WISCONSIN STATE ELECTRICAL CODE

Volume 2

History: The Electrical Code as it existed on January 31, 1968 was repealed and a new Electrical Code was created effective February 1, 1968.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In some instances an *entire* code has been repealed and recreated subsequent to the original printing date.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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Chapter E 1

GENERAL REQUIREMENTS AND DEFINITIONS

SCOPE

E 1.01 Scope of code. This 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.

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

Chapter E 10

GENERAL REQUIREMENTS

E 10.10 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 10.11 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 ment 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 10.12 Construction, inspection and repairs. All construction and equipment shall 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. 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.)

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

E 10.13 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, al-

terations, 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) PENALTIES. The Wisconsin Statutes, 1965, require:

102.57 Violations of safety provisions, penalty. Where injury is caused by the failure of the employer to comply with any statute or any lawful order of the commission, compensation and death benefits as provided in this chapter shall be increased 15 per cent. Failure of an employer reasonably to enforce compliance by employes with such statute or order of the commission shall constitute failure by the employer to comply with such statute or order.

102.58 Decreased compensation. Where injury is caused by the failure of the employe to use safety devices where provided in accordance with any statute or lawful order of the commission and adequately maintained, and their use is reasonably enforced by the employer, or where injury results from the employe's failure to obey any reasonable rule adopted by the employer for the safety of the employe and of which the employe has notice, or where injury results from the intoxication of the employe, the compensation and death benefit provided herein shall be reduced 15 per cent.

196.64 Utilities, liability for treble damages. If any public utility shall do or cause to be done or permit to be done any matter, act or thing prohibited or declared to be unlawful by chapter 196 or 197, or shall omit to do any act, matter or thing required to be done by it, such public utility shall be liable to the person injured thereby in treble the amount of damages sustained in consequence of such violation.

196.66 General penalty; utility responsible for agents. (1) If any public utility shall violate any provision of chapter 196 or 197, or shall do any act therein prohibited, or shall fail or refuse to perform any duty enjoined upon it for which a penalty has not been provided, or shall fail, neglect or refuse to obey any lawful requirement or order made by the commission or the municipal council or any judgment or decree made by any court upon its application, for every such violation, failure or refusal such public utility shall forfeit not less than twenty-five dollars nor more than one thousand dollars. (2) Every day during which any public utility or any officer, agent or employe thereof shall fail to observe and comply with any order or direction of the commission or to perform any duty enjoined by chapter 196 or 197, shall constitute a separate and distinct violation.

(4) 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.

(5) 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.

(6) 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 100

DEFINITION OF SPECIAL TERMS

E 100.02 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 in 2 or more rules are defined in full in chapter E 100; other definitions being defined in the individual rule where they apply; (3) Wherever practical the definitions will 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) AMPACITY: Current-carrying capacity expressed in amperes.

(6) ANESTHETIZING LOCATION: See Wis. Adm. Code section E 517.01 (2).

(7) ANTENNA CONFLICT: See "conflict".

(8) APPLIANCE: An appliance is utilization equipment, generally other than industrial, normally built in standardized sizes or types, which is installed or connected as a unit to perform one or more functions such as clothes washing, air conditioning, food mixing, deep frying, etc.

(9) APPLIANCE—FIXED: An appliance which is fastened or otherwise secured at a specific location.

(10) APPLIANCE—PORTABLE: An appliance which is actually moved or can easily be moved from one place to another in normal use.

(11) APPLIANCE—STATIONARY: An appliance which is not easily moved from one place to another in normal use.

(12) APPROVED: Acceptable to the administrative authority enforcing this code. (See section E 10.11).

(13) ASKAREL: A synthetic nonflammable insulating liquid which, when decomposed by the electric arc, evolves only nonflammable gaseous mixtures.

(14) ATTACHMENT PLUG (PLUG CAP) (CAP): An attachment plug is a device which, by insertion in a receptacle, establishes connection between the conductors of the attached flexible cord and the conductors connected permanently to the receptacle.

(15) AUTHORITY: See "administrative authority".

(16) 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").

(17) BLOCK (TOWN, OR VILLAGE): See section E 800.02.

(18) 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.

(19) 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.

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

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

(22) BRANCH CIRCUIT, MULTIWIRES. A multiwire branch circuit is a circuit consisting of 2 or more ungrounded conductors having a potential difference between them, and an identified grounded conductor having equal potential difference between it and each ungrounded conductor of the circuit and which is connected to the neutral conductor of the system.

