) VENTILATED: Provided with a means to permit circulation of the air sufficiently to remove an excess of heat, fumes, or vapors.

(169) VERTICAL CONDUCTOR: See "conductor".

(169a) VOLATILE FLAMMABLE LIQUID: A flammable liquid having a flash point below 100° F., or where temperature is above its flash point.

(170) VOLTAGE. (a) (of a circuit) Voltage of a circuit is the greatest root-mean-square effective difference of potential between any two conductors of the circuit concerned.

(b) (to ground) Voltage to ground in grounded circuits is the voltage between the given conductor and that point or conductor of the circuit which is grounded; in ungrounded circuits, the greatest voltage between the given conductor and any other conductor of the circuit.

(c) (of direct connected circuit) If one circuit is directly connected to another circuit of higher voltage (as in the case of an autotransformer) both are considered as of the higher voltage, unless the circuit of lower voltage is effectively grounded, in which case its voltage is not determined by the circuit of higher voltage. Direct connection implies electric connection as distinguished from connection merely through electromagnetic or electrostatic induction.

(d) When the term "volts" or voltage is used in Volume 1 without qualification, it means the voltage between conductors in an ungrounded system and voltage to ground in a grounded system. A system grounded through a Peterson coil or similar device is not considered grounded.

(171) WATERTIGHT: So constructed that moisture will not enter the enclosing case.

(172) WEATHERPROOF: So constructed or protected that exposure to the weather will not interfere with its successful operation.

(a) *Weatherproof* (As applied to the protective covering on a conductor): A covering made up of braids of fibrous material which are thoroughly saturated with a dense moisture-proof compound after they have been placed on the conductor, or an equivalent protective covering designed to withstand weather conditions.

(173) WET: (See "location—wet").

History: Cr. Register, January, 1968, No. 145, eff. 2–1–68; am. (36), (45), (60) note, (90), (92), (110) (intro. par.), and (127), Register, April, 1972, No. 196, eff. 5–1–72.

Chapter E 103

PROTECTIVE GROUNDING

E 103.01 Grounding general. (1) This chapter (Wis. Adm. Code sections E 103.01 through E 103.10) treats of protection by grounding of electrical generation, transmission, distribution, and some utilization facilities, the general requirements of which are covered in other chapters of this code. The orders in this section do not apply to the grounded return of electric railways, to the grounding of lightning protection wires which are independent of electric circuits and equipment, nor to the grounding of communication circuits and equipment.

(2) In general the rules in this chapter cover methods of grounding and such requirements that would have to be repeated if placed in the various parts of the code.

(3) Additional rules covering grounding requirements for interior wiring, radio, communication systems and signal circuits will be found in NEC-1971 Articles 250 except as changed in volume 2 (See section E 250.92), 810, 800 except as changed in volume 2 (See sections E 800.02 and E 800.21), 720 and 725, respectively.

(4) Insulation and guarding are suitable alternatives to grounding under certain conditions.

(5) Circuits are grounded for the purpose of limiting the voltage on the circuit which might otherwise occur through exposure to lightning or other voltages higher than that for which the circuit is designed; or to limit the maximum potential to ground due to normal voltage.

History: Cr. Register, January, 1968, No. 145, eff. 2–1–68; am. (3), Register, April, 1972, No. 196, eff. 5–1–72.

E 103.02 Grounding electric systems. (1) DIRECT CURRENT DISTRIBUTION SYSTEMS. (a) Two-wire direct-current systems supplying interior wiring systems and operating at not to exceed 300 volts between conductors shall be grounded on one conductor at one or more supply stations but not at individual services or elsewhere on the interior systems unless such system is used for supplying industrial equipment in limited areas and the circuit is equipped with a ground detector. It is recommended that two-wire direct-current systems operating at more than 300 volts between conductors be grounded if a neutral point can be established such that the maximum difference of potential between the neutral point and any other point on the system does not exceed 300 volts. It is recommended that two-wire

direct-current systems be not grounded if the voltage to ground of either conductor would exceed 300 volts after grounding.

(b) Three-wire direct-current systems supplying interior wiring systems shall be grounded on the neutral at one or more supply stations but not at individual services or elsewhere on the interior systems.

(2) ALTERNATING CURRENT DISTRIBUTION SYSTEMS. (a) Secondary alternating-current distribution systems supplying wiring systems serving utilization equipment and interior alternating-current systems shall be grounded if they can be so grounded that the maximum voltage to ground does not exceed 300 volts.

(b) In alternating-current distribution systems ground connections shall be made at the building service and near the transformer (or transformers) either by direct ground connection through an extended metallic water piping system or made electrode or by the use of a system ground wire to which are connected the grounding conductors of many secondary mains, and which is itself effectively grounded at intervals that will fulfill for any secondary utilizing the system ground wire the resistance and current carrying capacities of sections E 103.07 and E 103.09.

1. In single-phase, 3-wire systems the ground connection shall be made on the neutral conductor.

2. In single-phase, 2-wire systems the ground connection shall be made on the neutral point or on either conductor. If the ground is made at the neutral point the neutral shall be run to each individual service.

3. In 2-phase, 3-wire systems, the ground connection shall be made to the conductor common to both phases. In 2-phase 4-wire systems, a ground connection shall be made to the neutral point of each phase.

4. In 3-phase, 3-wire, delta systems, the ground connection shall be made on one conductor or on the neutral point of one phase. If the ground is made at the neutral of one phase the neutral shall be run to each individual service.

5. Where one phase of a 2 or 3 phase system is used for lighting, that phase shall be grounded at only one point, at the neutral conductor, if one is used, or at one of the phase wires.

6. In 3-phase, 3-wire or 4-wire, star connected systems, the ground connections shall be made at the point common to all the phases.

7. Alternating current secondary circuits supplied from a transformer outside the building shall not be grounded inside buildings except at the service entrance.

(c) 1. For an interior system not electrically connected to an exterior secondary distribution system, the grounding connection shall be made at the transformer, generator, or other source of supply, or at the switchboard and on the supply side of the first switch controlling the system.

2. Where transformers supply a common set of distribution mains, such fuses as are installed shall be so placed as not to leave any portion of the secondary system without grounding protection after the fuses have opened.

3. In the absence of a direct ground connection at all building services, ground connections shall be made to the grounded neutral or other grounded conductor of a secondary system supplying more than one utilization equipment, at intervals that will fulfill the resistance and current-carrying requirements of E 103.09. This is to take care of older installations without grounded services.

4. Where more than one building is served from a single service the conductor and equipment enclosures, and the neutral shall be grounded at each building.

(d) The primary neutral of a single or 3 phase supply system operating at not to exceed 22,000 volts between neutral and any phase conductor may be interconnected solidly with the secondary neutrals provided.

1. The customer's service entrance and the supply end are grounded in such a way that the requirements of section E 103.09 are met and 2. or 3. below are complied with.

2. The neutral is connected to an extended metallic underground water piping system or made electrodes complying with the resistance requirements of section E 103.09 at each transformer location and at a sufficient number of additional points to total 4 ground connections per mile.

3. The neutral is connected to single made electrodes complying with the dimensions specified in section E 103.08 (4) at each transformer location and at a sufficient number of additional points to total 9 grounds per mile. The additional grounds shall be placed first on poles adjacent to each customer's location, and then approximately equally spaced between the transformer locations.

(e) 1. A neutral conductor grounded as specified in section E 103.02(2)(d) is considered to be effectively grounded throughout its length.

2. A continuous metal sheath cable or supporting messenger is considered effectively grounded throughout its length if:

a. Connections are made to an extended metallic underground water piping system or to made electrodes complying with the resistance requirements of section E 103.09 at the beginning and at the end and at a sufficient number of additional points to total 4 ground connections per mile, or

b. Connections are made to single made electrodes complying with the dimensions specified in section E 103.08 (4) at a sufficient number of points to total 9 grounds per mile.

(f) The grounding conductor of a lightning arrester protecting a transformer which supplies a secondary distribution system may be interconnected solidly or through a gap with the grounded conductor of such transformer, provided that in addition to the direct grounding connection at the arrester either:

1. The secondary has elsewhere 2 grounding connections at least 20 feet apart to extended underground metallic water piping systems or to made electrodes complying with the resistance requirements of section E 103.09. One or both of these connections may be at customers' entrances.

2. The secondary neutral is common with the primary neutral and is grounded in the manner specified in section E 103.02 (2) (d).

Note: The lightning arrester must be an acceptable lightning protective device having valve characteristics. See definition in chapter E 100.

(3) CURRENT IN GROUNDING CONDUCTOR. Grounds shall be so arranged that under normal conditions of service there will be no objectionable passage of current over the grounding conductors. The temporary currents set up under accidental conditions, while the grounding conductors are performing their intended protective functions, are not to be considered as objectionable. If an objectionable flow of current occurs over a grounding conductor, due to the use of multiple grounds a. one or more of such grounds shall be abandoned, or b. their location shall be changed, or c. the continuity of the conductor between the grounding connections shall be suitably interrupted, or d. other means satisfactory to the authority enforcing this code shall be taken to limit the current.

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

E 103.03 Grounding conductor enclosures. The grounding of lighting and utilization wiring systems as well as metal envelopes containing supply conductors must comply with NEC-1971 Article 250 except as changed in volume 2 (see section E 250.92) even though in locations used exclusively by supply facilities.

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

E 103.04 Grounding of fixed equipment. (1) Fixed equipment which is a part of or used in connection with utilization wiring shall be grounded as required even if in locations used for supply facilities.

(2) Fixed non-current carrying parts on poles which are more than 8 feet from the ground such as transformer cases may or may not be grounded depending on the company's rules. The company shall follow a standardized practice and make their operating rules conform to the practice adopted. If any portion of these non-current carrying parts are located within 8 feet of the ground they shall be grounded.

(3) Instruments, meters, or relays which operate with windings or working parts at 300 volts or more to ground shall have the cases and other exposed bare metal parts grounded unless isolated by elevation or protected by suitable insulating barriers or guards. An exception is made where the equipment is inaccessible to other than qualified persons, in which case the above protection is not required up to and including 750 volts. Above 750 volts, cases shall be isolated by elevation or protected by suitable barriers, grounded metal, or insulating covers or guards, where instruments, meters, or relays are operated from current or potential instrument transformers on circuits of 300 volts or more to ground, having ungrounded secondary circuits and ungrounded primary circuits, the cases and other exposed bare metal parts shall be grounded (See section E 103.06 (2)).

(4) Non-current carrying parts of fixed equipment may be grounded by metallically connecting them to the grounded metal raceway or cable armor, or otherwise as provided in NEC-1971 section 250–57.

History: Cr. Register, January, 1968, No. 145, eff. 2–1–68; am. (4), Register, April, 1972, No. 196, eff. 5–1–72.

E 103.05 Grounding of portable equipment. The grounding of portable equipment is required by NEC-1971 Article 250 except as changed in volume 2 (see section E 250.92) and such portable equipment must

be grounded even though in locations used exclusively by supply facilities.

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

E 103.06 Grounding conductors. (1) MATERIAL AND CONTINUITY. In all cases the grounding conductor shall be of copper or of other metals or combination of metals which will not corrode excessively under the existing conditions. If joints are unavoidable they shall be so made and maintained as to not materially increase the resistance of the grounding conductor. Devices necessary for the proper operation of a supply system may be placed in a grounding conductor but no automatic cutout or switch shall be placed in the grounding conductor unless the opening of the cutout switch disconnects all sources of energy. For lightning arresters and ground detectors the grounding conductor shall be as short and straight as practicable and free from short bends.

(2) SIZE AND CAPACITY. The grounding conductor shall conform to the following:

(a) *For direct current circuits.* A grounding conductor for a direct-current supply system shall have a current-carrying capacity not less than that of the largest conductor supplied by the system and in no case less than that of No. 8 copper.

(b) *For alternating current circuits.* A grounding conductor for an alternating-current system shall have a current-carrying capacity not less than one-fifth that of the conductor to which it is attached but in no case shall the conductivity or tensile strength be less than that of No. 8 copper. See NEC-1971 Article 250 except as changed in volume 2 (see section E 250.92) for conductor size for grounding utilization equipment in interior wiring.

(c) *For instrument transformers.* The grounding conductor for instrument cases and secondary circuits of instrument transformers shall not be smaller than No. 12 if of copper or, if of other metal, shall have equivalent current-carrying capacity.

(d) *For primary lightning arresters.* The grounding conductor or conductors shall have a current-carrying capacity sufficient to insure continuity and continued effectiveness of the ground connection under conditions of excess current caused by or following discharge of the arrester. No individual grounding conductor shall have less conductance than No. 6 (0.162-inch) copper wire.

(e) *Interior utilization wiring, raceways, etc.* For conductor sizes for grounding utilization wiring, raceways, equipment, and portable and pendent equipment see NEC-1971 Article 250 except as changed in volume 2 (see section E 250.92).

(3) MECHANICAL PROTECTION AND GUARDING AGAINST CONTACT. (a) For a distance of 8 feet above the ground, floor, or platform, from which grounding conductors are accessible to the public, the conductors shall be protected by a substantial insulating conduit or wood molding.

1. Where the ground resistance is less than 3 ohms a metallic guard may be used provided that in the case of lightning arrester ground the ground conductor must be electrically connected to both ends and the metallic guard covered by an insulating conduit or molding.

2. In rural areas other than in farm and school yards, or spaces where people congregate, ground conductors of a multigrounded system may be of weatherproof insulation instead of a insulating conduit or molding.

3. Grounding conductors whose only purpose is to protect a pole against lightning need not be protected.

(b) The grounding wire must also be protected near supply and communication lines. (See section E 123.10).

(4) UNDERGROUND. Wires used for grounding conductors, if laid underground, shall, unless otherwise mechanically protected, be laid slack to prevent their being readily broken; and shall have joints carefully painted or otherwise protected against corrosion.

(5) COMMON GROUNDING CONDUCTOR FOR CIRCUITS, METAL RACEWAYS AND EQUIPMENT (See NEC-1971 Article 250 except as changed in volume 2 (see section E 250.92))

(6) BUSSES. In supply stations, manholes, and vaults accessible to qualified persons substantial bare busses may be used. Care should be taken to place them where accidental contact while working on live parts is difficult or they should be guarded.

History: Cr. Register, January, 1968, No. 145, eff. 2–1–68; am. (2) (b), (e) and (5), Register, April, 1972, No. 196, eff. 5–1–72.

E 103.07 Ground connections. The ground connection shall be permanent and effective, and be made as indicated below, but always to underground metallic water piping systems, if available. Where the alternating current system is connected to a grounding electrode in or at a building, the same electrode shall be used to ground the conductor enclosure and equipment in or on that building.

(1) PIPING SYSTEMS. For circuits, equipment, and arresters at supply stations, connections shall be made to all available active metallic underground water-piping systems between which no appreciable difference of potential normally exists, if the pipe is of sufficient capacity, and to one such system if appreciable differences of potential do exist between them. At other places connections shall be made to at least one such system if available. Gas piping should be avoided.

Note: The protective grounding of electric circuits and equipment to underground metallic water-pipe systems in accordance with these rules should always be permitted, since such grounding offers the most effective protection to life and property and is not injurious to the piping systems.

Note: Ground connections from circuits should not be made to jointed piping within buildings except water piping.

(2) ALTERNATE METHODS. Where underground metallic water-piping systems are not available, other methods which will secure the desired permanence and conductance may be permitted. Buried metal structures of considerable extent may be used. In some cases ground connection may be made to the steel frame of a building containing the grounded circuits or equipment, to which frames of machines and other noncurrent-carrying surfaces should also then be grounded. In such cases the building frame should be itself well grounded by effective connection to the ground. This may require made electrodes for steel frame buildings supported on masonry or concrete footings.

(3) MADE ELECTRODES. If resort must be had to made (buried or driven) electrodes the number should be determined by the following requirements:

(a) Not more than one such ground is required for lightning arresters, except where needed for large current capacity.

(b) At least 2 grounds are required for low-voltage alternating-current distribution circuits, one at the transformer or elsewhere and one at each customer's service.

(c) Where no part of the circuit or equipment protected can be reached by persons while they are standing on the ground or damp

floors, or by persons while touching any metallic piping to which the grounding conductor is not effectively connected, a single made electrode may be used even if its resistance exceeds that specified in section E 103.09. In such cases it is desirable to provide guards for the grounding conductor in accordance with subsection E 103.06(3), wherever it is otherwise accessible, or to provide insulating mats or platforms so located that persons cannot readily touch the grounding conductors without standing on such mats or platforms.

(d) Made electrodes may be arranged to minimize the potential gradient along the surface of the earth by use of radial connecting wires underneath the earth surface or by other suitable means.

(4) GROUNDS TO RAILWAY RETURNS. Protective ground connections should not be made to railway negative-return circuits when other effective means of grounding are available, except ground connections from electric-railway lightning arresters. When ground connections are of necessity made to the grounded track return of electric railways, they shall be made in such a manner as not to afford a metallic connection (as indirectly through a grounded neutral with multiple grounds) between the railway return and the other grounded conducting bodies (such as buried piping and cable sheaths).

Note: This does not prohibit the making of drainage connections (which are not protective grounds) between piping systems and railway negative-return circuits for the prevention of electrolysis.

Note: Multiple protective ground connections from other circuits to railway returns should be avoided; and where multiple made electrodes are made on such other circuits near such railway returns, they should be so arranged as to prevent the flow of any considerable current in and between such connections, which flow would reduce their effectiveness, or otherwise cause damage.

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

E 103.08 Method. (1) PIPING. The point of attachment of a grounding conductor to an underground metallic water-piping system shall be on the street side of the water meter or on a cold-water pipe of adequate current-carrying capacity, as near as practicable to the water-service entrance to the building or near the equipment to be grounded, and shall be accessible except by special permission. If the point of attachment is not on the street side of the water meter, the water-piping system shall be made electrically continuous by bonding together all parts between the attachment and the pipe entrance which are liable to become disconnected, as at meters and service unions. If water meters are located outside buildings or in concrete pits within buildings where piping connections are embedded in concrete flooring, the ground connections may be made on the building side of the meters. The use of gas piping systems in buildings should be avoided. An underground metallic water-pipe system having less than 50 feet of buried pipe exclusive of well casings; or having a resistance of more than 3 ohms to ground shall not be used as a grounding electrode unless connected to 2 made electrodes spaced at least 6 feet apart.

Exception: The connection to underground piping systems made outside buildings by electric distribution agencies need not be accessible.

(2) GROUND CLAMPS. The ground connection to metallic water piping systems shall be made by means of an approved clamp or fitting

firmly bolted to the pipe after all rust and scale have been removed, or by means of a brass plug which had been tightly screwed into a pipe fitting or, where the pipe is of sufficient thickness, screwed into a hole in the pipe itself, or by other equivalent means. The grounding conductor shall be attached to the clamp, fitting or plug by means of an approved solderless connector. The point of connection shall be as readily accessible as possible.

(3) CONTACT SURFACES. If conduit, couplings, or fittings having protective coating of nonconducting material, such as enamel, are used, such coating shall be thoroughly removed from threads of both couplings and conduit and such surfaces of fittings where the conduit or ground clamp is secured, in order to obtain the requisite good connection. Conduits, other metal raceways, and the armor of cables shall be securely fastened in outlet boxes, junction boxes, and cabinets, so as to secure good electrical connections.

(4) MADE ELECTRODES. (a) Where made electrodes are used they shall as far as practicable, be embedded below permanent moisture level. Made electrodes shall be of materials or combination of materials which shall not corrode excessively under the existing conditions.

(b) Buried plate electrodes shall present not less than 2 square feet of surface to exterior soil. Electrodes of plate copper shall be at least 0.06 inch in thickness. Electrodes of iron or steel plates shall be at least ¼ inch in thickness.

(c) Electrodes of iron or steel pipe shall be galvanized and not less than ¾ inch (nominal size). Electrodes of rods of steel or iron shall be at least ⅝ inch minimum cross-sectional dimension. Approved rods of nonferrous materials or their approved equivalent used for electrodes shall be not less than ½ inch in diameter. Driven electrodes of pipes or rods, if of less than standard commercial length, shall preferably be of one piece, and except where rock bottom is encountered, shall be driven to a depth of at least 8 feet regardless of size or number of electrodes used. Where rock is encountered at a depth of less than 4 feet, buried plate electrodes shall be used or pipe or rod electrodes shall be buried in a horizontal trench as deep as is practicable. If rock is at a greater depth than 4 feet, pipes or rods may be driven at an angle if this must be done to drive the full length of the electrode. Such pipes or rods shall have clean metal surfaces and shall not be covered with paint, enamel, or other poor conducting materials.

(d) Grounds used solely for wood pole lightning protection and which are not connected to any circuits or equipment may be of any form or size. The grounding conductor must be protected in the same manner as any grounding conductor where it passes through conductors but it need not be protected near the ground. A pole protection ground may be used as a made electrode for a circuit or equipment if the down conductor is fully protected and the wire which is attached to the pole previous to the setting has a continuous bare or exposed length below the ground level of not less than 12 feet, extended to the bottom of the pole, is not smaller than No. 6 and is of copper or other metals which will not corrode excessively.

(e) A guy and anchor may be used as a combined grounding conductor and made electrode if they are electrically bonded together and the anchor and rod present sufficient surface to the soil.

(f) Buried metal structures having a resistance of more than 8 ohms to ground shall not be used as a ground electrode unless connected to two made electrodes spaced at least 6 feet apart.

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

E 103.09 Ground resistance. (1) LIMITS. The combined resistances of the grounding wire and the connection with the ground shall not exceed 8 ohms for connections to extensive underground metal waterpipe systems nor 25 ohms for made electrodes. Where it is impracticable to obtain with one made electrode a resistance of 25 ohms, this requirement shall be waived, and two made electrodes, at least 6 feet apart shall be provided.

(2) The resistance of station grounds should be checked when made. All ground connections shall be inspected periodically. Ground connections on distribution circuits should, when installed, be tested for resistance unless multiple grounding is used.

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

E 103.10 Separate grounding conductors and grounds. (1) Grounding conductors from equipment and circuits of each of the following classes, if required by these rules, shall be run separately to the grounding electrode or to a sufficiently heavy grounding bus or system ground cable which is well connected to ground at more than one place, except as provided in subsection E 103.02(2)(d).

(a) Primary lightning arresters, except as is provided in subsection E 103.02(2)(f).

(b) Secondaries connected to low-voltage lighting or power circuits, except that if a secondary distribution system has multiple grounds, utilization equipment and wire enclosures may use the same grounding conductor.

(c) Frames of direct-current railway equipment and of equipment operating in excess of 750 volts.

(d) Lightning rods.

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

Part 1

ELECTRICAL SUPPLY STATIONS AND SUBSTATIONS

Chapter E 110

SCOPE OF ORDERS

E 110.01 Electrical equipment in stations, substations, factories and elsewhere. (1) The following chapters (E 110–E 119) apply to all electrical equipment and conductors of over 600 volts. If such equipment and conductors are not installed in supply stations or other quarters accessible only to qualified persons, they shall, in addition to complying with Wis. Adm. Code chapters E 110–E 119, comply also with the rules of volume 2.

(2) Equipment and wiring of less than 600 volts shall comply with the rules of volume 2, except that if such equipment or wiring is installed in supply stations or other quarters accessible only to qualified persons, it may be installed in conformity with chapters E 110–E 119, in which case only wiring used to distribute a power supply for lighting, service outlets and other utilization equipment need comply with the rules of volume 2.

(3) All primary utilization wiring, substations and vaults accessible to the customer shall be constructed to comply with volume No. 2 requirements.

(a) *Exception:* Outside overhead and underground lines shall comply with volume No. 1.

Note: For the intent of rules, waivers, etc., see section E 20.13.

History: Cr. Register, November, 1961, No. 71, eff. 12–1–61; am. (1) and (2), Register, April, 1972, No. 196, eff. 5–1–72.

Chapter E 111

GENERAL PROTECTIVE ARRANGEMENTS OF STATIONS AND SUBSTATIONS

E 111.01 General requirements for rooms and spaces. (1) ENCLOSURE OF ROOMS AND SPACES. Rooms and spaces shall be so arranged with fences, screens, partitions, or walls as to prevent entrance of unauthorized persons or interference by them with equipment inside, and the entrances not under observation of an authorized attendant shall be kept locked. Signs prohibiting entrance to unauthorized persons shall be displayed at entrances.

(2) ROOMS AND SPACES. All rooms or spaces in which electrical equipment is installed shall comply with the following requirements:

(a) *Fire resistant construction.* They shall be as far as practicable, noncombustible.

(b) *Storage and manufacturing processes.* They shall be used neither for the storage of material nor for manufacturing processes causing hazard to electrical operators, except those materials or processes attendant upon the production or distribution of a supply of electrical energy.

(c) *Hazardous conditions.* They shall be free from combustible dust or flyings, flammable gas, or acid fumes in dangerous quantities. (For battery rooms, see chapter E 114. For auxiliary equipment in hazardous locations, see E 112.08.) Also see rules on Dusts, Fumes, Vapors and Gases published by the Department of Industry, Labor and Human Relations.

(d) *Ventilation.* They should be well ventilated. See Department of Industry, Labor and Human Relations codes.

(e) *Moisture and weather.* They should be dry. In outdoor stations or stations in wet tunnels or subways, all live parts of equipment should be enclosed in weatherproof cases, unless the equipment is suitably designed to withstand the prevailing atmospheric conditions.

(3) ROTATING MACHINERY. Rotating machinery shall be installed upon suitable supports or foundations and if necessary secured in place.

(4) FENCES. Fences used to exclude the public from electrical equipment, shall be so placed that they are not closer to live parts or parts that may become alive than that given in column 3 of table 2, section E 112.05. Such fences shall be of a type that cannot be readily climbed and shall be not less than 6 feet in height excluding any barbed wire.

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

E 111.02 Illumination. (1) UNDER NORMAL CONDITIONS. Rooms and spaces in buildings where electrical apparatus or machinery is located shall have means for artificial illumination in accordance with the following table. The means of illumination shall be maintained ready for use at all times. (Also see section E 114.09)

Note: It is not intended that this rule should require permanent lighting in switch cells and similar small spaces occupied by electrical apparatus where permanent lighting is impracticable.

TABLE NO. 1

ILLUMINATION INTENSITIES

	Minimum Foot-Candles	Modern Practice Foot-Candles
(1) Switchboard instruments, gauges, switches, etc.	5	10 to 15
(2) Switchboards with no exposed live parts	3	5 to 10
(3) Storage battery room	3	5 to 10
(4) Generating room, boiler room, pump room (at machinery or exposed live parts)	5	10 to 15
(5) Stairways and passageways (Measurements made at floor level) where there is moving machinery, exposed live parts, hot pipes, etc.	5	10 to 15
(6) Any tranversed space (measured at floor level)	2	5 to 10

Note: The above illumination values are to be measured at working surfaces, except as stated.
The "minimum foot-candles" specify the lowest illumination for safety, but the "modern practice foot-candles" are recommended.

(2) EMERGENCY LIGHTING. A separate emergency source of illumination shall be provided in every station where an attendant is located. This source shall be from an independent generator, storage battery, gas main, portable light, or other suitable source.

Note: Flame lamps (gas or oil) should not be used in battery rooms.

(3) FIXTURES, PENDANTS AND PLUG RECEPTACLES. (See also NEC-1971 Article 410). Arrangements of permanent fixtures and plug receptacles shall be such that portable cords need not be brought into dangerous proximity to live or moving apparatus. All lamps shall be arranged to be controlled, replaced, or trimmed from safely accessible places. Pendant conductors shall not be installed where they can be readily moved so as to bring them in contact with live parts of electrical supply equipment.

(4) ATTACHMENT PLUGS. Portable conductors shall be attached to fixed wiring only through separable attachment plugs which will disconnect all poles by one operation.

History: Cr. Register, January, 1968, No. 145, eff. 2–1–68; am. (3), Register, April, 1972, No. 196, eff. 5–1–72.

E 111.03 Buildings, yards and general safety. (1) BUILDINGS TO COMPLY WITH BUILDING CODE. Buildings in which electrical supply equipment is installed shall be constructed in every detail to comply with the building and heating, ventilating and air conditioning code published by the Department of Industry, Labor and Human Relations.

(2) GENERAL RULES ON SAFETY TO BE COMPLIED WITH. Floors, passageways, stairways, floor openings, platforms, runways, moving ma-

chinery, etc., shall be constructed and safeguarded as required by the rules on safety published by the Industrial Commission.

(3) PROTECTION FROM RAIN AND FALLING OBJECTS. Electrical equipment located outdoors, when necessary, shall be protected against injury from rain, snow, sleet, flying or falling objects.

(4) EXITS. Each room or space and each working space about equipment shall have suitable means of exit which shall be kept clear of all obstructions. If the plan of the room or space and the character and arrangement of equipment are such that an accident would be liable to close or make inaccessible a single exit, as in the case of long narrow rooms, platforms, passageways, spaces behind switchboards, or wire and pipe tunnels, a second exit shall be provided if practicable. In all cases the building and heating, ventilating and air conditioning code should be consulted.

(5) FLOORS. Floors shall have even surfaces and afford secure footing. Projecting nails, loose boards, uneven or greasy floors, and slippery floors should be avoided.

Note: Otherwise slippery floors or stairs should be provided with antislip treads.

(6) PASSAGEWAYS. Passageways (including stairways) and working spaces shall be unobstructed, and (except such as are used solely for infrequent inspection, construction and repair) shall, where possible, provide at least 6.5 feet headroom. (See section E 112.06 for working space.) The rules on safety by the Department of Industry, Labor and Human Relations also contain orders applying to passageways.

(7) RUNWAYS AND PLATFORMS, RAILS AND TOE BOARDS. (See rules on safety published by the Department of Industry, Labor and Human Relations.

(8) STAIRWAYS, HANDRAILS. (See rules on safety published by the Department of Industry, Labor, and Human Relations.)

(9) PLATFORMS WITH STAIRWAYS OR STATIONARY LADDERS. (See rules on safety published by the Department of Industry, Labor and Human Relations.

(10) CONTINUITY. The heads of permanent ladders shall be provided with guards such as gates or sliding pipe sections whenever the heading breaks the continuity of a railing adjacent to working space. For very long ladders occasional landings, turns, or safety loops are recommended.

(11) STAIR TOE BOARDS. Toe boards shall, where practicable, be arranged at back of stairway treads where over exposed live or moving parts or over working spaces, passageways, or other stairways.

(12) WALKS AND PLATFORMS FOR OVERHEAD WORK. (See rules on safety published by the Department of Industry, Labor and Human Relations.)

(13) TRANSFORMER VAULTS ON CUSTOMER'S PREMISES. Transformer vaults on customer's premises shall comply with NEC-1971 Sections 450-41 to 450-48, inclusive, except as changed in volume 2 (see sections E 450.41 and E 450.42).

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68; am. (13), Register, April, 1972, No. 196, eff. 5-1-72.

E 111.04 Fire fighting appliances. (1) FIRE EXTINGUISHERS. Adequate approved fire-extinguishing appliances shall be conveniently located and conspicuously marked. Any such appliances which have not been listed by Underwriters' Laboratories, Inc. for use on live parts should be plainly and conspicuously marked with a warning to that effect.

(2) TEMPERATURE CONDITIONS. Fire extinguishers shall not be installed in locations subject to conditions of high and low temperature which will reduce their effectiveness.

Note: Carbon-tetrachloride extinguishers are not adversely affected by temperatures between 60° C. (140° F.) and minus 40° C. (—40° F.).

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

E 111.05 Oil filled apparatus. For the purpose of these rules, oil-filled apparatus is divided into 3 classes, each of which requires different treatment: (1) Oil switches and circuit-breakers (See also chapter E 117); (2) transformers, induction regulators, etc. (See also chapter E 115); and (3) lightning arresters (See also chapter E 119). The necessary safety precautions depend largely on whether the apparatus is located in buildings or outdoors.

(1) OIL SWITCHES OR CIRCUIT-BREAKERS. (a) Oil switches or circuit-breakers and their transformers, regulators, reactors, or other associated equipment should be separated from other apparatus by adequate non-flammable barriers, or otherwise adequately isolated. Floors and floor drains should be so arranged that oil will quickly collect in a suitable drainage or storage system provided for the purpose either inside or outside of the building as may be advisable.

(b) Where switches or switch compartments are constructed to prevent an appreciable amount of oil being thrown outside of the compartment, exterior drainage or storage systems are not necessary.

(c) If located outdoors they should be adequately isolated.

(d) If located near building walls the walls should be of fire resistive construction and should have doors or windows so located and arranged that burning oil is not liable to pass through them to flammable material or apparatus.

Note: It should be recognized that oil-switch or circuit-breaker failures may depend upon the size and rupturing capacity of the switch or circuit breaker and the short-circuit duty that may be required of it. The short-circuit current depends on the generating capacity supplying the system on which the switch or circuit-breaker is used as modified by the current-limiting characteristics of the system or by special apparatus installed for that purpose. By "generating capacity" is meant all of the apparatus contributing to the short-circuit current.

(2) TRANSFORMERS, INDUCTION REGULATORS, ETC. CONTAINING A LIQUID THAT WILL BURN. If transformers, induction regulators, etc. are in buildings, the floors and floor drains should be so arranged that oil will quickly collect in a suitable drainage or storage system provided for the purpose either inside or outside of the building as may be advisable. If the apparatus contains large quantities of oil, each unit or group should preferably be placed in a separate fireproof compartment suitably ventilated. If located outdoors, they should be adequately isolated. Provision should be made for quickly draining away to a safe distance any oil that may be spilled. This may be done by ditches and drains or the oil may be absorbed and danger of spreading removed by paving the yard around the transformers or other devices

with cinders or other absorbent material to a depth of several inches. If located in buildings, transformer tanks containing large quantities of oil shall, where practicable, be so arranged that approved fire-quenching material may be introduced above the oil inside the tank or in the surrounding compartment, except where tanks are completely filled with oil or where the space above the oil is filled with an inert gas.

(3) TRANSFORMERS, INDUCTION REGULATORS, ETC. CONTAINING A LIQUID THAT WILL NOT BURN. If in buildings, transformers, induction regulators, etc., filled with a liquid that will not burn should comply with section E 115.04.

(4) LIGHTNING ARRESTERS. If located in buildings, lightning arresters containing oil should be separated from other equipment by fire walls adequate to completely isolate them in case of fire. When located outdoors they should be adequately isolated. Provision for quickly draining away oil should be made as indicated for transformers in (2) above.

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

Chapter E 112

PROTECTIVE ARRANGEMENTS OF EQUIPMENT

E 112.01 General requirement. All electrical equipment shall be of such construction and so installed and maintained as to reduce the life and fire hazard as far as practicable.

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

E 112.02 Inspections. (1) REGULAR EQUIPMENT. Electrical equipment shall comply with these orders when placed in service and shall thereafter be cleaned when necessary and inspected at such intervals as experience has shown to be necessary. Any equipment or construction known to be defective so as to endanger life or property shall be promptly repaired, permanently disconnected, or isolated until repairs can be made. Repairs, additions and changes to electrical equipment and conductors shall be made by qualified persons only.

(2) IDLE EQUIPMENT. Infrequently used equipment or wiring maintained for future service should be thoroughly inspected before use to determine its fitness for service.

(3) EMERGENCY EQUIPMENT. Equipment or wiring maintained for emergency service should be periodically inspected and, where necessary, tested to determine its fitness for service.

(4) NEW EQUIPMENT. New equipment should be thoroughly inspected before being put in service.

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

E 112.03 Guarding shaft ends, pulleys and belts, and suddenly moving parts. (1) TRANSMISSION MACHINERY. This code is supplemented by the rules on safety and other Department of Industry, Labor and Human Relations requirements which specify methods for safeguarding pulleys, belts, and other equipment used in the mechanical transmission of power.

(2) SUDDENLY MOVING PARTS. Parts of equipment which move suddenly in such a way that persons in the vicinity are liable to be injured by being struck, such as handles and levers of circuit breakers, shall be guarded or isolated.

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

E 112.04 Protective grounding. (1) GROUNDING METHOD. All grounding which is intended to be a permanent and effective protection measure, such as lightning arrester, circuit, equipment, or wire raceway grounding, shall be made in accordance with the methods speci-

fied in Wis. Adm. Code chapter E 103 and NEC-1971 Article 250 except as changed in volume 2 (see section E 250.92).

(2) GROUNDING, NONCURRENT-CARRYING METAL PARTS. All electrical equipment, if operating at more than 150 volts to ground, or if in hazardous locations, regardless of voltage, shall have the exposed noncurrent-carrying parts, such as frames of generators and switchboards, cases of transformers, lightning arresters and switches, and operating levers, effectively grounded or isolated. It is recommended that exposed noncurrent-carrying parts of electrical apparatus operating at 150 volts or less to ground be effectively grounded. All metallic guards (including rails, screens, etc.) about electrical equipment should be effectively grounded where such grounding will reduce the hazard.

(a) Except in hazardous locations, exposed noncurrent-carrying parts of equipment operating at more than 150 volts to ground may be left ungrounded and either isolated, or guarded, or provided with insulating mats as required for live parts at the same voltage. Such isolation, guarding, or mats should be so arranged that persons cannot inadvertently touch these parts while also touching a grounded surface.

Note: Hazardous locations include those where dampness, acid fumes, explosives, inflammable gas, or flyings normally exist. (See chapter E 500)

(b) Exception 1: Exposed noncurrent-carrying metal parts of equipment of grounded direct-current circuits or series direct-current circuits are exempted from this order, if suitably insulated from the ground and from neighboring grounded surfaces. In addition suitable permanent insulating barrier guards shall be installed so that a person cannot, while touching such insulated frames, at the same time inadvertently touch or stand upon other grounded bodies.

(c) Exception 2: Exposed noncurrent-carrying metal parts of supply equipment for communication circuits are exempted from this order, provided they are suitably insulated from the ground and neighboring grounded conductors and surfaces.

(d) Exception 3: Metal shell sockets and metal guards of portable lamps, if suitably insulated, are exempted from this order.

(3) GROUNDING EQUIPMENT DURING REPAIRS. Electrical equipment or conductors normally operating at more than 750 volts on or about which work is occasionally done while separated from a source of electrical energy by switches or disconnectors only, shall be provided with some means, such as switches, connectors, or readily accessible ground conductor, for grounding them. (See sections E 142.04 and E 142.05)

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

E 112.05 Guarding live parts. It is the intent of this rule to require electrical facilities which are or may become alive to be arranged or guarded in such a way as to prevent inadvertent contact by persons or material. The rule requires guards unless the facilities have certain minimum clearances, are isolated by enclosure, or in some cases are arranged in such a way that contact cannot normally be made unless the person is insulated from ground. Station or substation buildings or enclosing walls or fences used to exclude the public or

house the parts are not enclosures within the meaning of this rule (See section E 112.05 (3)).

(1) WHERE REQUIRED. (a) Ungrounded parts of electrical equipment which operate at or may become charged to more than 150 volts shall be guarded when vertical clearances from ground, floors, platforms, or permanent supports for workmen are less than that given in column 2, table 2, of this rule, or when the horizontal clearance from the nearest edge of such surface is less than that given in column 3 of table 2. This includes parts exposed through windows, wall openings, etc.

1. Exception: Guards need not be provided where it is necessary to permit routine inspection of rotating equipment as required under operating conditions.

Note: The rule applies to the electrical parts energized or considered available for service in temporary or partially completed installations, as well as to permanent installations.

Definitions: The guard zone means the space of minimum clearance from guards to electrical parts where guards may be installed by workmen without definite engineering design. The radius of this zone varies with the voltage as specified in column 4 of table No. 2. (See subsection E 142.03(3) of the code for working clearances about live parts).

Permanent supporting surfaces for workmen include floors, platforms, or structures used regularly and frequently by workmen for inspections and maintenance near live adjacent parts: runways, ladders, stairways, etc.

(b) Parts over or near frequently traveled passageways through which material may be carried, or in or near spaces, such as corridors, storerooms, boiler rooms, etc. used for non-electrical work, should, where practicable, be guarded or given clearances in excess of those specified, such as may be necessary to secure reasonable safety. The guards should be substantial; should, where practicable, completely

TABLE NO. 2

MINIMUM CLEARANCE FROM LIVE PARTS

1	2		3		4
Voltage	Minimum Vertical Clearance of Unguarded Parts		Minimum Horizontal Clearance of Unguarded Parts		Minimum Clearance from Guards to Parts, Radius of Guard Zone
	Feet	Inches	Feet	Inches	Inches
150	7	6	3	0	0.5
300	7	7	3	1	1
600	7	8	3	2	2
2,300	7	9	3	3	3
6,600	7	10	3	4	4
11,000	9	0	3	6	6
22,000	9	3	3	9	9
33,000	9	6	4	0	12
44,000	9	10	4	4	16
66,000	10	5	4	11	23
88,000	11	0	5	6	30
110,000	11	7	6	1	37
132,000	12	2	6	8	44

Note: Interpolate for intermediate values.

The clearances in column 4 of this table are not a requirement for definite engineering design of either apparatus or guards, but are solely for the guidance of workmen installing guards without such design.

For example, the minimum clearances in the table above are not intended to refer to the clearances between live parts and the walls of cells, compartments, or similar enclosing structures. They do not apply to the clearances between bus bars and supporting structures, nor to clearances between the blade of a disconnecting switch and its base.

shield or enclose without openings the parts; and when in spaces used for non-electrical work should be removable only by means of tools or keys.

(c) Parts of indeterminate potential, such as telephone wires exposed to induction from high-tension lines, ungrounded neutral connections, ungrounded frames, ungrounded parts of lightning arresters, ungrounded instrument cases connected directly to the high-voltage circuit, etc., shall be classified and, where practicable, guarded on the basis of the maximum voltage which may be present.