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

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

(25) 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 multiconductor cables.

(26) CABLE VAULT: See "manhole".

(27) CELL (AS APPLIED TO RACEMAYS): See Wis. Adm. Code sections E 356.01 and E 358.01.

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

(29) CIRCUIT-BREAKER: A device designed to open and close a circuit by nonautomatic means, and to open the circuit automatically on a predetermined overload of current, without injury to itself when properly applied within its rating.

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

(31) COMMON USE: The simultaneous use of facilities by 2 or more agencies supplying the same type of service.

(32) COMMUNICATION CIRCUIT: See section E 800.01.

(33) COMMUNICATION LINES: See "lines".

(34) 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.

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

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

(37) CONDUCTOR CONFLICT: See "conflict".

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

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

(40) 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.

(41) 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.

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

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

(44) 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.

(45) 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 chapter E 900, table 4. For other materials, dimensions are to be the same.

(46) 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.

(47) CONFLICT—ANTENNA: An antenna or its guy wire is at a higher level than a supply or communication conductor and approximately parallel thereto, 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.

(48) CONFLICT—CONDUCTOR: 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) Five 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.

(49) 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.

(50) 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.

(51) CONTINUOUS LOAD: A load where the maximum current is expected to continue for three hours or more.

(52) CONTROL CIRCUIT: See section E 430.071.

(53) CONTROLLER: A device, or group of devices, which serves to govern, in some predetermined manner, the electric power delivered to the apparatus to which it is connected. See also section E 430.081 (1).

(54) 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").

(55) 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.

(56) CURRENT-LIMITING OVERCURRENT PROTECTIVE DEVICE: (See section E 240.27).

(57) 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.

(58) 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.

(59) 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.

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

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

(62) 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.

(63) DRY: See "location—dry."

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

(65) DUST-IGNITION-PROOF: See section E 502.01 (2).

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

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

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

(69) 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.

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

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

(72) 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 E 430.022 (1) for illustrations of various types of duty.

(73) DUTY CYCLE (WELDING): See section E 630.31 (3) (c).

(74) EFFECTIVELY GROUNDED: See "grounded".

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

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

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

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

(79) 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").

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

(81) 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.

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

(83) 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.

(84) EXPLOSION-PROOF APPARATUS. 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 explosion of the gas or vapor within, and which operates at such an external temperature that a surrounding flammable atmosphere will not be ignited thereby.

(85) 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.

(86) 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").

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

(88) EXTERNALLY OPERABLE: Externally operable means capable of being operated without exposing the operator to contact with live parts. This term is applied to equipment, such as a switch, that is enclosed in a case or cabinet.

(89) 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.

(90) 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.

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

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

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

(94) 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.

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

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

(97) GROUNDED—EFFECTIVELY: Permanently connected to earth through a ground connection of sufficiently low impedance and having sufficient ampacity to prevent the building up of voltages which may result in undue hazard to connected equipment or to persons.

(98) GROUNDED (EFFECTIVELY GROUNDED COMMUNICATION SYSTEM): See section E 800.02 (4) Note.

(99) 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.

(100) GROUNDING CONDUCTOR: A conductor used to connect an equipment, device or wiring system with a grounding electrode or electrodes.

(101) GUARDED: Covered, shielded, fenced, 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.")

(102) 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.)

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

(104) HAZARDOUS LOCATIONS: See chapter E 500.

(105) HEADER: See section E 356.01.

(106) HEADER DUCTS: See section E 358.01.

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

(108) IDENTIFIED: As used in chapter E 200, the conductor or terminal to which it refers is to be recognized as grounded.

(109) 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.

(110) INSULATING: (Where applied to the covering of a conductor or to clothing, guards, rods, and other safety devices) means that 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.)

(111) ISOLATED: Isolated means that an object is not readily accessible to persons unless special means for access are used.

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

(113) ISOLATING SWITCH: See "switch."

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

(115) JOINT USE: The simultaneous use of facilities by 2 or more agencies not furnishing like services but having use for similar facilities.

(116) LATERAL CONDUCTOR: See "conductor."

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

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

(119) 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 interupting follow current if present and restores itself to its original operating condition.

(120) LINE CONDUCTOR: See "conductor."

(121) 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 2 points of the circuit, and the transmitter 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 or police alarm, community television 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).)

(122) 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 section E 100.02 (121) above.

(a) Does not include open wiring on buildings, in yards 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.

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

(124) 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.

(125) LOCATION—WET: A location subject to saturation with water or other liquids, such as locations exposed to the weather, washrooms 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.

(126) 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 chapter E 725.)

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

(127) 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.

(128) 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 reestablishment of the power supply on return of voltage.

(129) 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.

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

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

(132) 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.

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

(134) NONAUTOMATIC: 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.

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

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

(137) 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.

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

(139) 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").

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

(141) 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.

(142) 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.

(143) PROJECTOR, NON-PROFESSIONAL: See section E 540.30.

(144) PROJECTOR, PROFESSIONAL: See section E 540.10.

(145) QUALIFIED PERSON: One familiar with the construction and operation of the apparatus and the hazards involved. For over 600 volts see section E 710.10 (1) Note 1.

(146) 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 nonmetallic 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.

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

(148) 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" and section E 195.23).

(149) RECEPTACLE (CONVENIENT OUTLET): A receptacle is a contact device installed at an outlet for the connection of an attachment plug and flexible cord.

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

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

(152) REFRIGERATION COMPRESSOR, SEALED (HERMETIC TYPE): See section E 430.002.

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

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

(155) 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 sttaight line between its 2 points of support, without any external load.

(156) 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.

(157) SEALED (MERMETIC 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.

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

(159) SERVICE CABLE: The service cable is the service conductors made up in the form of a cable.

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

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

(162) 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.

(163) 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.

(164) 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.

(165) 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.

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

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

(168) SHALL: Is used to indicate requirements.

(169) 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.

(170) 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.

(171) SIGN: See "electric sign."

(172) 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.

(173) SPAN LENGTH: The horizontal distance between 2 adjacent supporting points of a conductor.

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

(175) STRUCTURE CONFLICT: See "conflict".

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

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

(b) *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.

(c) *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.

(d) *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.

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

(f) *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.

(178) SWITCHBOARD: 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.")

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

(180) 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.

(181) 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 circuit currents.

(182) THERMAL PROTECTION: (As applied to motors.) The words "Thermal Protection" appearing on the nameplate of a motor indicate that the motor is provided with a thermal protector.

(183) THERMAL PROTECTOR: (As applied to motor.) 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.

(184) 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.

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

(186) UTILIZATION EQUIPMENT: Utilization equipment is equipment which utilizes electric energy for mechanical, chemical, heating, lighting, or similar useful purposes.

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

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

(189) VERTICAL CONDUCTOR: See "conductor".

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

(191) VOLTAGE: (a) *Voltage of a circuit.* Voltage is the greatest root-mean-square (effective) difference of potential between any 2 conductors of the circuit concerned.

(b) *Voltage to ground in grounded circuits.* The voltage between the given conductor and that point or conductor of the circuit which is grounded.

(c) *Voltage to ground in ungrounded circuits.* The greatest voltage between the given conductor and any other conductor of the circuit.

Note 1: Where one circuit is directly connected to another circuit of higher voltage (as is the case of auto-transformers), both are considered of the higher voltage, unless the circuit of lower voltage is effectively grounded.

Note 2: When the term "volts" or "voltage" is used without qualification, it means the voltage between conductors if no grounded conductor capable of carrying load is present. If such a grounded conductor is present, "volts" or "voltage" means volts to ground.

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

(193) WEATHERPROOF: (a) Weatherproof means so constructed or protected that exposure to the weather will not interfere with successful operation.

Note: Raintight or watertight equipment may fulfill the requirements for "weatherproof". However, weather conditions vary and consideration should be given to conditions resulting from snow, ice, dust, or temperature extremes.

(b) 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.

(194) WELDER, ELECTRIC:

Rated primary current: section E 630.31 (3) (a).

Actual primary current: section E 630.31 (3) (b).

(195) WET: (See "location—wet").

(196) X-RAY:
Continuous rating: section E 660.04 (1) (a) 1.
Long time rating: section E 660.04 (1) (a) 2.
Momentary rating: section E 660.04 (1) (a) 3.

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

PROTECTION OF BUILDINGS AND STRUCTURES AGAINST LIGHTNING

Chapter E 160

SCOPE, DEFINITIONS, ETC.

E 160.01 Scope and purpose. (1) The rules of this part of the code apply to the protection against lightning of buildings and other property, with the exception of property devoted to the production, storage and transportation of flammable liquids and gases, explosives manufacturing buildings and magazines and electrical lines and equipment.