(2) STRENGTH OF GUARDS. Guards shall be sufficiently strong and shall be supported rigidly and securely enough to prevent them from being displaced or dangerously deflected by a man slipping or falling against them.

(3) TYPES OF GUARDS. (a) *Location or isolation.* Parts having clearances equal to or greater than specified in subsection E 112.05 (1) above are guarded by location. Parts are guarded by isolation when all entrances to enclosed spaces, runways, ladders, etc. are kept locked or warning signs posted at all entrances, in which case no other permanent guards need be supplied. The enclosures referred to are those within stations, substations or vaults which contain limited amounts of equipment that must be entered for work of a very limited nature. For example, the area in back of an open back switchboard may be enclosed to eliminate the necessity of guards but enclosing an outdoor substation in a fence does not eliminate the necessity of guards.

(b) *Grounded metal cable sheaths.* These are suitable guards except where exposed to mechanical injury. Where so exposed, metal conduit or other suitable guards should be provided.

(c) *Railings and fences.* Railings are not substitutes for complete guards, and if used shall be located at a horizontal distance of at least 3 feet (and preferably not more than 4 feet) from the nearest point of guard zone, which is less than 7½ feet above the floor. Fences used to exclude the public from electrical equipment, shall be so placed that they are not closer to live parts or parts that may become alive than that given in column 3 of table 2, section E 112.05 (1) and the vertical clearance in the space between the equipment and the fence shall be governed by appropriate sections of the code. Such fences shall be of a type that cannot be readily climbed and shall be not less than 6 feet in height excluding any barbed wire.

(d) *Location of guards.* Guards inside of the guard zone or less than 4 inches outside, shall completely enclose the parts from contact up to the heights listed in column 2 of table No. 2 of subsection E 112.05(1). They shall not be closer to the live parts than listed in column 4 of the table in section E 112.05(1) except when suitable insulating material is used with circuits of less than 7,500 volts. (See note under table in section E 112.05 (1)). If more than 4 inches outside of the guard zone, the guards need not extend more than 7½ feet above the floor. Covers or guards, which must at any time be removed while the parts they guard are alive, should be arranged so that they cannot readily be brought in contact with live parts. This does not apply to enclosing fences as described in subsection (c) above and section E 111.01 (4).

(e) *Insulating covering on conductors or parts.* The insulating covering on parts exceeding 750 volts shall not be considered a pro-

tection. For parts less than 750 volts, positive barriers, enclosures, or similar arrangements are preferable, but in dry places where not exposed to mechanical injury, varnished-cloth tape, or other insulation suitable for the voltage involved may be used, as a guard. The taping over connections shall be of a type and thickness suitable for the voltage involved. Friction tape is not acceptable as the sole protection.

1. Exception: On circuits not exceeding 7500 volts, when other guarding is impracticable, insulation suitable for the voltage involved may be used back of the switchboards or in equivalent sheltered locations. Insulating mats or platforms shall be provided so that an operator cannot readily touch the insulating covering without standing on the mats.

(f) *Mats.* Suitable insulating mats placed so that a person cannot inadvertently come in contact with the live parts without standing on the mat may be used in the following cases:

1. Parts less than 750 volts, exposed at switchboards, switches, or on rotating machinery.

2. Disconnect switches less than 7,500 volts mounted on back of switchboards or in similar sheltered locations when barriers are placed between each blade so as to extend beyond the disconnected parts in any position. Other means of guarding may be used where convenient.

3. Ungrounded frames of existing high-voltage series generators.

4. As provided for in sections E 112.05 (3) (e) and (h).

5. Mats should be of rubber or other suitable insulating material, or in dry locations they may be of wood fastened with wood pins, cork matting, or heavy (one-fourth inch) linoleum laid without joints and without metal fastenings. A "nonslip" surface should be maintained and the mats should be laid and maintained so as to reduce the tripping hazard to a minimum.

Note: Beveled edges will help in many cases.

(g) *Parts below supporting surfaces for persons.* The supporting surfaces above live parts shall be without openings. Toe boards at least 6 inches high shall be provided at all edges.

(h) *Special rules for plug-type switchboards.* A mat is a suitable guard when placed so that the operator must stand on it when operating the plugs. Suitable guards on handles of all plugs shall be provided.

(4) PARTS OF LESS THAN 300 VOLTS. It is recommended that live parts of more than 150 volts be enclosed or guarded when in exposed locations.

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

E 112.06 Working space about electrical equipment. (1) WHERE REQUIRED. Adequate and readily accessible working space with secure footing shall be maintained about all electrical parts or equipment which require adjustment or examination if exposed while in service.

(2) WIDTH OF WORKING SPACE. The horizontal clearance from the farthest edge of the working space to the nearest live part of more than 300 volts, exposed after removing guards, shall be not less than 3 feet plus the guard zone radius as given in column 4 of the table in section E 112.05. (When the live parts are on only one side, column 3

of the table in section E 112.05 gives the minimum permissible value for the total width of the free space). See also subsection E 111.03(6) for headroom.

(3) ELEVATED PARTS. Clearance about normally elevated or isolated parts requiring occasional adjustment should be provided so the men need not come within the danger zone (See Wis. Adm. Code section E 142.03 (3)) around adjacent energized parts, unless guarded in accordance with sections E 112.05 and E 112.06.

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

E 112.07 Equipment for work on live parts. (1) 7,500 VOLTS OR LESS. When it is necessary for men to bring their bodies or any material or tools handled into the danger zone (see subsection E 142.03(2) of this code) suitable protective devices, such as rubber gloves, rubber sleeves (if necessary), insulating tools, portable rubber mats or insulating stools, rubber blankets, insulated fuse pullers, testing and grounding devices, switch sticks, etc., should be provided, periodically examined, and kept in safe condition. If the voltage exceeds the limit of 5,000 volts set for standard rubber gloves, special gloves should be furnished if the work is conducted so that their use is necessary.

(2) MORE THAN 7,500 VOLTS. Suitable protective devices, such as testing and grounding devices, switch sticks, fuse pullers, special insulated tools, etc., should be provided, periodically inspected, and kept in safe condition. Such devices shall provide an ample margin of safety for the voltage involved and should be constructed so that the workman's body can remain outside of the danger zone. (See subsection E 142.03(3) of this code).

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

E 112.08 Hazardous locations. (1) ENCLOSURE OF ARCING AND HEATING PARTS. In locations where flammable gas or flammable flyings normally exist in dangerous quantities, all parts where sparking, arcing, or dangerous heating is liable to occur shall be enclosed so as to reduce the hazards as far as practicable. This enclosure shall be by one of the following methods:

(a) By placing in separate compartments or rooms.

(b) By using nonabsorptive, noncombustible casings of the dusttight type when flammable dust or flyings are present.

(c) By using nonabsorptive, noncombustible casings designed for use in explosive atmospheres when flammable gas exists in dangerous quantities.

(2) GROUNDING. The metal frames and other exposed noncurrent-carrying metal parts of equipment in these locations shall be effectively grounded as specified in chapter E 103.

The flammable liquids code published by the Department of Industry, Labor and Human Relations should be consulted.

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

E 112.09 Shielding of equipment from deteriorating agencies. Suitable shields or enclosures shall be provided to protect exposed current-carrying parts, insulation of leads of electrical devices or equipment where susceptible to injury by being installed directly under rotating equipment or in other locations where dripping oil, excessive moisture,

steam, vapors, or similar agents exist. (For battery rooms see section E 114.07).

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

E 112.10 Identification. (1) EQUIPMENT IN GENERAL. Electrical equipment shall be suitably identified when necessary for safety. The identification may be by position, color, number, name-plate, label, design, or other means, but the method of identification chosen shall be uniform throughout any one system. (See section E 117.05 for switches). The voltage and intended use shall be shown when important. Identification marks should not, if possible, be placed on removable covers or casings, such as instrument covers and disconnector compartment doors, where the interchanging of these removable parts might lead to accident.

(2) GENERATORS AND MOTORS. Generators and motors shall each be provided with a name-plate giving the maker's name, the rating, normal full-load speed and the voltage.

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

Chapter E 113

ROTATING EQUIPMENT (THIS INCLUDES GENERATORS, MOTORS, MOTOR GENERATORS, AND CONVERTERS)

E 113.01 Speed-control and stopping devices. (1) SPEED LIMITS FOR PRIME MOVERS. Prime movers driving generating equipment shall be provided with automatic speed-limiting devices, where harmful overspeed can otherwise occur, in addition to their governors, if necessary as with some types of steam turbines.

(2) STOPS FOR ROTATING EQUIPMENT. Stopping devices, such as switches or valves which can be operated from locations convenient to machine operators, shall be provided for prime movers or motors driving generating equipment. Devices which operate in such a way that the development of defects or their becoming inoperative will stop the units protected should be used where practicable. Controls to be used in emergency for machinery and electrical equipment should be so located as to permit operation with a minimum of danger during such emergency (See E 117.06 for fuses and circuit-breakers).

(3) SPEED LIMIT FOR MOTORS. Machines of the following types shall be provided with speed-limiting devices unless their inherent characteristics or the load and the mechanical connection thereto are such as to safely limit the speed, or unless the machine is always under the manual control of a qualified operator:

(a) Separately excited direct-current motors.

(b) Series motors.

(c) Motor generators and converters which can be driven at excessive speed from the direct-current end, as by a reversal of current or decrease in load.

Note: The required limitation of speed may be obtained by the use of a relay, centrifugal switch or other similar device which will cut off the supply of energy when excessive speed is attained.

(4) LOW-VOLTAGE OR UNDER-VOLTAGE PROTECTION. All motors so employed or arranged that an unexpected starting of the motor is a hazard, shall be equipped with low-voltage protection which will automatically cause and maintain the interruption of the motor circuit when the voltage falls below an operating value.

(a) Exception: Those motors with an emergency or essential use or where the opening of the circuit will cause a special hazard to life or service are exempted.

(5) ADJUSTABLE SPEED MOTORS. Adjustable speed motors, if controlled by means of field regulation, shall be so equipped and connected that the field cannot be weakened sufficiently to permit dangerous speed.

(6) PROTECTION OF CONTROL CIRCUITS. Where speed-limiting or stopping devices are electrically operated, the control circuits by which such devices are actuated shall be in conduit or otherwise suitably protected from mechanical injury, in accordance with section E 116.02.

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

E 113.02 Guards for live parts. (1) GUARDS ON ROTATING EQUIPMENT. Guards complying with section E 112.05 shall be provided.

(2) ACCESS TO LIVE PARTS. Where necessary, steps and handrails shall be installed on or about large machines to afford ready access to live parts which must be examined or adjusted during operation.

(3) FRAME SWITCHES. Where switches are installed on the frames of generating equipment for the purpose of reducing inductive voltage in generator and converter field coils they shall be suitably constructed or guarded to prevent passersby from inadvertently coming in contact with the live parts, to protect persons handling them, and to prevent their being accidentally opened or closed.

(4) ARCING SHIELDS. Suitable shields or barriers other than rails shall be provided where practicable to prevent arcing on large commutators or any other parts of moving apparatus from injuring persons in the vicinity, as in the case of narrow working spaces located immediately above or beside such equipment.

(a) Exception: Twenty-five cycle apparatus of less than 150 volts is exempted.

(b) It is recommended that where suitable shields have not been installed goggles should be available.

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

E 113.03 Grounding machine frames. (1) GROUNDING MACHINE FRAMES. All frames of rotating electrical equipment shall be effectively grounded except as permitted below and in section E 112.08.

(2) COUPLED MACHINES. Where 2 or more machines, either of which operates at more than 150 volts, are mechanically coupled together and the operator can touch the frames of more than one at a time, the frames of all such shall be effectively grounded, or bonded together electrically.

(a) Exception: This rule may be waived with high-voltage series generator sets in existing installations where for operating reasons the generators must have their frames insulated from the ground and the motor frame is grounded, and where it is impracticable to place insulating barriers between the grounded and ungrounded frames.

(3) AUXILIARIES. Exciters and auxiliary circuits electrically connected to generators or other machines of more than 750 volts (with frames ungrounded) shall be installed, protected, and identified as machines and circuits of the same voltage as that of the machine for which they are auxiliaries.

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

E 113.04 Terminal bases and bushings. (1) TERMINAL BASES. Terminal bases, if used on motors or generators, should preferably be of suitable fire-resistant and moisture resistant insulating material such as slate, marble, or porcelain. It is recommended that unguarded termi-

nals be protected by a cover of insulating material or grounded metal.

(2) BUSHINGS. Bushings where used for wires coming through frames of motors or generators should preferably be of porcelain, suitable composition material, or of hardwood properly filled, except that soft rubber may be used if not exposed to oils, grease or other deleterious substances in such quantities as to cause their rapid destruction.

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

E 113.05 Deteriorating agencies. (1) PROTECTION REQUIRED. Suitable shields or enclosures shall be provided to protect exposed current-carrying parts, insulation of leads, balance coils, or other electrical devices belonging to motors and generating equipment where installed directly under equipment or in other locations where dripping oil, excessive moisture, steam vapors, or similar injurious agents exist.

(2) GROUNDING. The metal frames and other exposed noncurrent-carrying metal parts of equipment in these locations shall be effectively grounded.

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

E 113.06 Motors. (1) CONTROL. If the starting is caused automatically (not manually) as, for example, by a float switch, or if the starting device or control switch is not located close to the motor and all parts of the machinery operated, the starting arrangement shall be designed so that it can positively be kept open by means of locks or equivalent devices.

(2) MOTORS IN HAZARDOUS LOCATIONS. Motors with their auxiliary equipment, at which sparking or arcing or high temperature is liable to occur, when in rooms normally containing explosives, flammable gas, or flammable flyings shall be so installed, as to reduce the hazard by enclosure in an adequately ventilated separate compartment, by solidly enclosed equipment designed for use in explosive atmospheres, or, when protected against flyings only, by partitioning off a space or by a suitable boxing.

(3) MOTORS EXPOSED TO DUST. Motors should be protected from dust. Enclosed-type motors are recommended in dusty places, being preferable to boxing.

(4) MOTORS ON WOODEN FLOORS. Where practicable, motors permanently located on wooden floors should be provided with suitable drip pans.

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

Chapter E 114

STORAGE BATTERIES

E 114.01 General. (1) The provisions of this chapter are intended to apply to all stationary installations of storage batteries using acid or alkali as electrolyte, consisting of cells connected in series, with a nominal voltage in excess of 50 volts, and connected for service where so installed. (For exception, see section E 114.03(2)).

(2) Nominal battery voltage shall be calculated on the basis of 2.0 volts per cell for lead-acid type and 1.2 volts per cell for alkali type. "End" or "Emergency" cells, held in reserve for connection into circuit only to maintain voltage during discharge, are not included in calculating nominal battery voltage.

(3) Two types of cell construction are recognized in this section, viz:

(a) The sealed type in which the only passage for the escape of gases from the interior of the cell is provided by a vent of effective spray-trap design adapted to trap and return to the cell, particles of liquid entrained in the escaping gases.

(b) The nonsealed type, in which gases escaping from the cell may carry entrained particles of liquid into the surrounding atmosphere.

Note: Caution: Smoking or the use of open flames, or of tools which may generate sparks, should be avoided except when cells are not actively gassing and when prior ventilation has been ample. Sparks from frictional or static electricity should be avoided as they may ignite the gas if discharged close to its source, as at the vent of a sealed-type cell during overcharging. The electrolyte of storage batteries, and spray containing electrolyte, are somewhat corrosive, particularly when concentrated by evaporation, and contact with body or clothes should be avoided.

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

E 114.02 Isolation. Storage batteries should be so located as to be not accessible to other than properly qualified persons.

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

E 114.03 Ventilation. (1) DIFFUSION OF GASES. Provision shall be made for sufficient diffusion of the gases from the battery to prevent the accumulation of an explosive mixture.

(2) NONSEALED TYPE. Batteries of the nonsealed type shall be located in separate rooms or enclosures so arranged as to prevent the escape into other rooms of objectionable quantities of electrolyte spray. This applies also to batteries of the nonsealed type not exceeding 50 volts nominal voltage if the capacity at the 8-hour discharge rate exceeds 5 kw. hrs.

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

E 114.04 Insulation. (1) Cells of the nonsealed type shall be supported by suitable insulators such as glass, glazed porcelain, or oil type, or may be grouped and supported on glass or other suitable insulating trays.

(2) Cells of the alkali type in jars of conducting material shall be supported singly, or in groups assembled in nonconducting trays, on porcelain or other suitable insulators.

(3) Cells of the sealed type in containers of insulating material require no additional insulation except as follows:

(a) Cells in rubber or composition containers if the total voltage exceeds 150 volts, or cells in glass jars if the total voltage exceeds 250 volts, should preferably be sectionalized into groups not exceeding these voltages, and such groups shall be mounted on trays or racks supported by suitable insulators such as glass, glazed porcelain, or oil type.

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

E 114.05 Racks and trays. (1) RACKS. Racks as required in this section, refer to frames designed to support cells or trays. They shall be substantial and made of:

(a) Wood, so treated as to be resistant to deteriorating action by the electrolyte; or

(b) Metal, so treated as to be resistant to deteriorating action by electrolyte and provided with nonconducting members directly supporting the cells; or with suitable insulating material on conducting members; or

(c) Other similar suitable construction.

(2) TRAYS. Trays refer to frames such as crates or shallow boxes usually of wood or other nonconducting material so constructed or treated as to be resistant to deteriorating action by the electrolyte.

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

E 114.06 Floors. It is recommended that the floors of battery rooms in which large batteries comprised of cells in lead-lined wood tanks are installed be of acid-resistive material, or be painted with acid-resistive paint, or otherwise be protected, where acid is likely to drop and accumulate.

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

E 114.07 Wiring in battery rooms. Wiring shall be in accordance with the requirements of NEC-1971 Article 480 (storage batteries).

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

E 114.08 Guarding live parts in battery rooms. (1) GUARDING. The arrangement of cells and connections shall be such that any 2 current-carrying parts between which a voltage exceeding 150 volts exists shall be properly guarded if the parts are otherwise so exposed that persons are liable to make accidental contact with both at the same time.

(2) BARE CONDUCTORS. No bare conductor of more than 150 volts to ground shall be placed in any passageway, unless guarded or isolated by elevation.

(3) DETAILS OF GUARDS. Required guards shall comply with section E 112.05.

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

E 114.09 Illumination for battery rooms enclosing batteries of the nonsealed type. (1) TYPE OF LAMP. Storage-battery rooms, in addition to daylight which is desirable when available, should be lighted only by incandescent electric lamps in keyless porcelain or composition sockets, controlled from outside the battery room if practicable.

Note: It is recommended that portable lamps be used only in keyless sockets enclosed in holders provided with substantial guards to prevent lamp breakage and be provided with "hard-service" cord.

(2) HEATING APPLIANCES. Heating appliances with open flames or exposed incandescent resistors shall not be installed.

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

Chapter E 115

TRANSFORMERS, INDUCTION REGULATORS, RHEOSTATS, GROUND DETECTORS, AND SIMILAR EQUIPMENT

E 115.01 Current transformer secondary circuits. (1) SHORT-CIRCUITING. Secondary circuits of current transformers, including constant-current and instrument transformers, shall be provided with means (such as permanent connections for jumpers) for short-circuiting them which can be readily connected while the primary is energized and which are so arranged as to permit the removal of any instrument or other device from such circuits without opening the circuits.

(2) PROTECTION WHEN OF MORE THAN 7,500 VOLTS. Where primaries are of more than 7,500 volts, secondary circuits unless otherwise adequately protected from injury or contact of persons, shall be in conduit effectively grounded.

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

E 115.02 Grounding secondary circuits of instrument transformers. The secondary circuits of all instrument transformers shall be effectively grounded.

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

E 115.03 Grounding transformer cases. The metal case or exposed frame of each transformer, reactor, induction regulator, and similar equipment, which is located where dampness or flammable gas normally exists, or which is connected to a circuit operating at more than 150 volts, shall be effectively grounded.

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

E 115.04 Location and arrangement of power transformers. If located outdoors, transformers shall be installed in accordance with subsections (1), (2), or (3) below; if located indoors, or in sidewalk vaults communicating with the interior of the building, they shall be installed in accordance with subsections (4), (5), or (6) below.

(1) ON POLES. Transformers may be mounted on a pole or on a pole structure, in compliance with the rules of part 2.

(2) ON WALLS. If permitted by local authority, a transformer may be mounted on the exterior wall of a building, in compliance with the rules of part 2.

(3) ENCLOSED. A transformer may be mounted in an outdoor enclosure such that unauthorized persons cannot readily come in contact with any part of the casing or wiring.

(4) INDOORS, COMBUSTIBLE LIQUID. A transformer immersed in a liquid that will burn, and located in a station, should be provided with sills to confine any escaping liquid, or with suitable arrangements for draining. If located in a building used for other than station purposes, and the amount of such liquid is considerable, the transformer should be placed in a suitable transformer vault which is ventilated. Such a vault shall be accessible to authorized persons only.

(5) INDOORS, INCOMBUSTIBLE LIQUID. A transformer rated in excess of 25 Kv.-a. and immersed in a liquid that will not burn shall be furnished with a pressure-relief vent. If installed inside a building used for other than station purposes and not well ventilated, (a) the transformer shall be furnished with a means for absorbing any gases generated by arcing inside the case, or (b) the pressure-relief vent shall be connected to a chimney or flue which will carry such gases outside the building.

(6) INDOORS, OTHER TYPES. Other types of transformers, such as air-cooled transformers, or small transformers (25 kv.-a. or less) immersed in a liquid that will not burn, may be installed in stations or, if properly enclosed or guarded, in buildings used for other than station purposes.

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

E 115.05 Resistance devices. (1) Rheostats shall be not less than 1 foot from combustible material or separated therefrom by a slab or panel of noncombustible, nonabsorptive material of suitable thickness, not less than one-half inch, somewhat larger than the rheostat, and secured in place by bolts independently of the rheostat supports.

(2) Rheostats or resistance devices shall not be placed where spattering molten metal due to high temperature in the rheostat may fall upon flammable material or spaces frequently occupied by persons.

(3) Rheostats or resistance devices exposed to excessive dust or flyings should preferably be installed in suitable cabinets or equipped with dust-tight side and face plates. (For installation in hazardous locations see section E 112.08).

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

E 115.06 Ground detectors. One or more reliable means of ground detection shall be available for every station supplying circuits which are not effectively grounded in accordance with chapter E 103.

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

Chapter E 116

CONDUCTORS

E 116.01 Electrical protection. (1) OVERCURRENT PROTECTION REQUIRED. Conductors shall be suitable for the location, use, and voltage. Conductors should be protected against excessive heating by the design of the system or by suitable fuses or automatic circuit-breakers except as provided in section E 117.06.

(2) FUSES IN GROUNDED CONDUCTORS. Conductors normally grounded for the protection of persons shall be arranged without fuses or automatic circuit-breakers interrupting their continuity between the source of electrical supply and the point at which the ground conductor is attached, unless the circuit-breaker opens all conductors of the circuit with one operation.

(3) CIRCUITS EXPOSED TO HIGHER VOLTAGES. If exposed through transformer windings or outdoor circuits to higher voltages, circuits of less than 750 volts shall be isolated or grounded unless in suitable cable with grounded metal sheath, placed in grounded conduit or other suitable duct or identified and guarded as required for conductors of the highest voltage to which they are exposed.

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

E 116.02 Precaution against mechanical and thermal damage. (1) PROTECTION AGAINST INJURY. Where exposed to mechanical injury suitable casing, armor, or other means shall be employed to prevent injury or disturbance to conductors, their insulation, or supports.

(2) FLAME PROOFING. Where conductors with insulating coverings are closely grouped and any one is liable to damage from near-by conductors (as sometimes on the rear of switchboards or in cableways) they shall have a substantial flameproof outer covering. Flame proofing shall be stripped back on all conductors a sufficient distance from the terminals to give the necessary insulation for the voltage of the circuit on which the conductor is used.

(3) PROTECTION AGAINST CONTACT. Large conductors liable to be torn from their supports by the forces to which they are subjected (as by the magnetic fields produced) shall be so supported that they cannot come in contact with the surfaces along which they are run if uninsulated or with other conductors and equipment.

Note: This applies in particular to generator leads and conductors liable to large short-circuit currents.

(4) CONDUCTORS BETWEEN GENERATORS AND OUTSIDE LINES. Conductors between generators and outside lines shall be accessible and sup-

ported on approved noncombustible, nonabsorptive insulators or placed in approved cable, metal conduit, tile, or other fireproof ducts.

(5) HIGH TEMPERATURES. Insulated conductors exposed to excessive temperatures shall have insulation which remains effective and does not rapidly deteriorate under such conditions.

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

E 116.03 Isolation. All conductors of more than 750 volts, and ungrounded bare conductors of more than 150 volts, shall be isolated by elevation or guarded in accordance with section E 112.05, so that no person can inadvertently come in contact with them; provided that busses and bus structures and line connections thereto may be installed in accordance with section E 112.06, in suitable locations specially arranged for such purposes.

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

E 116.04 Guarding conductors. (1) METAL SHEATHED CABLE OUTLETS OF MORE THAN 750 VOLTS. The insulation of the several conductors of multiple-conductor cable, where leaving the metal sheath at outlets, shall be thoroughly protected from mechanical injury, moisture, and electrical strains by means of a pothead or equivalent method.

(2) FORM OF GUARDS. Guards shall comply with section E 112.05.

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

E 116.05 Guarding in hazardous locations. (1) RIGID STEEL CONDUIT. Conductors in locations where flammable gas normally exists shall be in metal conduit. All fittings and outlets of such conduit shall be electrically and mechanically continuous with the conduit or metal sheath, and the conduit shall be sealed to prevent entrance of gases. (See NEC-1971 Article 500.)

Note: This rule does not apply to conductors of large section which obviously cannot be placed in conduit, such as copper bars connecting large cells with end-cell switches. This rule does not apply to adequately ventilated locations.

(2) INSULATING SUPPORTS. Conductors in damp locations, if neither in conduit nor in waterproof metal sheaths in other suitable ducts, shall be effectively isolated and supported on a suitable type of insulator.

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

E 116.06 Taping ends and joints. Ends and joints of insulated conductors, unless otherwise adequately guarded, shall have equal insulating covering with other portions of the conductor.

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

E 116.07 Wiring for illumination. Wiring installed for the illumination of the station should be installed and protected as required for similar utilization equipment and conductors in volume 2 of the code.

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

Chapter E 117

FUSES, CIRCUIT-BREAKERS, SWITCHES AND CONTROLLERS

E 117.01 Accessible and indicating. (1) ARRANGEMENT. All switches, fuses, automatic circuit-breakers, starting rheostats and other control devices shall be readily and safely accessible to authorized persons, unless remotely controlled. They shall be so arranged or marked as to identify the equipment controlled by them, and (except fuses) shall indicate whether they are open or closed.

(2) ACCIDENTAL CLOSING. Switches shall be so installed as to minimize the danger of accidental operation, and where practicable so that gravity cannot close them; such switches as may tend to close by gravity shall be provided with a proper latch or stop block to prevent accidental closing. Where practicable, the blades of knife switches should be dead when the switches are open.

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

E 117.02 Oil Switches. (1) Oil circuit-breakers and oil switches shall, wherever practicable, be isolated from other types of switches, and other electrical apparatus to conform to section E 111.05(1).

(2) Remote control of switches and circuit-breakers shall be used on circuits of more than 7,500 volts, or when they may be subject to large short-circuit values.

Note: Remote control may be mechanical, electrical, or other type. It is not intended to prohibit the use of switches and circuit-breakers operated manually by means of levers or poles from a remote position (see note in section E 111.05 for conditions usually applying to electrical systems).

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

E 117.03 Where switches are required. Suitable disconnectors, switches or circuit-breakers which may be manually operated shall be inserted in all leads to all supply equipment and all outgoing supply circuits, except as listed below:

Exceptions: (1) Where 2 or more pieces of electrical supply equipment or supply lines are operated as a single unit no switch is necessarily required between them.

(2) Switches are not required in transformer vaults except as may be deemed necessary by the engineer in charge to meet operating requirements.

(3) Switches are not required in leads to instrument transformers.

(4) Switches are not required in grounded conductors.

Note: In most cases the switch called for should be capable of opening the circuit under loads. In some cases, as between generators and transformer banks used with them, disconnectors only would be required.

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

E 117.04 Switches or other grounding devices. It is recommended that switches or other suitable means be provided, where practicable, to facilitate short-circuiting and grounding equipment or lines for which the operating rules (see Wis. Adm. Code sections E 142.04 and E 142.05), require grounding to protect workmen. (See section E 112.04(3)).

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

E 117.05 Capacity of switches and disconnectors. (1) SUITABILITY. Switches used otherwise than as disconnectors shall be of suitable voltage and ampere rating for the circuit on which they are installed and should preferably be marked with the current which they can safely interrupt. Disconnectors shall be of suitable voltage and ampere rating for the circuit on which they are installed.

(a) It is recommended that disconnectors be marked with a warning against opening when carrying load. Where a group of disconnectors is contained in one room or compartment, a single conspicuous sign may be sufficient.

(2) LOCKING. Remotely controlled switches, oil switches, and disconnectors shall be so arranged that they can be secured in the open position or plainly tagged to prevent careless closing while work is being done on equipment controlled by them. It is important that the control circuit be tagged or provided with a positive disconnecting means near the apparatus to prevent accidental operation of the mechanism. For switches and disconnectors the accidental opening of which may cause hazard, similar arrangements are desirable for retaining them in closed position. Locking is recommended rather than blocking wherever parts of equipment are remote from the point of control.

(3) AIR BREAKS. Unless a switch operating on a circuit between 750 and 7,500 volts makes an air break, it is recommended that there shall be installed between it and the source of energy supply a suitable air or oil break disconnector or equivalent device having an air or oil gap suitable for the operating voltage of the circuit. An air-break switch or air-break disconnector shall be inserted in each conductor between electrical supply equipment or lines and sources of energy of more than 7,500 volts, if the equipment or lines may have to be worked on without protective grounding while the sources may be alive (for lightning arresters see section E 119.02).

(4) ALINEMENT. Knife switches shall maintain such alinement under service conditions that they can be closed with a single unhesitating motion.

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

E 117.06 Where fuses or automatic circuit-breakers are required. (1) All circuit leads to motors, constant-potential generators, transformer primaries, and station auxiliaries, and all outgoing circuits shall be protected from excessive current by suitable fuses or automatic circuit-breakers, except as indicated below.

(2) Fuses and automatic circuit-breakers may be omitted from the following:

(a) A motor-driven generator or rotary converter when the supply leads to such apparatus are already protected by fuses or automatic circuit-breakers.

(b) Ground conductors.

(c) Circuits for field excitation.

(d) Leads of alternating-current generators.

(e) Leads connecting 2 or more pieces of electrical supply equipment operated as a single unit.

(f) Circuits supplying interconnected 3-wire systems of direct-current distribution.

(g) Leads of series transformers.

(h) Leads of potential transformers or other circuits, the opening of which may cause greater hazard to life or property through interruption of service.

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

E 117.07 Disconnection of fuses before handling. (1) Fuses in circuits of more than 150 volts or more than 60 amperes shall be arranged in one of the following ways:

(a) So that the fuses are necessarily disconnected from all sources of electrical energy before they can be touched.

(b) So that the fuses can be disconnected from all sources of electrical energy by a suitable switch.

(c) So that the fuses can be conveniently handled by means of insulating handles or portable appliances provided for the purpose.

Exception: Circuits of less than 150 volts and less than 60 amperes capacity are exempted from the provisions of this rule.

(d) The use of insulating gloves and mats is permissible on circuits not exceeding 750 volts.

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

E 117.08 Arcing or suddenly moving parts. (1) PROTECTION FROM BURNS. Fuses and circuit-breakers shall, as far as possible, be so located and shielded that persons will not be burned by their operation.

(2) PROTECTION AGAINST MOVING PARTS. Handles or levers of circuit-breakers, and similar parts which may move suddenly in such a way that persons in the vicinity are liable to be injured by them, shall be guarded or isolated.

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

E 117.09 Grounding noncurrent-carrying metal parts. Exposed noncurrent-carrying parts of switch and fuse cases, levers, and other similar parts to which leakage is liable to occur from live parts, and thereby create a hazard, shall be effectively grounded in accordance with section E 112.04.

(1) Exception: Minor parts, such as ferrules of knife switches, which are not liable to become alive, are excepted.

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

E 117.10 Guarding live parts of switches, fuses and automatic circuit-breakers. Switches, fuses, and automatic circuit-breakers shall be isolated or guarded in accordance with sections E 112.05 and E 112.06.

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

Chapter E 118

SWITCHBOARDS

E 118.01 Location and accessibility. (1) GENERAL LOCATION. Switchboards shall, where practicable, be so placed that the operator will not be endangered by any live or moving parts of machinery or equipment located near the board. They shall be so placed as to reduce to a minimum the danger of communicating fire to adjacent combustible material.

(2) SPACES ABOUT BOARDS. The space back of the board shall be kept clear of rubbish and shall not be used for storage.

(3) ACCESSIBILITY. Switchboards shall be accessible to authorized operators from both front and back when the connections are on the back (see Wis. Adm. Code section E 112.06 for working space), but may be placed against a wall when operating at not more than 750 volts with the wiring entirely on the face.

(4) ARRANGEMENTS. Switchboards shall have all switches so arranged that the points of control are readily accessible to the operator. Instruments, relays, and other devices requiring reading or adjustments shall be so placed that work can be readily performed from the working space.

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

E 118.02 Material and illumination. (1) MATERIAL. Switchboards shall be made of noncombustible material and be kept free from moisture.

(2) ILLUMINATION. In attended stations sufficient illumination shall be provided both for the front and rear of the switchboard so that the switchboard may be readily operated and instruments conveniently read. (See section E 111.02).

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

E 118.03 Necessary equipment. Switchboards which control generating equipment or outgoing supply circuits shall (except in substations without regular attendance) be equipped with such instruments as are necessary to show operating conditions. (See section E 115.06 for ground detectors).

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

E 118.04 Arrangement and identification. Connections, wiring, and equipment of switchboards and panelboards shall be arranged in an orderly manner, and all switches, fuses, and circuit breakers shall be plainly marked or labeled on fixed parts of equipment or arranged so as to afford ready means for identifying circuits or equipment supplied through them, in accordance with section E 112.10.

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

E 118.05 Spacings and barriers against short-circuit. (1) BARE PARTS. Switchboards shall have the number of bare parts at different potentials on any panel reduced to a minimum, and these parts shall be effectively separated. Protection or separation of such parts by suitable barriers is recommended where the voltage exceeds 750.

Note: It is recommended that such parts, including bus bars, should be so located, or provided with such insulating coverings or barriers, that parts at different potentials will not be readily short-circuited by tools or other conducting objects.

(2) FUSES. Fuses should be so located as to minimize the danger, in removing or replacing them, of short-circuiting parts at different potentials by the fuses or by the hands of the operator.

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

E 118.06 Switchboard grounding. (1) FRAMES. Switchboard frames and non-current-carrying parts shall be effectively grounded under the conditions and with the exceptions noted in section E 112.04.

(a) *Exception:* Parts of switchboards, such as name plates, screws, and similar small parts which are not liable to become alive, except under very unusual circumstances, are not considered as coming under the rule and may be left ungrounded.

(2) CIRCUITS WORKED ON. Where protective grounds are occasionally required on circuits for the protection of workmen, an effective ground connection shall be provided, and also suitable means for effectively and readily connecting the parts being grounded to the ground connection, in accordance with section E 112.04(3).

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

E 118.07 Guarding live parts on switchboards. (1) GUARDS. Live parts of switchboards shall be guarded in accordance with section E 112.05.

(2) PLUG-TYPE SWITCHBOARDS. Plug-type switchboards should, except while connections are being changed, have no current-carrying part exposed on face of boards and, if practicable, they and their plug connectors shall be so arranged where the operating voltage exceeds 150 as to have all current-carrying parts guarded so long as they are alive, even while connections are being changed.

(3) EXPOSED PARTS OF MORE THAN 7,500 VOLTS. No switchboard shall have current-carrying parts of more than 7,500 volts exposed (unguarded) unless these parts are effectively isolated by elevation, except at times when occasionally left exposed by removal of covers or entrance into enclosures, such as switch and instrument-transformer cells or compartments which are ordinarily unoccupied by persons. For such parts, if exposed while alive for any purpose (including busses and disconnectors in compartments) working space shall be provided complying with the requirements under section E 112.06.

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

E 118.08 Instrument cases. When mounted on switchboards, metal cases of instruments (unless isolated by elevation) operating at more than 750 volts shall be grounded or enclosed in suitable covers, which are either of grounded metal or of insulating material.

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

Chapter E 119

LIGHTNING ARRESTERS

E 119.01 Location. (1) WHERE RECOMMENDED. Suitable precautions should be taken to protect station equipment against excessive lightning which might enter from associated overhead lines.

(a) Exception: Precautions need not be taken in locations where thunderstorms are infrequent at all seasons of the year.

(2) INDOORS. Lightning arresters with auxiliaries when installed inside of buildings shall be located well away from all other equipment, passageways, and combustible parts of buildings. When of a type containing oil they should be installed in accordance with section E 111.05.

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

E 119.02 Provisions for disconnecting. (1) AIR-BREAK DISCONNECTORS. Lightning arresters on circuits of more than 7,500 volts requiring regular maintenance shall be so arranged, isolated and equipped that they may be readily disconnected from conductors to which they are connected by means of disconnects or clamping devices operable from a safe working distance.

(2) WORKING SPACE. Such disconnectors, unless remotely controlled and operated, shall have the adjacent working spaces required by Wis. Adm. Code section E 112.06 for disconnectors generally.

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

E 119.03 Connecting wires. Grounding wires shall be run as directly as possible and be of low impedance and ample current capacity. (See chapter E 103). Kinks, coils, and sharp bends in the wires between the arresters and the outdoor lines shall be avoided as far as possible.

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

E 119.04 Grounding frames and cases of lightning arresters. All non-current-carrying metal parts of arresters shall be grounded, unless effectively isolated by elevation or guarded as required for live parts of the voltage of the circuit to which the arrester is connected, and suitably identified as of that voltage, in accordance with section E 112.04.

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

E 119.05 Guarding live and arcing parts. (1) PROTECTION FROM CONTACT OR ARCING. All current-carrying parts of arresters on circuits of more than 750 volts, unless effectively isolated by elevation, shall

be adequately guarded to protect persons from inadvertent contact with them, or from injury by arcing, in accordance with section E 112.05.

(2) MAKING ADJUSTMENTS. Lightning arresters, unless provided with disconnectors which are always opened before work is done on the arresters, shall be so arranged that necessary adjustments are possible (without approach to current-carrying parts) through the use of effectively grounded mechanisms or suitable insulating appliances. Where charging or adjusting must be done with arresters alive, effectively grounded mechanisms or suitable insulating appliances shall always be provided.

(3) INSULATION OF ATTACHMENTS. All choke coils, gap electrodes, or other attachments, inherent to the lightning protective equipment, shall have an insulation from the ground or other conductors equal at least to the insulation demanded at other points of the circuit in the station.

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

Part 2

SUPPLY AND COMMUNICATION LINES

Chapter E 120

SCOPE OF ORDERS AND GENERAL STATEMENTS

Note: For the intent of the rules, waivers, etc. see Wis. Adm. Code Chapter E 20.

E 120.01 Scope of orders. (1) EXTENT OF APPLICATION. The orders in this part of the code, namely, chapters E 120 to E 129 inclusive, apply to all supply and communication lines in overhead and underground construction, whether operated in connection with public utilities, privately or municipally owned, with industrial establishments, or otherwise.

(2) NOT COMPLETE SPECIFICATIONS. These rules are not complete specifications but are intended to embody the requirements which are most important from the standpoint of safety to employees and the public.

(3) CONFORMITY WITH GOOD PRACTICE. Construction should be made according to accepted good practice for the given local conditions in all particulars not specified in these rules.

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

E 120.02 Minimum requirements. The rules state the minimum requirements for spacings, clearances, and strength of construction. More ample spacings and clearances or greater strength of construction may be provided if other requirements are not neglected in so doing.

Note: Some of these minimum values are exceeded in much existing construction; service requirements frequently call for stronger supports and higher factors of safety than the minimum requirements of these rules.

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

Chapter E 121

GENERAL REQUIREMENTS APPLYING TO OVERHEAD AND UNDERGROUND LINES

E 121.01 Design and construction. All electrical supply and communication lines and equipment shall be of suitable design and construction for the service and conditions under which they are to be operated.

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

E 121.02 Installation and maintenance. All electrical supply and communication lines and equipment shall be installed and maintained so as to reduce life and fire hazards as far as practicable.

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

E 121.03 Accessibility. All parts which must be examined or adjusted during operation shall be arranged so as to be readily accessible to authorized persons by the provision of adequate climbing spaces, working spaces, working facilities, and clearances between conductors.

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

E 121.04 Inspection and tests of lines and equipment. (1) WHEN IN SERVICE. (a) *Initial compliance with rules.* Lines and equipment shall comply with these rules upon being placed in service.

(b) *Inspection of structures and equipment.* Each pole, post, tower, structure, conductor, or guy used for the support or attachment of electrical conductors or lamps shall be inspected with reasonable frequency and all major equipment shall be inspected periodically to determine its fitness for service and the necessity for replacement or repair.

(c) *Tests.* Lines and equipment shall be subjected, when necessary, to tests which will determine their fitness for service.

(d) *Record of defects.* Any defects revealed by inspection, if not promptly corrected, shall be recorded.

(e) *Remedying defects.* Defective lines and equipment shall be put in good order or effectively disconnected.

(2) WHEN OUT OF SERVICE. (a) *Lines infrequently used.* Supply lines and equipment infrequently used shall be inspected to see that they are in safe condition for service.