(2) The purpose is the prevention of fire loss and other damages from lightning by directing attention to the available means of protection which are believed to be effective.

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

E 160.02 Interpretation and exceptions. (1) This code shall be liberally construed. In cases of practical difficulty or unnecessary hardships exceptions from its literal requirements may be made if equivalent protection is otherwise secured.

(2) It is not intended that this code shall be interpreted as recommending the protection of every class of property to which it applies, but shall constitute the standard where economic or other considerations make it appear that protection is necessary or desirable.

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

E 160.03 Mandatory and advisory requirements. The word "shall" where used is to be understood as mandatory and the word "should" as advisory. "May" is used in the permissive sense.

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

E 160.04 Terms and definitions.

(1) AIR TERMINAL: The combination of elevation rod, and brace, or footing placed on upper portions of structures, together with tip or point if used.

(2) CONDUCTOR: The portion of a protective system designed to carry the current of a lightning discharge from air terminal to ground.

(3) BRANCH CONDUCTOR: A conductor which branches off at an angle from a continuous run of conductor.

(4) CABLE: A number of wires twisted or braided to form a conductor.

(5) COPPER-CLAD STEEL: Steel with a coating of copper welded to it as distinguished from copper-plated or copper-sheathed material.

(6) DOWN CONDUCTOR: The vertical portion of a run of conductor which ends at the ground.

(7) ELEVATION ROD: The vertical portion of a conductor in an air terminal by means of which it is elevated above the object to be protected.

(8) FASTENER: A device used to secure the conductor to the structure which supports it.

(9) GROUND CONNECTION: A buried body of metal with its surrounding soil and a connecting conductor which together serve to bring an object into electrical continuity with the earth.

(10) METAL-ROOFED BUILDING: A building with a roof made of or covered with metal.

(11) METAL-CLAD BUILDING: A building with sides made of or covered with metal.

(12) POINT: The pointed piece of metal used at the upper end of the elevation rod to receive a lightning discharge.

(13) ROOF CONDUCTOR: The portion of the conductor above the eaves running along the ridge, parapet, or other portion of the roof.

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

Chapter E 161

LIGHTNING PROTECTION FOR ORDINARY BUILDINGS

Note: Sections E 161.01 to E 161.04, inclusive, hereunder apply more particularly to buildings of the ordinary types which have roofs of slate, tile, or other non-conducting material. Section E 161.05 sets forth modification to the rules preceding it which may be made for the case of buildings which are roofed, or roofed and clad, with metal. Grounding and interconnection of metals are included in section E 161.06 to E 161.08, while chapter E 162 is to be referred to when buildings are equipped with spires, steeples, flag poles or towers.

E 161.01 Conductors. (1) MATERIALS. The materials of which protective systems are made shall be relatively resistant to corrosion or shall be acceptably protected against corrosion. No combination of materials shall be used that forms an electrolytic couple of such nature that in the presence of moisture corrosion is accelerated, but where moisture is permanently excluded from the junction of such metals contact between them is not objectionable.

(a) The following list of materials comprises those commonly used for protective systems, or parts of protective systems, and with their accompanying specifications constitute materials to be regarded as standard for the purposes of this rule.

1. *Copper.* Where copper is used it shall be of the grade ordinarily required for commercial electrical work, generally designated as being of 98% conductivity when annealed.

2. *Alloys.* Where alloys of metals are used they shall be substantially as resistant to corrosion as copper under similar conditions.

3. *Copper-clad steel.* Where copper-clad steel is used, the copper covering shall be permanently and effectively welded to the steel core, and the proportion of copper shall be such that the conductance is not less than 30% of the conductance of an equivalent cross-section of solid copper.

4. *Galvanized steel.* Where steel is used it shall be thoroughly protected against corrosion by a zinc coating which will satisfactorily withstand a standard test for galvanized coatings.

Note: The importance of resistance to corrosion of lightning-conductor materials should be emphasized at this point because corrosion, either soil or atmospheric, leads to deterioration and consequent impairment of the initial degree of reliability of a system and should be forestalled wherever possible. In this connection, there are several combinations of metals, and alloys of metals, that do not lead to marked corrosion when placed in contact in the presence of moisture, whereas others do, and while it is not practicable to give here a list of such combinations, manufacturers and purchasers of lightning conductors are cautioned to use only those that have been shown by experience or adequate tests to be free from objectionable features. It may also be pointed out that atmospheric conditions in certain sea-coast sections of the United States, notably the South Atlantic and Gulf coasts, are known to be destructive to galvanized steel, and in such regions galvanized steel should be used with caution, a preference being given to copper. Copper is also to be preferred where corrosive gases are encountered, but it needs to be reinforced with a lead covering under exceptional conditions, such as are found near the tops of smokestacks. (See section E 164.02 (5).)