(b) *Lines temporarily out of service.* Lines temporarily out of service shall be maintained in such condition that a hazard will not be created.

(c) *Lines permanently abandoned.* Lines permanently abandoned shall be removed.

Note: Overhead service drops to consumers may be disconnected without removal if the service is discontinued. This is considered good practice when it is undesirable to remove the service drop entirely.

(3) TEMPORARY DECORATIVE LIGHTING. Attachment of temporary decorative lighting on poles shall not be made without the concurrence of the owners and the occupants thereof.

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

E 121.05 Isolation, guarding and marking. (1) CURRENT-CARRYING PARTS. To promote safety to the general public and to employees not authorized to approach conductors and other current-carrying parts of electrical supply lines, such parts shall be arranged so as to provide adequate clearance from the ground or other space generally accessible, or shall be provided with guards so as to isolate them effectively from accidental contact by such persons.

(2) NONCURRENT-CARRYING PARTS. Ungrounded metal-sheathed service cable, service conduits, metal fixtures, and similar noncurrent-carrying parts, if located in urban districts and where liable to become charged to more than 300 volts, shall be isolated or guarded so as not to be exposed to accidental contact by unauthorized persons. As an alternative to isolation or guarding, grounding of certain noncurrent-carrying parts as permitted by sections E 121.06 (2) and E 128.01 (1) (d) may be used.

(3) MARKING OF POLES CARRYING HIGH VOLTAGES. Section 196.67, Wis. Stats., provides the following in part: Every corporation, company or person constructing, operating or maintaining an electric transmission line with a voltage of 6,000 or more between conductors or between conductors and the ground shall place warning signs, not less than 4 feet nor more than 6 feet from the ground, upon all poles or other structures supporting such line when within one hundred feet of school grounds; and when within 100 feet of any place where such line crosses a public highway; and when within any city or village.

Every such sign shall be in red, black, orange or reflective letters not less than 2 inches high on a contrasting background and shall read: "Danger—High Voltage". The commission may establish standards for electric transmission line pole signs having at least equivalent warning qualities to signs specified in this subsection, and warning signs meeting standards established or approved by the commission shall be deemed to be in compliance with this section.

Note: This has been interpreted as applying to distribution as well as transmission lines.

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

E 121.06 Grounding of circuits and equipment. (1) METHODS. The methods to be used for effective grounding for lightning arresters of supply lines, for circuits, for equipment and for wire raceways are given in Wis. Adm. Code chapter E 103. The methods to be used for grounding of lightning arresters on communication lines are specified in NEC-1971 section 800-31.

(2) PARTS TO BE GROUNDED. (a) Metal conduits, cable sheaths, and frames, cases, and hangers of equipment shall be effectively grounded.

1. Exception 1: This order does not apply when such parts are guarded from accidental contact by unauthorized persons.

2. Exception 2: This order does not apply where such parts are 8 feet or more above the ground.

3. Exception 3: This requirement does not apply to metal conduit enclosing communication conductors or supply conductors which consist of metal sheathed underground cables provided the metal sheath is connected to a good ground or is in good contact with the earth.

Recommendation: It is recommended that supply cables have the sheath bonded to any conduit extending above the ground surface.

(b) Fixed non-current carrying parts on poles which are more than 8 feet from the ground such as transformer cases may or may not be grounded depending on the company's rules. The company shall follow a standardized practice and make their operating rules conform to the practice adopted. If a portion of these non-current carrying parts are located within 8 feet of the ground they shall be grounded.

(3) USE OF GROUND AS PART OF CIRCUIT. Supply circuits shall not be designed to use the ground normally as the sole conductor for any part of the circuit.

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

E 121.07 Arrangement of switches. (1) ACCESSIBILITY. All switches shall be readily accessible to authorized persons.

(2) INDICATING OPEN OR CLOSED POSITION. All switches shall indicate clearly whether they are open or closed.

(3) Pole-top switches accessible to unauthorized persons shall have provision for locking in both open and closed positions.

(4) UNIFORM POSITION. The handles or control mechanism for all switches throughout any system shall have, so far as practicable, the same position when open and a uniformly different position when closed, in order to minimize operating errors. Where it is advisable to depart from this practice, the switches should be marked so as to minimize the liability to mistakes in operation.

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

Chapter E 122

RELATIONS BETWEEN VARIOUS CLASSES OF LINES

E 122.01 Relative levels. (1) STANDARDIZATION OF LEVELS. The levels at which different classes of conductors are to be located should be standardized where practicable for any given community by agreement of the utilities concerned.

Note: This practice facilitates the extension of lines and promotes the safety of the public and workers by permitting the relative levels and required clearances to be readily obtained on jointly or commonly used poles as well as at crossings and conflicts.

(2) RELATIVE LEVELS—supply and communication conductors.

(a) *Preferred levels.* Where supply and communication conductors cross each other or are in conflict, or are located on the same poles or towers, the supply conductors shall preferably be carried at the higher level.

1. Exception: This does not apply to trolley feeders which may be located for convenience approximately at the level of the trolley contact conductor.

Note: Supply lines generally use larger conductors than communication lines so there is less liability of contact between the two if the supply conductors are located in the upper position. This relative location also avoids the necessity of workmen on communication conductors passing through supply conductors and working above them and avoids the necessity of increasing the grade of construction required for communication conductors.

(b) *Minor extensions.* In localities where the practice of placing conductors of communication circuit for public use above supply conductors has been generally established, minor extensions may be made in either system, keeping the conductors in the same relative position. These extensions should not continue beyond a location at which it becomes practicable to change to the arrangement standardized by these orders.

(c) *Special construction for supply circuits, the voltage of which is 550 volts or less and carrying power not in excess of 3,200 watts.* Where all circuits are owned or operated by one party or where cooperative consideration determines that the circumstances warrant and the necessary coordinating methods are employed, single-phase alternating-current or 2-wire direct-current circuits carrying a voltage of 550 volts or less, with transmitted power not in excess of 3,200 watts,

when involved in the joint use of poles with communication circuits, may be installed in accordance with footnote of table 1 in subsection E 123.03(1), and footnote (a) of table 11 in section E 123.09 (1), under the following conditions:

1. That such supply circuits are of wire having a good grade of commercial double-braid weatherproof covering not smaller than No. 8 AWG medium hard-drawn copper or its equivalent in strength, and the construction otherwise conforms with the requirements for supply circuits of the same class.

2. That the supply circuits be placed on the end and adjacent pins of the lowest through signal crossarm and that a 30-inch climbing space be maintained from the ground up to a point at least 24 inches above the supply circuits. The supply circuits shall be rendered conspicuous by the use of insulators of different form or color from others on the pole line or by stenciling the voltage on each side of the crossarm between the pins carrying each supply circuit, or by indicating the voltage by means of metal characters.

3. That there shall be a vertical clearance of at least 2 feet between the crossarm carrying these supply circuits and the next crossarm above. The other pins on the crossarm carrying the supply circuits may be occupied by communication circuits used in the operation or control of a signal system or other supply system if owned, operated and maintained by the same company operating the supply circuits.

4. That such supply circuits shall be equipped with arresters and fuses installed in the supply end of the circuit and where the signal circuit is alternating current, the protection shall be installed on the secondary side of the supply transformer. The arresters shall be designed so as to break down at approximately twice the voltage between the wires of the circuit, but the break-down voltage of the arrester need not be less than 1,000 volts. The fuses shall have a rating not in excess of approximately twice the maximum operating current of the circuit, but their rating need not be less than 10 amperes. The fuses likewise shall in all cases have a rating of at least 600 volts, and where the supply transformer is a step-down transformer, shall be capable of opening the circuit successfully in the event the transformer primary voltage is impressed upon them.

5. Such supply circuits when enclosed in effectively grounded metal-sheathed cable, or other cables carried on effectively grounded messenger, may be carried on a pole below communication attachments, with not less than 2 feet vertical separation between the supply cable and the lowest communication crossarm. Communication circuits other than those used in connection with the operation of the supply circuits shall not be carried in the same cable with such supply circuits.

6. Where such supply conductors are carried below communication conductors, transformers and other apparatus associated therewith shall be attached only to the sides of the crossarm in the space between and at no higher level than, such supply wires.

7. Lateral runs of such supply circuits carried in a position below the communication space shall be protected through the climbing space by wood molding or equivalent covering, or shall be carried in multiple-conductor cable having a suitable substantial insulating covering,

and such lateral runs shall be placed on the under side of the crossarm.

(3) RELATIVE LEVELS; SUPPLY LINES OF DIFFERENT VOLTAGE CLASSIFICATIONS (as classified in table 11). (a) *At crossings or conflicts.* Where supply conductors of different voltage classifications cross each other or are in conflict, the higher-voltage lines shall preferably be carried at the higher level.

(b) *On poles used only by supply conductors.* Where supply conductors of different voltage classifications are on the same poles, relative levels should be as follows:

1. Where all circuits are owned by one utility, the conductors of higher voltages should generally be placed above those of lower voltage.

Note: These relative levels will often avoid the necessity of increasing the grade of construction for crossarms, pins, and conductor fastenings of the lower voltage conductors.

2. Where different circuits are owned by separate utilities, the circuits of each utility may be grouped together and one group of circuits may be placed above the other group provided that the circuits in each group are located so that those of higher voltage are at the higher levels and that either of the following conditions is met:

3. A vertical spacing of not less than 4 feet (or 6 feet where required by table 11, section E 123.09 (1)), is maintained between the nearest line conductors of the respective utilities (this space to be identified if necessary as a division space).

(c) *Conductors of a lower voltage classification.* Conductors of a lower voltage classification are at a higher level than those of a higher classification only where on the opposite side of the pole.

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

E 122.02 Avoidance of conflict and cooperation to avoid hazard. (1) Two parallel pole lines, either of which carries supply conductors, shall where practicable be so separated from each other that neither conflicts with the other. If this is impracticable, then the conflicting line or lines shall be built of the grade of construction required by Wis. Adm. Code chapter E 124 for a conflicting line or the 2 lines shall be combined in a single pole line.

(2) Under certain circumstances the proximity of supply lines to communication circuits may produce undesirable effects which may become hazardous. Because of the varied nature of the influence it is difficult to define limits of voltage, parallelism, etc., which will apply in all cases, but by means of cooperation between the supply and communication interests, the companies themselves can doubtless work out the problem in such a way that a serious hazard will not result. In order to aid in keeping these effects at a minimum, it is expected that the utilities or parties responsible for the extension or change of electric or communication facilities will cooperate by notifying each other of contemplated extensions; or changes in location, operation, or voltage. All the utilities or companies affected should determine in conference just what limits of line characteristics, separation and parallelism will be allowed without notification to each other. However in the absence of such an agreement any company before building a line

within 500 feet of the line of other companies shall give notice to all companies having lines within the given distance. Such notices will give all companies the opportunity to take such steps for the protection of their property as the law provides.

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

E 122.03 Joint use of poles by supply and communication circuits. (1) ADVANTAGES. Joint use of poles under suitable conditions and with certain types of circuits offers many advantages and promotes safety.

(2) COOPERATIVE STUDY. Joint use involves contractual relations between utilities, consideration of service requirements, and economics as well as safety. It, therefore, requires cooperative study by the utilities concerned.

(3) CONDITIONS UNDER WHICH JOINT USE IS DESIRABLE. In the case of local or distribution circuits along the same highway or similar right of way, where, under the provisions of chapter E 124 applying to joint use, grade C construction or less would be required, joint use is generally preferable to separate pole lines unless the number of conductors is very large or the character of the circuits makes joint use undesirable. Where circuits other than those mentioned above are involved, the choice between joint use of poles and separate pole lines shall be determined through cooperative consideration, by the utilities concerned, of all the factors involved, including the character of circuits, the total number and weight of conductors, tree conditions, number and location of branches and service drops, availability of right of way, etc. Where such joint use is mutually agreed upon, it shall be subject to the appropriate grade of construction as specified in chapter E 124. Where such joint use is not employed, separate lines as specified in section E 122.04 shall be used. In any event, joint use is preferable to separate lines where it would be impracticable to avoid an overbuilt conflict with separate lines.

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

E 122.04 Separate pole lines. Where 2 separate pole lines are to be used, one of which carries supply conductors and the other communication conductors, they shall be separated, if practicable, so that neither conflicts with the other, but if within conflicting distance, they shall be separated as far as practicable and shall be built of the grade of construction required by chapter E 124.

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

E 122.05 Approval of conflicts and joint use of facilities. The following section of the Wisconsin Statutes applies to the joint use of facilities. The Public Service Commission also has other orders, not included in this code or referred to in the following section of the statutes, which require certain lines and construction projects to be approved.

196.04 Facilities granted other utilities; physical telephone connections; petition; investigation. (1) Every public utility and every person having conduits, subways, poles, towers, transmission wires or other equipment on, over or under any street or highway, shall for a reasonable compensation, permit the use of the same by any public utility, whenever public convenience and necessity require such use, and such use will not result in irreparable injury to the owner or other users of such equipment, nor in any substantial detriment to the service to be rendered by such owners or other users; and every utility for the conveyance of telephone messages shall permit physical connections

to be made, and telephone service to be furnished, between any telephone system operated by it, and the telephone toll line operated by another such public utility, or between its toll line and the telephone system of another such public utility, or between its toll line and the toll line of another such public utility, or between its telephone system and the telephone system of another such public utility, whenever public convenience and necessity require such physical connections, and such physical connections will not result in irreparable injury to the owners or other users of the facilities of such public utilities, nor in any substantial detriment to the service to be rendered by such public utilities. The term "physical connections," as used in this section, shall mean such number of trunk lines or complete wire circuits and connections as may be required to furnish reasonably adequate telephone service between such public utilities.

(2) In case of failure to agree upon such use or the conditions or compensation for such use, or in case of failure to agree upon such physical connections, or the terms and conditions upon which the same shall be made, any public utility or any other person interested may apply to the commission, and if after investigation the commission shall ascertain that public convenience and necessity require such use or such physical connections, and that such use or such physical connections would not result in irreparable injury to the owner or other users of such equipment or of the facilities of such public utilities, nor in any substantial detriment to the service to be rendered by such owner or such public utilities or other users of such equipment or facilities, it shall by order direct that such use be permitted and prescribe reasonable conditions and compensation for such joint use, and that such physical connections be made, and determine how and within what time such connections shall be made, and by whom the expense of making and maintaining such connections shall be paid.

(3) Such use so ordered shall be permitted and such physical connections so ordered shall be made, and such conditions and compensation so prescribed shall be the lawful conditions and compensation for such use, and the lawful terms and conditions upon which such physical connections shall be made, observed, followed and paid. Any such order may be, from time to time, revised by the commission.

(4) Provided the parties cannot agree and the commission finds that public convenience and necessity or the rendition of reasonably adequate service to the public requires that a public utility should be permitted to extend its lines on, over or under the right of way of any railroad, or requires that the tracks of any railroad should be extended on, over or under the right of way of any public utility, the commission is empowered to order such extension by said public utility or railroad on, over or under the right of way of the other when it will not materially impair the ability of the railroad or utility, on, over or under whose right of way such extension would be made, to serve the public. Such use so ordered shall be permitted upon such conditions and such compensation as the commission shall deem equitable and reasonable in the light of all the circumstances, which conditions and compensation so prescribed shall be the lawful conditions and compensation for such use and the lawful terms and conditions upon which such use shall be made, observed, followed and paid.

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

E 122.06 Construction near airports. When any portion of a contemplated overhead line or structure will be at a greater height above the level of an existing airport or water surface used for landing than one-fiftieth of the distance from the boundary of such site, the owner or users and the division of aeronautics shall be notified. The division of aeronautics will supply maps showing the location of prospective and existing publicly-owned airport sites and information relative to their development.

Note: It is recommended that a reasonable effort be made to determine if private airports are contemplated in the area where the construction will be located.

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

Chapter E 123

CLEARANCES

Note: The following sections of the Wisconsin statutes apply to clearances, etc. Where the code requires greater clearance than the statutes the code requirements shall be used.

86.16 Electric lines on highways; place of poles; penalty.

(1) Any person, firm or corporation including any foreign corporation authorized to transact business in this state may, with the written consent of the town board, but subject to the approval of the state highway commission, construct and operate telegraph, telephone or electric lines, or pipes or pipe lines for the purpose of transmitting messages, water, heat, light or power along, across or within the limits of any highway.

(2) All poles used in the construction of such lines shall be set in such manner as not to interfere with the use of such highway by the public, nor with the use of the adjoining land by the owner thereof; and all pole lines shall hereafter be constructed so as to meet the requirements of the Wisconsin state electrical code.

(3) No tree shall be cut, trimmed or the branches thereof cut or broken in the construction or maintenance of any such line without the consent of the owner of the tree.

(4) Any person erecting any telephone, telegraph, electric light or other pole or stringing any telephone, telegraph, electric light or other wire, or constructing any pipes or pipe lines in violation of the provisions of this section shall forfeit a sum not less than $10 nor more than $50.

(5) Any person, firm or corporation whose written application for permission to construct such lines within the limits of any highway of any town has been refused, or when such application shall have been on file with the town clerk for 20 days and no action shall have been taken thereon, such applicant may file with such town clerk a notice of appeal to the state highway commission. The town clerk shall thereupon make return of all the papers and action of the board to the state highway commission, and such commission shall proceed to hear and try and determine such appeal on 10 days' notice to the town board, and the applicant. The order entered by the commission shall be final.

182.017 Transmission lines; privileges; damages.

(1) Right of way for. Any domestic corporation organized to furnish telegraph, telephone, service or transmit heat, power or electric current to the public or for public purposes, and any co-operative association organized under chapter 185 to furnish telegraph, telephone

or transmit heat, power or electric current to its members, may, subject to reasonable regulations made by any city or village through which its transmission lines or systems may pass, construct and maintain such lines or systems with all necessary appurtenances in, across or beneath any public highway or bridge or any stream or body of water, or upon any lands of any owner consenting thereto, and for such purpose may acquire lands or the necessary easements; and may connect and operate its lines or system with other lines or systems devoted to like business, within or without this state, and charge reasonable rates for the transmission and delivery of messages or the furnishing of heat, power or electric light.

(2) Not to obstruct public use. But no such line or system or any appurtenances thereto shall at any time obstruct or incommode the public use of any highway, bridge, stream or body of water.

(3) Abandoned lines removed. The public service commission after a public hearing as provided in section 196.26, and subject to the right of review as provided in chapter 227, may declare any line to have been abandoned or discontinued, if the facts warrant such finding. Whenever such a finding shall have been made the corporation shall remove such line, and on failure for 3 months after such finding of abandonment or discontinuance, any person owning land over, through or upon which such line shall pass, may remove the same, or the supervisors of any town within which said lines may be situated, may remove the said lines from the limits of its highways, and such person or supervisors shall be entitled to recover from the company owning the lines the expense for labor involved in removing the property.

(4) Location of poles. In case of dispute as to the location of poles, pipes or conduits, the commissioners appointed in condemnation proceedings under chapter 32 may determine the location. In no case, except where the owner consents, shall poles be set in front of or upon any residence property, or in front of a building occupied for business purposes, unless the commissioners find that the same is necessary and the court may review the finding.

(5) Limitation of action. The proceedings authorized in chapter 32 shall not be taken nor other action commenced against the corporation in respect to its rights to use or possess lands, unless begun within 6 years after the commencement of such use or possession.

(6) Trees protected, penalties. Any such corporation which shall in any manner destroy, trim or injure any shade or ornamental trees along any such lines or systems, or cause any damage to buildings, fences, crops, live stock or other property, except by the consent of the owner, or after the right so to do has been acquired, shall be liable to the person aggrieved in 3 times the actual damage sustained, besides costs.

(7) Municipal franchise required. No lighting or heating corporation shall have any right hereunder in any city or village until it has obtained a franchise or written consent for the erection or installation of its lines from such city or village.

182.018 Wires over railroads. (1) All wires strung over any steam railroad prior to August 1, 1949, shall be tied to insulators fastened to double cross-arms attached to a pole at each side of the crossing. The poles if of wood shall not be less than 6 inches in diameter at the top (if of other materials at least the equivalent strength thereof), set not less than 5 feet in the ground, securely guyed, and, unless the railroad right of way is over 100 feet in width, shall be set not more than 100 feet apart. The cross-arms shall be attached to the poles by machine bolts, and braced by at least one iron brace from each cross-arm to the pole. All wires shall be maintained not less than 25 feet above the rails, except street railway trolley wires, which shall be maintained not less than 22 feet above the rails.

(2) Any person ordered by the public service commission to change its wires so as to conform to this section failing to comply with such order within 10 days from the service thereof shall forfeit $25, and a like forfeiture for every additional 10 days of noncompliance with the order, unless a greater length of time to make such change shall be granted.

(3) All wires strung over any steam railroad on or after August 1, 1949 shall be strung in such a way as to meet requirements of the

Wisconsin state electrical code. Any person stringing wires in violation of the code shall be subject to a forfeiture of not more than $100 nor less than $25. Each 10-day period, after the first day, that such violation occurs shall be a separate violation and shall subject the violator to an additional forfeiture of not less than $25 nor more than $100 for each such violation.

E 123.01 General. (1) APPLICATION. This section covers clearances, including separations and climbing spaces, involving poles and wires. Clearances of lamps from pole surfaces, from spaces accessible to the general public, and height above ground are covered in subsection E 128.07(4).

(2) CONSTANT-CURRENT CIRCUITS. The clearances for constant-current circuits shall be determined on the basis of their nominal full-load voltage.

(3) SUPPLY CABLES. As far as clearances are concerned, effectively grounded continuous metal-sheathed supply cables and any insulated supply conductors lashed to or twisted with an effectively grounded messenger or neutral, all voltages, are classified the same as open supply wires of 0 to 750 volts. See section E 103.02(2)(e)2. for effective grounding.

(4) NEUTRAL CONDUCTORS. Neutral conductors of supply circuits shall have the same clearances as the phase wires of the circuit with which they are associated, except that neutral conductors which are effectively grounded throughout their length in the manner prescribed in section E 103.02(2)(e)1. and associated with circuits operating from 0 to 22,000 volts to ground may have the same clearances as circuits 0 to 750 volts. See note (q) of table 1 section E 123.03 for special construction over railroads.

(5) MAINTENANCE OF CLEARANCES. (a) The clearances required by this section shall be maintained at the specific values under the basic conditions stated for the various clearance situations.

(b) When the overhead facilities of one utility cross the overhead facilities of another utility, it is the responsibility of the utility crossing over or under an existing utility to determine if any increased clearances are required under section E 123.04 (2) (a).

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

E 123.02 Horizontal clearances of supporting structures from other objects. No pole or attachment shall obstruct or incommode the public use of any highway, bridge, stream, or body of water. Poles, towers, and other supporting structures and their guys and braces shall have the following horizontal clearances from other objects. The clearance shall be measured between the nearest parts of the objects concerned.

(1) FROM FIRE HYDRANTS. Not less than 3 feet.

Note: Recommendation: Where conditions permit, a clearance of not less than 4 feet is recommended.

(2) FROM STREET CORNERS. Where hydrants are located at street corners, poles and towers should not be set so far from the corners as to make necessary the use of flying taps inaccessible from the poles.

(3) FROM CURBS. Not less than 6 inches measured to the street side of the curb if practicable.

(4) FROM RAILROAD TRACKS. Where railroad tracks are parallel or crossed by overhead lines, the poles and their guys and braces shall, be located not less than 12 feet from the nearest track rail.

(a) Exception 1: At sidings a clearance of not less than 7 feet may be allowed, provided sufficient space for a driveway be left where cars are loaded or unloaded.

(b) Exception 2: Supports for overhead trolley contact conductors may be located as near their own track rail as conditions require. If very close, however, permanent screens on cars will be necessary to protect passengers.

Note: The parties concerned shall cooperate with each other in locating poles, signs, signals, etc., along tracks so that the view of all signals and signs will be as clear as practicable.

(5) PROTECTION FROM FIRES. Poles and towers should be so placed, guarded, and maintained, as to be exposed as little as practicable to brush, grass, rubbish, or building fires.

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

E 123.03 Vertical clearance of wires above ground or rails. The vertical clearance of all wires above ground in generally accessible places or above rails shall be not less than the following:

(1) BASIC CLEARANCES. The clearances of table 1 apply under the following conditions:

(a) Temperature of 60° F

(b) No wind.

(c) Final unloaded sag.

(d) Fixed conductor supports.

(e) Span lengths 0–150 feet for 3-strand conductors, each wire of which is 0.09 inch or less in diameter.

(f) Span lengths 0–175 feet for other types of wire.

(g) Voltage 0 to 50,000 volts.

(h) For other conditions see subsection E 123.03(2).

(i) For definition of voltage see definition 170, section E 101.02.

(2) INCREASED CLEARANCES. Greater clearances than given in table 1, section E 123.03 (1), shall be provided where required by (a), (b) and (c) below. Increases are cumulative where more than one applies.

Exception: Increased clearances are not required for trolley contact conductors, for guys, or for cable supported by messenger.

(a) *Spans longer than specified in section E 123.03(1).* In applying the following rules the "point of crossing" in the case of roads, streets, alleys and driveways is considered to be the edge of the traveled way farthest from the nearer support of the crossing span. In the case of a railroad crossing, it is the track rail which is farthest

from the nearer support of the crossing span. In other situations it is the location under the conductors of any topographical feature which is the determinant of the clearance.

1. Where point of crossing occurs at point of maximum total sag of the conductor.

a. General. For spans exceeding the limits specified in section E 123.03(1), the clearance specified in table 1 shall be increased by 0.1 foot for each 10 feet of the excess span length over such limits. (See c. below.)

b. Railroad crossings. For spans exceeding the limits specified in section E 123.03(1), the clearance specified in table 1 shall be increased by the following amounts for each 10 feet by which the crossing span lengths exceed such limits. (See c. below.)

Amount of Increase per 10 Feet

For conductors equal to or smaller than the following------0.30 foot

Solid copper 0.160 inches in diameter

Stranded copper 0.250 inches in diameter

Other than all copper (solid) 0.250 inches in diameter

Other than all copper (stranded) 0.275 inches in diameter

For conductors larger than the above----------0.15 foot

c. Limits for a and b above. The maximum additional clearance need not exceed 75% of the "maximum sag increase" for the conductor concerned. The "maximum sag increase" is the arithmetic difference between final unloaded sag with a temperature of 60° F., no wind, and the maximum total sag under the entire conductor loading of section E 125.02, or with a temperature of 120° F., no wind, whichever sag is greater, computed for the span length for which such difference is greatest.

d. Temperature. For conductors to be normally operated at temperatures in excess of 120° F., the clearance specified in table 1 and c above shall be increased by the difference between final unloaded sag at 120° F., no wind, and the final unloaded sag at the maximum temperature at which the conductor will operate.

2. Where point of crossing is not at point of maximum total sag of the conductor. Under these conditions the required clearance may be obtained by multiplying the clearance determined by subsections

Distance from Nearer Support of Crossing Span to Point of Crossing in Percentage of Crossing Span Length	Factors
5	0.85
10	.88
15	.91
20	.94
25	.96
30	.98
35	.99
40 to 50	1.00

Interpolate for intermediate values.

TABLE 1

MINIMUM VERTICAL CLEARANCE OF WIRES (IN FEET) ABOVE GROUND OR RAILS (SUPPLY WIRES INCLUDE TROLLEY FEEDERS)

Location of Wires and Cables	Guys, Communication Cables; Messengers and Wires, Grounded Supply Cables; Messengers and Lightning Protection Wires (a) (b) (e)	Open Supply Line Wires, Arc Wires, and Service Drops (o) (c)			Trolley Contact Conductors and Associated Span or Messenger Wires (d)	
		0 to 750 Volts	750 to 15,000 Volts	15,000 to 50,000 Volts	0 to 750 Volts to Ground	Exceeding 750 Volts to Ground
Over track rails of railroads (e)	27 (f) (q)	27 (f) (q)	28	30	22	22
Over streets, alleys or roads (g)	18 (r)	18	20	22	18	20
Along streets or alleys in urban districts (g)	18 (h) (r)	18 (h)	20	22	18	20
Along roads in rural districts (g)	14 (h) (t)	15 (h)	18	20	18	20
Over areas used for agricultural purposes	15	15	18	20	18	20
Over fenced or otherwise guarded rights of way in which only authorized persons are permitted (i)	15 (j)	15 (x)	15	17	16 (n)	18 (n)
Over normal high water of lakes, streams or ponds See (y)	18	18	18	20	----------	----------
Over commercial areas such as parking lots and drive-in establishments not subject to truck traffic	12	15	18	20	----------	----------
Over driveways to residence garages	12	15 (s)	20	22	18	20
Over commercial and industrial areas, parking lots and other areas subject to truck traffic	15	15	20	22	18	20
Over agricultural areas subject to truck traffic	15	15	20	22	18	20
Over footwalks and spaces accessible to pedestrians only	15 (w)	15 (x)	18	20	16 (n)	18 (n)
Over spaces or ways not covered above:						
In rural districts (p)	10 (j)	15 (x)	18 (m)	20 (m)	18	20
In urban districts (p)	10 (j)	18 (x)	20	22	18	20

(a) Including supply line guys where effectively grounded or insulated against the highest voltage to which they are exposed. Note: No clearance from ground is required for anchor guys not crossing streets, driveways, roads or pathways nor for anchor guys provided with traffic guards and paralleling sidewalk curbs.

(b) This relates to a supply cable of any voltage having effectively grounded continuous metal sheath supported by continuous grounded messenger and to insulated conductors lashed to or twisted with an effectively grounded continuous metallic messenger or neutral. This does not include a so-called cable where a messenger supports separate conductors with an insulating yoke.

(c) A conductor which is effectively grounded throughout its length and is associated with a supply circuit of 0 to 22,000 volts may have the clearance specified for conductors 0–750 volts.

(d) Where subways, tunnels or bridges require it, less clearances above ground or rails than required by Table 1 may be used locally. The trolley contact conductor should be graded very gradually from the regular construction down to the reduced elevation.

(e) In the case of electrified railroads served by overhead trolley conductors, these clearances do not apply if other orders require greater clearances.

(f) This clearance may be reduced to 25 feet where paralleled by trolley contact conductor on the same street or highway.

(g) These requirements apply only to wires within the limits of public highways or other public rights of way for traffic.

(h) Where a pole line along a road is located relative to fences, ditches, embankments, etc., so that the grounds under the line will never be traveled except by pedestrians, this clearance may be reduced to the following values:

(1) Communication conductors limited to 160 volts to ground and communication cables	8 Feet
(2) Conductors of other communication circuits	10 Feet
(3) Supply conductors	12 Feet
(4) Guys	8 Feet

(i) These clearance requirements do not apply in transformer or substation areas which are so fenced or guarded that they are never accessible to other than authorized persons. (See section E112.05)

(j) This clearance may be reduced to 8 feet for guys, cables, messengers and communication wires limited to 160 volts where the ground underneath the wires or cables is accessible to pedestrians only.

(m) This clearance may be reduced by 3 feet for distribution circuits in rural districts not along or across the yard or space near to the buildings of a farmstead, residence or school, if the wires are located relative to embankments, marshes, woods, etc., so that the ground underneath is not likely to be traveled by high loaded vehicles.

(n) Trolley contact conductors for industrial railways when not along or crossing roadways may be placed at a less height if suitably guarded.

(o) A diagonal clearance the same as the vertical clearance, shall be maintained to uneven or sloping terrain within a horizontal distance of ¾ of the vertical clearance. All distances to be measured from the conductors in their deflected position.

(p) See section E128.07(5) for street lamps and drops.

(q) This value may be reduced to 25 feet for guys, for cables having effectively grounded continuous metal sheaths, and for insulated conductors lashed to or twisted with an effectively grounded messenger or neutral.

and for conductors effectively grounded throughout their length and associated with supply circuits of 0 to 22,000 volts only if such conductors are stranded, are of corrosion resistant material, and conform to the strength and tension requirements for messengers given in section E126.02(7).

(r) Where communication wires or communication cables cross over or run along alleys, this clearance may be reduced to 15 feet.

(s) Service drop operating at less than 600 volts may have the clearance reduced to 12 feet.

(t) This clearance may be reduced to 18 feet for communication conductors where no part of the line overhangs any part of the highway which is ordinarily traveled, and where it is unlikely that loaded vehicles will be crossing under the line into a field.

(w) This clearance may be reduced to the following values:

(1) For communication conductors of circuits limited to 160 volts to ground, and communication cables 8 Feet
(2) For conductors of other communication circuits 10 Feet
(3) For guys 8 Feet
(4) For supply cables having effectively grounded continuous metal sheath, and or insulated conductors lashed to or twisted with an effectively grounded messenger or neutral, all voltages 10 Feet

(x) This clearance may be reduced to the following values:

(1) Supply wires (except trolley contact wires) limited to 300 volts to ground 12 Feet
(2) Supply wires (except trolley contact wires) limited to 150 volts to ground and located at entrances to buildings 10 Feet
(3) Where supply circuits of 550 volts or less, with transmitted power of 3,200 watts or less, are run along fenced (or otherwise guarded) private rights of way in accordance with the provisions specified in section E122.01(2)(c) 10 Feet

(y) Lines shall not obstruct, or endanger navigation or activities associated therewith. Application of section 30.15, Wis. Statutes may require greater clearances than shown and clearances specified by the Army Engineers over waters considered navigable by the United States may be greater. The largest requirement shall be complied with.

E 123.03(1) and E 123.03(2)(a)1. by the following factors, but in no case shall the clearance be less than required by table 1.

(b) *Voltages exceeding 50,000 volts.* For these voltages the clearances given in table 1, section E 123.03 (1), shall be increased at the rate of 0.4 inch for each 1,000 volts of the excess.

(c) *Conductors supported by suspension-type insulators at crossings over track rails.* The clearance shall be increased by such an amount that the values specified in table 1, section E 123.03(1), will be maintained in case of a broken conductor in either adjoining span if the conductor is supported as follows.

1. At one support by suspension-type insulators in a suspended position, and at the other support by insulators which are not free to swing (including semistrain-type insulators).

2. At one support by strain insulators, and at the other support by semistrain-type insulators.

(d) *Methods of avoiding this increase of clearance.* Any of the following construction methods will avoid the necessity for the increase in clearance required by section E 123.03 (2) (c).

1. Suspension-type insulators in a suspended position at both supports.

2. Semistrain-type insulators at both supports.

3. Arrangement of insulators so that they are restrained from displacement toward the crossing.

(3) SUPPLY POLE WIRING AT UNDERGROUND RISERS. Unguarded supply wires connecting to underground systems shall not be run open closer to the ground than is indicated in table 2.

TABLE 2
CLEARANCE ABOVE GROUND FOR OPEN UNGUARDED SUPPLY WIRING

Voltage				
0 to 150 Volts	150 to 300 Volts	300 to 750 Volts	750 to 15,000 Volts	More Than 15,000 Volts
Feet	Feet	Feet	Feet	Feet
10	12	14	16	18

History: Cr. Register, January, 1968, No. 145, eff. 2–1–68; am. table 1, (left-hand column), Register, April, 1972, No. 196, eff. 5–1–72.

E 123.04 Crossing clearances of wires carried on different supports. The clearance between any 2 wires crossing each other and carried on different supports shall not be less than the following:

Note: Recommendation: Crossings shall be made on a common crossing pole or structure where practicable.

(1) BASIC CLEARANCES. The clearances given in table 3 below apply under the following conditions:

(a) Temperature of 60° F., no wind, with the upper conductor or wire at its final unloaded sag and the lower conductor or wire at its initial unloaded sag.

(b) Span lengths not greater than the following for the upper conductor or wire:

1. 0–150 feet for 3-strand conductors, each wire of which is 0.09 inch or less in diameter.

2. 0–175 feet for other types of wire.

(c) Fixed supports for the upper conductor or wire.

(d) For other conditions, see section E 123.04(2).

TABLE 3
MINIMUM CLEARANCES OF CROSSINGS OF WIRES CARRIED ON DIFFERENT SUPPORTS

(The insertion of a given clearance in parentheses indicates that in general the lines operating at the voltage named above this clearance should not cross over the lines at the voltage to the left of the clearance in parentheses)

Nature of Wires Crossed Over	Communication Wires Including Cables and Messengers	Open supply wires 0–750 volts; supply cable having effectively grounded continuous metal sheath, or insulated conductors lashed to or twisted with an effectively grounded messenger or neutral, all voltages; messengers associated with such cable		Open supply wires and service drops (a)		Guys, Span Lightning Protection Wires
		Line Wires	Service Drops	750 to 8,700 Volts	8,700 to 50,000 Volts	
	Feet	Feet	Feet	Feet	Feet	Feet
Communication, including cables and messengers	(b)2	(c)(j)(i)4	(i)2	(f)4	6	(b)2
Supply cable having effectively grounded continuous metal sheath or insulated conductors lashed to or twisted with an effectively grounded messenger or neutral, all voltages; messengers associated with such cable	(j)4	2	2	2	4	2
Open supply wires						
0 to 750 volts	(4)	2	2	2	4	2
750 to 8,700 volts	(4)	(2)	(4)	2	4	4
8,700 to 50,000 volts	(6)	(4)	(6)	(4)	4	4
Trolley contact conductors	(d)4	(d)(e)4	(d)4	6	6	(d)4
Guys, span wires, lightning protection wires, service drops						
0 to 750 volts	(b)(g)2	2	2	4	4	(b)(h)2

Footnotes for table 3

(a) A conductor which is effectively grounded throughout its length in accordance with subsection E 103.02(2)(e) and is associated with a cir-

cuit of 0 to 22,000 volts may have the clearances specified for open supply wires of 0 to 750 volts.

(b) The clearance of communication conductors and their guy spans, and messenger wires from each other in locations where no other classes of conductors are involved may be reduced by mutual consent of the parties concerned, subject to the approval of the administrative authority, except for fire-alarm wires and wires used in the operation of railroads, or where one set of conductors is for public use and the other used in the operation of supply systems.

(c) A clearance of 2 feet may be permitted where the supply conductor is above the communication conductor, provided the crossing is not within 6 feet of any pole concerned in the crossing and the voltage does not exceed 300 volts. (See note (i))

(d) Trolley contact conductors of more than 750 volts should have at least 6 feet clearance. This clearance should also be provided over lower-voltage trolley-contact conductors unless the crossover conductors are beyond reach of a trolley pole leaving the trolley-contact conductor or are suitably protected against damage from trolley poles leaving the trolley-contact conductor.

(e) Trolley feeders are exempt from this clearance requirement for trolley-contact conductors if they are of the same nominal voltage and of the same system.

(f) If the final unloaded sag at 60° F. will be lower than a straight line joining the points of support of the highest communication conductor, or the crossing is within 6 feet horizontally of a communication pole, the clearance shall be increased to 6 feet.

(g) This clearance shall be increased to 4 feet where communication cables cross over open supply service wires.

(h) Completely insulated sections of guys attached to supporting structures having no conductor of more than 8,700 volts may have less than this clearance from each other.

(i) Where a 2-foot clearance is required at 60° F. and where conditions are such that the sag in the upper conductor would increase more than 1.5 feet at the crossing point under the applicable loading of section E 125.02, the 2-foot clearances shall be increased by the amount of sag increase less 1.5 feet.

(j) Supply cables, all voltages, having effectively grounded metal sheaths and messengers associated with such cables, and insulated conductors lashed to or twisted with an effectively grounded messenger or neutral may have a clearance of 2 feet except where they cross under communication cables.

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(2) INCREASED CLEARANCES. Greater clearances than given in table 3, section E 123.04(1), shall be provided under the following conditions: The increases required in subsections (a), (b), and (c) below are cumulative where more than one is applicable.

(a) *Crossing spans longer than specified in section E 123.04(1)(b).* Under these conditions the clearances specified in table 3 shall be increased as follows:

1. Where the crossing occurs at the point of maximum total sag in the upper conductor, the clearances of table 3 shall be increased by the following amounts for each 10 feet by which the crossing span length exceeds the limits specified in section E 123.04 (1) (b).

Amount of Increase per 10 Feet

For conductors equal to or smaller than the following _____0.30 foot
Solid copper 0.160 inches in diameter
Stranded copper 0.250 inches in diameter
Other than all copper (solid) 0.250 inches in diameter
Other than all copper (stranded) 0.275 inches in diameter
For conductors larger than the above _____0.15 foot

The maximum additional clearance in 1. for conductors not normally operating at temperatures in excess of 120° F., need not exceed 75% of the "maximum sag increase" for the conductor concerned. The "maximum sag increase" is the arithmetic difference between final unloaded sag with a temperature of 60° F., no wind, and the maximum total sag under the entire conductor loading of section

E 123.02 or with a temperature of 120° F., no wind, whichever sag is greater computed for the span length for which such difference is greatest.

2. If the crossing point is located elsewhere than at the point of maximum total sag in the upper span, the required clearance may be obtained by multiplying the clearance determined in sections E 123.04(1) and (2) (a)1. by the following factors, but in no case shall the clearance be less than required by table 3.

Distance from Nearer Support of Crossing Span to Point of Crossing, in Percentage of Crossing Span Length	Factors for Basic Clearance of	
	4 Feet	6 Feet
5	0.35	0.47
10	.47	.58
15	.60	.68
20	.71	.78
25	.82	.85
30	.90	.92
35	.96	.98
40 to 50	1.00	1.00

Interpolate for intermediate values, in vertical column.

3. Temperature. For conductors to be normally operated at temperatures in excess of 120° F., the clearance specified in 1. above shall be increased by the difference between final unloaded sag at 120° F., no wind, and the final unloaded sag at the maximum temperature at which the conductor will operate.

(b) *Voltages exceeding 50,000 volts.* For these voltages the clearances given in table 3, section E 123.04 (1), shall be increased at the rate of 0.4 inch for each 1,000 volts in excess.

(c) *Conductors supported by suspension-type insulators at crossings over communication wires.* For such conductors the clearance shall be increased by such an amount that the values specified in table 3, section E 123.04 (1) will be maintained in case of a broken conductor in either adjacent span, provided such conductor is supported as follows:

1. At one support by suspension-type insulators in a suspended position, and at the other support by insulators not free to swing (including semistrain-type insulators).

2. At one support by a strain insulator, and at the other support by a semistrain-type insulator.

(d) *Methods of avoiding this increase of clearance.* Any of the following construction methods will avoid the necessity for the increase in clearance required by section E 123.04(2)(c).

1. Suspension-type insulators in a suspended position at both supports.

2. Semistrain-type insulators at both supports.

3. Arrangement of insulators so that they are restrained from displacement toward the crossing.

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

E 123.05 Clearances of conductors of one line from other conductors and structures. (1) CLEARANCES FROM CONDUCTORS OF ANOTHER LINE. The clearance in any direction between any conductor of one line and any conductor of a second and conflicting line shall be not less than

the largest value required by (a), (b), or (c) below at 60° F., and no wind.

(a) 4 feet.

(b) The values required by sections E 123.06(1)(b)1., a. or b. for separation between conductors on the same support.

(c) The apparent sag of the conductor having the greater sag, plus 0.2 inch per kilovolt of the highest voltage concerned.

1. Exception: In situations where supply-line conductors only are involved, the clearance required by (c) above need not be greater than the value required by sections E 123.04(1) and (2) for a center-span crossing, assuming the conductor having the larger sag swinging through an arc of 45° from the vertical.

(2) CLEARANCES FROM SUPPORTING STRUCTURES OF ANOTHER LINE. Conductors of any line passing near a pole or similar supporting structure of a second line without being attached thereto, shall have clearances from any part of such structure not less than the larger value required by either (a) or (b) below at 60°F., and no wind.

(a) Three feet if practicable.

(b) The values required by sections E 123.06(1)(b)1., a. and b. for separation between similar conductors on the same support, increased by 1 inch for each 2 feet of the distance from the supporting structure of the second line to the nearest supporting structure of the first line.

The climbing space on the structure of the second line shall in no case be reduced by a conductor of the first line.

(3) CLEARANCES FROM BUILDINGS. (a) *General.* Conductors shall be arranged and maintained so as to hamper and endanger firemen as little as possible in the performance of their duties.

(b) *Ladder space.* Where buildings exceed three stories (or 50 feet) in height, overhead lines should be arranged where practicable so that a clear space or zone at least 6 feet wide will be left, either adjacent to the building or beginning not over 8 feet from the building to facilitate the raising of ladders where necessary for fire fighting.

1. Exception: This requirement does not apply where it is the unvarying rule of the local fire departments to exclude the use of ladders in alleys or other restricted places which are generally occupied by supply lines.

(c) *Open supply conductors attached to buildings.* Where the permanent attachment of open supply conductors of any class to buildings is necessary for an entrance, such conductors shall meet the following requirements:

1. Conductors of more than 300 volts shall not be carried along or near the surface of the building unless they are guarded or made inaccessible.

2. Clearance of wires from building surface shall be not less than those required in table 9, section E 123.06(1)(c)1., for clearance of conductors from pole surfaces.

3. Service head and service drop attachments and communication cables or conductors attached to or carried along the surface of a building shall be so located that no part of the drip-loops or service drop conductors within 3 feet of the service head and service drop attachments shall be less than 12 inches from communication cables or conductors.

(d) *Conductor passing by or over buildings.* 1. Crossing roofs. Supply conductors exceeding 8,700 volts should not be carried over buildings not concerned in the operation of the utility owning them, if this can be avoided. When it is necessary to attach wires to the roofs of buildings, the supporting structure shall be of substantial construction. Wherever feasible, wires crossing over buildings shall be supported on structures which are independent of the buildings crossed over.

2. Minimum clearances. Unguarded or accessible supply conductors carrying voltages in excess of 300 volts may be run either beside or over buildings. The vertical or horizontal clearance to any building or its attachments (balconies, platforms, etc.) shall be as listed below. The horizontal clearance governs above the roof level to the point where the diagonal equals the vertical clearance requirement. From this point the diagonal clearance shall be equal to the vertical clearance requirement. This rule should not be interpreted as restricting the installation of a trolley contact conductor over the approximate center line of the track it serves.

a. Spans 0 to 150 feet. For spans 0 to 150 feet, the clearances shall be as given in table 4.

TABLE 4

CLEARANCES OF SUPPLY CONDUCTORS FROM BUILDINGS

Voltage of Supply Conductors	Horizontal Clearance	Vertical Clearance
	Feet	Feet
0 to 300	3	(a) 8
300 to 8,700	3	8
8,700 to 15,000	8	8
15,000 to 50,000	10	10
Exceeding 50,000	10 plus 0.4 inch per Kv. in excess	10 plus 0.4 inch per Kv. in excess

Note: Conductors shall have a clearance of not less than 8 feet from the highest point of roofs over which they pass, except that where the voltage between conductors does not exceed 300 and the roof has a slope of not less than 4 inches in 12 inches the clearance may be not less than 3 feet. Service-drop conductors of 300 volts or less which do not pass over other than a maximum of 4 feet of the overhang portion of the roof for the purpose of terminating at a (through-the-roof) service raceway or approved support may be maintained at a minimum of 18 inches from any portion of the roof over which they pass.

b. Spans exceeding 150 feet. Where span lengths exceed 150 feet, the increased clearance required by section E 123.03 (2) (a) shall be provided.

1. Exception: These increased clearances are not required where the voltage of the supply conductors is from 300 to 8,700 volts.

3. Guarding of supply conductors. Supply conductors of 300 volts or more shall be properly guarded by grounded conduit, barriers, or otherwise, under the following conditions:

a. Where the clearances set forth in table 4, section E 123.05 (3) (d) 2. a., cannot be obtained.

b. Where such supply conductors are placed near enough to windows, verandas, fire escapes, or other ordinarily accessible places, to be exposed to contact by persons.

Note: Supply conductors in grounded metal-sheathed cable are considered to be guarded within the meaning of this section.

(e) For clearance of conductors from scaffolding and buildings under construction see Wis. Adm. Code chapter Ind 35

(4) CLEARANCES FROM BRIDGES. (a) *Clearances of conductors from bridges.* Supply conductors which pass under, over or near a bridge shall have clearances therefrom not less than given in table 5.

TABLE 5

CLEARANCES FROM BRIDGES

Voltages	Readily Accessible Portions (Other Than Traveled Ways) (a) of Any Bridge, Including Wing Walls or Bridge Attachments		From Ordinarily Inaccessible Portions (b) of Bridges (Other Than Brick, Concrete or Masonry) and From Abutments	
	For Conductors Attached to Bridge	For Conductors Not Attached to Bridge	For Conductors Attached to Bridge(c)	For Conductors Not Attached to Bridge(c)
	Feet	Feet	Feet	Feet
0 to 2,500	3.0	3.0	0.5	3.0
Over 2,500 to 5,000	3.0	3.0	1.0	3.0
Over 5,000 to 8,700	3.0	3.0	3.0	3.0
Over 8,700 to 15,000	5.0	5.0	5.0	5.0
Over 15,000 to 25,000	7.5	7.5	7.5	7.5
Over 25,000 to 35,000	7.5	9.0	7.5	9.0
Over 35,000 to 50,000	7.5	12.0	7.5	12.0
Exceeding 50,000	7.5 plus 0.4 inch per Kv in excess	12.0 plus 0.4 inch per Kv in excess	7.5 plus 0.4 inch per Kv in excess	12.0 plus 0.4 inch per Kv in excess

(a) Where over traveled ways on or near bridges the clearances of section E 123.03 apply.
(b) Bridge seats of steel bridges carried on masonry, brick, or concrete abutments which require frequent access for inspection shall be considered as readily accessible portions.
(c) Where conductors passing under bridges are adequately guarded against contact by unauthorized persons and can be deenergized for maintenance of the bridge, clearances of the conductors from the bridge, at any point, may have the clearances specified in table 9 for clearance from surfaces of crossarms plus one-half the final unloaded sag of the conductor at that point.

1. Exception: Grounding conductors, effectively grounded neutrals, conductors installed in grounded conduit, metal sheathed cables and cables supported on effectively grounded messengers.

(b) *Guarding trolley contact conductors located under bridges.*

1. Where guarding is required. Guarding is required where the trolley contact conductor is located so that a trolley pole leaving the conductor can make simultaneous contact between it and the bridge structure.

2. Nature of guarding. Guarding shall consist of a substantial inverted trough of non-conducting material located above the contact conductor, or of other suitable means of preventing contact between the trolley pole and the bridge structure.

(5) CLEARANCE FROM SIGNS. The clearance of lines from buildings shall govern the clearance of lines from signs. Where signs are animated, contain lamps, or where the sign is periodically renewed, replaced or changed the minimum horizontal clearance shall not be less than 10 feet. This does not apply to the conductors supplying the sign.

(6) CLEARANCE FROM LIGHT STANDARDS. Conductors not used to supply light standards shall have clearances equal to the clearance from buildings between such conductors and independent lighting supports.

(a) *Exception 1:* Conductors properly attached to the lighting standards are permitted. Such conductors shall not interfere with the safe servicing of the lighting fixtures and shall have the clearance required for conductors on poles.

(b) *Exception 2:* A vertical clearance of 5 feet is permitted for lines 300 to 8,700 volts.

(7) LINES IN TREES. Supply wires shall not be run through fruit trees that must be climbed to gather the fruit.

(a) *Exception:* Insulated supply lines and associated neutral conductors operating at less than 300 volts to ground are exempt.

(8) NEAR STORED MATERIAL. Lines should not be run over areas where material is regularly stored and handled by cranes or other types of high machinery unless the clearance of such lines is adequate to permit full use of the equipment.

(9) NEAR STORAGE TANKS. A horizontal clearance of at least 15 feet shall be maintained between above ground flammable liquids storage tanks and open conductors operating at more than 300 volts to ground. When voltages are 300 volts or below, a horizontal clearance of not less than 8 feet shall be maintained.

Note: This requirement does not apply to LPG tanks with capacity of 1,000 gallons or less.

(10) NEAR WELLS. A horizontal distance of at least ¾ of the required vertical clearance of the conductors to ground shall be maintained between open conductors and wells.

(11) E 123.03 Table 1, note o, requires a diagonal clearance the same as the vertical clearance be maintained to uneven or sloping terrain within a horizontal distance of ¾ of the vertical clearance. Distances are to be measured from the conductors in their deflected position.

(12) NEAR SWIMMING POOLS. A horizontal clearance of at least 10 feet shall be maintained between service drops or other open overhead wiring, and swimming pools, diving structures, observation stands, towers or platform. (See NEC-1971 section 680-8.)

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68; am. (3) (d) 2. a. Table 4 Note (a) and (12), Register, April, 1972, No. 196, eff. 5-1-72.

E 123.06 Minimum line-conductor clearances and separations at supports.

(1) SEPARATION BETWEEN CONDUCTORS ON POLE LINES.

(a) *Application of rule.* 1. Multiconductor wires or cables. Cables and duplex, triple or paired conductors supported on insulators or messengers, whether single or grouped, are for the purpose of this rule considered single conductors even though they may contain individual conductors not of the same phase or polarity.

2. Conductors supported by messengers or span wires. Clearances between individual wires or cables supported by the same messenger, or between any group and its supporting messenger, or between a trolley feeder, supply conductor, or communication conductor, and their respective supporting span wires, are not subject to the provisions of this rule. This paragraph also refers to spacer installations where the distance between conductors is maintained by spacers placed at intervals which are much less than the length of a span.

3. Measurement of clearances. The clearances and separations stated may be measured from the center of the supporting insulator instead of from the conductor itself.

(b) *Horizontal separations between line conductors.* 1. Fixed supports. Line conductors attached to fixed supports shall have horizontal separations from each other not less than the larger value required by either a. or b., below for the situation concerned.

Exception 1: The pin spacing at buckarm construction may be reduced as specified in section E 123.07 (6), to provide climbing space.

Exception 2: The pin spacing at bridge fixtures may be reduced as specified in section E 123.06(3).

Exception 3: Grades D and N need meet only the requirements of a. below.

Exception 4: These clearances do not apply where conductors have insulating covering adequate for the voltage concerned.

a. Minimum horizontal separation between line conductors of the same or different circuits. Separations shall not be less than given in table 6.

TABLE 6

MINIMUM HORIZONTAL SEPARATION AT SUPPORTS BETWEEN LINE CONDUCTORS OF THE SAME OR DIFFERENT CIRCUITS

Class of Circuit	Separation	Notes
	Inches	
Communication conductors	6	Preferable minimum. Does not apply at conductor transposition points.
	3	Permitted where pin spacings less than 6 inches have been in regular use. Does not apply at conductor transposition points.
Railway feeders 0 to 750 volts, No. 4/0 or larger	6	
0 to 750 volts, smaller than No. 4/0	12	Where 10 to 12 inch separation has already been established by practice, it may be continued, subject to the provisions of rule E 123.06(1)(b)1.a., for conductors having apparent sags not over 3 feet and for voltages not exceeding 8,700.
750 volts to 8,700 volts	12	
Other supply conductors 0 to 8,700 volts	12	
For all conductors of more than 8,700 volts add for each 1,000 volts in excess of 8,700 volts	0.4	

b. Separations according to sags. The separation at the supports of conductors of the same or different circuits of grades B or C shall in no case be less than the values given by the following formulas, at 60° F., no wind. The requirements of section E 123.06 (1) (b) 1.a., apply if they give a greater separation than this rule.

For line conductors smaller than No. 2 A.W.G.:

$$\text{Separation} = 0.3 \text{ inch per kilovolt} + 7\sqrt{(S/3)-8}$$

For line conductors of No. 2 A.W.G. or larger:

$$\text{Separation} = 0.3 \text{ inch per kilovolt} + 8\sqrt{(S/12)}$$

S is the apparent sag in inches of the conductor having the greater sag, and the separation is in inches.

TABLE 7

SEPARATION IN INCHES REQUIRED FOR LINE CONDUCTORS SMALLER THAN NO. 2 A.W.G.

Voltages between Conductors	Sag (In Inches)						
	36	48	72	96	120	180	240
2,400	14.5	20.5	28.5	35.0	40.5	51.5	60.0
7,200	16.0	22.0	30.0	36.5	42.0	52.5	61.5
13,200	18.0	24.0	32.0	38.5	43.5	54.5	63.5
23,000	21.0	27.0	35.0	41.5	46.5	57.5	66.5
34,500	24.5	30.5	38.5	44.5	50.5	61.0	70.0
46,000	28.0	34.0	42.0	48.0	53.5	64.5	73.0
69,000		40.5	48.5	55.0	60.5	71.0	80.0

TABLE 8

SEPARATION IN INCHES REQUIRED FOR LINE CONDUCTORS OF SIZE NO. 2 A.W.G. OR LARGER

Voltages between Conductors	Sag (In Inches)						
	36	48	72	96	120	180	240
2,400	14.5	16.5	20.5	23.5	26.0	31.5	36.5
7,200	16.0	18.0	22.0	25.0	27.5	33.0	38.0
13,200	18.0	20.0	23.5	26.5	29.5	35.0	39.5
23,000	21.0	23.0	26.5	29.5	32.0	38.0	42.5
34,500	24.0	26.5	30.0	33.0	35.5	41.5	46.0
46,000	27.5	30.0	22.5	36.5	39.0	45.0	49.5
69,000		36.5	40.5	43.5	46.0	51.5	56.5

2. Suspension insulators not restrained from movement. Where suspension insulators are used and are not restrained from movement, the conductor separation shall be increased so that one string of line insulators may swing transversely through an angle of 30° from a vertical position without reducing the values given in 1. above.

(c) *Clearances in any direction from line conductors to supports and to vertical or lateral conductors, span or guy wires, attached to the same support.*

1. Fixed supports. Clearances shall be not less than given in table 9.

2. Suspension insulators not restrained from movement. Where suspension insulators are used and are not restrained from movement, the conductor clearances from surfaces of supports, from span or guy wires, or from vertical or lateral conductors shall be such that the values of clearances required by 1. above will be maintained with an insulator swing of 30° from the vertical position.

(d) *Conductor separation—vertical racks.* Conductors or cables may be carried on vertical racks or separate brackets other than wood placed vertically at one side of the pole and securely attached thereto, if all the following conditions are met.

1. The voltage shall be not more than 750 volts, except that cables having effectively grounded continuous metal sheath or insulated conductors lashed together with an effectively grounded messenger may carry any voltage.

2. Conductors shall be of the same material or materials, except that different materials may be used if their sag-tension characteristics and arrangement are such that the separations specified in 3. below are maintained under all service conditions.

TABLE 9

MINIMUM CLEARANCE IN ANY DIRECTION FROM LINE CONDUCTORS TO SUPPORTS, AND TO VERTICAL OR LATERAL CONDUCTORS, SPAN OR GUY WIRES, ATTACHED TO THE SAME SUPPORT

Clearance of Line Conductors From—	Communication Lines		Supply Lines		
			0 to 8,700 Volts		Exceeding 8,700 Volts Add For Each 1,000 Volts of Excess
	In General	On Jointly Used Poles	In General	On Jointly Used Poles	
	Inches	Inches	Inches	Inches	Inches
Vertical and Lateral conductors					
Of same circuit	3	3	3	3	0.25
Of other circuits	3	3	(f)6	(f)6	0.4
Span and guy wires attached to same pole:					
General	(h)3	(a)(h)6	6	6	(j)0.4
When parallel to line	(h)3	(a)(h)6	(a)12	(a)12	(j)0.4
Lightning-protection wires parallel to line	(b)(e)	(b)(e)	(b)(e)	(b)(e)	0.4
Surfaces of crossarms	(c)3	(c)3	3	3	0.20
Surfaces of poles	(c)3	(c)5	(g)(i)3	(d)(g)5	0.20

Footnotes to table 9

(a) For guy wires, if practicable. For clearances between span wires and communication conductors, see section E 123.09 (5) (c). On jointly used poles, guys which pass within 12 inches of supply conductors, and also pass within 12 inches of communication cables, shall be protected with a suitable insulating covering where the guy passes the supply conductors unless the guy is effectively grounded or insulated with a strain insulator at a point below the lowest supply conductor and above the highest communication cable.

(b) Clearance shall not be less than the separation required by table 6 or section E 123.06 (1) (b) 1., b. between two line conductors of the voltage concerned.

(c) Communication conductors may be attached to supports on the sides or bottoms of crossarms or surfaces of poles with less clearances, if at least 40 inches from any supply line conductor of less than 8,700 volts and at least 60 inches from any supply line conductor of more than 8,700 volts carried on the same pole

(d) This clearance applies only to supply conductors carried on crossarms below communication conductors on joint poles. Where supply conductors are above communication conductors this clearance may be reduced to 3 inches except for supply conductors 0 to 750 volts whose clearance may be reduced to one inch.

(e) For the purpose of applying the above table, the voltage of lightning protection wires shall be considered as being the voltage to ground of the associated supply conductors.

(f) For supply circuits of 0 to 750 volts, this clearance may be reduced to 3 inches.

(g) A neutral conductor which is effectively grounded throughout its length and is associated with a circuit of 0 to 22,000 volts may be attached directly to the pole surface.

(h) Guys and messengers may be attached to the same strain plates or to the same through bolts.

(i) For supply circuits of 0 to 750 volts this clearance may be reduced to one inch.

(j) May be reduced to .25 for anchor guys.

3. Vertical spacing between conductors shall be not less than the following:

Span Length	Vertical Clearance Between Conductors
Feet	(Inches)
0–150	4
150–200	6
200–250	8
250–300	12

(See table 9, section E 123.06(1)(c), for necessary clearances from pole surfaces and section E 123.07(7)(a) for method of providing climbing space)

(e) *Separation between supply circuits of different voltage classifications on the same crossarm.* Supply circuits of any one voltage classification as given in table 11, section E 123.09(1)(a), may be maintained on the same crossarm with supply circuits of the next consecutive voltage classification only under the following conditions:

1. If they occupy pin positions on opposite sides of the pole.

2. If in bridge-arm or side-arm construction they are separated by a distance of not less than the climbing space required for the higher voltage concerned and provided for in section E 123.07.

3. If the higher-voltage conductors occupy the outer pin positions and the lower-voltage conductors the inner pin positions.

4. If series lighting or similar circuits, are ordinarily dead during periods of work on or above the crossarm concerned.

5. If the 2 lines concerned are communication lines used in the operation of supply lines, and supply lines of less than 8,700 volts, and are owned by the same utility, provided they are installed as in 1. or 2. above.

(2) SEPARATION BETWEEN CONDUCTORS ATTACHED TO BUILDINGS. Separation of wires from each other shall be not less than those required in table 6, section E 123.06(1)(b)1.a., for separation of conductors from each other at supports.

(a) Exception: Conductors on vertical racks or separate brackets other than wood placed vertically meeting the requirements of subsection E 123.06(1)(d), may have the separations specified in that subsection.

(3) SEPARATION BETWEEN CONDUCTORS ATTACHED TO BRIDGES. Supply conductors attached to bridges and supported at frequent intervals may have less separation at supports than required by subsections E 123.06(1)(b)1.a. and b. The separation shall not be less than the clearance between supply conductors and the surfaces of poles or crossarms, required by subsection E 123.06 (1)(c)1., or less than the following:

Span Length	Separation
	Inches
0 to 20 feet	6
20 to 50 feet	9

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

E 123.07 Climbing space. (1) LOCATION AND DIMENSIONS. (a) A climbing space having the horizontal dimensions specified in section E 123.07(5), shall be provided past any conductors, crossarms, or other parts.

(b) The climbing space need be provided on one side or corner of the pole only.

(c) The climbing space shall extend vertically past any conductor or other part between levels above and below the conductor as specified in sections E 123.07(5), (6), (7) and (8), but may otherwise be shifted from any side or corner of the pole to any other side or corner.

(2) PORTIONS OF SUPPORTING STRUCTURES IN CLIMBING SPACE. Portions of the pole or structure when included in one side or corner of the climbing space are not considered to obstruct the climbing space.

(3) CROSSARM LOCATION RELATIVE TO CLIMBING SPACE.

Note: Recommendation: All crossarms should be located on the same side of the pole.

Exception: This recommendation does not apply where double crossarms are used on any pole or where crossarms on any pole are not all parallel.

(4) LOCATION OF SUPPLY APPARATUS RELATIVE TO CLIMBING SPACE. Transformers, regulators, lightning arresters, and switches when located below conductors or other attachments shall be mounted outside of the climbing space.

(5) CLIMBING SPACE THROUGH CONDUCTORS ON CROSSARMS. (a) *Conductors of same voltage classification on same crossarm.* Climbing space between conductors shall be of the horizontal dimensions specified in table 10, (section E 123.07(5)(c)), and shall be provided both along and across the line, and shall be projected vertically not less than 40 inches above and 40 inches below the limiting conductors. Where communication conductors are above supply conductors of more than 8,700 volts between conductors, the climbing space shall be projected vertically at least 60 inches above the highest supply conductor.

1. Exception 1: This rule does not apply if it is the unvarying practice of the employers concerned to prohibit employees from ascending beyond the conductors of the given line, unless the line is killed.

2. Exception 2: For supply conductors carried on a pole in a position below communication facilities in the manner permitted in subsection E 122.01(2)(c), the climbing space need not extend more than 2 feet above such supply space.

(b) *Conductors of different voltage classifications on the same crossarm.* The climbing space shall be that required by table 10 (section E 123.07(5)(c)), for the highest voltage of any conductor bounding the climbing space. The climbing space shall extend vertically to the limits specified in section E 123.07 (5) (a), and the exception thereto.

(c) *Horizontal climbing space dimensions.* See Table 10.

(6) CLIMBING SPACE ON BUCKARM CONSTRUCTION. The full width of climbing space shall be maintained on buckarm construction and shall extend vertically in the same position at least 40 inches (or 60 inches where required by section E 123.07(5)(a)), above and below any limiting conductor.

(a) *Method of providing climbing space on buckarm construction.* With circuits of less than 8,700 volts and span lengths not exceeding 150 feet and sags not exceeding 15 inches for wires of No. 2 and larger sizes, or 30 inches for wires smaller than No. 2, a six-pin crossarm having pin spacing of 14½ inches may be used to provide a 30-inch climbing space on one corner of a junction pole by omitting the pole pins on all arms, and inserting pins midway between the remaining pins so as to give a spacing of 7¼ inches, provided that each conductor on the end of every arm is tied to the same side of its insulator, and that the spacing on the next pole is not less than 14½ inches.

TABLE 10

MINIMUM HORIZONTAL DIMENSIONS OF CLIMBING SPACE

Character of Conductors Adjacent to Climbing Space	Voltage of Conductor	Horizontal Dimensions of Climbing Space (Inches)			
		On Poles Used Solely By		On Jointly Used Poles	
		Communication Conductors	Supply Conductors	Supply Conductors Above Communication Conductors	Communication Conductors Above Supply Conductors (a)
Communication Conductors	0 to 150	No Requirement	----------	(b)	No Requirement
	Exceeding 150	24 recommended	----------	(b)	24 Recommended
Supply Conductors	Less than 300	----------	24	24	30
	300 to 8,700	----------	30	30	30
	8,700 to 15,000	----------	36	36	36
	Exceeding 15,000	----------	More than 36(c)	More than 36(c)	More than 36(c)

(a) This relation of levels is not, in general, desirable and should be avoided.

(b) The climbing space shall be the same as required for the supply conductors immediately above, with a maximum of 30 inches, except that a climbing space of 16 inches across the line may be employed for communication cables or conductors where the only supply conductors at a higher level are secondaries (0 to 750 volts) supplying airport or airway marker lights or crossing over the communication line and attached to the pole top or to a pole-top extension fixture.

(c) Where practicable. Attention is called to the operating requirements of section E 142.03

(7) CLIMBING SPACE PAST LONGITUDINAL RUNS NOT ON CROSSARMS. The full width of climbing space shall be provided past longitudinal runs and shall extend vertically in the same position from 40 inches below the run to a point 40 inches above (or 60 inches where required by section E 123.07(5)(a)). The width of climbing space shall be measured from the longitudinal run concerned. Longitudinal runs on racks, or supply cables on messengers, are not considered as obstructing the climbing space if all wires concerned are covered by rubber protective equipment or otherwise guarded as an unvarying practice before workmen climb past them. This does not apply where communication conductors are above the longitudinal runs concerned.

(a) *Exception 1:* If a supply longitudinal run is placed on the side or corner of the pole where climbing space is provided, the width of climbing space shall be measured horizontally from the center of the pole to the nearest supply conductors on crossarms, under the following conditions: Where the longitudinal run consists of open supply conductors carrying not more than 750 volts; or supply cable having effectively grounded continuous metal sheath, or insulated conductors lashed to or twisted with an effectively grounded messenger or neutral, all voltages and is supported close to the pole as by brackets, racks or pins close to the pole and where the nearest supply conductors on crossarms are parallel to and on the same side of the pole as the longitudinal run and within 4 feet above or below the run.

(b) *Exception 2:* For supply conductors carried on a pole in a position below communication facilities in the manner permitted in section E 122.01(2)(c), the climbing space need not extend more than 2 feet above such supply space.

(8) CLIMBING SPACE PAST VERTICAL CONDUCTORS. Vertical runs incased in suitable conduit or other protective covering and securely attached to the surface of the pole or structure are not considered to obstruct the climbing space.

(9) CLIMBING SPACE NEAR RIDGE-PIN CONDUCTORS. The climbing space specified in section E 123.07(5)(c), shall be provided above the top crossarm and past the ridge-pin conductor.

(a) *Exception:* Where a single crossarm carrying only two conductors is mounted so that the conductors are 2 feet below a single ridge-pin conductor, the climbing space specified in subsection (5)(c), shall be carried up to the ridge-pin conductor, but need not be carried past it.

(10) CLIMBING SPACE IN RACK CONSTRUCTION. A climbing space shall be maintained through the levels of conductors supported in rack construction and for a vertical distance of not less than 4 feet above the top conductor and not less than 4 feet below the bottom conductor so supported. The width of the climbing space measured horizontally through the center of the pole shall be not less than 5 inches plus the diameter of the pole and the extremities of such width shall be equidistant from the center line of the pole. The depth of the climbing space shall be not less than 30 inches measured perpendicularly to this climbing space boundary through the center line of pole. The width of the climbing space, perpendicular to and at the extremity of this 30-inch depth dimension, shall be not less than 38 inches and neither of the other 2 side boundaries shall make an angle of less than 90 degrees with the boundary through the center line of pole. The position of the climbing space through the levels of conductors in rack construction shall be related to climbing spaces through the levels of conductors on crossarms in accordance with requirements of section E 123.07(5). The climbing spaces through the levels of conductors of two or more rack groups which are separated less than 6 feet shall be maintained in the same quadrant or on the same side of pole. Vertical conductors are not permitted in the climbing spaces through conductors in rack construction.

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

E 123.08 Lateral working space. (1) LOCATION OF WORKING SPACES. Working spaces shall be provided on the climbing face of the pole at each side of the climbing space.

(2) DIMENSIONS OF WORKING SPACES. (a) *Along the crossarm.* The working space shall extend from the climbing space to the outmost pin position on the crossarm.

(b) *At right angles to the crossarm.* The working space shall have the same dimension as the climbing space (see section E 123.07 (5)). This dimension shall be measured horizontally from the face of the crossarm.

(c) *Vertically.* The working space shall have a height not less than that required by section E 123.09 for the vertical separation of line conductors carried at different levels on the same support.

(3) LOCATION OF VERTICAL AND LATERAL CONDUCTORS RELATIVE TO WORKING SPACES. The working spaces shall not be obstructed by vertical or lateral conductors. Such conductors shall be located on the opposite side of the pole from the climbing side or on the climbing side of the pole at a distance from the crossarms at least as great as the width of climbing space required for the highest-voltage conductors concerned. Vertical conductors enclosed in suitable conduit may be attached on the climbing side of the pole. Cutouts and their leads may be installed in the working space but not in the climbing space. Switches and their leads may extend into the working space but not into the climbing space.

(4) LOCATION OF BUCKARMS RELATIVE TO WORKING SPACES. Buckarms may be used under any of the following conditions, provided the climbing space is maintained. Climbing space may be obtained as in section E 123.07(6).

(a) *Standard height of working space.* Lateral working space of height required by table 11, (section E 123.09(1)(a)) may be provided between the buckarms and adjacent line arms to which conductors on the buckarms are not attached.

1. Method of meeting requirements. This may be accomplished by increasing the spacing between the line crossarm gains.

(b) *Reduced height of working space.* Where no circuits exceeding 8,700 volts between conductors are involved, and the clearances of sections E 123.06(1)(b), 1., a. and b., are maintained, buckarms may be placed between line arms having normal spacing; even though such buckarms obstruct the normal working space; provided that a working space of not less than 18 inches in height is maintained either above or below each line arm and each buckarm.

1. Exception: The above working space may be reduced to 12 inches if both of the following conditions exist: Not more than 2 sets of line arms and buckarms are involved. Working conditions are rendered safe by providing rubber protective equipment or other suitable devices to insulate and cover line conductors and equipment which are not being worked on.

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

E 123.09 Vertical separation between line conductors, cables, and equipment located at different levels on the same pole or structure. All line conductors, cables, or equipment located at different levels on the same pole or structure shall have the vertical separations set forth below.

(1) VERTICAL SEPARATIONS BETWEEN HORIZONTAL CROSSARMS. Crossarms supporting line conductors shall be spaced in accordance with table 11. Vertical separations between crossarms shall be measured from center to center.

(a) *Basic separations.* The separations given in table 11 are for crossarms carrying conductors of 0 to 50,000 volts attached to fixed supports.

(b) *Increased separations for voltages exceeding 50,000.* For voltages greater than 50,000, the clearances of table 11 shall be increased at the rate of 0.4 inch per 1,000 volts of the excess.

(2) VERTICAL SEPARATION BETWEEN LINE CONDUCTORS ON HORIZONTAL CROSSARMS. Where line conductors are supported on horizontal cross-

TABLE 11

VERTICAL SEPARATION OF CROSSARMS CARRYING CONDUCTORS

Conductors Usually at Lower Levels	Supply Conductors: Preferably at Higher Levels (g)				
	Open Wires 0 to 750 Volts; supply cable having effectively grounded continuous metal sheath or insulated conductors lashed to or twisted with an effectively grounded messenger or neutral, all voltages; messengers associated with such cable or conductors	750 to 8,700 Volts	8,700 to 15,000 Volts	15,000 to 50,000 Volts	
				Same Utility	Diff. Utilities
	Feet	Feet	Feet	Feet	Feet
Communication Conductors:					
General	(a)(b)4	4	6	--------	6
Used in operation of supply lines	2	(c)2	4	4	6
Supply Conductors:					
0 to 750 volts	2	(d)2	4	4	6
750 to 8,700 volts	----------	(d)2	4	4	6
8,700 to 15,000 volts	----------	--------	(e)4	(e)4	6
15,000 to 50,000 volts	----------	--------	--------	(e)4	6

Footnotes to table 11

(a) When supply circuits of 550 volts or less, with transmitted power of 3,200 watts or less, are run below communication circuits in accordance with section E 122.01(2)(c), the clearance may be reduced to 2 feet.

(b) In localities where the practice has been established of placing on jointly used poles, crossarms carrying supply circuits of less than 300 volts and crossarms carrying communication circuits at a vertical separation less than specified in the table, such existing construction may be continued until the said poles are replaced provided that—

The minimum separation between existing crossarms is not less than 2 feet, and that—

Extensions to the existing construction shall conform to the clearance requirements specified in table 11.

When communication conductors are all in cable, a supply crossarm carrying only wires of not more than 300 volts may be placed at not less than 2 feet above the point of attachment of the cable to the pole provided that—

The nearest supply wire on such crossarm shall be at least 30 inches horizontally from the center of the pole, and that—

The cable be placed so as not otherwise to obstruct the climbing space.

(c) This shall be increased to 4 feet when the communication conductors are carried above supply conductors unless the communication-line conductor size is that required for grade C supply lines.

(d) Where conductors are operated by different utilities, a minimum vertical spacing of 4 feet is recommended.

(e) These values do not apply to adjacent crossarms carrying phases of the same circuit or circuits. The vertical separation between adjacent crossarms carrying conductors of the same circuit or circuits may be reduced by 25% from that given in the table but not to less than that given for horizontal separation in section E 123.06(1)(b).

(f) Conductors which are grounded in accordance with section E 103.02 (2)(e) and are associated with circuits of 0 to 22,000 volts may have the clearances specified for open supply line wires of 0 to 750 volts.

(g) A conductor which is effectively grounded throughout its length and is associated with a supply circuit of 0 to 22,000 volts may have clearances specified for cables having effectively grounded continuous metal sheath or messenger.

arms spaced as required in section E 123.09(1), the vertical separation between such conductors shall be not less than the following:

(a) *Where conductors on the crossarm are of the same voltage classification.* Under these conditions, the vertical separation required by table 11 may be reduced as follows: [see table at top of page 106].

(b) *Where conductors of different voltage classifications are on same crossarm.* Under these conditions, the vertical separation between

Where Crossarm Separation Required by Table 11 is	Separation Between Conductors May Be Reduced to
2 feet	16 inches
4 feet	40 inches
5 feet	50 inches
6 feet	60 inches

conductors on adjacent crossarms shall be that required by table 11 (section E 123.09(1)(a)) above for the highest voltage classification concerned.

(c) *Conductors of different sags on same support.* 1. Variation in clearances. Line conductors supported at different levels on the same structure and strung to different sags shall have vertical spacings at the supporting structures so adjusted that the minimum spacing at any point in the span, at 60° F., with no wind, shall not be reduced more than 25% from that required at the supports by sections E 123.06(1)(b), 1. a. and b. and E 123.09 (2).

2. Readjustment of sags. Sags should be readjusted when necessary to accomplish the foregoing, but not reduced sufficiently to conflict with the requirements of section E 126.02(6)(d). In cases where conductors of different sizes are strung to the same sag for the sake of appearance or to maintain unreduced clearance throughout storms, the chosen sag should be such as will keep the smallest conductor involved in compliance with the sag requirements of section E 126.02 (6) (d).

3. Increased vertical separation at supports. For span lengths in excess of 150 feet, vertical separation at the pole between open supply conductors and communication cables or conductors shall be adjusted so that under conditions of 60° F., no wind and final unloaded sag, no supply conductor of 750 volts or less shall be lower in the span than a straight line joining the points of support of the highest communication cable or conductor, and no supply conductor of over 750 volts but less than 50,000 volts shall be lower in the span than 30 inches above such straight line.

Exception: Effectively grounded supply conductors associated with systems of 22,000 volts or less need meet only the provisions of section E 123.09(2)(c), 1.

(3) SEPARATION IN ANY DIRECTION. The separation in any direction between conductors of the same or different voltage classification when carried on the same structure, but on crossarms which are not horizontal, or on different types of supports at the two levels (such as a horizontal crossarm and a vertical rack) shall be not less than the values given in sections E 123.09 (2) (a) and E 123.09 (2) (b) for vertical separation. The separation in any direction shall not in any case be less than the horizontal separation specified in sections E 123.06(1)(b)1., a. and b.

(4) VERTICAL SEPARATION FOR LINE CONDUCTORS NOT CARRIED ON CROSSARMS. The vertical separation between conductors not carried on crossarms shall be the same as required in section E 123.09 (2) (a) for conductors on crossarms.

(a) *Exception 1:* Conductors on vertical racks or separate brackets other than wood placed vertically, meeting the requirements of

section E 123.06(1)(d), may have separations as specified in that rule.

(b) *Exception 2:* Where communication service drops cross under supply conductors on a common crossing pole, the separation between the communication conductor and an effectively grounded supply conductor may be reduced to 4 inches, provided the separation between the communication conductor and supply conductors not effectively grounded meet the requirements of sections E 123.09(2)(a), (b) or (4) as appropriate.

(5) VERTICAL SEPARATION BETWEEN CONDUCTORS AND NONCURRENT-CARRYING METAL PARTS OF EQUIPMENT. (a) *Equipment.* For the purpose of measuring separations under this rule, "equipment" shall be taken to mean noncurrent-carrying metal parts of equipment, including metal supports for cables or conductors, and metal supply-crossarm braces which are attached to metal crossarms or are less than 1 inch from transformer cases or hangers which are not effectively grounded.

(b) *Separations in general.* Vertical separations between supply conductors and communication equipment, between communication conductors and supply equipment, and between supply and communication equipment shall be as follows, except as provided in (c) below.

Supply Voltage	Vertical Separation
	Inches
0 to 8,700	(a) 40
Exceeding 8,700	(a) 60

Note a. Where noncurrent-carrying parts of equipment and supply cables are effectively grounded consistently throughout well-defined areas, and where communication is at lower levels, separations may be reduced to 30 inches.

(c) *Separations for span wires and brackets.* Span wires or brackets carrying lamps or trolley conductors shall have at least the vertical separations in inches from communication equipment set forth below.

	Span Wires and Brackets			
	Carrying Lamps		Carrying Trolley Conductors	
	Not Effectively Grounded	Effectively Grounded	Not Effectively Grounded	Effectively Grounded
	Inches	Inches	Inches	Inches
Above Communication Crossarms	20a	20a	20a	20a
Below Communication Crossarms	24	24	24	24
From Messenger Carrying Communication Cables	20a	4	12	4
From Terminal Box of Communication Cable	20a	4	12b	4
From Communication Brackets, Bridle Wire Rings or Drive Hooks	16a	4	4	4

Note a. This may be reduced to 12 inches for either span wires or metal parts of brackets at points 40 inches or more from the pole surface.

Note b. Where it is not practicable to obtain a clearance of 1 foot from terminal boxes of communication cables, all metal parts of terminals shall have the greatest possible separation from fixtures or span wires including all supporting screws and bolts of both attachments.

(d) *Separation from drip loops of street light brackets.* Drip loops of conductors entering street light brackets from the surface of the pole, shall be at least 12 inches above communication cables or through bolts.

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

E 123.10 Clearances of vertical and lateral conductors from other wires and surfaces on the same support. Vertical and lateral conductors shall have the clearances and separations required by this rule from other conductors, wires, or surfaces on the same support.

Exception 1: This rule does not prohibit the placing of supply circuits of the same or next voltage classification in the same iron pipe, if each circuit or set of wires be enclosed in a metal sheath.

Exception 2: This rule does not prohibit the placing of paired communication conductors in rings attached directly to the pole or to messenger.

Exception 3: This order does not prohibit placing grounding conductors, neutral conductors which are effectively grounded throughout their length and associated with supply circuits of 0 to 22,000 volts, metal sheathed supply cables, or conductors enclosed in conduit, directly on the pole.

Exception 4: This order does not prohibit placing supply circuits of 550 volts or less and not exceeding 3,200 watts and properly insulated in the same cable with control circuits with which they are associated.

(1) LOCATION OF VERTICAL OR LATERAL CONDUCTORS RELATIVE TO CLIMBING SPACES, WORKING SPACES, AND POLE STEPS. Vertical or lateral conductors shall be located so that they do not obstruct climbing spaces, or lateral working spaces between line conductors at different levels or interfere with the safe use of existing pole steps.

(a) *Exception 1:* This rule does not apply to portions of the pole which workmen do not ascend while the conductors in question are alive.

(b) *Exception 2:* This rule does not apply to vertical runs incased in suitable conduit or other protective covering. (See subsection E 123.07(8))

(2) CONDUCTORS NOT IN CONDUIT. Conductors not incased in conduit shall have the same clearances from conduits as from other surfaces of structures.

(3) MECHANICAL PROTECTION NEAR GROUND. For a distance of 8 feet above the ground, floor, or platforms from which grounding conductors are accessible to the public, the conductors shall be protected by a substantial insulating conduit or wood molding.

(a) Where the ground resistance is less than 3 ohms a metallic guard may be used provided that in the case of lightning arrester ground the ground conductor must be electrically connected to both ends and the metallic guard covered by an insulating conduit or molding.

(b) In rural areas other than in farm and school yards, or spaces where people congregate, grounding conductors of a multi-grounded system may be weatherproof insulation instead of an insulating conduit or molding.

(c) Grounding conductors whose only purpose is to protect a pole against lightning need not be protected.

(4) REQUIREMENTS FOR VERTICAL AND LATERAL SUPPLY CONDUCTORS ON SUPPLY LINE POLES OR WITHIN SUPPLY SPACE ON JOINTLY USED POLES. (a) *General clearances.* In general, clearances shall be not less than the values specified in table 12.

TABLE 12

Clearance of Vertical and Lateral Conductors	Clearances (in Inches) for Highest Voltage Concerned in the Clearance	
	0 to 8,700 Volts	Exceeding 8,700 Volts (add the Following for Each 1,000 in Excess)
From surfaces of supports	3	0.20
From span, guy or messenger wires	6	.40
From line conductors rigidly supported on fixed supports	3	.25
From line conductors not rigidly supported on fixed supports	(a)	(a)

(a) The clearances shall be increased beyond the values given above from line conductors on fixed supports. (See subsections E 123.06(1)(b)2., and b., 3.)

(b) *Special cases.* The following apply only to portions of a pole which workmen ascend while the conductors in question are alive.

1. Side-arm construction. Vertical conductors in metal-sheathed cables and grounding wires may be run without insulating protection from supply line conductors on poles used only for supply lines and employing side-arm construction on the side of the pole opposite to the line conductors if climbing space is provided on the line conductor side of pole.

2. On insulators. Vertical and lateral conductors of less than 8,700 volts if on poles used only for supply lines may be run in multiple-conductor cables having suitable substantial insulating covering, if such cable is held taut on standard insulators supported on pins or brackets and is arranged so that the cable is held at a distance of approximately 5 inches from the surface of the pole, and from any pole step.

3. Conductors to street lamps. On poles used only for supply lines, open wires may be run from the supply line arm directly to the head of a street lamp, provided the clearances of table 12 are obtained and the open wires are substantially supported at both ends.

4. Conductors of less than 300 volts. Vertical or lateral secondary supply conductors of not more than 300 volts may be run in multiple-conductor cable attached directly to the pole surface or to crossarms in such a manner as to avoid abrasion at the point of attachment. Each conductor of such cable which is not effectively grounded, or the entire cable assembly, shall have an insulating covering required for a conductor of at least 600 volts.

5. Other conditions. If open wire conductors are within 4 feet of the pole, vertical conductors where within a zone of 4 feet above and below such line conductors of not more than 8,700 volts or where within a zone 6 feet above and below such line conductors of more than 8,700 volts, shall be run in one of the following ways:

a. So as to clear the pole center by not less than 15 inches if the vertical conductors are of 8,700 volts or less, or 20 inches if more than 8,700 volts;

b. Enclosed in insulating conduit, or in metal conduit or cable protected by an insulating covering;

c. Conductors with weatherproof covering and covered by wood molding;

d. Methods a. and b. apply also to lateral runs and to grounding conductors, except that conductors for grounding lightning protection wires are not required to be covered within 6 feet above or below circuits of 15,000 volts or more.

(5) REQUIREMENTS FOR VERTICAL AND LATERAL COMMUNICATION CONDUCTORS ON COMMUNICATION LINE POLES OR WITHIN THE COMMUNICATION SPACE ON JOINTLY USED POLES. (a) *Clearances from wires.* The clearances and separations of vertical and lateral conductors from other conductors (except those in the same ring run) and from guy, span, or messenger wires shall be 3 inches.

(b) *Clearances from pole and crossarm surfaces.* Vertical and lateral insulated communication conductors may be attached directly to a pole or crossarm. They shall have a vertical clearance of at least 40 inches from any supply conductors (other than vertical runs or lamp leads) of 8,700 volts or less, or 60 inches if more than 8,700 volts between conductors.

(c) *Exception:* These clearances do not apply where the supply circuits involved are those carried in the manner specified in section E 122.01(2)(c).

(6) REQUIREMENTS FOR VERTICAL SUPPLY CONDUCTORS PASSING THROUGH COMMUNICATION SPACE ON JOINTLY USED POLES. Vertical supply conductors, including grounding wires, which pass through communication line space on joint poles shall be installed as follows:

(a) *Metal-sheathed supply cables.* Metal-sheathed supply cables shall be covered as follows:

1. Extent of covering. Covering shall extend from the lowest points of such cables up to 40 inches above the highest communication conductors.

2. Nature of covering. The covering shall consist of wood molding or other suitable insulating material at points higher than 8 feet above the ground.

a. Exception 1: Metal pipe may be used throughout, under the following conditions:

On poles where there are no trolley attachments and the metal pipe is effectively grounded, no insulating covering is required.

On poles where there are trolley attachments or where the metal pipe is not effectively grounded, the pipe shall be covered with the wood molding or other suitable insulating material from a point 6 feet below the lowest communication wire or trolley attachment to a point 40 inches above the highest communication wire or trolley attachment.

b. Exception 2: No insulating covering is required over supply secondary multi-conductor cables attached directly to the pole surface in accordance with the requirements of section E 123.10(6)(b)3.

c. Exception 3: Where there are no trolley attachments on the pole, no insulating covering is required over supply cables having

effectively grounded lead sheath, or supply cables having effectively grounded metal sheath of other types where mutually agreed to by the parties concerned.

(b) *Supply conductors.* Supply conductors shall be installed in one of the following ways:

1. In conduit. Conductors of all voltages may be enclosed in the same way and to the same extent as required in (a) above for metal-sheathed cables.

2. On pins and insulators. Vertical and lateral conductors of street-lighting circuits and service leads of less than 750 volts may be run in multiple-conductor cable having suitable substantial insulating covering if such cable is held taut on standard insulators supported on pins or brackets and arranged so that the cable shall be held at a distance of approximately 5 inches away from the surface of the pole or from any pole steps.

3. Installed on the pole surface. Secondary supply conductors of not more than 300 volts may be run in multiple-conductor cables attached directly to the pole surface in such a manner as to avoid abrasion at the points of attachment. In the case of aerial services, the point where such cables leave the pole shall be at least 40 inches above the highest, or 40 inches below the lowest communication attachment. Each conductor of such cable which is not effectively grounded shall be insulated for a potential of at least 600 volts.

4. Suspended from supply crossarm. Lamp leads of street-lighting circuits may be run from supply crossarms directly to a street lamp bracket or luminaire under the following conditions:

a. The vertical run shall consist of paired wires or multiple-conductor cable securely attached at both ends to suitable brackets and insulators.

b. The vertical run shall be held taut at least 40 inches from the surface of the pole (through the communication space), at least 12 inches beyond the end of any communication crossarm by which it passes, at least 6 inches from communication drop wires, and at least 20 inches from any communication cable.

c. Insulators attached to lamp brackets for supporting the vertical run shall be capable of meeting, in the position in which they are installed, the same flashover requirements as the luminaire insulators.

d. Each conductor of the vertical run shall be No. 10 A.W.G. or larger.

(c) *Supply grounding wires.* Supply grounding wires shall be covered with wood molding or other suitable insulating covering to the extent required for metal-sheathed cables in (a) above.

(d) *Separation from through bolts.* Vertical runs of supply conductors shall be separated from the ends of through bolts associated with communication line equipment by one-eighth of the circumference of the pole where practicable, but in no case less than 2 inches. Vertical runs of effectively grounded supply conductor may have a separation of one inch from the end of communications through bolts.

(7) REQUIREMENTS FOR VERTICAL COMMUNICATION CONDUCTORS PASSING THROUGH SUPPLY SPACE ON JOINTLY USED POLES. All vertical runs of communication conductors passing through supply space shall be installed as follows:

(a) *Metal-sheathed communication cables.* Vertical runs of metal-sheathed communication cables shall be covered with wood molding, or other suitable insulating material, where they pass trolley feeders or other supply-line conductors. This insulating covering shall extend from a point 40 inches above the highest trolley feeders, or other supply conductors to a point 6 feet below the lowest trolley feeders or other supply conductors but need not extend below the top of any mechanical protection which may be provided near the ground.

1. Exception: Communication cables may be run vertically on the pole through space occupied by railroad signal supply circuits in the lower position, as permitted in section E 122.01(2)(c), without insulating covering within the supply space.

(b) *Communication conductors.* Vertical runs of insulated communication conductors shall be covered with wood molding, or other suitable insulating material, to the extent required for metal-sheathed communication cables in (a) above, where such conductors pass trolley feeders or other supply conductors.

1. Exception: Communication conductors may be run vertically on the pole through space occupied by railroad-signal supply circuits in the lower position, as permitted in section E 122.01(2)(c), without insulating covering within the supply space.

(c) *Communication grounding conductors.* Vertical communication grounding conductors shall be covered with wood molding or other insulating material between points at least 6 feet below and 40 inches above any trolley feeders or other supply line conductors by which they pass.

1. Exception: Communication grounding conductors may be run vertically on the pole through space occupied by railroad-signal supply circuits in the lower position, as permitted in section E 122.01 (2)(c), without insulating covering within the supply space.

(d) *Separation from through bolts.* Vertical runs of communication conductors shall be separated from the ends of through bolts associated with supply-line equipment by one-eighth of the circumference of the pole where practicable, but in no case less than 2 inches.

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

GRADES OF ES WITH OTHER CONDUCTORS

Conductors, Tracks and Rights of Way at Lower Levels		current nductors	Direct current railway feeders			Communication conductors used exclusively in the operation of, and run as, supply lines
			0 to 750 Volts	Exceeding 750 Volts		
		Cable	Open or Cable	Open	Cable	Open or Cable
Exclusive private rights of way		or N 4.03 (1)	B, C or N See E 124.03 (2)			C or N See E 124.03 (3)
Common or Public rights of way						
Railroad tracks—Main or Minor		B	B	B	B	B
Street-railway tracks having no		N	N	N	N	N
Constant-potential supply conductors	0–750	or N 4.03 (1)	B, C or N See E 124.03 (2)			B, C or N See E 124.03 (3)
	750 to 87					
	Exceeding					
Constant current supply conduct Open or Cable		or N 4.03 (1)	B, C or N See E 124.03 (1) & (2)			B, C or N See E 124.03 (1) & (3)
Direct current railway feeders—		or N 3 (1) & (2)	B, C or N See E 124.03 (2)			B, C or N See E 124.03 (2) & (3)
Trolley contact conductors—Alt						
Communication conductors, Ope in the operation of supply line		or N 3 (1) & (3)	B, C or N See E 124.03 (2) & (3)			B, C or N See E 124.03 (3)
Communication conductors—Url Open or Cable (f)		C or N see 124.03 (1)	N	B(h)	C	B, C or N See E 124.03 (3)

(a) The words "open" and "c following meanings as applied t specially installed cables descri open wire and also supply cabl

(b) Where lines are located s private rights of way into urba with the grades specified for lin for corresponding voltages.

(c) If circumstances within a need only meet the requiremen circuits are so constructed, ope will be promptly deenergized, breaker operations, in the event or other grounded objects.

supply and communication circuits are so constructed, ated and maintained that the supply voltage will be promptly oved from the communication plant by deenergization or r means, both initially and following subsequent breaker ations in the event of a contact with the communication t.

voltage and current impressed on the communication plant he event of a current with the supply conductors are not in ss of the safe operating limit of the communication pro- ive devices.

C construction may be used if the current cannot exceed or the open-circuit voltage of the transformer supplying the ot exceed 2,900 volts.

Chapter E 124

GRADES OF CONSTRUCTION

E 124.01 General. For the purposes of chapter E 126, "Strength requirements," and chapter E 127, "Line insulators," conductors and their supporting structures are classified under the grades specified in this chapter on the basis of the relative hazard existing.

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

E 124.02 Application of grades of construction to different situations. (1) SUPPLY CABLES. For the purpose of these rules supply cables are divided into 2 classes as follows:

(a) *Specially installed cables.* In this class are included supply cable having effectively grounded continuous metal sheath, or insulated conductors supported on and lashed together with an effectively grounded messenger, installed in accordance with subsection E 126.02 (7) (a).

Note: Such cables are sometimes permitted to have a lower grade of construction than open-wire supply conductors of the same voltage.

(b) *Other cables.* In this class are included all other supply cables.

Note: Such cables are required to have the same grade of construction as open-wire supply conductors of the same voltage.

(2) TWO OR MORE CONDITIONS. In any case where two or more conditions affecting the grade of construction exist, the grade of construction used shall be the highest one required by any of the conditions.

(3) ORDER OF GRADES. For supply and communication conductors and supporting structures, the relative order of grades is B, C, and N, grade B being the highest. Where grades D and N are specified for communication lines, grade D is the highest.

Note: Grade D cannot be directly compared with the series B and C, but section E 124.02 (4) (c) 3. provides for cases where these two conditions are present.

(4) AT CROSSINGS. (a) *Grade of upper line.* Conductors and supporting structures of a line crossing over another line shall have the grade of construction specified in sections E 124.02(4)(c), E 124.03 and E 124.04.

(b) *Grade of lower line.* Conductors and supporting structures of a line crossing under another line need only have the grades of construction which would be required if the line at the higher level were not there.

(c) *Multiple crossings.* 1. Where a line crosses in one span over two other lines. The grade of construction of the uppermost line shall be not less than the highest grade which would be required of either one of the lower lines if it crossed the other lower line.

Example: If a 2,300-volt line crosses in the same span over a communication line and a direct-current trolley contact conductor of more than 750 volts, the 2,300-volt line is required to comply with grade B construction at the crossing.

This is a double crossing and introduces a greater hazard than where the upper supply line crosses the communication line only.

2. Where one line crosses over a span in another line, which span is in turn involved in a second crossing. The grade of construction for the highest line shall be not less than that required for the next lower line.

a. Exception: This requirement does not apply when the 2 upper lines are of such nature and have such circuit protection that the danger of causing a break in the lower of these 2 lines by mechanical or electrical contact is eliminated.

3. Where communication conductors cross over supply conductors and railroad tracks in the same span. The grades of construction shall be in accordance with table 13.

TABLE 13

GRADES OF CONSTRUCTION FOR COMMUNICATION CONDUCTORS CROSSING OVER RAILROAD TRACKS AND SUPPLY LINES

When crossing over—	Communication conductor grades
Railroad tracks and supply lines of 0 to 750 volts, or specially installed supply cables of all voltages	D
Railroad tracks and supply lines exceeding 750 volts	B

Recommendation: It is recommended that the placing of communication conductors above supply conductors at crossings, conflicts, or on jointly used poles be avoided unless the supply conductors are trolley contact conductors and their associated feeders.

(5) CONFLICTS. (a) *How determined.* Where 2 lines are adjacent (except at crossing spans) the distance between them and the relative heights above ground of poles and of conductors on each line determine whether conflict exists, and, if so, whether the conflict is a structure conflict (see definition) or a conductor conflict (see definition), or both.

(b) *Conductor conflict.* At conductor conflicts the grade of construction of the conflicting conductor shall be as required by section E 124.02(4)(c) and section E 124.03.

(c) *Structure conflict.* At structure conflicts, the grade of construction of the conflicting structure shall be as required by section E 124.04.

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

E 124.03 Grades of construction for conductors. The grades of construction required for conductors of all classes in different situations are given in tables 14 and 15. For the purpose of these tables certain classes of circuits are treated as follows:

(1) STATUS OF CONSTANT-CURRENT CIRCUITS. The grade of construction for a constant-current supply circuit involved with a communication circuit and not in specially installed cable shall be based on either its current rating or on the open-circuit voltage rating of the trans-

former supplying such circuit, as set forth in tables 14 and 15. In all other cases the grade of construction for a constant-current circuit shall be based on its nominal full-load voltage.

(2) STATUS OF RAILWAY FEEDERS AND TROLLEY CONTACT CONDUCTORS. In determining grades of construction where railway feeders and trolley contact conductors are involved they shall be considered as other supply conductors of the same voltage.

(a) *Exception:* Direct-current trolley circuits exceeding 750 volts where crossing over, conflicting with, or on jointly used poles with and above communication circuits, shall have the grades of construction specified in table 14 for direct-current railway feeders.

(3) STATUS OF COMMUNICATION CIRCUITS USED EXCLUSIVELY IN THE OPERATION OF SUPPLY LINES. In determining grades of construction where communication circuits used exclusively in the operation of supply lines are concerned, they shall be considered as ordinary communication circuits when run as such (see section E 128.09(1)(c)) and as supply circuits when run as such (see section E 128.09(1)(d)).

(a) *Exception:* Communication circuits located below supply circuits with which they are used shall not require such supply circuits to meet any rules for grade of construction other than that the sizes of such supply conductors shall not be less than required for grade C (see section E 126.02(6) (b)).

(4) STATUS OF FIRE-ALARM CONDUCTORS. In determining grades of construction where fire-alarm conductors are concerned, they shall be considered as other communication circuits.

(a) *Exception:* Fire-alarm conductors shall always meet grade D where the span length is from 0 to 150 feet, and grade C where the span length exceeds 150 feet.

(5) STATUS OF NEUTRAL CONDUCTORS OF SUPPLY CIRCUITS. Supply-circuit neutral conductors, which are effectively grounded throughout their length in accordance with section E 103.02(2) (d) and are not located above supply conductors of more than 750 volts, shall have the same grade of construction as supply conductors of not more than 750 volts, except that they need not meet any insulation requirements. Other neutral conductors shall have the same grade of construction as the phase conductors of the supply circuits with which they are associated.

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

E 124.04 Grades of supporting structures. (1) POLES OR TOWERS. The grade of construction shall be that required for the highest grade of conductors supported.

Note: See section 182.018, Wis. Stats., 1959 for additional R. R. crossing requirements.

(a) *Exception 1:* The grade of construction of jointly used poles, or poles used only by communication lines, need not be increased merely because of the fact that communication wires carried on such poles cross over trolley contact conductors of 0 to 750 volts.

(b) *Exception 2:* Poles carrying grade C or D fire-alarm conductors, where alone, or where concerned only with other communication conductors, need meet only the requirements of grade N.

TABLE 15

GRADES OF CONSTRUCTION FOR COMMUNICATION CONDUCTORS WHEN ALONE, OR IN UPPER POSITION AT CROSSINGS, AT CONFLICTS, OR ON JOINT POLES

Conductors, tracks and rights of way at lower levels		Communication conductors at higher levels (a)	Communication conductors, rural or urban, open or cable, including communication conductors run as such, but used exclusively in the operation of supply lines
Exclusive private rights-of-way			N
Common or Public rights-of-way			N
Railroad tracks			D
Street-railway tracks having no overhead contact wire			N
Constant-potential supply conductors (b)	0 to 750 volts	Open or cable	N
	750 to 5000 v.	Open or cable	C
	5000 to 7500 v.	Open	B
		Cable	C
	Exceeding 7500 volts (f)	Open	B
		Cable	C
Constant current supply conductors (b)	0 to 7.5 amp.	Open (c)	C
	Exceeding 7.5 amp.	Open (c)	(d) B
Direct-current railway feeders (b)	0 to 750 volts	Open or cable	N
	Exceeding 750 v.	Open or cable	B
Trolley Contact Conductors	0 to 750 volts	A.C. or D.C.	C
	Exceeding 750 v.	A.C.	(e), B, or C
		D.C.	B
Communication conductors, open or cable used exclusively in the operation of Supply Lines			(f) B, C, or N
Communication conductors, open or cable, urban or rural			N

Footnotes to table 15

(a) It is recommended that the placing of communication conductors above supply conductors at crossings, conflicts, or jointly used poles be avoided if practicable, unless the supply conductors are trolley contact conductors and their associated feeders.

(b) The words "open" and "cable" appearing in the headings have the following meaning as applied to supply conductors: "Cable" means the specially installed cables described in section E 124.02 (1) (a). "Open" means open wire and also supply cables not "specially installed."

(c) Where constant-current circuits are in specially installed cable, they are considered on the basis of the nominal full-load voltage.

(d) Grade C construction may be used if the open-circuit voltage of the transformer supplying the circuit does not exceed 2,900 volts.

(e) See section E 124.03(2).

(f) See section E 124.03(3).

(c) *Exception 3:* Poles carrying supply service loops of 0 to 750 volts shall have at least the grade of construction required for supply line conductors of the same voltage.

(d) *Exception 4:* Where communication lines cross over supply conductors and a railroad in the same span and grade B is required by

section E 124.02(4) (c)3. for the communication conductors, due to the presence of railroad tracks, the grade of the poles or towers shall be D.

(e) *Exception 5:* At structure conflicts even though no conductor conflict exists, the grade of construction which would be required by section E 124.03 if the conductors were in conflict, shall be applied to the pole or tower.

Note: This requirement may result in a higher grade of construction for the pole or tower than for the conductors carried thereon.

(f) *Exception 6:* In the case where a structure conflict does not exist, but any conductor is in conductor conflict, the grade of construction of the pole or tower is not required to meet the conductor grade due to the conductor conflict.

(2) CROSSARMS. The grade of construction shall be that required for the highest grade of conductors carried by the crossarm concerned.

(a) *Exception 1:* The grade of construction of crossarms carrying only communication conductors need not be increased merely because of the fact that such conductors cross over trolley contact conductors of 0 to 750 volts.

(b) *Exception 2:* Crossarms carrying grade C or D fire-alarm conductors, where alone or where concerned with other communication conductors need meet only the requirements for grade N.

(c) *Exception 3:* Crossarms carrying supply service loops of 0 to 750 volts shall have at least the grade of construction required for supply line conductors of the same voltage.

(d) *Exception 4:* Where communication lines cross over supply conductors and a railroad in the same span and grade B is required by section E 124.02 (4) (c) 3. for the communication conductors due to the presence of railroad tracks, the grade of the crossarm shall be D.

(3) PINS, INSULATORS, AND CONDUCTOR FASTENINGS. The grade of construction shall be that required for the conductor concerned.

(a) *Exception 1:* The grade of construction of pins, insulators, and conductor fastenings carrying only communication conductors need not be increased merely because of the fact that such conductors cross over trolley contact conductors of 0 to 750 volts.

(b) *Exception 2:* In case of grade C or D fire-alarm conductors where alone or where concerned only with other communication conductors, pins, insulators, and conductor fastenings need meet only the requirements for grade N.

(c) *Exception 3:* In the case of supply service loops of 0 to 750 volts, pins, insulators, and conductor fastenings shall have at least the same grade of construction as required for supply line conductors of the same voltage.

(d) *Exception 4:* Where communication lines cross over supply conductors and a railroad in the same span, and grade B is required by section E 124.02 for the communication conductors due to the presence of railroad tracks, the grade of pins, insulators, and conductor fastenings shall be grade D.

(e) *Exception 5:* In case communication conductors are required to meet grade B or C, the insulators need meet only the requirements for mechanical strength for these grades.

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

Chapter E 125

LOADING FOR GRADES B, C, AND D

E 125.01 Loading general. Three degrees of severity are recognized in the United States for the loading, due to weather conditions, and are designated, respectively as heavy, medium, and light loading. The districts in which these loadings apply are determined by weather reports as to wind and ice and by local experience of utilities using overhead lines. The state of Wisconsin is considered as being in the heavy loading district. No data will therefore be given on light and medium loading. (See section E 125.02).

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

E 125.02 Conductor loading. (1) The loading on conductors shall be assumed to be the resultant loading per foot equivalent to the vertical load per foot of the conductor and ice combined with the transverse loading per foot due to a transverse, horizontal wind pressure upon the projected area of the conductor and ice to which equivalent resultant shall be added a constant. In the tabulation below are the values for ice, wind, temperature, and constants which shall be used to determine the conductor loading.

Radial thickness of ice (inches)	0.50
Horizontal wind pressure in pounds per square foot	4
Temperature (°F.)	0
Constant to be added to the resultant in pounds per foot	
For bare conductors of copper, steel, copper-alloy, copper-covered steel, and combinations thereof	0.29
For bare conductors of aluminum (with or without steel reinforcement)	0.31
For weatherproof and similar covered conductors (all materials)	0.31

Note: Since heavy ice does not often form on conductors in a heavy wind the transverse loading assumed is deemed sufficient for the purpose, but is not sufficient to represent the vertical (or combined) load which is imposed on conductors by the heavy deposits of ice which frequently form in comparatively still air. In order to apply a total loading to conductors representing more nearly the conditions encountered in practice, constants have been added to the conductor loading which makes no substantial change in the conductor loading specified in the fourth edition of this code.

(2) Where cables are concerned, the specified loadings shall be applied to both cable and messenger.

(3) In applying loadings to bare stranded conductors, the coating of ice shall be considered as a hollow cylinder touching the outer strands.

Note: If anyone desires to obtain a description of light and medium loading he should refer to "The National Electrical Safety Code" published by the Bureau of Standards.

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

E 125.03 Loads upon line supports. (1) ASSUMED VERTICAL LOADING. The vertical loads upon poles, towers, foundations, crossarms, pins,

insulators, and conductor fastenings shall be their own weight plus the superimposed weight which they support, including all ice covered wires and cables, together with the effect of any difference in elevation of supports. The radial thickness of ice shall be computed only upon wires, cables, and messengers, and shall be taken as 0.50 inch of ice. Ice is assumed to weigh 57 pounds per cubic foot.

Note: The weight of ice upon supports is ignored for the sake of simplicity.

(2) ASSUMED TRANSVERSE LOADING. In computing the stresses in poles, towers, and side guys the loading shall be taken as follows:

(a) *Cylindrical surfaces.* A horizontal wind pressure, at right angles to the direction of the line, of 4 pounds per square foot upon the projected area of cylindrical surfaces of all supported conductors and messengers, when covered with a layer of ice 0.5 inch in radial thickness and on surfaces of the poles and towers without ice covering, shall be assumed. (See (c) and (d) following.) For supporting structures carrying more than 10 wires, not including cables supported by messengers, where the pin spacing does not exceed 15 inches, the transverse load shall be calculated on two-thirds of the total number of such wires with a minimum of 10 wires.

(b) *Trolley contact conductors.* When a trolley contact conductor is supported on a commonly used pole it shall be included in the computation of the transverse load on the structure.

(c) *Flat surfaces.* For flat surfaces the assumed unit wind pressure shall be increased by 60%. Where latticed structures are concerned the actual exposed area of one lateral face shall be increased by 50% to allow for the pressure on the opposite face; this total, however, need not exceed the pressure which would occur on a solid structure of the same outside dimensions. The results obtained by more exact calculations may be substituted for the values obtained by this simple rule.

(d) At angles (combined longitudinal and transverse loading) where a change in direction of wires occurs, the loading upon the structure, including guys, shall be assumed to be a resultant load equal to the vector sum of the transverse wind load given in subsection E 125.03(2)(a) above and the resultant load imposed by the wires due to their change in direction. In obtaining these loadings, a wind direction shall be assumed which will give the maximum resultant load, proper reduction being made in loading to account for the reduced wind pressure on the wires resulting from the angularity of the wind to the wires.

(3) ASSUMED LONGITUDINAL LOADING. (a) *Change in grade of construction.* The longitudinal loading upon supporting structures, including poles, towers, and guys at ends of sections required to be of grade B construction, shall be taken as an unbalanced pull in the direction of the higher grade section equal to the larger of the following values:

1. The pull of two-thirds and in no case less than 2 of the conductors supported thereon which have ultimate strength of 3000 pounds or less, such two-thirds of the conductors being selected so as to produce the maximum stress in the support; the nearest whole number of conductors to be used, or

2. The pull of one conductor when there are 8 or less conductors (including overhead ground wires) having ultimate strength of more than 3,000 pounds, and the pull of 2 conductors when there are more than 8 conductors, such conductors being selected so as to produce the maximum stress in the support.

(b) *Jointly used poles at crossings over railroads or communication lines.* Where a joint line crosses over a railroad or a communication line and grade B is required for the crossing span, the tension in the communication conductors of the joint line may be considered as limited to one-half their breaking strength, provided they are smaller than No. 8 Stl. W.G., if of steel, or No. 6 A.W.G., if of copper, regardless of how small the initial sags of the communication conductors at 60°F.

(c) *Dead ends.* The longitudinal loading upon supporting structures at dead-ends for line terminations shall be taken as an unbalanced pull equal to the tensions of all conductors and messengers (including overhead ground wires), under the conditions of conductor loading specified in section E 125.02; except that with spans in each direction from the dead-end structure the unbalanced pull shall be taken as the difference in tensions plus, if applicable, the tensions with broken wire conditions specified in section E 125.03(3) (a).

(d) *Communication conductors on unguyed supports at railroad crossings.* The longitudinal loading shall be assumed equal to an unbalanced pull in the direction of the crossing of all open-wire conductors supported, the pull of each conductor being taken as 50% of its ultimate strength.

(4) AVERAGE SPAN LENGTHS. (a) *General.* The calculated transverse loads, upon poles, towers, and crossarms, except as provided in (b) below, shall be based upon the average span length of a section of line that is reasonably uniform as to height, number of wires, grade, and span length. In no case shall the average value taken be less than 75% or more than 125% of the actual average of the 2 spans adjacent to the structure concerned.

(b) *Crossings.* In the case of crossings over railroads or communication lines the actual lengths of the two spans adjacent to the two structures concerned shall be used.

(5) SIMULTANEOUS APPLICATION OF LOADS. (a) When calculating transverse strength, the assumed transverse and vertical loads shall be taken as acting simultaneously.

(b) In calculating longitudinal strength, the assumed longitudinal loads shall be taken without consideration of the vertical or transverse loads.

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

Chapter E 126

STRENGTH REQUIREMENTS

E 126.01 Preliminary assumptions. It is recognized that deformation, deflection, or displacement of parts of the structure will, in some cases, change the effects of the loads assumed. In the calculation of stresses, however, no allowance shall be made for such deformation, deflection, or displacement of supporting structures (including poles, towers, conductor fastenings, and suspension insulators) unless the methods used to evaluate them have been approved by the administrative authority.

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

E 126.02 Grades B and C construction. (1) POLES AND TOWERS. The strength requirements for poles and towers may be met by the structures alone or with the aid of guys or braces.

(a) *Average strength of 3 poles.* A pole (single-base structure) not individually meeting the transverse strength requirements will be permitted when reinforced by a stronger pole on each side, if the average strength of the 3 poles meets the transverse strength requirements, and the weak pole has not less than 75% of the required strength. An extra pole inserted in a normal span for the purpose of supporting a service loop may be ignored, if desired, in the calculation of the strength of the line.

1. Exception: In the case of crossings over railroads or communication lines the actual strengths of the crossing poles shall be used.

(b) *Reinforced-concrete poles.* Reinforced-concrete poles shall be of such material and dimensions as to withstand for vertical and transverse strength, the loads assumed in sections E 125.03(1) and (2) and for longitudinal strength the loads in section E 125.03(3) without exceeding the following percentages of their ultimate strength at the ground line for unguyed poles, or at the point of guy attachment for guyed poles. (Where guys are used, see subsection E 126.02 (3).)

	Percentages of Ultimate Strength for Different Grades	
	Grade B	Grade C
For transverse strength (when installed)	25	37.5
For longitudinal strength (at all times)		
In general	100	No requirement
At dead-ends	50	75

(c) *Metal supporting structures.* In the design of metal structures, the term "overload capacity factor" referred to in table 16 is to be interpreted in such a manner that the completed structure, if tested, shall support without permanent deflection the maximum loading to which it will be subjected as specified in chapter E 125, multiplied by the factors given in table 16. The absence of permanent set on the structure indicates that no part has been stressed beyond the strength point. Allowance should be made for bolt slip. Steel supports, steel towers, and metal poles shall be designed and constructed so as to meet the following requirements:

1. Vertical and transverse strength. The completed structure shall be so designed and of sufficient strength as to provide overload capacity factors specified in table 16 under the vertical and transverse loading specified in sections E 125.03(1) and (2).

2. Longitudinal strength. Grade B. The completed structure shall be so designed and of sufficient strength as to provide overload capacity factors specified in table 16 under the longitudinal loading specified in section E 125.03(3).

Grade C. No longitudinal strength requirements except at dead-ends.

3. Minimum strength. Metal structures shall have strength sufficient to withstand, with an overload capacity factor of 1.1, a transverse load on the structures without conductors, equal to 6 times the specified wind pressure.

4. At an angle in a line having supports of metal poles or towers, the strength of the support shall be sufficient to withstand the total transverse loadings specified in section E 125.03(2) (d). Before combining the 2 loads, the transverse wind load shall be multiplied by the appropriate overload capacity factor for transverse strength given in table 16, and the load arising from the change in direction of conductors shall be multiplied by the appropriate overload capacity factor at dead-ends given in table 16.

TABLE 16

MINIMUM OVERLOAD CAPACITY FACTORS OF COMPLETED STRUCTURES

(Based on Strength of Metal)

	Overload Capacity Factors	
	Grade B	Grade C
Vertical Strength	1.27	1.10
Transverse Strength	2.54	2.20
Longitudinal Strength:		
At Crossings		
In general	1.10	No requirement
At dead-ends	1.65	1.10
Elsewhere		
In general	1.00	No requirement
At dead-ends	1.65	1.10

5. Thickness of metal. The thickness of metal in members of steel poles or towers shall be not less than the following:

TABLE 17

THICKNESS OF STRUCTURAL SHAPES

Kind of Member	Thickness of Main Members of Crossarms and Legs	Thickness of Other Members
	Inches	Inches
Galvanized:		
For localities where experience has shown deterioration of galvanized material is rapid	1/4	5/16
For other localities	5/16	1/8
Painted	1/4	1/4 a

a. Painted bracing members having L/R not exceeding 125 may be 1/8 inches in thickness.

6. Unsupported length of compression members. The ratio of L, the unsupported length of a compression member, to R, the least radius of gyration of the member, shall not exceed the following: (These figures do not apply to the complete structure.)

TABLE 18

L/R FOR COMPRESSION MEMBERS

Kind of Compression Member	L/R
Leg members	150
Other members having figured stresses	200
Secondary members without figured stresses	250

7. General construction features. Metal poles or towers, including parts of footings above ground, shall be constructed so that all parts are accessible for inspection, cleaning, and painting, and so that pockets are not formed in which water can collect.

Note: Recommendation: Unless sample structures, or similar ones, have been tested to assure the compliance of structures in any line with these requirements, it is recommended that structures be designed to have a computed strength at least 10 percent greater than that required by these rules.

8. Protective covering or treatment. All metal towers, or supporting structures shall be protected by galvanizing, painting, or other treatment which will effectively retard corrosion.

(d) *Wood poles.* Wood poles shall be of such material and dimensions as to meet the following requirements. Where guys are used, see section E 126.02(3).

1. Transverse strength. Wood poles shall withstand the transverse and vertical loads assumed in sections E 125.03(1) and (2) without exceeding at the ground line for unguyed poles, or at the point of guy attachment for guyed poles, the appropriate allowable percentages of their ultimate stress given in table 20.

2. Longitudinal and dead-end strength. The longitudinal and dead-end strength of wood poles shall be such that they will withstand the appropriate longitudinal loading specified in section E 125.03(3) without exceeding, at the ground line for unguyed poles or at the point of guy attachment for guyed poles, the following percentages of the applicable ultimate fiber stress.

	Percentages of Ultimate Fiber Stress for Wood Poles	
	Grade B	Grade C
Longitudinal:		
When installed	(a) 75	No requirement
At replacement	100	No requirement
Dead-Ends:		
When installed	(a) 50	(a) 75
At replacement	75	100

(a) Where lines are built for a fixed period of temporary service not exceeding 5 years, the prescribed percentage of fiber stress at installation may be increased, provided the percentage of ultimate fiber stress required at replacement is not exceeded during the life of the line.

a. Exception 1: At a Grade B crossing in a straight section of line, wood poles of approximately round cross-section complying with the transverse strength requirements of section E 126.02(1) (d)1. without the use of transverse guys, shall be considered as having the required longitudinal strength. This exception does not modify the requirements of this rule for dead-ends.

b. Exception 2: At a Grade B crossing of a supply line over a communication line, where there is an angle in the supply line, wood poles of approximately round cross-section shall be considered as having the required longitudinal strength if all of the following conditions obtain:

i The angle is not over 20 degrees.

ii The corner pole is guyed in the plane of the resultant of the conductor tensions on both sides of the corner pole; the tension in this guy not to exceed 50% of its ultimate strength under the loading of section E 125.03(2) (d).

iii The corner pole has sufficient strength to withstand without guys, the transverse loading of section E 125.03(2) (a), which would exist if there were no angle at that pole without exceeding 25% of its ultimate stress when installed, or 37½% at replacement.

3. Ultimate fiber stress. Various species of wood poles are considered as having the ultimate fiber stresses approved as standard by the American Standards Association under conditions specified in Section 4 of ASA 05.1—1963.

Note: It is recognized that fiber glass, plastics and other developments may become available and that the United States of America Standards Institute's approved values will be determined for such materials or combinations of them. It is further recognized that while these materials are in the process of development, they are subject to such test evaluation and trial installations as may be approved by the administrative authority.

4. Allowable percentages of ultimate stress. The allowable percentages of ultimate stress of treated and untreated poles to withstand vertical and transverse loads are given in table 20, except as modified in the following paragraph.

a. At crossings where Grade B construction is required, if the supply line is not maintained throughout (or between and including the nearest guyed points on each side of the crossing) so that the poles will not be stressed at any time in excess of 50% of their ultimate stress under the transverse loading assumed in section E 125.03 (2), the crossing poles, if unguyed, shall be of such strength that they will withstand the transverse loading assumptions of section E 125.03

(2) (a) without exceeding 16 2/3% of their ultimate stress at installation or 25% at replacement. If the crossing poles are side guyed, such guys shall meet the requirements of section E 126.02 (3) (e).

TABLE 20

ALLOWABLE PERCENTAGES OF ULTIMATE STRESS FOR TREATED OR UNTREATED WOOD POLES UNDER VERTICAL AND TRANSVERSE LOADING

	When Installed	At Replacement
Grade B	25.0	37.5
Grade C		
At crossings	37.5	75.0
Elsewhere	50.0	75.0

5. Freedom from defects. Wood poles shall be of suitable and selected timber free from observable defects that would decrease their strength or durability.

6. Minimum pole sizes. Wood poles shall have a nominal top circumference of not less than 15 inches.

7. Spliced and stub-reinforced poles. Spliced poles shall not be used at crossings, conflicts, or joint-use sections requiring Grades B or C construction.

a. The use of stub reinforcements that develop the required strength of the pole is permitted, provided the pole above the ground is in good condition and is of sufficient size to develop its required strength.

(e) *Transverse strength requirements for structures. Where side guying is required, but can only be installed at a distance. Grade B.* In the case of structures where, because of very heavy or numerous conductors or relatively long spans, the transverse-strength requirements of this section cannot be met except by the use of side guys or special structures, and it is physically impracticable to employ side guys, the transverse-strength requirements may be met by side-guying the line at each side of and as near as practicable to, the crossing or other transversely weak structure, and with a distance between such side-guyed structures of not over 800 feet provided that:

1. The side-guyed structures for each such section of 800 feet or less shall be constructed to withstand the calculated transverse load due to wind on the supports and ice-covered conductors, on the entire section between the side-guyed structures.

2. The line between such side-guyed structures shall be substantially in a straight line and the average length of span between the side-guyed structures shall not be in excess of 150 feet.

3. The entire section between the transversely strong structures shall comply with the highest grade of construction concerned in the given section, except as to the transverse strength of the intermediate poles or towers.

Grade C. The above provision is not applicable to grade C.

(f) *Longitudinal-strength requirements for sections of higher grade in lines of a lower grade of construction.*

1. Methods of providing longitudinal strength. Grade B. The longitudinal-strength requirements for sections of line of higher grade in lines of a lower grade (see for assumed longitudinal loading section E 125.03(3)(a)) are usually met by placing supporting structures of the required longitudinal strength at either end of the higher-grade section of the line.

a. Where this is impracticable, the supporting structures of the required longitudinal strength may be located one or more span lengths away from the section of higher grade, within 500 feet on either side and with not more than 800 feet between the longitudinally strong structures, provided such structures, and the line between them meet the requirements, as to transverse strength and stringing of conductors, of the highest grade occurring in the section, and provided that the line between the longitudinally strong structures is approximately straight or suitably guyed.

b. The requirements may also be met by distributing the head guys over 2 or more structures on either side of the crossing, such structures and the line between them complying with the requirements for the crossing as to transverse strength and as to conductors and their fastenings.

c. Where it is impracticable to provide the longitudinal strength, the longitudinal loads shall be reduced by increasing the conductor sags. This may require greater conductor separations. See section E 123.06(1)(b)1.)

Grade C. The above provision is not applicable to grade C.

2. Flexible supports. Grade B. When supports of the section of higher grade are capable of considerable deflection in the direction of the line, as with wood or concrete poles, or some types of metal poles and towers, it may be necessary to increase the normal clearances specified in chapter E 123 or to provide head guys or special reinforcement to prevent such deflection.

a. So-called flexible steel towers or frames, if used at such locations, shall be adequately reinforced to meet the requirements of section E 126.02(1)(c)2.

b. When the situation is one involving an isolated crossing of higher grade in a line of lower-grade construction, then the structure shall, when practicable, be head-guyed or otherwise reinforced to prevent reduction in the clearances required in chapter E 123. Grade C. The above provision is not applicable to grade C.

(g) *Strength at angles in a line.* At an angle in the line, the strength of a pole at the ground line, if not guyed or at the point of guy attachment if guyed, shall be sufficient to withstand the total transverse loadings specified in section E 125.03 (2) (d). The transverse wind load shall be multiplied by the appropriate factor as shown below before combining with the load arising from change in direction

Grade of Construction	When Installed	At Replacement
B	2.0	2.0
C at crossings	2.0	1.33
C elsewhere	1.5	1.33

of conductors. The allowable percentage of ultimate stress at dead-ends given in section E 126.02(1) (d) shall not be exceeded for the total load thus computed.

(2) FOUNDATIONS. (a) *Use of foundations.* 1. Wood and reinforced-concrete poles. No special foundation construction is generally required.

2. Metal poles or towers. Metal poles or towers set in earth shall be suitably protected against injurious corrosion at and below the ground line.

(b) *Strength of foundations.* 1. Metal supports. The foundations and footings shall be so designed and constructed as to withstand the stresses due to the loads assumed in section E 125.03. Metal parts shall withstand these loads with the overload capacity factors specified in table 16. Since in many localities the soil and climatic conditions are such as to alter the strength of foundations considerably from time to time, there should usually be provided a considerable margin of strength in foundations above that which (by calculation) will just withstand the loads under the assumption of average conditions of climate and soil.

2. Wood and concrete poles. Foundations and settings for unguyed poles shall be such as to withstand the loads assumed in sections E 125.03 (1), (2) and (3).

MINIMUM DEPTH OF SETTING POLES

Length of Pole	Setting in Firm Soil	Setting in Rock
Feet	Feet	Feet
20	3.5	2.0
25	4.0	2.5
30	4.5	3.0
35	5.0	3.5
40	5.5	4.0
45	6.0	4.5
50	6.5	4.5
55	6.5	4.5
60	7.0	5.0
65	7.0	5.0
70	7.5	5.5
75	8.0	5.5
80	8.5	6.0

(3) GUYS. (a) *General.* The general requirements for guys are covered under "Miscellaneous requirements for overhead construction" (see chapter E 128).

(b) *For poles in insecure earth.* Where crossing poles are set in insecure earth the transverse strength requirements should, where practicable be met by the use of side guys or braces.

(c) *On metal structures.* The use of guys to obtain compliance with these requirements is regarded as generally undesirable. When guys are necessarily used, the steel supports or towers, unless capable of considerable deflection, shall be regarded as taking all of the load up to their allowable working load, and the guys shall have sufficient strength to take the remainder of the assumed maximum load. (See section E 126.02(1) (f)2. for flexible supports).

(d) *On wood or concrete poles.* When guys are used to meet the strength requirements for wood or concrete poles, they shall be considered as taking the entire load in the direction in which they act, the poles acting as struts only. Frequently the use of shorter spans or larger poles will permit the omission of guys at crossings.

(e) *Strength of guys.* 1. Guys when required, shall be of such material and dimensions as will withstand the transverse loads assumed in section E 125.03(2) and the longitudinal load assumed in section E 125.03(3) without exceeding the following percentages of their ultimate strength:

	Percentages of Ultimate Strength	
	Grade B	Grade C
For transverse strength (when installed)	37.50	50.00
For longitudinal strength (at all times)		
In general	100	No requirement
At dead-ends	(a) 66.70	(a) 87.50

(a) If deflection of supporting structures is taken into account in the computations, 66⅔% shall be reduced to 60% and 87½% shall be reduced to 75%.

2. At an angle in the line, the strength of a transverse guy or guys shall be sufficient to withstand the total transverse loadings specified in section E 125.03(2) (d). The transverse wind load shall be multiplied by 1.78 for both grades B and C before combining with the load arising from the change in direction of conductors. The allowable percentage of ultimate strength at dead-ends given in 1. above shall not be exceeded for the total load thus computed.

(4) CROSSARMS. (a) *Vertical strength.* Crossarms shall, when installed, withstand the vertical loads specified in section E 125.03(1) without the stress under these loads exceeding 50% of the assumed ultimate stress of the material.

1. Exception: For built-up metal crossarms on metal structures, see table 16 for minimum overload capacity factors.

(b) *Bracing.* Crossarms shall be securely supported by bracing, if necessary, so as to support safely all other loads to which they may be subjected in use, including linemen working on them. Any crossarm or buck arm except the top one shall be capable of supporting a vertical load of 225 pounds at either extremity in addition to the weight of the conductors.

(c) *Longitudinal strength.* 1. General. Crossarms shall withstand any unbalanced longitudinal loads to which they are exposed, with a limit of unbalanced tension where conductor pulls are normally balanced, of 700 pounds at the outer pin.

2. At dead-ends and at ends of higher-grade-construction in line of lower grade. Grade B. Wood crossarms shall be of sufficient strength to withstand at all times, without exceeding their ultimate stresses, an unbalanced pull equal to the tension in all supported conductors under assumed maximum loading as given in section E 125.02. Metal arms shall withstand this load with the overload capacity factor for longitudinal loads given in table 16.

Grade C. The above provisions do not apply to grade C.

8. At ends of transversely weak sections. Grade B. The crossarms connected to the structure at each end of the transversely weak section, such as described in section E 126.02(1) (e), shall be such as to withstand at all times without exceeding their ultimate stresses, under the conditions of loading prescribed in chapter E 125, an unbalanced load equivalent to the combined pull in the direction of the transversely weak section of all the conductors supported.

Grade C. The above provisions do not apply to grade C.

4. Methods of meeting section E 126.02(4). Grade B. Where conductor tensions are limited to a maximum of 2,000 pounds per conductor, double wood crossarms fitted with spacing bolts equipped with spacing nuts and washers, pipe spacers, or similar construction, or with spacing blocks or plates, or metallic support of equivalent strength will be considered as meeting the strength requirements in 2. and 3. preceding.

Grade C. The above provisions do not apply to grade C.

(d) *Dimensions of crossarms of selected yellow pine or fir.* The cross-sectional dimensions of selected yellow pine or fir crossarms shall not be less than values of table 21.

TABLE 21

CROSSARM CROSS SECTIONS

Number of Pins	Grade B	Grade C	
		Supply	Communication
	Inches	Inches	Inches
2 or 4	3 by 4	2¾ by 3¾	
6 or 8	3¼ by 4¼	3 by 4	
6			2¾ by 3¾
10			3 by 4

(e) *Double crossarms or brackets.* Grade B. Where pin-type construction is used, double crossarms or a metallic support of equivalent strength shall be used at each crossing structure, at ends of joint use or conflict sections, at dead-ends and at corners where the angle of departure from a straight line exceeds 20 degrees. Where a bracket or rack supports a conductor operated at more than 750 volts to ground and there is no crossarm below, double brackets or double racks shall be used.

1. Exception: The above does not apply where communication cables or conductors cross below supply conductors and either 1. are attached to the same pole or 2. where supply conductors are continuous and of uniform tension in a crossing span and each adjacent span. This exception does not apply to railroad crossings.

Grade C. The above provisions do not apply to Grade C.

(f) *Location.* In general, crossarms should be maintained at right angles to the axis of the pole and to the direction of the attached conductors. At crossings, crossarms should be attached to that face of the structure away from the crossing, unless special bracing or double crossarms are used.

(5) PINS AND CONDUCTOR FASTENINGS. (a) *General.* 1. The conductor fastenings and the height, material and cross section of the pin shall be chosen so as to afford the required strength.

2. Tie wires, fastenings, or conductor supports shall have no sharp edges or burrs at contacts with conductors.

3. Where tie wires or similar fastenings are used with pin type construction, conductors shall be placed so that the side pull due to change in direction shall be against the insulator rather than the tie wire.

(b) *Strength.* 1. General. Pins and ties or other conductor fastenings shall have sufficient strength to withstand an unbalanced tension in the conductor, up to a limit of 700 pounds per pin or conductor fastening. (The unbalanced tensions often encountered especially with small conductors will be less than the maximum specified above. For these cases, the conductor fastenings need only develop strength equal to the anticipated unbalance.)

2. At dead-ends and at ends of higher-grade construction in line of lower grade. Grade B. Pins and ties or other conductor fastenings connected to the structure at a dead-end or at each end of the higher-grade section shall be of sufficient strength to withstand at all times without exceeding their ultimate strength, an unbalanced pull due to the conductor loading specified in section E 125.02.

Grade C. The above provisions do not apply to grade C except for dead-ends.

3. At ends of transversely weak sections. Grade B. Pins and ties or other conductor fastenings connected to the structure at each end of the transversely weak section as described in section E 126.02 (1) (e) shall be such as to withstand at all times without exceeding their ultimate strength, the unbalanced pull in the direction of the transversely weak section of the conductor supported, under the loading prescribed in section E 125.02. Grade C. The above provisions do not apply to grade C.

4. Methods of meeting sections E 126.02(5) (b)2. and 3. Grade B. Where conductor tensions are limited to 2,000 pounds and such conductors are supported on pin insulators, double wood pins and ties or their equivalent will be considered to meet the requirements of 2. and 3. preceding. Grade C. The above provision does not apply to Grade C.

(c) *Double pins and conductor fastenings.* Grade B. Where wood pins are used, double pins and conductor fastenings shall be used where double crossarms or brackets are required by section E 126.02 (4) (e).

1. Exception: The above does not apply where communication cables or conductors cross below supply conductors and either 1. are attached to the same pole, or 2. where supply conductors are continuous and of uniform tension in a crossing span and each adjacent span. This exception does not apply in the case of railroad crossings.

Grade C. The above provision does not apply to grade C.

(d) *Single supports used in lieu of double wood pins.* A single conductor support and its conductor fastening when used in lieu of double wood pins, shall develop strength equivalent to double wood pins and their conductor fastenings as specified in section E 126.02(5)(b)1.

(6) OPEN SUPPLY CONDUCTORS. (a) *Material.* Conductors shall be of material or combinations of materials which will not corrode excessively under the prevailing conditions.

Note: Recommendation: It is recommended that hard-drawn or medium-hard-drawn copper wire (conforming to the specifications of the American Society for Testing Materials) be used instead of soft in new construction, especially for sizes smaller than No. 2.

(b) *Minimum sizes of supply conductors.* Supply conductors, both bare and covered, shall have an ultimate strength and an overall diameter of metallic conductor not less than that of medium-hard-drawn copper of the gage size A.W.G. shown in table 22, except that conductors made entirely of bare or galvanized iron or steel shall have an overall diameter not less than Stl. W.G. of the gage sizes shown.

1. Exception 1: At railroad crossings, for stranded conductors, other than those in which a central core wire is entirely covered by the outside wires, any individual wire of such a stranded conductor containing steel shall be not less than 0.100 inch in diameter if copper-covered and not less than 0.115 inch in diameter if otherwise protected or if bare.

2. Exception 2: Supply service leads of 0 to 750 volts may have the sizes set forth in section E 126.04(5).

3. Exception 3: Where the short-span method of construction is employed in accordance with section E 126.02(11) the conductor sizes and sags herein specified are not required.

TABLE 22

MINIMUM OVERALL CONDUCTOR SIZES

Grade of Construction	Gage Size (a)
B	6
C	8

(a) For No. 6 and No. 8 medium-hard-drawn copper wire the nominal diameters are 0.1620 and 0.1285 inch, and the minimum values of breaking load are 1,010 and 643.9 pounds, respectively. For steel wire gage the nominal diameters are 0.192 inch for No. 6 and 0.162 inch for No. 8.

(c) *Lightning protection wires.* The requirements as to size, material, and stringing of wires used as lightning protection wires when placed above and paralleling supply conductors shall be the same as that required for supply conductors.

(d) *Sags and tensions.* Conductor sags shall be such that, under the assumed loading of section E 125.02 the tension of the conductor shall be not more than 60% of its ultimate strength. Also the tension at 60°F., without external load, shall not exceed the following percentages of the conductor ultimate strength:

Initial unloaded tension	35%
Final unloaded tension	25%

1. Exception: In the case of conductors having a cross-section of a generally triangular shape, such as cables composed of three wires,

the final unloaded tension at 60°F. shall not exceed 30 percent of the ultimate strength of the conductor.

Note: The above limitations are based on the use of recognized methods for avoiding fatigue failures by minimizing chafing and stress concentration. If such practices are not followed, lower tensions should be employed.

(e) *Splices and taps.* Grade B. Splices shall as far as practicable be avoided in the crossing and adjacent spans. If it is impracticable to avoid such splices, they shall be of such a type and so made as to have a strength substantially equal to that of the conductor in which they are placed. Taps shall be avoided in the crossing span where practicable, but if required shall be of a type which will not impair the strength of the conductors to which they are attached.

Grade C. The above does not apply to grade C.

(f) *Trolley contact conductors.* In order to provide for wear, no trolley contact conductor shall be installed of less size than No. 0, if of copper; of No. 4, if of silicon bronze.

(7) SUPPLY CABLES. (a) *Specially installed supply cables.* Cable having effectively grounded continuous metal sheath or armor, or insulated conductors supported on and lashed together with an effectively grounded messenger, where located on jointly used poles, or where located on other poles, and having a grade of construction less than that required for open wire supply lines of the same voltage, shall meet the requirements of section E 126.02(7)(a) 1., 2., 3. and 4. below.

1. Messengers. Messengers shall be stranded and of corrosion-resistant material, and shall not be stressed beyond 60% of their ultimate strength under the loadings specified in section E 125.02.

2. Grounding of cable sheath and messenger. Each section of metal sheath or armored cable between splices shall be suitably and effectively bonded to the messenger wire at not less than 2 places. The messenger wire shall be grounded at the ends of the line and at intermediate points not exceeding 800 feet apart. (See Wis. Adm. Code chapter E 103 for method).

3. Cable splices. Splices in the cable shall be made so that their insulation is not materially weaker than the remainder of the cable. The sheath or armor wire, when present, shall be made electrically continuous at the splice.

4. Cable insulation. The conductors of the cable shall be insulated so as to withstand a factory potential test of at least twice the operating voltage at operating frequency applied continuously for 5 minutes between conductors and between any conductor and the sheath or armor.

(b) *Other supply cables.* The following requirements apply to all supply cables not included in section E 126.02(7)(a) above.

1. Messenger. The messenger shall be of corrosion-resistant material, and shall not be stressed beyond 60% of its ultimate strength under the loadings specified in section E 125.02.

2. Cable. There are no strength requirements for cables supported by messengers.

(8) OPEN-WIRE COMMUNICATION CONDUCTORS. Open-wire communication conductors in grade B or C construction shall have the sizes and sags given in section E 126.02(6)(b) and (d) for supply conductors of the same grade.

(a) *Exception:* Where open-wire communication conductors in spans of 150 feet or less are above supply circuits of 5,000 volts or less, grade C sizes and sags may be replaced by grade D sizes and sags, except that where the supply conductors are trolley-contact conductors of 0 to 750 volts. No. 12 hard-drawn copper wire may be used for spans 0 to 100 feet, and No. 10 steel or No. 12 high strength steel wire may be used for spans of 125 to 150 feet.

(9) COMMUNICATION CABLES. (a) *Metal-sheathed communication cables.* There are no strength requirements for such cables supported by messengers.

(b) *Messenger.* The messenger shall be of corrosion-resistant material, and shall not be stressed beyond 60% of its ultimate strength under the loadings specified in section E 125.02.

(10) PAIRED COMMUNICATION CONDUCTORS. (a) *Paired conductors supported on messenger.*

1. Use of messenger. A messenger of corrosion-resistant material may be used for supporting paired conductors in any location, but is only required for paired conductors crossing over trolley-contact conductors of more than 750 volts.

2. Sag of messenger. Messenger used for supporting paired conductors required to meet grade B construction because of crossing over trolley-contact conductors shall meet the sag requirements for grade D messengers.

3. Size and sag of conductors. There are no requirements for paired conductors when supported on messenger.

(b) *Paired conductors not supported on messenger.*

1. Above supply lines. Grade B. Sizes and sags shall be not less than those required by sections E 126.02(6)(b) and (d) for supply conductors of similar grade.

Grade C. Sizes and sags shall be not less than the following:

Spans 0 to 100 feet. No sag requirements. Each conductor shall be of corrosion-resistant material, and shall have an ultimate strength of not less than 170 pounds.

Spans 100 to 150 feet. Sizes and sags shall be not less than required for grade D communication conductors.

Spans exceeding 150 feet. Sizes and sags shall be not less than required for grade C supply conductors (section E 126.02(6)(d)).

2. Above trolley-contact conductors.

Grade B. Sizes and sags shall be not less than the following:

Spans 0 to 100 feet. No size requirements. Sags shall be not less than for No. 8 A.W.G. hard-drawn copper. (See section E 126.02 (6)(d).)

Spans exceeding 100 feet. Each conductor shall be of corrosion-resistant material, and shall have an ultimate strength of not less than 170 pounds. Sags shall be not less than for No. 8 A.W.G. hard-drawn copper. (See section E 126.02(6)(d).)

Grade C. Sizes and sags shall be as follows:

Spans 0 to 100 feet. No requirements.

Spans exceeding 100 feet. No sag requirements. Each conductor shall be of corrosion-resistant material, and shall have an ultimate strength of not less than 170 pounds.

(11) SHORT-SPAN CROSSING CONSTRUCTION. Where supply lines cross over railways or communication lines by the short-span method, the requirements for grade B or C conductor sags and sizes are waived, in so far as such grades are required by the crossing, provided that an effectively grounded guard arm is installed at each cross-over support in such a manner as to prevent conductors which break in either adjoining span from swinging back into the conductors crossed over, or in the case of a railroad crossing into the space between the crossing supports.

Note: The short-span method of crossing requires the cross-over span to be of such height that a conductor breaking in that span can not come within 15 feet of the ground or rails at a railroad crossing or make contact with any wires crossed over at a wire crossing.

This character of construction is facilitated where the cross-over supports can be placed quite near together and in the case of wire crossings where the span crossed over is at a minimum elevation above ground.

(12) CRADLES AT SUPPLY LINE CROSSINGS. Cradles should not be used.

Note: It is less expensive and better to build the supply line strong enough to withstand extreme conditions than to build a cradle of sufficient strength to catch and hold the supply line if it falls.

(13) PROTECTIVE COVERING OR TREATMENT FOR METAL WORK. All hardware, including bolts, washers, guys, anchor rods and similar parts of material subject to injurious corrosion under the prevailing conditions, shall be protected by galvanizing, painting, or other treatment which will effectively retard corrosion.

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

E 126.03 Grade D construction. (1) POLES. (a) *Strength of unguyed poles.* Unguyed poles, except as provided in section E 126.03 (1) (h) shall withstand the vertical and transverse loads specified in sections E 125.03(1) and (2), and the longitudinal loads specified in section E 125.03(3)(d) without exceeding the following percentages of their ultimate stress.

	Percentages of Ultimate Stress
For transverse loads:	
When installed	25.0
At replacement	37.5
For longitudinal loads:	
When installed	75.0
At replacement	100.0

(b) *Strength of guyed poles.* Where poles are guyed, the poles shall be considered as acting as struts, resisting the vertical component of the tension in the guy calculated as in section E 126.03(3) combined with the vertical load.

(c) *Strength requirements for poles where guying is required, but can only be installed at a distance.* Where on account of physical conditions it is impracticable to guy or brace the crossing poles as specified in section E 126.03(3), the requirements there given may be met by head-guying and side-guying the line as near as practicable to the crossing, but at a distance not exceeding 500 feet from the nearest crossing pole, provided that the line is approximately straight

and that a stranded steel wire or other standard strand of strength equivalent to that of the head guy is run between the 2 guyed poles, being attached to the guyed poles at the point at which the head guys are attached, this wire being securely attached to every pole between the guyed poles.

(d) *Pole locations at crossings.* Where communication lines cross over railroads, the poles shall be located as follows:

1. The poles supporting the crossing span and the adjacent spans should be located in a straight line, if practicable. Where the poles supporting the crossing span and the adjacent spans are not in line, additional guying shall be placed to take care of the unbalanced load.

2. The crossing span shall, where practicable, not exceed 100 feet.

(e) *Freedom from defects.* Wood poles shall be of suitable and selected timber free from observable defects that would decrease their strength or durability.

(f) *Minimum pole sizes.* Wood poles shall have a nominal top circumference of not less than 15 inches.

(g) *Spliced and stub-reinforced poles.* Spliced poles shall not be used at grade D crossings. The use of stub reinforcements that develop the required strength of the pole is permitted, provided the pole above the ground is in good condition and is of sufficient size to develop its required strength.

(h) *Poles located at crossings over spur tracks.* Where a communication line paralleling a railroad track on the right of way of the railroad crosses a spur or stub track without any change in the general direction of line, the transverse strength requirements for grade D construction may be met without the use of side guys, providing the pole is not stressed beyond one-third its ultimate stress. No requirements for longitudinal strength are made if the conductor tensions are balanced. Where conductor tensions are not balanced, due to a small angle in the line at one or both poles, or to dead-ending any of the wires, either guys or braces shall be installed capable of withstanding such unbalanced tensions.

(2) POLE SETTINGS. Foundations and settings for unguyed poles shall be such as to withstand the loads assumed in sections E 125.03 (1), (2) and (3). (See section E 126.02(2)(b)2.)

(3) GUYS. (a) *General.* The general requirements for guys are covered under "Miscellaneous requirements for overhead construction" (See chapter E 128).

(b) *Where used.* Side guys or braces shall be used on poles supporting the crossing span to withstand the loads put upon them in accordance with the conditions specified in section E 125.03(2). Head guys shall be installed in accordance with table 23.

1. Exception 1: Side guys are not required where the crossing poles have the transverse strength specified in section E 126.03(1)(a) without the reduction for conductor shielding specified in sections E 125.03 (2)(a) and (b).

2. Exception 2: Head guys are not required where the crossing poles have the longitudinal strength specified in section E 126.03(1)(a), or for lines carrying only aerial cable. For lines carrying both open wire and aerial cable, head guying is required only for the number

of wires in excess of 10 if the cable is supported by a 6,000 pound messenger, or for the number of wires in excess of 20 if the cable is supported by a 10,000 pound messenger.

3. Exception 3: Where a line crossing a railroad changes direction more than 10 degrees at either crossing support, the side guy within the angle may be omitted and the head guy, if required, shall be placed in the direction of the adjacent span unless the angle of turn is greater than 60 degrees.

4. Exception 4: Guying may be omitted where communication lines cross over spur or stub tracks as provided in section E 126.03(1)(b).

5. Exception 5: This rule does not apply to crossing poles under the special conditions set forth in section E 126.03(1)(c).

TABLE 23

STRENGTH (IN POUNDS) OF HEAD GUYS REQUIRED

(Combinations of standard-size guys may be used)

Number of Wires	Ratio of Guy Lead to Height Not Less Than				
	1¼	1	¾	⅜	½
2	4,000	4,000	4,000	4,000	4,000
6	4,000	4,000	4,000	4,000	6,000
10	6,000	6,000	6,000	10,000	10,000
20	10,000	10,000	12,000	16,000	16,000
30	16,000	16,000	20,000	20,000	26,000
40	20,000	20,000	26,000	26,000	32,000
50	20,000	20,000	30,000	32,000	42,000
60	26,000	30,000	36,000	36,000	48,000
70	30,000	30,000	40,000	48,000	60,000
80	36,000	40,000	48,000	60,000	70,000

Note to Table 23. This table is based on ultimate or breaking strength of guys equal to seven-sixths of the nominal strengths shown in the table and a wire load of 50% No. 8 B.W.G. iron and 50% No. 9 A.W.G. copper with an average pull of 408.75 pounds per wire. No guy will be required for a cable, since the suspension strands serve as a head guy.

(c) *Guys used for transverse strength.* Side guys used in straight sections of line shall be considered as taking the entire load in the direction in which they act, without exceeding 37.5% of their ultimate strength.

(d) *Guys used for longitudinal strength.* 1. Direction of head guys. Where head guys are required, they shall be installed in the direction away from the crossing.

2. Size and number of head guys. Guys, if required for various open-wire loads, shall be in accordance with table 23.

(e) *Maintenance.* Guys and anchors shall be maintained so that the guys carry the load.

(4) CROSSARMS. (a) *Material.* Wood crossarms supporting the crossing span shall be of yellow pine, fir, or other suitable timber. Metal crossarms protected against corrosion and of strength equal to wood crossarms may be used.

(b) *Minimum size.* 1. Wood crossarms. Wood crossarms shall have a cross-section not less than the following:

Maximum Number of Wires to be Carried	Nominal Length		Nominal Cross-section (Inches)
	Feet	Inches	
2	1	4½	2⅝ by 3⅝
4	3	4½	2⅝ by 3⅝
6	6	0	2¾ by 3¾
10	8	6	2¾ by 3¾
10	10	0	3 by 4
12 (a) (b)	10	0	3¼ by 4¼

(a) Where crossarms are bored for ½ inch steel pins, 3-inch by 4¼-inch crossarms may be used.
(b) Maximum number allowed.

2. Steel or iron crossarms. Galvanized or painted iron or steel crossarms of strength equal to wood crossarms may be used.

(c) *Double crossarms.* Crossarms and insulators shall be double on the crossing poles. The crossarms shall be held together with properly fitted spacing blocks or bolts placed immediately adjoining the outside pins. Spacing blocks or spacing bolts are not required for two-pin crossarms.

1. Exception: Single dead-end type crossarms may be used where it is necessary to dead-end conductors of the crossing span, provided such crossarms and associated dead-end fastenings are of sufficient size and strength to withstand the maximum tension of the conductors under the loading specified in section E 125.02 and provided further that the conductors are dead-ended on insulators so designed and installed that the conductor will not fall in the event of insulator breakage.

(5) BRACKETS AND RACKS. Wood brackets may be used only if used in duplicate or otherwise designed so as to afford two points of support for each conductor. Single metal brackets, racks, drive hooks or other fixtures may be used if designed and attached in such a manner as to withstand the full dead-end pull of the wires supported.

(6) PINS. (a) *Material.* Insulator pins shall be of steel, or other appropriate metal or locust or equivalent wood.

(b) *Strength.* Insulator pins shall have sufficient strength to withstand the loads to which they may be subjected.

(c) *Size.* 1. Wood pins. Wood pins shall be sound and straight-grained with a diameter of shank not less than 1¼ inches.

2. Metal pins. Steel or iron pins shall have diameter of shank not less than one-half inch.

(7) INSULATORS. Each insulator shall be of such pattern, design and material that when mounted it will withstand without injury and without being pulled off the pin, the ultimate strength of the conductor attached to the insulator.

(8) ATTACHMENT OF CONDUCTOR TO INSULATOR. The conductors shall be securely tied to each supporting insulator.

(9) CONDUCTORS. (a) *Material.* Conductors shall be of material or combinations of materials which will not corrode excessively under the prevailing conditions.

(b) *Size.* Conductors of the crossing span, if of hard-drawn copper or galvanized steel, shall have sizes not less than specified in sections

E 126.03(9)(b)1. and 2. Conductors of material other than the above shall be of such size and so strung as to have a mechanical strength not less than that of the sizes of copper conductors given in sections E 126.03(9)(b)1. and 2. below.

1. Spans not exceeding 150 feet. The sizes in table 24 apply.

TABLE 24

GRADE D MINIMUM WIRE SIZES

(A.W.G. for Copper; Stl. W.G. for Steel)

Conductor	Spans of 125 Feet or Less	Spans of 125 Feet to 150 Feet
Copper, hard-drawn	10	9
Steel, galvanized:		
In General	10	8

2. Spans exceeding 150 feet. If spans in excess of 150 feet are necessary, the size of conductors specified above or the sags of the conductors shall be correspondingly increased.

(c) *Paired conductors without messengers.* Paired wires without a supporting messenger shall be eliminated as far as practicable and where used shall meet the following requirements:

1. Material and strength. Each conductor shall be of material or combinations of materials which will not corrode excessively under the prevailing conditions and shall have an ultimate strength of not less than 170 pounds.

2. Limiting span lengths. Paired wires shall in no case be used without a supporting messenger in spans longer than 100 feet.

(d) *Sags.* Table 25 specifies the recommended sags for wires shown in table 24.

TABLE 25

STRINGING SAGS

Length of Span	100°F.	80°F.	60°F.	40°F.	20°F.	0°F.
Feet	In.	In.	In.	In.	In.	In.
70	5.7	4.4	3.4	2.7	2.2	1.8
75	6.4	5.1	4.0	3.1	2.5	2.1
80	7.4	5.8	4.5	3.5	2.9	2.4
85	8.4	6.6	5.1	4.0	3.2	2.7
90	9.4	7.3	5.7	4.5	3.6	3.0
95	10.0	8.2	6.3	5.0	4.0	3.4
100	11.6	9.0	7.0	5.5	4.5	3.7
110	14.0	11.0	8.5	6.7	5.4	4.5
120	16.6	13.0	10.1	7.9	6.4	5.4
130	19.5	15.3	11.8	9.3	7.6	6.3
140	22.6	17.7	13.7	10.8	8.8	7.3
150	26.0	20.3	15.8	12.4	10.1	8.4

1. For conductors other than copper, conductor sags shall be such that, under the assumed loading of section E 125.02, and assuming rigid structures for the purpose of calculations, the tension of the conductor shall be not more than 60% of its ultimate strength. Also the tension at 60 degrees F., without external load, shall not exceed 20% of the conductor ultimate strength.

(e) *Splices and taps.* Splices shall as far as practicable be avoided in the crossing and adjacent spans. If it is impracticable to avoid such splices, they shall be of such a type and so made as to have a strength substantially equal to that of the conductor in which they are placed. Taps shall be avoided in the crossing span where practicable, but if required shall be of a type which will not impair the strength of the conductors to which they are attached.

(10) MESSENGERS. (a) *Minimum size.* 1. Spans not exceeding 150 feet. Table 26 gives the minimum sizes of galvanized steel-strand messenger to be used for supporting different sizes of cables:

TABLE 26

MINIMUM SIZES OF MESSENGER

Size of Cable in Weight per Foot	Messenger (Nominal Breaking Load) Pounds
Less than 2.25 pounds	6,000
2.25 to 5 pounds	10,000
Exceeding 5 and less than 8.5 pounds	16,000

2. Spans exceeding 150 feet. For spans exceeding 150 feet or for heavier cables a proportionately larger messenger or other proportionately stronger means of support shall be used.

(b) *Sags and tensions.* Multiple-wire cables and their messengers shall be so suspended that when they are subjected to the loading prescribed in section E 125.02, the tension in the messenger will not exceed 60% of its ultimate strength.

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

E 126.04 Grade N construction. (1) POLES AND TOWERS. Poles used for lines for which neither grade B, C, or D is required shall be of such initial size and so guyed or braced, where necessary, as to withstand the wind and ice loading specified in chapter E 125 plus the weight of lineman and pole mounted equipment without exceeding the allowable stress.

(2) GUYS. The general requirements for guys are covered under "Miscellaneous Requirements" (chapter E 128).

(3) CROSSARM STRENGTH. Crossarms shall be securely supported, by bracing if necessary, so as to support safely loads to which they may be subjected in use, including linemen working on them. Any crossarm, or buckarm, except the top one, shall be capable of supporting a vertical load of 225 pounds at either extremity in addition to the weight of the conductors.

(4) SUPPLY-LINE CONDUCTORS. (a) *Material.* All supply-line conductors shall be of material or combinations of materials which will not corrode excessively under the prevailing conditions.

(b) *Sizes.* Supply-line conductors shall be not smaller than the following:

TABLE 27

GRADE N MINIMUM GAUGE SIZES FOR SUPPLY-LINE CONDUCTORS

(A.W.G. for Copper and Aluminum; Stl. W.G. for Steel)

	Urban	Rural
Soft copper	6	8
Medium or hard-drawn copper	8	8
Steel	9	9
	Urban and Rural	
	Spans 150 ft. or Less	Spans Exceeding 150 ft.
Stranded aluminum		
Not reinforced	1	0
Steel-reinforced	6	4

Recommendation: It is recommended that, except as modified in subsection E 126.02(6)(b), these minimum sizes for copper and steel not be used in spans longer than 150 feet.

(5) SUPPLY SERVICES. (a) *Material.* All supply service conductors shall be of material or combinations of materials which will not corrode excessively under the prevailing conditions and the ungrounded service conductors extending from the service entrance to the first pole shall have rubber or approved equivalent insulation if in a raceway; and rubber, weatherproof, or approved equivalent insulation where exposed.

(b) *Size of open-wire services.* 1. Not over 750 volts. Supply-service leads of not over 750 volts shall be not smaller than required by a. or b. below.

a. Spans not exceeding 150 feet. Sizes shall be not smaller than specified in table 28.

TABLE 28

MINIMUM SIZES OF SERVICE LEADS CARRYING 750 VOLTS OR LESS

(A.W.G. for Copper; Stl. W.G. for Steel)

Situation	Copper Wire		Steel Wire
	Soft-drawn	Medium or Hard-drawn	
Alone	10	12	12
Concerned with communication conductors	10	12	12
Over supply conductors of 0–750 volts	10	12	12
750 to 8,700 volts (a)	8	10	12
Exceeding 8,700 volts (a)	6	8	9
Over trolley contact conductors			
0 to 750 volts a.c. or d.c.	8	10	12
Exceeding 750 volts d.c.	6	8	9

(a) Installation of service leads of not more than 750 volts over supply lines of more than 750 volts should be avoided where practicable.

b. Spans exceeding 150 feet. Sizes shall be not smaller than required for grade C (section E 126.02(6)(b)).

2. Exceeding 750 volts. Sizes of supply-service leads of more than 750 volts between conductors shall be not less than required for supply line conductors of the same voltage.

(c) *Sag, open-wire services.* 1. Not over 750 volts. Supply service leads of not over 750 volts shall have sags not less than shown in table 29.

TABLE 29

SAGS FOR OPEN-WIRE SERVICES

Span Lengths (in feet)	Sag
	Inches
100 or less	12
100 to 125	18
125 to 150	27
Exceeding 150	Grade C sags

2. Exceeding 750 volts. Supply service leads of more than 750 volts shall comply as to sags with the requirements for supply line conductors of the same voltage.

(d) *Cabled services.* Supply service leads may be grouped together in a cable, provided the following requirements are met:

1. Conductivity. The conductivity of each conductor shall not be less than the conductivity of No. 12 copper.

2. Stress. The messenger member of an assembly designed to have the insulated conductors supported by the messenger shall not be stressed beyond 60% of its ultimate strength with the loading specified in section E 125.02.

3. Insulation. The insulation should be sufficient to withstand twice the normal operating voltage.

(6) LIGHTNING PROTECTION WIRES. The requirements as to size and materials for wires used as lightning protection wires when placed above and paralleling supply conductors shall be the same as that required for supply conductors.

(7) TROLLEY CONTACT CONDUCTORS. In order to provide for wear, no trolley contact conductors shall be installed of less size than No. 0, if of copper, or No. 4, if of silicon bronze.

(8) CRADLES AT SUPPLY-LINE CROSSINGS. Cradles should not be used.

Note: It is less expensive and better to build the supply line strong enough to withstand extreme conditions than to build a cradle of sufficient strength to catch and hold the supply line if it falls.

(9) COMMUNICATION CONDUCTORS. There are no specific requirements for grade N communication line conductors or service drops.

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

Chapter E 127

LINE INSULATORS

E 127.01 Application of rule. These requirements apply only to supply lines. (See section E 124.03(5) for insulation requirements for neutral conductors).

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

E 127.02 Material and marking. Insulators for operation on supply circuits at voltages of 2,300 and above shall be of porcelain, made by the wet process or one equally suitable as regards electrical and mechanical properties, or other material which will give equally good results in respect to mechanical and electrical performance and durability. They should be marked by the maker with his name, trademark, or identification number so applied as not to reduce the electrical or mechanical strength of the insulator.

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

E 127.03 Electrical strength of insulators in strain position. Where insulators are used in strain position they shall have not less electrical strength than the insulators generally used on the line when under the normal mechanical stresses imposed by the loadings specified in chapter E 125.

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

E 127.04 Ratio of flash-over to puncture voltage. Insulators shall be designed so that their dry flash-over voltage is not more than 75% of their puncture voltage at a frequency of 60 cycles per second.

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

E 127.05 Test voltages. Insulators when tested under American Standards Association specifications shall not flash-over at values less than given in table 30.

TABLE 30

TEST-VOLTAGE REQUIREMENTS

(For application see section E 127.07)

Nominal Voltage	Minimum Test Dry Flash-over Voltage of Insulators	Nominal Voltage	Minimum Test Dry Flash-over Voltage of Insulators
750	5,000	46,000	125,000
2,400	20,000	69,000	175,000
7,200	40,000	115,000	315,000
13,200	55,000	138,000	390,000
23,000	75,000	161,000	445,000
34,500	100,000	230,000	640,000

(Interpolate for intermediate values)

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

E 127.06 Factory tests. Each insulator or insulating part thereof for use on lines operating at voltages in excess of 15,000 volts between conductors shall be subjected to a routine dry flash-over test at the factory for a period of 3 minutes at a frequency of 60 cycles per second or to any other test sanctioned by good modern practice, such as high-frequency tests.

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

E 127.07 Selection of insulators. (1) INSULATION OF CONSTANT-CURRENT CIRCUITS. Insulators for use on constant-current circuits shall be determined on the basis of the nominal full-load voltage of the circuit.

(2) INSULATORS FOR SINGLE-PHASE CIRCUITS DIRECTLY CONNECTED TO THREE-PHASE CIRCUITS. Insulators used on single-phase circuits directly connected to three-phase circuits (without intervening transformers) shall have a flash-over voltage not less than that required for the insulators on the three-phase circuits.

(3) INSULATORS FOR NOMINAL VOLTAGES BETWEEN CONDUCTORS. In selecting insulators of the test voltage to be used for any nominal voltage between conductors, consideration shall be given to the conditions under which the line will operate as follows:

(a) Where the system is of moderate extent, in open country, subject to intermittent rains and moderate lightning, insulators having flash-over values not less than given in table 30 shall be used.

(b) Where operating conditions are more severe than set forth in (1) above, due to extent of system, prevalence of exceptionally severe lightning, bad atmospheric conditions (caused by chemical fumes, smoke, cement dust, salt fog, or other foreign matter), or to a long, dry season with heavy dust accumulation followed by moisture, insulators having a higher flash-over than given in table 30 or other equally effective means of increasing insulation shall be used. The increase is to be determined by local conditions and experience.

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

E 127.08 Protection against arcing. In installing the insulators and conductors, such precautions as are sanctioned by good modern practice shall be taken to prevent, as far as possible, any arc from forming or to prevent any arc which might be formed from injuring or burning any parts of the supporting structures, insulators or conductors which might render the conductors liable to fall. In no case shall the insulation at crossings be less than that employed in adjacent sections of the line.

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

Chapter E 128

MISCELLANEOUS REQUIREMENTS FOR OVERHEAD LINES

E 128.01 Supporting structures. (1) POLES AND TOWERS. (a) *Rubbish.* Poles and towers should be placed, guarded, and maintained so as to be exposed as little as practicable to brush, grass, rubbish, or building fires.

(b) *Guarding poles.* 1. Protection against mechanical injury. Where poles and towers are exposed to abrasion by traffic or to other damage which would materially affect their strength, they shall be protected by guards.

2. Protection against climbing. On closely latticed poles or towers carrying supply conductors exceeding 300 volts, either guards or warning signs shall be used except as follows: See section E 121.05(3).

a. Exception 1: Where the right of way is completely fenced.

b. Exception 2: Where the right of way is not completely fenced, provided the poles or towers are not adjacent to roads, regularly traveled thoroughfares, or places where people frequently gather, such as schools or public playgrounds.

(c) *Warning signs.* 1. On poles or towers. For warning signs on poles or towers, see sections E 128.01(1)(b)2. and E 121.05(3).

2. On bridge fixtures. Structures attached to bridges for the purpose of supporting conductors shall be plainly marked with the name, initials, or trademark of the utility responsible for the attachment and, in addition, where the voltage exceeds 750 volts, by the following sign or its equivalent: "Danger-High Voltage" (See section E 121.05 (3)).

(d) *Grounding metal poles.* Metal poles not guarded or isolated shall always be specially grounded where in contact with metal-sheathed cable or the metal cases of equipment operating at voltages exceeding 750 volts. Metal poles not guarded, isolated, or specially grounded should always be considered as imperfectly grounded and the insulators supporting line conductors as well as the strain insulators in attached span wires should therefore, have a suitable margin of safety and be maintained with special care to prevent leakage to the pole as far as practicable.

(e) ***Pole steps; Metal steps.*** Steps closer than 6½ feet from the ground or other readily accessible place shall not be placed on poles.

(f) *Identification of poles.* Poles, towers and other supporting structures on which are maintained electrical conductors shall be so constructed, located, marked, or numbered as to facilitate identification by employees authorized to work thereon. Date of installation of such structures shall be recorded where practicable by the owner.

(g) *Obstructions.* All poles and towers should be kept free from posters, bills, tacks, nails, and other unnecessary obstructions, such as through bolts not properly trimmed.

(2) CROSSARMS. (a) *Location.* In general, crossarms should be maintained at right angles to the axis of the pole and to the direction of the attached conductors, and at crossings should be attached to that face of the structure away from the crossing, unless special bracing or double crossarms are used.

Note: Double crossarms are generally used at crossings, unbalanced corners, and dead-ends in order to permit conductor fastenings at two insulators and so prevent slipping, although single crossarms might provide sufficient strength. To secure extra strength, double crossarms are frequently used and crossarm guys are sometimes used.

(b) *Bracing.* Crossarms shall be securely supported, by bracing if necessary, so as to support safely loads to which they may be subjected, including linemen working on them. Any crossarm or buckarm, except the top one, shall be capable of supporting a vertical load of 225 pounds at either extremity in addition to the weight of the conductors.

(3) UNUSUAL CONDUCTOR SUPPORTS. Where conductors are attached to structures other than those used solely or principally for supporting the lines, all rules shall be complied with as far as they apply and such additional precautions as may be deemed necessary by the administrative authority shall be taken to avoid injury to such structures or to the person using them. The supporting of conductors on trees and roofs should be avoided where practicable.

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

E 128.02 Tree trimming. (1) GENERAL. Where trees exist near supply-line conductors, they shall be trimmed, if practicable, so that neither the movement of the trees nor the swinging or increased sagging of conductors in wind or ice storms or at high temperatures will bring about contact between the conductors and the trees. (See sections 86.03, 86.16 and 182.017, Wis. Stats., 1959).

(a) *Exception:* For the lower-voltage conductors, where trimming is difficult, the conductor may be protected against abrasion and against grounding through the tree by interposing between it and the tree a sufficiently nonabsorptive and substantial insulating material or device.

(2) AT WIRE CROSSINGS AND RAILROAD CROSSINGS. The crossing span and the next adjoining spans shall be kept free, as far as practicable, from overhanging or decayed trees which might fall into the line.

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

E 128.03 Guying. (1) WHERE USED. When the loads to be imposed on poles, towers, or other supporting structures are greater than can safely be supported by the poles or towers alone, additional strength shall be provided by the use of guys, braces, or other suitable construction. Guys shall be used also, where necessary, wherever con-

ductor tensions are not balanced, as at corners, angles, dead-ends, and changes of grade of construction.

Note: This is to prevent undue increase of sags in adjacent spans as well as to provide sufficient strength for those supports on which the loads are considerably unbalanced.

(2) STRENGTH. The strength of the guy shall meet the requirements of chapter E 126 for the grade of construction that applies. When guys are used with wood or other poles or towers capable of considerable deflection before failure, the guys shall be able to support the entire load in the direction in which they act, the pole acting simply as a strut.

(3) POINT OF ATTACHMENT. The guy should be attached to the structure as near as practicable to the center of the conductor load to be sustained, but for voltages exceeding 8,700 volts the insulation afforded by wood crossarms and poles should not be reduced any more than necessary.

(4) GUY FASTENINGS. Guys should be stranded and where attached to anchor rods should be protected by suitable guy thimbles or their equivalent. Cedar and other soft wood poles around which any guy having a strength of 10,000 pounds or more is wrapped should be protected by the use of suitable guy shims and, where there is a tendency for the guy to slip off the shim, guy hooks or other suitable means of preventing this action should be used. Shims are not necessary in the case of supplementary guys, such as storm guys.

(5) GUY GUARDS. The ground end of a guy attached to a ground anchor shall be provided with a conspicuous guard not less than 8 feet long. In selecting the type of guard material, consideration shall be given to exposure to damage. Where there are multiple guys attached to an anchor only one need be guarded. Guards need not be used in inaccessible locations or where the presence of other objects makes contact unlikely.

Note: Recommendation: It is recommended that in exposed or poorly lighted locations such guards be painted white or some other conspicuous color.

(6) INSULATING GUYS FROM METAL POLES. Where anchors would otherwise be subject to electrolysis, guys attached to metal poles or structures and not containing guy insulators should be insulated from the metal pole or structure by suitable blocking.

(7) ANCHOR RODS. Anchor rods shall be installed so as to be in line with the pull of the attached guy when under load, except in rock or concrete. The anchor rod shall have an ultimate strength in the eye and shank equal to that required of the guy.

(8) GROUNDING. The anchored end of guys attached to wood poles carrying circuits of more than 15,000 volts shall be effectively grounded (see chapter E 103 for method) wherever this part of the guy has a clearance of less than 8 feet to ground.

(a) Exception 1: This does not apply to guys in rural districts.

(b) Exception 2: This does not apply if the guy contains an insulator which will meet the requirements of section E 128.04(1)(b) for the highest voltage liable to be impressed on it.

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

E 128.04 Insulators in guys attached to poles and towers. (1) PROPERTIES OF GUY INSULATORS. (a) *Material.* 1. Grade B. Guy insulators

shall be made of wet process porcelain, wood, or other material of suitable mechanical and electrical properties.

2. Grades C, D, and N. No requirements are made for material.

(b) *Electrical strength.* Guy insulators shall have a dry flash-over voltage at least double the normal line voltage and a wet flash-over voltage at least as high as the normal line voltage between conductors.

(c) *Mechanical strength.* Guy insulators shall have a mechanical strength at least equal to that required of the guys in which they are installed.

(2) USE OF GUY INSULATORS. (a) *One insulator.* An insulator shall be located in each guy which is attached to a pole or structure carrying any supply conductors of more than 300 volts and not more than 15,000 volts, or in any guy which is exposed to such voltages. This guy insulator shall be located not less than 8 feet above the ground.

1. Exception 1: A guy insulator is not required where the guy is grounded under the conditions set forth in section E 128.04(2)(d).

2. Exception 2: A guy insulator is not required if the guy is attached to a pole on private right of way carrying no supply circuits whose voltage exceeds 550 volts or where transmitted power exceeds 3,200 watts.

3. Exception 3: A guy insulator is not required if all supply conductors are in a cable having a grounded metal sheath or insulated conductors lashed to a grounded messenger.

(b) *Two insulators.* Where a guy attached to any pole carrying communication or supply conductors or both, is carried over or under overhead supply conductors of more than 300 volts and where hazard would otherwise exist, 2 or more guy insulators shall be placed so as to include the exposed section of the guy between them as far as possible. Neither insulator shall be within 8 feet of the ground.

1. Exception: Those insulators are not required where the guy is grounded under the conditions set forth in section E 128.04(2)(d).

(c) *Relative location of insulators in guys located one above the other.* Where guys in which it is necessary to install insulators are so arranged that one crosses or is above another, insulators shall be so placed that in cases any guy sags down upon another the insulators will not become ineffective.

(d) *Insulators not required.* Insulators are not required in guys under any of the following conditions:

1. Where the guy is electrically connected to grounded steel structures or to an effective ground connection on wood poles.

2. Where the guys are uniformly effectively grounded throughout any system of overhead lines.

3. Where the guys are connected to a line conductor grounded as specified in section E 103.02(2)(e).

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

E 128.05 Span-wire insulators. (1) MECHANICAL STRENGTH. Span-wire insulators shall have a mechanical strength at least equal to that required of the span wire in which they are installed.

(2) USE OF SPAN-WIRE INSULATORS. All span wires, including bracket span wires, shall have a suitable strain insulator (in addition to an insulated hanger if used) inserted between each point of support of the span wire and the lamp or trolley contact conductor supported,

except that single insulation, as provided by an insulated hanger, may be permitted when the span wire or bracket is supported on wooden poles supporting only trolley, railway feeder, or communication conductors used in the operation of the railway concerned. In case insulated hangers are not used, the strain insulator shall be located so that in the event of a broken span wire the energized part of the span wire cannot be reached from the ground.

(a) *Exception:* This rule does not apply to insulated feeder taps used as span wires.

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

E 128.06 Overhead conductors. (1) IDENTIFICATION. All conductors of electrical supply and communication lines should be arranged to occupy definite positions throughout, as far as practicable, or shall be so constructed, located, marked, or numbered, or attached to distinctive insulators or crossarms, as to facilitate identification by employees authorized to work thereon. This does not prohibit systematic transposition of conductors.

(2) BRANCH CONNECTIONS. (a) *Accessibility.* Connections of branches to supply circuits, service drops, and equipment in overhead construction shall be readily accessible to authorized employees. When possible, connections should be made at poles or other structures.

(b) *Clearance.* Branch connections shall be supported and placed so that swinging or sagging cannot bring them in contact with other conductors, or interfere with the safe use of pole steps, or reduce the climbing or lateral working space.

(3) COMMON NEUTRAL. Primary and secondary circuits may utilize a single conductor as a common neutral if such conductor is grounded as indicated in sections E 103.02(2)(d) and (e).

(4) SERVICE DROPS. Service drops shall comply with NEC-1971 sections 230–21 through 230–27 except as changed in volume 2 (see section E 230.24) and except as otherwise provided in volume No. 1.

History: Cr. Register, January, 1968, No. 145, eff. 2–1–68; am. (4), Register, April, 1972, No. 196, eff. 5–1–72.

E 128.07 Equipment on poles. (1) IDENTIFICATION. All equipment of electrical supply and communication lines should be arranged to occupy definite positions throughout, as far as practicable, or shall be constructed, located, marked, or numbered so as to facilitate identification by employees authorized to work thereon.

(2) LOCATION. Transformers, regulators, lightning arresters, and switches when located below conductors or other attachments shall be mounted outside of the climbing space. This equipment shall be so placed that unguarded conductors entering the equipment will have clearances from ground specified in table 2, subsection E 123.03(3).

(3) GUARDING. Current-carrying parts of switches, automatic circuit-breakers, and lightning arresters shall be suitably enclosed or guarded if all the following conditions apply:

(a) If of more than 300 volts, and

(b) If located on the climbing side of the pole less than 20 inches from the pole center, and

(c) If located below the top crossarm.

(4) HAND CLEARANCE. All current-carrying parts of switches, fuses, lightning arresters, also transformer connections and other connec-

tions which may require operation or adjustment while alive and are exposed at such times, shall be arranged so that in their adjustment while alive the hand need not be brought nearer to any other current-carrying part at a different voltage than the clearances from pole surfaces required in table 9, section E 123.06(1)(c)1. for conductors of corresponding voltages. (See also sections E 142.03 (1), (2) and (3), for clearances from live parts).

(5) STREET-LIGHTING EQUIPMENT. (a) *Clearance from pole surface.* All exposed metal parts of lamps and their supports (unless effectively insulated from the current-carrying parts) shall be maintained at the following distances from the surface of wood poles:

	Inches
1. In general	20
2. If located on the side of the pole opposite the designated climbing side	5

Exception: This does not apply where lamps are located at pole tops.

(b) *Clearance above ground.* Street lamps shall be mounted at not less than the following heights above ground:

	Feet
1. Over walkways	10
2. Over roadways—	
Connected to circuits of 150 volts or less	14
Connected to circuits of more than 150 volts	15

Note: Drops to street lights need have no greater clearance than the street lights themselves.

(c) *Horizontal clearances.* Arc and incandescent lamps in series circuits should have at least 8 feet horizontal clearance from windows, porches, and other spaces accessible to the general public.

(d) *Material of suspension.* The lowering rope or chain for lighting units arranged to be lowered for examination or maintenance, shall be of a material and strength designed to withstand climatic conditions and to sustain the lighting unit safely. The lowering rope or chain, its supports, and fastenings shall be examined periodically.

(e) *Insulators in suspension ropes.* Effective insulators as specified in section E 128.04(1), shall be inserted at least 8 feet from the ground in metallic suspension ropes or chains supporting lighting units of series circuits.

(f) *Arc-lamp disconnectors.* A suitable device shall be provided by which each arc lighting unit on series circuits of more than 300 volts may be safely and entirely disconnected from the circuit before the lamp is handled unless the lamps are always worked on from suitable insulating stools, platforms, or tower wagons, or handled with suitable insulating tools, and treated as under full voltage of the circuit concerned.

(g) *Grounding lamp posts.* Metal lamp posts shall be effectively grounded.

(6) TRANSFORMERS. Transformers mounted on arms or poles on public thoroughfares shall be at a height above ground not less than 10 feet where over walkways and not less than 15 feet where over roadways.

(a) *Exception:* Where it is the established practice to mount trans-

formers at lesser distances above ground, such practice may be continued if the reduced mounting heights are carefully maintained.

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

E 128.08 Protection for exposed overhead communication lines. (1) OPEN WIRE. Communication lines for public use and fire-alarm lines shall be treated as follows if at any point they are exposed to supply (including trolley) lines of more than 400 volts.

(a) At stations for public use they shall be protected by one of the methods specified in NEC-1971 Article 800 except as changed in volume 2 (see sections E 800.02 and E 800.21).

(b) Elsewhere they shall be isolated by elevation or otherwise guarded so as to be inaccessible to the public.

(2) METAL-SHEATHED CABLE. Metal-sheathed cables and messengers shall be isolated or grounded in conformity with the general requirements of chapter E 121.

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

E 128.09 Circuits of one class used exclusively in the operation of circuits of another class. (1) OVERHEAD COMMUNICATION CIRCUITS, USED EXCLUSIVELY IN THE OPERATION OF SUPPLY CIRCUITS. (a) *Choice of method.* Communication circuits used exclusively in the operation of supply lines may be run either as ordinary communication circuits or as supply circuits under the conditions specified in section E 128.09(1)(c) and (d), respectively. After selection of the type of communication-circuit construction and protection for any section which is isolated, or is separated by transformers, such construction and protection shall be consistently adhered to throughout the extent of such isolated section of the communication system.

(b) *Guarding.* Communication circuits used in the operation of supply lines shall be isolated by elevation or otherwise guarded at all points so as to be inaccessible to the public.

(c) *Where ordinary communication line construction may be used.* Communication circuits used in the operation of supply lines may be run as ordinary communication conductors under the following conditions:

1. Where such circuits are below supply conductors in the operation of which they are used (including high voltage trolley feeders) at crossings, conflicts, or on commonly used poles, provided:

a. Such communication circuits occupy a position below all other conductors or equipment at crossings, conflicts or on commonly used poles.

b. Such communication circuits and their connected equipment are adequately guarded and are accessible only to authorized persons.

c. The precautions in Wis. Adm. Code chapter E 144 and NEC-1971 Article 800 except as changed in volume 2 (see sections E 800.02 and E 800.21) have been taken.

d. Where such circuits are below supply conductors in the operation of which they are used and are above other supply or communication conductors at wire crossings, conflicts, or on the same poles, provided the communication circuits are protected by fuseless lightning arresters, drainage coils, or other suitable devices to prevent the communication circuit voltage from normally exceeding 400 volts.

Note: The grades of construction for communication conductors with inverted levels apply.

(d) *Where supply line construction must be used.* Communication circuits used in the operation of supply lines shall comply with all requirements for the supply lines with which they are used, where they do not comply with the provisions of section E 128.09(1)(c)1. or 2.

1. Exception 1: Where the voltage of supply conductors concerned exceeds 8,700, the communication conductors need only meet the requirements for supply conductor of 5,000 to 8,700 volts.

2. Exception 2: Where the supply conductors are required to meet grade C, the size of the communication conductors may be the same as for grade D (see section E 126.03(9)(b)) for spans up to 150 feet.

(2) SUPPLY CIRCUITS USED EXCLUSIVELY IN THE OPERATION OF COMMUNICATION CIRCUITS. Circuits used for supplying power solely to apparatus forming part of a communication system may be run either in open wire or in aerial or underground cable as follows:

(a) Where run in open wire, such circuits shall have the grades of construction, clearances, insulation, etc. prescribed elsewhere in part 2 for supply or communication circuits of the voltage concerned.

(b) Where run in aerial or underground cable and the following requirements are met, the grades of construction, clearances, separations, locations, etc. prescribed elsewhere in part 2 for communication cables shall apply.

1. Such cables are covered with effectively grounded continuous metal sheaths or are carried in metal cable rings on effectively grounded messengers.

2. All circuits in such cables are owned or operated by one party and are maintained only by qualified employees.

3. Supply circuits included in such cables are terminated at points accessible only to qualified employees.

4. Communication circuits brought out of such a cable, if they do not terminate in a repeater station or terminal office, shall be so protected or arranged that in the event of a failure within the cable, the voltage on these communication circuits will not exceed 400 volts.

5. Terminal apparatus for the power supply shall be arranged so that live parts are inaccessible when such supply circuits are energized.

a. Exception: The provisions of sections E 128.09 (2) (a) and (b), do not apply to supply circuits of 550 volts or less and which carry power not in excess of 3,200 watts, covered in section E 122.01 (2) (c).

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

E 128.10 Overhead electric railway construction. (1) TROLLEY CONTACT CONDUCTOR SUPPORTS. All overhead trolley-contact conductors shall be supported and arranged so that the breaking of a single contact conductor fastening will not allow the trolley conductor, live span wire, or current-carrying connection to come within 10 feet (measured vertically) from the ground, or from any platform accessible to the general public. Span-wire insulation for trolley contact conductors shall comply with section E 128.05.

(2) HIGH-VOLTAGE CONTACT CONDUCTORS. Every trolley contact conductor of more than 750 volts in urban districts where not on fenced right of way shall be suspended so as to minimize the liability of a

break, and, as far as practicable, so that if broken at a single point, it cannot fall within 12 feet (measured vertically) from the ground or any platform accessible to the general public.

(3) THIRD RAILS. Third rails shall be protected where not on fenced rights of way by adequate guards composed of wood or other suitable material.

(4) PREVENTION OF LOSS OF CONTACT AT RAILROAD CROSSINGS. Trolley contact conductors shall be arranged as set forth in either section E 128.10(4)(a) or (b), at grade crossings with interurban or other heavy-duty or high-speed railroad systems.

(a) The trolley contact conductor shall be provided with live trolley guards of suitable construction, or,

(b) The trolley contact conductor shall be as far as practicable at the same height above its own track throughout the crossing span and the next adjoining spans. Where a uniform height above rail is not adhered to, the change shall be made in a very gradual manner. Where the crossing span exceeds 100 feet, catenary construction shall be used.

1. Exception: This rule does not apply where the system is protected by interlocking derails or by gates.

(5) GUARDS UNDER BRIDGES. (a) *Where guarding is required.* Guarding is required where the trolley contact conductor is so located that a trolley pole leaving the conductor can make simultaneous contact between it and the bridge structure.

(b) *Nature of guarding.* Guarding shall consist of substantial inverted trough of nonconducting material located above the contact conductor, or other suitable means of preventing contact between the trolley pole and the bridge structure.

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

Chapter E 129

UNDERGROUND LINES

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 interconnected 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.

Part 3

RULES TO BE OBSERVED IN THE OPERATION OF ELECTRIC AND COMMUNICATION EQUIPMENT AND LINES

(See sections 102.37 and 196.72, Wis. Stats., and Wis. Adm. Code chapter PSC 104).

Chapter E 140

SCOPE AND APPLICATION

E 140.01 Scope. (1) WIS. ADM. CODE CHAPTERS E 141 TO E 143. The safety rules in chapters E 141, E 142, and E 143 do not apply to new construction not yet energized, but apply to the operation of, or to work on or about, the following:

(a) Supply lines.

(b) Communication lines used in connection with supply lines.

(c) Electrical equipment of central stations, substations, and private plants.

(d) Electrical tests.

(e) Electrical work in tunnel, subway, or similar underground structures.

(2) CHAPTERS E 144 AND E 145. The safety rules in these chapters apply to commercial telephone and telegraph, and other communication equipment and lines, with terminology adapted to the special needs of the employees concerned. Communication equipment and lines include fire and police alarm systems, district messenger systems, and other communication systems not operated in connection with supply lines.

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

E 140.02 Application. While all the rules find application in the larger industrial or private plants and in moderate-sized utilities, some do not apply, or apply less fully, in the smaller ones. It has seemed unwise, however, to attempt to restrict the scope of these rules to rules which are applicable to all organizations or to all classes of electrical work.

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

E 140.03 Exposed communication lines. Communication equipment and lines are not considered alive, except where made alive by leakage from supply equipment or lines. They are, however, a source of danger when near live supply conductors on wood poles, due to their liability of being grounded.

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

Chapter E 141

SUPPLY SYSTEMS; RULES FOR EMPLOYERS

E 141.01 General requirements. (1) INTERPRETATION AND ENFORCEMENT OF RULES. (a) *Distribution.* The employer shall furnish to each regular employee operating or working on electrical supply equipment, supply or communication lines, or hazardous electrical tests a copy of these safety rules for operation (or such of these rules as apply to his work), either separately or incorporated in more comprehensive rule books, and shall take means to secure the employee's compliance with the same.

Note: Many companies number their books of rules and require a receipt from each employee for his copy.

(b) *Interpretation.* If a difference of opinion arises with regard to the meaning or application of these rules or as to the means necessary to carry them out, the decision of the employer or his authorized agent shall be final, unless an appeal is taken to the administrative authority.

(c) *Modification.* Cases may arise where the strict enforcement of some particular rule will seriously impede the progress of the work in hand; in such cases the employee in charge of the work to be done may, with the consent of the chief operator concerned, make such temporary modification of the rule as will expedite the work without materially increasing the hazard.

(2) ORGANIZATION DIAGRAM. An organization diagram or written statement clearly showing the division of responsibility between officials and employees, down to and including the grade of foreman, should be supplied with the book of rules, or the diagram should be posted conspicuously in offices and stations of the employer and in other places where the number of employees and the nature of the work warrant.

(3) FIRST-AID RULES AND PHYSICIANS' ADDRESSES. The rule book should contain or be accompanied by the following:

(a) A list of names and addresses of those physicians and members of the organization who are to be called upon in emergencies.

(b) A copy of rules for first aid, an approved method of resuscitation and fire extinguishment. These should also be kept in conspicuous locations in every station and testing room, in line wagons, and in other places where the number of employees and the nature of the work warrant.

(4) INSTRUCTING EMPLOYEES. Employees regularly working on or about equipment or lines shall be thoroughly instructed in methods of first aid, resuscitation by an approved method, and where advisable in fire extinguishment.

(5) QUALIFICATION OF EMPLOYEES. The employer shall use every reasonable means and precaution to assure himself that each employee is mentally and physically qualified to perform his work in accordance with these rules.

(6) CHIEF OPERATOR. (a) *Authority.* A properly qualified chief operator, system operator, load dispatcher, general superintendent, or otherwise designated employee shall be in charge of the operation of electrical equipment and lines and directly responsible for their safe operation. His duties shall be those prescribed in section E 142.02(1).

(b) *Deputy.* In large organizations the duties of the chief operator may be delegated for any particular section of the system to a deputy chief operator (or otherwise designated employee) who shall report as required to the chief.

(c) *Large organizations or extended systems.* When it is impracticable to have the entire system placed in charge of one chief operator, the duties of the chief operator may be performed by a local superintendent, local manager, or other employee who may also perform other duties.

(d) *Small organizations.* The duties of the chief operator in small organizations may be performed for a portion of the system by a local superintendent, electrician, engineer, or some other employee who may also perform other duties.

Note: In these rules the various employees listed by above titles including the deputy chief operator, will be designated (for simplicity) by the title of chief operator, where referred to in this capacity.

(7) RESPONSIBILITY. If more than one person is engaged in work on or about the same electrical equipment or lines at any one location, one of the persons shall be designated as the foreman locally in charge of the work; or, all of the workmen shall be instructed as to the work they are to perform, and the employee instructing the workmen shall be considered in charge of the work.

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

E 141.02 Protective methods. (1) ATTENDANCE. Unless a qualified employee is kept on duty where generators or rotary converters are operating such equipment shall be made inaccessible to unauthorized persons.

(2) REQUIREMENT FOR TWO WORKMEN. In wet weather or at night, no employee shall work alone on or dangerously near live conductors or parts of overhead or underground lines of more than 750 volts.

(a) Exception: Trouble or emergency work is excepted.

(3) UNQUALIFIED WORKMEN AND VISITORS. Unqualified employees or visitors shall be prohibited from approaching any live parts, unless accompanied by a qualified employee, who should warn the unqualified employee or visitor of the danger attendant upon such approach.

(4) DIAGRAMS FOR CHIEF OPERATOR. Diagrams or equivalent devices, showing plainly the arrangement and location of the electrical equipment and lines, should be maintained on file or in sight of the chief operator.

Note: These diagrams may be of the entire system, or of each specific portion of the system, or they may show typical arrangements.

(5) INSTRUCTIONS TO EMPLOYEES. All employees shall be instructed as to the character of all equipment or lines on or dangerously near to which work must be done by them. Instructions shall describe the equipment and lines to be worked on, identifying them either by position, letter, color, number, or name.

(6) PROTECTIVE DEVICES. (a) A supply of suitable protective, first-aid, and fire extinguishing devices and equipment, sufficient to enable employees to meet the requirements of these rules, shall be provided in conspicuous and suitable places in electrical stations, testing departments, and line construction and repair wagons. The following is a list of suitable devices and equipment, the kinds and numbers of which will depend on the requirements of each case:

1. First-aid outfits.
2. Insulating wearing apparel, such as insulating gloves, sleeves, and boots. Insulating shields, covers, mats, stools, and platforms. Insulating appliances, such as rods and tongs, for any necessary handling or testing of live equipment or lines.
3. Protective goggles of suitable materials and construction.
4. Tools of such special design and insulation as to eliminate so far as practicable the danger of forming short-circuits across conducting parts at different potentials or bringing the user into contact with such parts.
5. "Men at work" or equivalent tags, log books, operation diagrams, or equivalent devices, and portable danger signs.
6. Fire-extinguishing devices, for safe use on live parts or plainly marked that they must not be so used.
7. Grounding devices for making protective grounds.
8. Fixed or portable lighting equipment.

(7) INSPECTION OF PROTECTIVE DEVICES. Such devices and equipment shall be inspected and tested to insure that they are kept in good order, and in dependable condition and shall not be used unless so inspected, and in the case of insulating devices, tested as frequently as their use necessitates. Safety belts, whether furnished by employer or employee, should be inspected from time to time to assure that they are in safe working condition.

(8) WARNING SIGNS. Permanent warning signs forbidding entrance to unauthorized persons shall be displayed in conspicuous places at all unattended and unlocked entrances to electrical supply stations, substations, and testing rooms containing exposed current-carrying parts or moving parts.

(9) DANGER SIGNS. Suitable danger signs shall be placed in supply stations, substations, switching towers, and testing rooms about equipment having exposed current-carrying parts of more than 750 volts.

(10) IDENTIFICATION. Circuits should be tagged, marked or lettered unless identification be obtained by location.

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

Chapter E 142

SUPPLY SYSTEMS; GENERAL RULES FOR ALL EMPLOYEES

E 142.01 General precautions. (1) RULES AND EMERGENCY METHODS. The safety rules should be carefully read and studied. Employees may be called upon at any time to show their knowledge of the rules. Employees should familiarize themselves with approved methods of first-aid, resuscitation, and fire extinguishment.

(2) HEEDING WARNINGS, WARNING OTHERS. Employees whose duties do not require them to approach or handle electrical equipment and lines should keep away from such equipment or lines. They should cultivate the habit of being cautious, heeding warning signs and signals, and always warning others when seen in danger near live equipment or lines. An employee should report as soon as practicable to his superior or some suitable authority any obvious hazards to life or property observed in connection with any electric equipment or lines. Any imminently dangerous conditions shall be guarded until they can be made safe.

(3) INEXPERIENCED OR UNFIT EMPLOYEES. (a) No employee shall do work for which he is not properly qualified on or about live equipment or lines.

(b) If an employee is in doubt as to the proper performance of any work assigned to him, he should request instructions from the foreman or other responsible person.

Exception: Work done under the direct supervision of an experienced and properly qualified person is excepted.

(4) SUPERVISION OF WORKMEN. Workmen, whose employment incidentally brings them in the vicinity of electrical supply equipment or lines with the dangers of which they are not familiar, shall proceed with their work only when authorized. They shall then be accompanied by a properly qualified and authorized person, whose instructions shall be strictly obeyed.

(5) EXERCISING CARE. Employees near live equipment and lines should consider the effect of each act and do nothing which may endanger themselves or others. Employees should be careful always to place themselves in a safe and secure position and to avoid slipping, stumbling, or moving backward against live parts. The care exercised by others should not be relied upon for protection.

(6) LIVE AND ARCING PARTS. (a) *Treat everything as alive.* Electrical equipment and lines should always be considered as alive, unless they

are positively known to be dead. Before starting to work, preliminary inspection or test should always be made to determine what conditions exist. (See section E 142.03(1) for general requirements and section E 142.05(3) for test of circuit).

(b) *Protection against arcs.* The hands should be covered by protecting and insulating gloves and the eyes by suitable goggles or other means if exposed to injurious arcing. Either a thin rubber glove used with a protective outer glove or a heavier rubber glove used alone shall be considered as both protecting and insulating. Employees should keep all parts of their bodies as far away as possible from brushes, commutators, switches, circuit-breakers, or other parts at which arcing is liable to occur during operation or handling.

(7) SAFETY APPLIANCES. Employees at work on or near live parts should use the protective devices and the special tools provided. Before starting work these devices or tools should be examined to make sure that they are suitable and in good condition.

Note: Protective devices may get out of order or be unsuited to the work in hand.

(8) SUITABLE CLOTHING. Employees should wear suitable clothing while working on or about live equipment and lines. In particular, they should keep sleeves down and avoid wearing unnecessary metal or flammable articles, such as rings, watch or key chains, or metal cap visors, celluloid collars, or celluloid cap visors. Loose clothing and shoes that slip easily should not be worn near moving parts.

(9) SAFE SUPPORTS. (a) Employees should not support themselves on any portion of a tree, pole structure, scaffold, ladder, or other elevated structure without first making sure that the support is strong enough. Supports should be reinforced if necessary.

(b) Where portable ladders are treated for preservation, only a transparent coating or other preservation which does not hide the grain and wood structure shall be used. Only a non-conducting preservation and non-conducting bracing shall be used where ladders are used in stations or around electric equipment. (See Department of Industry, Labor and Human Relations rules on safety in construction.)

(c) Portable ladders should be in a safe position before being climbed. The slipping of a ladder at either end should be carefully guarded against, especially where the supporting surfaces are smooth or vibrating.

(10) SAFETY BELTS. Employees working in elevated positions should use a suitable safety belt or other adequate means to guard against falling. Before an employee trusts his weight to the belt, he should determine that the snaps or fastenings are properly engaged and that he is secure in his belt. No safety belt or other protective device shall be used that has not been approved and recently inspected as provided in section E 141.02(7).

(11) FIRE EXTINGUISHERS. In fighting fires near exposed live parts, employees should avoid using fire-extinguishing liquids which are non-insulating. If necessary to use them, all neighboring equipment should be first killed.

(12) REPEATING MESSAGES. Each person receiving an unwritten message concerning the handling of lines and equipment shall immedi-

ately repeat it back to the sender and secure his full name or other identification and acknowledgment. Each person sending an unwritten message shall require it to be repeated back to him by the receiver and secure the latter's full name.

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

E 142.02 Operating routines. (1) DUTIES OF CHIEF OPERATOR. The chief operator, described in section E 141.01(6) shall:

(a) Keep informed of all conditions affecting the safe and reliable operation of the system.

(b) Keep a suitable record or log book showing all changes in such conditions. He shall read and sign such record when assuming duty and sign again on being relieved.

(c) Keep within sight operating diagrams or equivalent devices indicating whether electrical supply circuits are open or closed at stations under his immediate jurisdiction, and where work is being done under his special authorization.

1. Exception: These indicating devices shall not be required for any chief operators classed under sections E 141.01(6)(c) and (d), if the record or log sheets show all conditions affecting the safe and reliable operation of the system.

Note: In these rules the person performing these duties is designated as chief operator, regardless of his ordinary title.

(2) DUTIES OF FOREMAN. Each foreman in charge of work shall adopt such precautions as are within his power to prevent accidents and to see that the safety rules are observed by the employees under his direction. He shall make all the necessary records, and shall report to his chief operator when required. He shall, as far as possible, prevent unauthorized persons from approaching places where work is being done. He shall also prohibit the use of any tools or devices unsuited to the work in hand or which have not been tested as provided in section E 141.02(7).

(3) QUALIFIED GUIDES. The qualified persons accompanying uninstructed workmen or visitors near electrical equipment or lines shall take precautions to provide suitable safeguards and see that the safety rules are observed.

(4) SPECIAL AUTHORIZATION. (a) *Special work.* Special authorization from the chief operator shall be secured before work is begun on or about station equipment, transmission, or interconnected feeder circuits or live circuits of more than 8,700 volts, and in all cases where lines are to be killed by regular procedure at stations, and a report shall be made to him when such work ceases.

1. Exceptions: In emergency, to protect life or property, or when communication with the chief operator is difficult, due to storms or other causes, any qualified employee may make repairs on or about the equipment or lines covered by this order without special authorization if the trouble is such as he can promptly clear with help available in compliance with the remaining orders. The chief operator shall thereafter be notified as soon as possible of the action taken. (See subsection (8) (b) for crossed or fallen wires).

(b) *Operations at stations.* In the absence of specific operating schedules for opening and closing supply circuits at stations, or start-

ing and stopping equipment, employees shall secure special authorization from the chief operator before performing these operations. In all cases such special authorization shall be secured where circuit or equipment control devices are tagged at stations to protect workmen. (See subsection (6) for tagging electrical circuits).

1. Exceptions: In emergency, to protect life or property, any qualified employee may open circuits and stop moving equipment without special authorization if, in his judgment, his action will promote safety, but the chief operator shall be notified as soon as possible of such action, with reasons therefor. To maintain service, any qualified employee may also reclose circuits which have opened by fuses or automatic circuit-breakers except where this is prohibited by rule.

(c) *Cutting out sections of circuits.* Special authorization shall be secured from the chief operator before sections of overhead or underground circuits are cut off by employees at points other than at stations by means of sectionalizing switches.

1. Exception: Portions of distribution circuits of less than 8,700 volts may be cut off by authorized employees without special authorization from the chief operator, by means of sectionalizing switches, if the chief operator is thereafter notified as soon as possible of the action taken. This may also be done even for circuits of more than 8,700 volts when communication with the chief operator is difficult.

(5) RESTORING SERVICE AFTER WORK. Instructions for making alive equipment or lines which have been killed by permission of the chief operator to protect workmen shall not be issued by him until all workmen concerned have been reported clear. When there is more than one workman at a location, a person authorized for the purpose shall report clear for such workmen, but only after all have reported clear to him. If there is more than one gang, each shall be so reported clear to the chief operator.

(6) TAGGING ELECTRICAL SUPPLY CIRCUITS. (a) *When tags are placed at direction of chief operator.* Before work is done at direction of chief operator on or about equipment or circuits, under any of the conditions listed below, the chief operator shall have "Man at work" or equivalent tags attached at all points, where such equipment or circuits can be manually controlled by regular operators. The tags should be placed to plainly identify the equipment or circuits worked on.

1. Transmission or interconnected feeder circuits.
2. Circuits operating at more than 8,700 volts.
3. Circuits killed at stations and substations to protect workmen.

(b) *When tags are placed at direction of authorized employees.* Before work is done on or about any equipment or lines which are killed by authorized employees at points other than at stations, the employees shall have "Men at work" or equivalent tags placed at all points where the circuit has been disconnected to identify the portion worked on.

(7) MAINTAINING SERVICE. (a) *Closing tagged circuits which have opened automatically.* When live circuits on which "Men at work" or equivalent tags have been placed have opened automatically, they should be kept disconnected until the chief operator has given proper authorization for reconnection.

(b) *Closing circuits operated automatically.* When overhead circuits, other than trolley and third-rail circuits, open automatically, the employer's local operating rules shall determine in what manner and how many times they may be closed with safety for persons on or near those circuits. The chief operator shall be advised of the conditions.

(c) *Grounded circuits.* When circuits feeding supply lines become accidentally grounded, they shall be tested to determine where the ground exists. If the ground cannot be definitely located and removed by the station operator, an immediate report of the finding shall be given to the chief operator, who shall order a patrol of the lines affected to definitely locate and remove the ground as soon as practicable.

Note: On circuits exceeding 8,700 volts, it will usually be found advisable to disconnect the circuit or effectively ground the accidentally grounded conductor until the lines have been cleared of the accidental ground.

(8) PROTECTING TRAFFIC. (a) *Barrier guards.* Employees shall first erect suitable barrier guards before engaging in such work as may endanger traffic. They shall also display danger signs or red lamps placed so as to be conspicuous to approaching traffic. Where the nature of work and traffic requires it, a man shall be stationed to warn passers-by while work is going on.

(b) *Crossed or fallen wires.* An employee finding any crossed or fallen wires which may create a hazard shall remain on guard or adopt other adequate means to prevent accidents, and shall have the chief operator notified. If the employee can observe the rules for handling live parts by the use of insulating appliances, he may correct the condition at once; otherwise he shall first secure the authorization from the chief operator for so doing. (See subsection E 142.02(4) for special authorization).

(9) PROTECTING WORKMEN BY SWITCHES AND DISCONNECTORS. When equipment or lines are to be disconnected from any source of electrical energy, for the protection of workmen, the operator shall first open the switches or circuit-breakers designed for operation under load, and then the air-break disconnectors, when provided.

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

E 142.03 Handling live equipment or lines. (1) GENERAL REQUIREMENTS. (a) *Touching live parts.* An employee should never touch with bare hands two parts at different potential at the same time. He should never touch with bare hands even a single exposed ungrounded live part at a dangerous potential to ground unless he is insulated from other conducting surfaces, including the ground itself, and stands on insulating surfaces. Employees may be supported by an insulating support especially designed for the purpose of working on live parts and whose position can be controlled within narrow limits.

(b) *Wire insulation.* Employees should not place dependence for their safety on the insulating covering of wires. All precautions in this section for handling live parts shall be observed in handling insulated wires.

Note: Covering or insulation on a wire may look perfect, but it frequently will not prevent shock.

(c) *Exposure to higher voltages.* Every employee working on or about equipment or lines exposed in overhead construction to voltages higher than those guarded against by the safety appliances provided should as far as practicable assure himself that the equipment or lines worked on are free from dangerous leakage or induction or have been effectively grounded.

(d) *Cutting into insulating coverings of live conductors.* When the insulating covering on live wires or cable must be cut into, the employee should use a suitable tool.

Note: Recommendation: While doing such work, it is recommended that suitable goggles be worn to protect the eyes, and insulating gloves to protect the hands.

When metal sheathing must be removed from cables, it should be done with special tools which will not injure the insulation. The sheathing should be cut so as to leave enough exposed insulation after the conductor has been bared to avoid arcing over between the conductor and the sheath. If the cable consists of more than one conductor, similar exposed insulating surface should be left for each conductor, using insulating separators between conductors, if necessary.

Insulating devices, such as wood separators, etc., should be examined, and conducting dust or chips, sharp edges, or nails should be eliminated to avoid defeating the purpose for which the devices are intended.

(e) *Metal tapes or ropes.* Metal measuring tapes, and tapes, ropes, or hand lines having metal threads woven into the fabric should not be used near exposed live parts.

(f) *Metal reinforced ladders.* Ladders reinforced by metal in a longitudinal direction should not be used near exposed live parts.

(2) VOLTAGES BETWEEN 750 AND 8700. No employee should go, or take any conducting object without a suitable insulating handle, within 6 inches of any exposed live part whose voltage exceeds 750, where it is practicable to avoid this. Where safe distance from live parts cannot be secured by use of the special insulating tools and appliances furnished, properly tested insulating gloves and sleeves may serve as the sole portable insulating devices between the person and live parts.

(a) Exception 1: In dry locations this distance may be less than 6 inches, if insulating devices, such as shields, covers, or gloves are placed between the person and the part or object.

(b) Exception 2: In dry locations, the distance may also be reduced if insulating barriers (such as mats, stools, or platforms) are placed between the person and the ground, and suitable insulating shields between the person and all other conducting or grounded surfaces, which he could accidentally touch at the same time.

(c) Exception 3: In all damp or dark locations, the distance may be less than 6 inches only if insulating devices are used between the person and the live parts and also between him and all other conducting surfaces with which he might otherwise come in contact at the same time.

Note: Care should be exercised in using insulating gloves to avoid puncturing them on sharp edges, especially in making wire splices. It is generally advisable to wear protecting gloves over insulating gloves.

Under some circumstances it is desirable to cover with protective insulating material any grounded conductor or other grounded metal adjacent to work on live conductors, where the lineman might inadvertently contact it while handling a live conductor.

(3) VOLTAGES EXCEEDING 8,700. (a) *Clearances from live parts.* No employee should go, or take any conducting object, within the distances named below from any exposed live part at or above the voltage specified.

Operating Voltage	Distance in Inches
8,700	12
13,800	22
15,000	24
26,400	28
34,500	31
44,000	34
50,000	36
69,000	48
70,000	48
88,000	55
110,000	60
132,000	72

Distances for intermediate voltages to be determined by interpolation.

1. Exception 1: In dry locations these distances may be reduced if suitable insulating guards or barriers are placed between the person and such part or object.

2. Exception 2: These distances need not be maintained if the person uses an insulating support especially designed for the voltage to be worked on and arranged so that its position can be controlled within narrow limits.

(b) *Guards.* If the part is being directly worked on, the tools or other mechanical appliances used shall have insulating handles of sufficient length to permit the operator to maintain the distance specified in section E 142.03(3)(a) preceding.

1. Exception: This does not apply if protective guards are also used between the person and the live part.

Note: These protective guards may be permanent insulating covers or shields, or may be disks of insulating material, suitable for the voltages to be handled and for the attendant conditions, attached to the handles of rods or tools.

(4) REQUIREMENT FOR TWO WORKMEN. In wet weather or at night no employee shall work alone on or dangerously near live lines of more than 750 volts.

(a) Exception: Trouble and emergency work is excepted.

(5) WHEN TO KILL PARTS. An employee shall not approach, or willingly permit others to approach, any exposed ungrounded part normally alive closer than permitted by sections E 142.03 (1), (2) or (3), unless the supply equipment or lines are killed.

Note: This is to ensure the employee of his own safety and the safety of those working under his direction.

(6) OPENING AND CLOSING SWITCHES. Manual switches and disconnectors should always be closed by a single unhesitating motion, and, if possible, with one hand. Care should be exercised in opening switches to avoid causing serious arcing.

(7) WORK FROM BELOW. Employees should avoid working on equipment or lines from any position by reason of which a shock or slip will tend to bring the body toward exposed live parts. Work should, therefore, generally be done from below, rather than from above.

(8) ATTACHING CONNECTING WIRES AND GROUNDS. (a) *Handling connecting lines.* In connecting dead equipment or lines to a live circuit by means of a connecting wire or device, employees should first attach the wire to the dead part before attaching it to the circuit. When dis-

connecting, the live end should be removed first. Loose conductors shall be kept away from exposed live parts.

(b) *Applying grounds.* In applying a grounding device to normally live parts, the device shall be grounded before being brought near the parts and shall be removed from the live parts before being removed from the ground connection.

(9) HANDLING SERIES CIRCUITS. Secondaries of current transformers to meters or other devices should not be opened when alive until a jumper has been connected across the point of opening or the circuit has been short-circuited elsewhere. Before working on arc lights connected to series circuits, they shall be short-circuited or (when necessary to avoid hazard) disconnected entirely from such circuits by absolute cutouts.

(10) STRINGING WIRES. In stringing wires near live conductors, they should be treated as alive unless they are effectively grounded.

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

E 142.04 Killing equipment or lines. (1) APPLICATION OF RULE. (a) If workmen must depend on others for operating switches to kill circuits on which they are to work, or must secure special authorization from the chief operator before themselves operating such switches, the following precautionary measures shall be taken in the order given, before work is begun on or about the equipment or lines concerned, as a means for preventing misunderstanding and accident.

(b) In small organizations the chief operator may himself operate the switches and disconnectors instead of instructing others to do so, thus much simplifying and abbreviating the procedure. In certain cases the chief operator may direct the workman who wishes the section killed for his own protection to operate some or all switches necessary himself, thus also abbreviating the procedure.

(c) In cases where there is no station with regular attendants at either end of a section of line to be killed for the protection of workers, the rules below need not apply for disconnection of that end of the section concerned, provided that the employee under whose direction that end of the section is disconnected is in sole charge of the section and of the means of disconnection employed or that the point of disconnection at that end of the section is suitably tagged before work proceeds.

(2) WORKMAN'S REQUEST. The workman in charge of the work shall apply to the chief operator to have the particular section of equipment or lines killed, identifying it by position, letter, color, number, or other means.

(3) OPENING DISCONNECTORS AND TAGGING. (a) The chief operator at his discretion shall direct the proper persons to open all switches and air-break disconnectors through which electrical energy may be supplied to the particular section of equipment and lines to be killed, and shall direct that such switches and disconnectors be tagged with a tag of a distinctive character indicating that men are at work. All oil switches and remotely controlled switches should also be blocked where necessary for avoiding mistakes.

(b) A record shall be made when placing the tag giving the time of disconnection, the name of the man making the disconnection and the

name of the workman who requested the disconnection, and the name of the chief operator.

(c) Where the section of equipment or lines can be made alive from 2 or more sources, all such sources shall be disconnected.

Note: This will apply to work on lines with more than one station, also sometimes to work on transformers in banks, rotary converters, motor generators, switches, and other similar equipment.

(4) STATION PROTECTIVE GROUNDS. When all the switches and disconnectors designated have been opened, blocked, and tagged in accordance with section E 142.04(3), the chief operator shall require that protective grounds be made upon the lines which have been killed and that they are reported to him when placed.

(a) Exception: This requirement does not apply under conditions where the making of such grounds or the conditions resulting from having made the grounds would be more hazardous than working on lines without grounding.

(5) PERMISSION TO WORK. Upon receipt of information from all persons operating switches and disconnectors that protective grounds are in place, the chief operator shall advise the workman who requested the killing of the section that the specified section of equipment or line has been killed and that he may proceed to work.

(6) WORKMEN'S PROTECTIVE GROUNDS FOR OVERHEAD LINES. The workman in charge should immediately proceed to make his own protective grounds on the disconnected lines, except under conditions where the making of such grounds or the conditions resulting therefrom would be more hazardous than working on the lines without grounding. Such grounds shall be made between the particular point at which work is to be done and every source of energy.

(7) PROCEEDING WITH WORK. After the equipment or lines have been killed (and grounded, if required by section E 142.04(6)), the workman in charge and those under his direction may proceed with work on the grounded or killed parts. Care, however, shall be taken to guard against adjacent live circuits or parts.

(8) PROCEDURE FOR OTHER GANGS. Each additional workman in charge desiring the same equipment or lines to be killed for the protection of himself or the men under his direction shall follow the same procedure as the first workman and secure similar protection.

(9) REPORTING CLEAR; TRANSFERRING RESPONSIBILITY. The workman in charge, upon completion of his work, and after assuring himself that all men under his direction are in safe positions, shall remove his protective grounds and shall report to the chief operator that all tags protecting him may be removed, and shall give his location and report as follows: "Mr. _____ and men clear and all grounds removed." The workman in charge who received the permission to work may transfer this permission and the responsibility for men under him, as follows: He shall personally inform the chief operator of the proposed transfer, and if this is permitted, the name of the successor shall be entered at that time on the tags concerned or in the records of the persons placing the tags and of the chief operator. Thereafter the successor shall report clear and shall be responsible for the safety of the original workmen, so far as this is affected by the removal of tags.

(10) REMOVAL OF TAGS. The chief operator shall then direct the removal of tags for that workman and the removal shall be reported back to him immediately by the persons removing them. Upon the removal of any tag, there shall be added to the record the name of the chief operator and workman who requested the tag, the time of removal, and the signature of the person removing the tag.

(11) RESTORING SERVICE. Only after all protecting tags have been removed by the above procedure from all points of disconnection shall the chief operator, at his discretion, direct the removal of protective grounds and blocks and the closing of any or all disconnectors and switches.

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

E 142.05 Making protective grounds. (1) APPLICATION OF RULE. When making temporary protective grounds on a normally live circuit, the following precautionary measures shall be observed in the order given, and the ground shall be made to all wires of the circuit which are to be considered as grounded.

(2) GROUND CONNECTIONS. The employee making a protective ground on equipment or lines shall first connect one end of grounding device to an effective ground connection supplied for the purpose.

(3) TEST OF CIRCUIT. The normally live parts which are to be grounded should next be tested for any indication of voltage, the employee carefully keeping all portions of his body at the distance required from such parts when alive by the use of suitable insulating rods or handles of proper length, or other suitable devices.

(4) COMPLETING GROUNDS. If the test shows no voltage, or the local operating rules so direct, the free end of the grounding device shall next be brought into contact with the normally live part and securely clamped or otherwise secured thereto before the employee comes within the distances from the normally live parts specified in subsections E 142.03(1) and (2), or proceeds to work upon the parts as upon a grounded part. In stations, remote-control switches can sometimes be employed to connect the equipment or lines being grounded to the actual ground connection. On lines it is generally necessary to resort to portable grounding devices handled directly by means of insulating handles, rods, or ropes.

(5) REMOVING GROUNDS. In removing a protective ground the employee shall not remove the grounding device from the ground connection until the device has been disconnected from all normally live current-carrying parts.

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

Chapter E 143

SUPPLY SYSTEMS; RULES FOR EMPLOYEES DOING SPECIALIZED WORK

E 143.01 Supply stations and switchboards. (1) APPLICATION OF RULE. Engineers, machine attendants, switchboard operators, and helpers shall study and strictly observe the following in addition to all the general sections E 142.01 to E 142.05 which apply to their work.

(2) CARE ABOUT MACHINES. Do not allow oil cans, tools, dusters, or wiping cloths to catch in moving parts of machinery. In passing any switchboard or machine in operation, do not touch it unnecessarily nor allow metal tools or other metal objects to touch the apparatus or connections. Do not use iron or tin oil cans near field magnets, and use only dusters and wipers with insulating handles on or about exposed live parts. Employees about to work on normally moving parts of remotely controlled equipment during periods of rest, shall be protected against their accidental starting by "Men at work" or equivalent signs first being placed on the starting devices, and by locking or blocking these where practicable. All employees shall, before starting any work, satisfy themselves that all these protective devices have first been installed. (See section E 142.03). Do not use a metal bar to turn over the motor of any energized machine. Do not use a metal rule or tape or metal-reinforced fabric tape near live circuits. Do not use air hose with metallic covering or fittings around live electric apparatus or conductors. Do not use flashlight with metal case near live parts.

(3) CARE ABOUT LIVE OR MOVING PARTS. (a) Do not work on or near exposed live or moving parts unless authorized to do such work, and then strictly observe the rules applying.

(b) When working near fuses and circuit breakers or other apparatus which may arc suddenly, be careful to avoid injury from their operation.

(c) When working on one section of a switchboard or in one compartment, mark it conspicuously and place barriers to prevent your accidental contact with live parts in that section or adjacent sections.

(d) When working on or near live parts and standing on insulated stools or ladders, or when otherwise insulated from the ground, avoid handing metal tools or other objects to other persons who are not insulated.

(e) Do not stand on, sit on, or pass through belts, whether the belt is at rest or in motion.

(4) HANDLING FUSES OR BRUSHES. (a) In handling fuses of more than 750 volts, use the special rods or tongs and stand on insulating platforms or mats, where provided. Keep the body as distant and as far below as possible.

(b) Replace or remove link fuses from live terminals and handle brushes on live equipment only when absolutely necessary, and then with due precautions.

(5) BATTERY ROOMS. Smoking, or the use of open flames, or of tools which may generate sparks, should be avoided except when cells are not actively gassing and when prior ventilation has been ample. Sparks from frictional or static electricity should be avoided, as they may ignite the gas if discharged close to its source, as at the vent of a sealed-type cell during overcharging. The electrolyte of storage batteries, and spray containing electrolyte, are somewhat corrosive, particularly when concentrated by evaporation, and contact with body or clothes should be avoided. Do not handle live parts of batteries or their connections unless standing on insulating platforms or wearing suitable insulating boots.

(6) WORKING IN ELEVATED POSITIONS. When working in an elevated position, especially above live or moving parts, assure yourself of the security of your position and support, and take precautions to avoid dropping tools or materials.

(7) HANDLING SWITCHBOARD EQUIPMENT. All ungrounded metal parts of devices on switchboards shall be handled as if operating at the highest voltage to which any portion of the equipment on the same switchboard panel is subject, unless the parts are known, by test or otherwise, to be free from such voltage. When cable plug connectors are used, do not allow one end to remain hanging loose while the other end is connected to a live terminal. In handling instrument circuits, never open the secondary of a current transformer while it is alive.

(8) REPORTING CIRCUIT TROUBLE TO CHIEF OPERATOR. Report to your immediate superior or to the chief operator any unusual conditions of load and the indication of any accidental ground on an outgoing circuit.

(9) REPORTING DEFECTS. Promptly report to your superior any dangerous conditions of equipment or surroundings, including defective tools, switches, or protective devices, or live cases or frames of apparatus or instruments.

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

E 143.02 Meters. (1) APPLICATION OF RULE. All meter setters and testers shall study and strictly observe the following in addition to all the general sections E 142.01 to E 142.05 which apply to their work.

(2) TAPED JOINTS. Never leave joints or loose ends of wires untaped unless otherwise protected.

(3) CARE ABOUT LIVE PARTS. Do not use bare fingers or hands to determine whether a circuit is alive. Never remove or replace fuses in live circuits of more than 750 volts except by means of the suitable appliances provided.

(4) OPENING CIRCUITS AT SWITCHES. Special care should be exercised in opening circuits at meter connections unless the circuits have been first properly opened at switches.

(5) CURRENT-TRANSFORMER SECONDARIES. Before working on an instrument or other device in a current-transformer secondary circuit, always bridge the device with jumpers, so that the circuit cannot be opened at the device. Never open such a circuit at meter connections until it has been bridged elsewhere.

(6) SPECIAL TOOLS. Use only hand tools suited to the work being done and so reduce the danger of short-circuits.

(7) REPORTING DEFECTS. Promptly report to your immediate superior any live meter case or any condition of a meter or its connections, of the interior wiring or of overhead lines, or your own or other utilities, which might endanger life and property.

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

E 143.03 Testing. (1) APPLICATION OF RULE. All electrical testers, helpers, and others working about electrical tests shall study and strictly observe the following, in addition to all the general rules in sections E 142.01 to E 142.05. Owing to the diversified character of testing work this study should usually extend also to the special rules in sections E 143.04 to E 143.05.

(2) AUTHORIZATION OF WORK. Do not work on or about equipment or lines without first receiving authorization from the person in charge.

Note: If such equipment or lines are under control of a chief operator, this authorization must come from him. This will include the attaching of tags at the proper points and the observation of all rules for general operation in section E 142.01.

(3) CHECKING OF CONDITIONS. (a) Thoroughly familiarize yourself with all conditions surrounding equipment or lines to be tested before making any change in these conditions.

(b) Do not make any change in equipment or lines unless you fully understand the effect of the change.

(c) Be very careful of capacity effects of transformers and other high-voltage apparatus, the discharge from which may be very dangerous if passed through the body. Ground the coils before touching them.

(4) FOREMAN. One properly qualified person shall be in immediate charge of all testing work, or all of the workmen shall be instructed as to the work they are to perform and the employee instructing them shall be considered in charge of the work.

(5) WARNINGS AND BARRIERS. (a) Display danger signs and erect suitable guards about all equipment or lines under test when in places where traffic is frequent, if live or moving parts would otherwise be exposed.

(b) When temporary wiring, belts, pulleys, or other temporary live or moving parts must be guarded, suitable portable or temporary guards and warning signs shall be used.

(6) REQUIREMENT FOR TWO WORKMEN. No person should work alone in testing or experimental work on or about parts on which the voltage can exceed 750 volts, except in routine testing where the live parts are properly guarded.

(7) REPORTING DEFECTS. Promptly report to your immediate superior any conditions of equipment or lines under test which may endanger life or property.

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

E 143.04 Overhead lines. (1) APPLICATION OF RULE. Linemen and assistants and groundmen, in construction, extension, removal, or repair work, shall study and strictly observe the following, as well as all the general rules in sections **E 142.01 to E 142.05 which apply to** their work.

(2) TESTING STRUCTURES BEFORE CLIMBING. Before climbing poles, ladders, scaffolds, or other elevated structures, first assure yourself that the pole, ladder, scaffold, tree, crossarm, messenger wire, cable car, or boatswain's chair, or other elevated support, is strong enough to safely sustain your weight.

Note: Poles may be tested for decay near the ground line with a bar, screw driver, or other tool, and sounded for decay at the center by rapping with a heavy tool or block of wood.
If poles or crossarms are apparently unsafe because of decay or unbalanced tensions of wires on them, they should be properly braced or guyed before they are climbed.

(3) USE OF POLE STEPS. If poles are stepped, make use of such steps in climbing.

(4) UNSAFE SUPPORTS. Do not support yourself by pins, brackets, or conductors.

(5) SPURS. Spurs with gaffs worn short shall not be used. The gaffs on spurs shall be kept sharp, and spurs shall fit properly. Spurs shall not be worn on work for which they are not required, nor while men are traveling to or from work.

(6) CARE ABOUT LIVE PARTS. (a) Do not go among any wires until you know their voltage.

(b) Leaning over and crowding through unprotected wires should be avoided wherever possible.

(c) Place yourself so that you will not be liable to fall on wires should an accident occur.

(d) Do not depend on the insulating covering of wires, and treat all lines as alive unless they have been properly killed (except communication lines known to be clear).

(e) Avoid use of hand lines or measuring tapes containing metal strands.

(f) In handling dangerous switches or fuses, do so only by means of suitable insulating handles, rods, or tongs.

(7) WHEN TOUCHING LIVE PARTS. (a) When working on live equipment or wires never allow any portion of the body to come in contact with any live or grounded part other than that worked on.

(b) While touching supply wires or equipment, avoid as far as possible touching ground wires, guy wires, span wires, metal pipes, metal poles, metal sheaths, communication wires or equipment, transformer cases, hangers, and other metal fixtures.

Note: Communication wires are included principally because of their liability of being grounded. The other equipment and wires listed may become either alive or grounded.
While touching communication wires or equipment, metal sheaths, metal pipes, ground wires, or metal fixtures on poles, avoid as far as possible touching supply wires or equipment, guy or span wires.

(8) PROTECTING TRAFFIC. (a) When working overhead, keep tools and materials not in use in proper receptacles; tools or materials should not be thrown to or from the man on the pole, but should be raised or lowered by means of a hand line, using proper receptacles

where practicable. Pole holes and obstructions along public highways and other frequented places shall be protected by watchmen or by suitable guards or danger signals so located as to be conspicuous to traffic.

(b) When working overhead, or hoisting or lowering materials above places where frequent traffic occurs, a man should be stationed to warn passers-by.

Note: Where traffic is light, warning signs or barriers may be used in lieu of watchmen. Where traffic is congested, it may be necessary to rope off the space.

(9) AVOID FALLING OBJECTS. Do not unnecessarily stand where you can be struck by materials dropped by men working overhead.

(10) STRINGING LINES. (a) Never string wire near live lines except by means of suitable insulating hand lines or other appliances. Avoid bringing them in contact with the live wires. Regard them as live wires of the same voltage because of their liability to come in contact with the live wires.

(b) Never change the strains on a pole by adding or removing wires until assured that the pole will stand the altered strains.

(c) In stringing wires do not allow them to sag so as to endanger vehicles or pedestrians below, unless traffic is intercepted by watchmen or otherwise.

(11) REPORTING DEFECTS. Report promptly to your immediate superior any dangerous conditions of your own or other utilities observed arising from defective insulators, pins, crossarms, abnormally sagging wires, etc.

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

E 143.05 Series street lamps. (1) APPLICATION OF RULE. All series-lamp trimmers, hangers, and inspectors shall study and strictly observe the following, in addition to the general rules in sections E 142.01 and E 142.05 and the special rules under the sections for overhead and underground operation, respectively, in sections E 143.04 and E 143.07 which apply to their work.

(2) PRECAUTIONS ON SERIES CIRCUITS. Series lamps and devices in series circuits should always be treated as alive unless disconnected by absolute cut outs or protected by the grounding of the circuit.

(3) HANDLING SERIES LAMPS. Trimmers, inspectors, or patrolmen shall wear suitable insulating gloves and stand on insulating stools, platforms, or tower wagons, or on dry, well seasoned wood poles while touching series lamps or their cut outs, when these are alive. Where insulating stools, platforms or tower wagons are used which provide sufficient insulation from ground for the voltages to be handled, the insulating gloves may be dispensed with.

(4) BRIDGING SERIES LAMPS. Before working on lamps or other devices in live series circuits always bridge the device with jumpers such as series lamp cut outs usually provide.

Note: This will insure that the circuit will not be opened at the device, and possibly be completed through your body or will not arc at the point of opening and burn you.

(5) TESTING SERIES LAMP CIRCUITS. Series lamp circuits should not be tested at their full operating voltage unless it is impracticable to

test otherwise. Tests should be made only in accordance with a time schedule, concerning which all persons whose safety may be affected are informed.

(6) PERIODICALLY DISCONNECTED CIRCUITS. If circuits, such as series lamp circuits, are not effectively grounded during the idle period, all rules for handling live parts shall be strictly observed.

(7) REPORTING DEFECTS. Report promptly to your immediate superior any abnormally sagging wires, broken insulators, leaning poles, defective pole steps, broken globes or lamp supports, and other defects giving rise to a dangerous condition of your own or other utilities, or any indication of voltage on lines supposed to be dead.

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

E 143.06 Communication circuits used in connection with supply lines. (1) APPLICATION OF RULE. All men working on or near telephone and telegraph circuits operated in connection with supply lines shall study and strictly observe the following in addition to all the general rules in chapter E 142 and the special rules in sections E 143.04 and E 143.07 which apply to their work. For rules governing the operation of commercial communication lines see chapters E 144 and E 145.

(2) TITLE OF OFFICIAL IN CHARGE. In those rules where the words "chief operator" are used the official in charge of safeguarding operation is to be understood.

(3) PRECAUTIONS BEFORE CLIMBING POLES. Make a careful inspection to ascertain if possible whether there are any crosses with supply circuits before climbing poles or other structures to work on or about communication wires, especially where such poles or structures are occupied in common with, or located near power circuits. Apply mechanical tests as far as practicable to messenger wires before trusting the wires to carry your weight.

(4) APPROACHING SUPPLY WIRES. Avoid contact with all wires other than those you know to be communication wires, assuming such other wires always to be alive. Do not approach any supply wire or supply equipment within the distances given in subsections E 142.03 (2) and (3), unless you can comply with all the rules under that chapter as far as they apply.

Note: Communication wires in trouble may be in contact with supply wires at some distant point, and should be treated with proper care.

(5) TOUCHING EQUIPMENT. (a) While handling communication wires, metal sheaths, or communication equipment avoid touching guy or span wires and supply wires or equipment. Especially avoid standing on or touching transformer cases, hangers, or connections.

(b) While touching open communication wires avoid contact also with grounded parts, such as sheaths and ground wires.

(6) STRINGING WIRES. (a) When stringing wires or cables over or under supply lines avoid any possibility of their coming in contact. Do not string them above live supply lines where it is practicable to avoid it.

(b) Where liability of contact cannot be entirely avoided, the lines being handled shall be treated as alive (unless they are effectively

grounded), and the rules of section E 142.03, so far as they are applicable, shall be carefully observed.

(7) REPORTING DANGEROUS CONDITIONS. Promptly report to the proper official abnormally sagging wires, broken or defective insulators, pins, crossarms, defective poles, or any other dangerous conditions of your own or other utilities.

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

E 143.07 Underground lines. (1) APPLICATION OF RULES. All cable splicers and other workmen in underground construction or operation shall study and strictly observe the following, in addition to the general rules in sections E 142.01 to E 142.05, which apply to their work.

(2) GUARDING MANHOLES, HANDHOLES, AND STREET OPENINGS. When removing manhole or handhole covers or making excavations, promptly protect the opening with a barrier, temporary cover, or other suitable guard, and see that danger signals or red lights are displayed in a location conspicuous to the traffic until permanent covers are in place or the excavations are filled.

Exception: Red lights are not required on private right of way or at other locations not accessible to vehicular or pedestrian traffic.

(3) TESTING FOR GAS. Do not enter manholes until you have assured yourself that the manholes are free from dangerous gases, by testing with approved testing devices, by ventilation, or by other adequate methods. (See section E 145.03(2), for testing for gas).

(4) WATCHMAN ON SURFACE AT MANHOLES. Do not enter a manhole unless a temporary cover is placed over the opening or a watchman is stationed at the surface. Where any gas is liable to be present always see that the watchman is stationed at the surface. Where any hazard is involved do not leave a manhole unwatched until all workmen are out.

(5) AVOIDING FLAMES. Do not smoke in manholes and avoid as far as practicable open flames or torches in or near manholes. Avoid sparks in handling live parts or cable sheaths, and avoid igniting the flux in soldering and wiping joints. In using hot paraffin see that it does not reach a temperature at which it will ignite. (See subsection E 145.03(4) for avoiding flames).

(6) PULLING CABLES. When pulling in cables make sure that the gear cannot slip so as to injure workmen. Avoid the danger of having the hands drawn into the tackle by the pulling line.

(7) UNIDENTIFIED CABLES. If lines and cables are not properly identified by markings or positions, do not work upon them.

(8) TESTING AND SPLICING LIVE CABLES. Always ascertain, if practicable, whether cables are alive, by testing with the test devices provided, before cutting into the cable sheaths. Live cable should be spliced only by men experienced in the work, and they should use extreme caution and suitable devices in so doing.

(9) REPORTING DEFECTS. Promptly report to your immediate superior any dangerous condition of your own or other utilities, whether observed in underground or overhead construction. Particularly report insanitary conditions, gas, or missing cable tags in man-

holes, and abnormally sagging wires or broken supports in overhead construction.

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

E 143.08 Tunnel and subway. (1) APPLICATION OF RULE. Tunnel and subway electricians, operators, and others working on or about underground electrical equipment (not in stations, substations, or in underground conduit systems) shall study and strictly observe the following, in addition to the rules in sections E 142.01, E 142.02, E 142.03, E 143.01 and E 143.07, so far as they apply to their work.

(2) DANGEROUS LOCATIONS. The value of insulation (insulating covering) as protection from shock is reduced by the dampness usually present in these and similar locations. The restricted spaces often bring the worker closer to equipment and wires than in other kinds of electrical work, and the imperfect illumination also makes special care necessary to avoid contacts. The human body and all surrounding surfaces becomes more conducting where dampness exists, and electrical shocks are, therefore, more severe.

(3) LIVE ELECTRICAL PARTS. Before handling any electrical equipment or wires make sure whether they are alive or dead.

Note: It is not advisable to work on live equipment or wires when the current can be shut off without interrupting necessary operations.

(4) UNAUTHORIZED WORK. Never touch or disturb any electrical equipment or wires without being authorized.

(5) STANDING ON GROUND. (a) Do not touch any electric wire, cable, or third rail, no matter how well it is insulated, while you are standing on the ground or on a grounded conducting surface, such as a pipe, track, or rail.

(b) Do not touch the metal frame or case of a motor if it is ungrounded, and you are in contact with ground or a grounded object.

Note: Remember that water and the surfaces of damp ground are conducting. Insulation on a wire may look perfect, but it frequently will not prevent shock.

(6) CARRYING TOOLS. In carrying tools or metal implements in passageways containing electric wires, especially near exposed wires, never permit the tools or implements to touch them. In particular, do not carry such objects on the shoulder when there are conductors overhead. Do not travel on that side of passageways where third rails or side trolley wires are exposed.

(7) HANDLING AND REPAIRING LIVE PARTS. (a) When necessary to handle or repair live trolley wires, third rails, cables, motors, or other electrical equipment, wear suitable insulating gloves or stand on the waterproof insulating mats or platforms provided, or obtain dry wood free from metal.

(b) Before handling or making use of any electrical cable, carefully examine it to make sure that its insulation is not injured.

(8) INSPECTION OF PORTABLE CABLES. Portable cables should be inspected at least once daily during the period of their use.

(9) HANDLING PORTABLE DEVICES. In handling portable motors or lamps, first make sure that the external metal frame is not alive by contact with or leakage from live parts within. Have such portable equipment inspected at least once daily during the period of their use.

(10) FUSES AND SWITCHES. Never handle fuses nor close switches or circuit-breakers unless you are authorized to perform that special duty, and then use the insulating handles or rods provided. Before closing switches first make sure that you are not endangering other persons.

(11) INJURING CABLES AND WIRES. Do not fire shots (blasting), handle tools, or perform other work in such a manner as to injure cables or wires in the vicinity. If in doubt, consult your superior.

(12) TEMPORARY WIRING. (a) Never use bare conductors nor arrange for earth return in the wiring of any temporary circuit.

Note: This particularly applies to the temporary portions of shot-firing circuits and to the leads of portable motors and lamps.

(b) Never employ temporary circuits without seeing that they are installed at the junction with the permanent wiring, suitable disconnecting switches or plug connectors, arranged to disconnect all conductors of the temporary circuit by a single operation.

(c) For shot-firing circuits, their disconnectors should be left open until the shot is to be fired, and should preferably be arranged for locking in the open position.

(13) GENERAL PRECAUTIONS. Never get on or off locomotives or cars on the side where the trolley wire or third rail is located. Do not place combustible or explosive materials near electric wires, trolley tracks, third rails, or motors. Do nothing that will cause sparking, or expose parts that may arc or spark during operation, if any explosive gases may be present.

(14) REPORTING DANGEROUS CONDITIONS. Promptly report to your superior any dangerous or unusual conditions observed. In particular, report the presence of gas, broken insulators, bad insulation on wires, defective third-rail construction, live frames of motors, broken ground wires on motor frames, and sparking, arcing, or shocks noticed at any point. Report also any fallen, crossed, or abnormally sagging wires, whether electric wires or not. This includes trolley wires at switches and crossings and wires injured through falling roofs.

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

Chapter E 144

COMMUNICATION SYSTEMS; RULES FOR EMPLOYERS

E 144.01 Distribution and enforcement of rules. (1) DISTRIBUTION. The employer shall furnish to each regular employee working on or about commercial telephone or telegraph equipment or lines, safety rules governing his conduct while so engaged, and shall take suitable means to secure the employee's compliance with the same.

(2) FORM. The safety rules furnished to any employee may be in such form as the employer may determine is best suited to the needs of individual employees. They shall, however, include the principles set forth in the following rules, or at least such part thereof as is applicable to the work in which the employee is engaged, and shall not conflict with these rules.

(3) INTERPRETATION. If a difference of opinion arises with regard to the meaning or application of these rules, or as to the means necessary to carry them out, the decision of the employer or his authorized agent shall be final, subject to an appeal (if taken) to the regulative body having jurisdiction.

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

E 144.02 Address list and emergency rules. (1) The rule books should contain or be accompanied by the following:

(a) A list of names and addresses of those physicians and members of the organization who are to be called upon in emergencies.

(b) A copy of rules for first aid, an approved method of resuscitation, and fire extinguishment.

(2) These should also be kept in conspicuous locations in central offices, on line wagons, and in other locations where the number of employees and nature of the work warrants.

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

E 144.03 Instructing employees. (1) Employees regularly working on or about communication equipment or lines, if their duties render such training necessary, shall be thoroughly instructed in approved methods of first aid, an approved method of resuscitation, and fire extinguishment, and if advisable, regularly drilled.

(2) Groups of employees, such as commercial telephone operators, shall be thoroughly drilled to make prompt and orderly exit from buildings in case of fire.

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

E 144.04 Qualification of employees. The employer shall use every reasonable means and precaution to assure himself that each employee is mentally and physically qualified to perform his work in accordance with these rules.

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

E 144.05 Protective devices. (1) There shall be provided in conspicuous and suitable places in stations and on line wagons a sufficient supply of suitable protective, first-aid and fire-extinguishing equipment to enable employees to meet the requirements of these rules. Such devices and equipment shall be inspected or tested to insure that they are kept in good order and in dependable condition and shall not be used unless so inspected or tested. The following is a list of suitable devices and equipment, the kinds and numbers of which will depend on the requirements of each case:

(a) First-aid outfits.

(b) Insulating wearing apparel, such as insulating gloves, boots, and shields.

(c) Safety belts.

(d) Fire-extinguishing apparatus.

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

Chapter E 145

COMMUNICATION SYSTEMS; RULES FOR EMPLOYEES

E 145.01 General precautions. (1) HEEDING WARNINGS, WARNING OTHERS. Employees should cultivate the habit of being cautious, heed warning signs and signals, and always warn others when seen in danger near equipment and lines.

(2) INEXPERIENCED EMPLOYEES. No employee shall do work for which he is not properly qualified on or about equipment or lines, except under the direct supervision of an experienced and properly qualified person.

(3) ELECTRICAL SUPPLY EQUIPMENT OR WIRES. Workmen whose duties do not require them to approach or handle electrical supply equipment and wires should keep away from such equipment or wires. Electrical supply equipment and wires should always be considered as alive unless positively known to be dead.

(4) SAFE SUPPORTS AND SAFETY BELTS. (a) *Safe supports.* Employees should not support themselves on any portion of a tree, pole structure, lamp bracket, or similar fixtures on poles, scaffold, ladder, roof, skylight, or other elevated structure without first making sure that the supports are strong enough, reinforcing them if necessary. Portable ladders should be in a safe position before being climbed. The slipping of a ladder at either end should be carefully guarded against, especially where the supporting surfaces are smooth or vibrating. Insecure makeshift substitutes for ladders should not be used. An employee should never trust his weight on thin wooden boxes, sinks, washbowls, window shelves, or chair backs. A ladder should not be placed upon a box, barrel, or other movable or insecure object. Care should be taken to see that chairs, rolling ladders, and similar equipment are in first-class condition before being used.

(b) *Safety belts.* Employees should not work in elevated positions unless secured from falling by a suitable safety belt or other adequate means (sometimes including suitably located pole steps). Before an employee trusts his weight to the belt, he should determine that the snaps or fastenings are properly engaged and that he is secured in his belt.

(c) *Safety ropes.* Ropes used for supporting boatswains' chairs, platforms, or for other purposes on which the security of the employee depends shall be frequently inspected to assure that they are maintained in good condition.

(5) DUTIES OF FOREMAN. (a) *Duties.* Each foreman in charge of work shall see that the safety rules are observed by the employees

under his direction. He shall make all necessary records; reporting to his superior when required. He shall permit only authorized persons to approach places where work is being done. He shall adopt such precautions as are within his power to prevent accidents, and prohibit the use of tools or devices which are defective, or not suited to the work in hand.

(b) *Qualified guides.* The qualified person accompanying uninstructed workmen or visitors near electrical equipment or lines shall take precautions to provide suitable safeguards and see that the safety rules are observed.

(6) HANDLING LIVE PARTS. No employee should touch, with bare hands, any exposed ungrounded live part of more than 150 volts to ground, unless he is insulated from other conducting surfaces, including the ground itself. When employees must touch, at the same time, two parts between which a considerable potential exists, insulating gloves or other protection shall be used.

(7) POWER CIRCUITS IN CENTRAL OFFICES. (a) When making repairs on electric light or power circuits, the circuits shall, whenever possible, be made dead.

(b) Where practicable, moving apparatus, as, for example, a fan, shall be stopped before working upon it.

(c) None other than duly authorized persons shall be admitted to central-office transformer vaults or battery rooms.

(d) Care shall be used while working on or near circuits of more than 150 volts to ground, particularly in alternating-current districts.

(8) HANDLING FUSES OR BRUSHES. (a) When working on the brushes of a machine in operation, employees shall use care not to break a circuit, the flashing of which may injure the eyes or burn the hands. If it is necessary to remove a brush from the holder, the machine shall be shut down.

(b) When inspecting or changing fuses, care should be taken to prevent injury to the eyes. If it is necessary to handle the fuses, the circuits should be cut off, if possible.

(9) BATTERY ROOMS. (a) Smoking, or the use of open flames, or of tools which may generate sparks, should be avoided except when cells are not actively gassing and when prior ventilation has been ample. Sparks from frictional or static electricity should be avoided as they may ignite the gas if discharged close to its source, as at the vent of a sealed-type cell during overcharging. The electrolyte of storage batteries, and spray containing electrolyte, are somewhat corrosive, particularly when concentrated by evaporation, and contact with body or clothes should be avoided.

(b) Do not handle live parts of batteries or their connections unless adequate precautions are taken to avoid shock.

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

E 145.02 Overhead lines. (1) PRECAUTIONS TO BE OBSERVED BEFORE CLIMBING STRUCTURES. (a) Before climbing poles, ladders, scaffolds, or other elevated structures first assure yourself that the pole, ladder, scaffold, tree, crossarm, messenger wire, cable car, or boatswain's chair, or other elevated support is strong enough to safely sustain your weight.

(b) On pole-replacement work no pole shall be climbed for the purpose of clearing it of all wire and cables without first guying or bracing the pole securely.

(c) If poles or crossarms are apparently unsafe because of decay, or unequal pulls of wire on them, they should be properly braced or guyed, if necessary, before they are climbed.

(d) An uncoiled hand line, rope, or wire of any sort should not be fastened to the employee while climbing a pole, but where this must be done the employee should exercise due care to prevent the line from catching on obstructions.

(e) In climbing poles careful watch should be kept for nails or other foreign attachments which might catch in the clothing and cause a fall.

(2) USE OF POLE STEPS. (a) When poles are stepped make use of such steps in climbing, first making sure that the steps are firmly set in solid material before trusting your weight upon them. Pay particular attention, on icy poles, to each step.

(b) Do not support yourself by pins, brackets, or conductors.

(3) SPURS. Spurs with gaffs worn short shall not be used. The gaffs on spurs shall be kept sharp and spurs shall fit properly. Spurs shall not be worn on work for which they are not required, nor while men are traveling to or from work.

(4) APPROACHING SUPPLY LINES. (a) Avoid contact with all wires other than those you know to be communication wires, assuming such other wires always to be alive. Communication wires in trouble may be in contact with supply lines at some distant point, and should be treated as live supply lines unless known to be free from any dangerous voltage.

(b) Do not approach any supply wire or supply equipment within the distances given in section E 142.03 under Wis. Adm. Code chapter E 142, unless you comply with all the rules under that section.

(5) TOUCHING EQUIPMENT. While handling communication wires, metal sheaths, or communication equipment avoid touching trolley or arc-lamp span wires and supply lines or equipment. Especially avoid standing on or touching transformer cases, hangers, or connections.

(6) CARE ABOUT ELECTRICAL SUPPLY LINES. (a) Do not go among any wires until you know their voltage.

(b) Leaning over and crowding through unprotected supply wires should be avoided wherever possible.

(c) Place yourself so that you will not be liable to fall on supply wires should an accident occur.

(d) Do not depend on the insulating covering of wires, and treat all wires as alive unless they have been killed properly (except communication wires known to be clear).

(e) Treat also as alive all wires (unless thoroughly grounded) which are being strung near supply wires; regard them as being of the same voltage as the supply wires.

(f) Avoid use of hand lines or measuring tapes containing metal strands.

(g) When necessary to work in the vicinity of supply wires, transformers, and similar equipment assure yourself before starting work

that the position of the body is such that should you momentarily forget yourself or fall, no portion of the body will come in contact with the foreign wires or equipment. Have the supply circuits killed where possible before approaching them.

(h) Railway span wires, pull-offs, and trolley brackets shall be treated as if alive, even though equipped with strain or other insulators.

(7) STRINGING WIRES. (a) Never string wires near live circuits except by means of suitable insulating hand lines or other appliances.

(b) Avoid the use of single or paired wires as a substitute for a hand line.

(c) Wires should not be strung above live circuits operating at more than 750 volts, unless the wires being strung are effectively grounded or otherwise suitably protected, or in handling them all the precautions are observed as provided in section E 142.03, for work on parts at the voltage of the circuits concerned, and the spacings maintained.

(d) Never change the strains on a pole by adding or removing wires until assured that the pole will stand the altered strains.

(e) When wires are being pulled up on corner poles employees should stand in such a position that they cannot be struck by the wire in case it slips.

(f) Where it is necessary to remove communication wires below which are supply wires, power should be shut off of the supply wires where possible, and, if this is not practicable, rope cradles and suitable guards should be erected. Extraordinary care should be exercised to prevent the communication wires from sagging into the supply wires.

(g) In stringing wires, cables, messengers, span wires, or guys do not allow them to sag so as to endanger vehicles or pedestrians below, unless traffic is intercepted by watchmen or otherwise. This may necessitate keeping a watchman at the coil or reel. When stringing wires for long distances, precautions shall be taken to prevent the possibility of vehicles or pedestrians coming into contact with the wires at the intersecting streets or highway crossings.

(8) PROTECTING TRAFFIC. (a) When working overhead, keep tools and materials not in use in proper receptacles; tools or materials should not be thrown to or from the man on the pole, but should be raised or lowered by means of a hand-line, using a proper receptacle, if practicable. Also tools and loose materials should not be left at the top of poles, ladders, or other elevated structures.

(b) Workmen shall not stand where they are liable to be struck by materials dropped by men working overhead.

(c) Pole holes, open manholes, excavations, and obstructions along the public highway and other frequented places shall be protected by watchmen, barriers or suitable guards, warning signs, or danger signals so located as to be conspicuous to traffic.

(d) When working overhead or hoisting or lowering materials above places where traffic occurs, a man should be stationed to warn passersby.

(e) Where traffic is light, warning signs may be used in lieu of watchmen. Where traffic is congested, it may be necessary to rope off the space.

(9) REPORTING DANGEROUS CONDITIONS. An employee should report as soon as practicable to his superior or some suitable authority any obvious hazards to life or property observed in connection with any electric equipment or lines. Any imminently dangerous conditions shall be guarded until they can be made safe.

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

E 145.03 Underground lines. (1) GUARDING MANHOLES, HANDHOLES, AND STREET OPENINGS. When removing manhole or handhole covers or making excavations, promptly protect the opening with a barrier, temporary cover, or other suitable guard, and see that danger signals or red lights are displayed in a location conspicuous to the traffic until permanent covers are in place or the excavations are filled.

(a) Exception: Red lights are not required on private right of way or at other locations not accessible to vehicular or pedestrian traffic.

(2) TESTING FOR GAS. (a) Do not enter manholes until you have assured yourself that the manholes are free from dangerous gases, as indicated by approved testing devices, by ventilation, or by other adequate methods.

(b) When work is being carried on for any length of time in manholes where gas collects, suitable ventilation shall be provided, or tests with the safety device should be repeated at regular intervals to make certain that gas is not accumulating in the manhole in dangerous quantities.

(3) WATCHMAN ON SURFACE AT MANHOLE. Where any hazard to the workmen is involved observe the following:

(a) Do not enter a manhole unless a man is stationed at the surface.

(b) Do not leave a manhole unwatched until all workmen are out.

(4) AVOIDING FLAMES. (a) Do not smoke in manholes, and avoid as far as practicable open flames or torches in or near manholes.

(b) If it is necessary to illuminate a manhole, electric lights only should be used. When doing this, it should be known that the leads, sockets, and connections are well insulated and in good condition in order to avoid the possibility of a spark. Special attention should be paid to the sparking of any motors used for ventilating purposes.

(c) Avoid sparks in handling live parts or cable sheaths, and avoid igniting the flux in soldering and wiping joints. In using hot paraffin see that it does not reach a temperature at which it will ignite.

(d) In central-office cable vaults, tests shall be made for the presence of gas before using exposed flames, and such flames shall not be used in vaults where gas collects.

(5) PULLING CABLES. When pulling cables, make sure that the gear cannot slip so as to injure workmen. Avoid the danger of having the hands drawn into the tackle by the pulling line.

(6) REPORTING DANGEROUS CONDITIONS. Promptly report to your immediate superior any dangerous condition of your own or other utilities, whether observed in underground or overhead construction. Particularly report unsanitary conditions, gas, or missing cable tags in manholes and abnormally sagging wires or broken supports in overhead construction.

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

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