5. *Aluminum.* Where aluminum is used, care should be taken not to use it in contact with the ground or elsewhere where it will rapidly deteriorate, and precautions should be observed at connections with dissimilar metals. Cable conductors shall be of electrical conductor grade aluminum.

(2) FORM AND SIZE. (a) The following sub-sections give minimum sizes and weights for main and branch conductors. Conductors used for bonding and inter-connecting metallic bodies to the main cable, and which will not normally be required to carry the main lightning current, may be reduced in size.

(b) Conductors for inter-connection to domestic water systems, steam or hot water heating systems, or other metallic masses having a low resistance to ground shall be full size, since in the event of a direct stroke the major portion of the discharge current may flow to ground over such a system.

1. *Copper cable.* Copper cable conductors shall weigh not less than 187.5 lb. per M ft. The size of any wire of a cable shall be not less than No. 17 AWG (0.045 inch).

2. *Copper tube, copper solid section and copper-clad steel.* Tube, or solid section conductors of copper or copper-clad steel shall weigh not less than 187.5 lb. per M ft. The thickness of any tube wall shall be not less than No. 20 AWG (0.032 inch). The thickness of any copper ribbon or strip shall be not less than No. 16 AWG (0.051 inch).

3. *Galvanized-steel.* Galvanized-steel conductors shall have a net weight of steel of not less than 320 lb. per M ft. and a zinc coating of not less than 2 ounces per square foot of galvanized surface. The thickness of any tube wall, web or ribbon before galvanizing shall be not less than No. 17, U. S. Standard Sheet Gage (0.056 inch) and the diameter of any wire of a cable before galvanizing shall be not less than No. 14 Steel Wire Gage (0.080 inch).

4. *Aluminum.* a. Aluminum cable conductors shall weigh not less than 95 pounds per thousand feet and the size of any wire of the cable shall be not less than No. 14 AWG (0.064 inch). Aluminum conductors for bonding and interconnecting metallic bodies to the main cable shall be at least the equivalent in strength and cross-sectional area of a No. 4 AWG (0.204 inch) aluminum wire. Aluminum strip conductors for interconnecting metallic bodies to the main conductor cable, if void of perforations, shall be not less than No. 14 AWG (0.064 inch) in thickness and at least ½ inch wide. If perforated, the strip shall be as much wider as the diameter of the perforations. Aluminum strip for connecting exposed water pipes shall be not less than No. 12 AWG (0.080 inch) in thickness and at least 1½ inch wide.

b. Aluminum connectors shall be not less than No. 12 AWG (0.080 inch) in thickness and of the same design and dimensions required for stamped copper connectors.

c. Aluminum tubular points shall be not less than ⅝ inch O.D., No. 16 AWG (0.050 inch) wall thickness and of the same lengths as required for copper points. Solid aluminum points shall be not less than ½ inch in diameter and of the same lengths as required for copper points.

d. Aluminum air terminal supports (for points and elevation rods), when stamped, shall be not less than No. 14 AWG (0.064 inch) in thickness and of the same design and dimensions required for copper supports.

e. Cast aluminum parts (fasteners, clamps, connectors, fixtures, etc.), shall be of the same designs and dimensions required for copper alloy fittings and equivalent in strength and conductivity.

f. Copper, copper-covered and copper alloy fixtures and fittings shall not be used for the installation of aluminum lightning protection systems. Aluminum, galvanized iron or aluminum alloy fixtures and fittings are the only types permitted, except for ground connections as provided in the next paragraph.

Note: The use of aluminum materials for direct grounding of aluminum systems of lightning protection is not acceptable and they should never be buried in earth. Galvanized iron ground rods, leads and clamps are satisfactory for grounding aluminum systems. Copper or copper-covered ground rods and leads may be employed, provided the clamps for connecting the aluminum down conductors to the copper or copper-covered grounding equipment are types specially designed for making the connection between the 2 dissimilar metals. The connection of the aluminum down conductors to the grounding equipment shall be made at a point not less than one foot above ground line. Protecting the connection from mechanical injury and displacement by the use of suitable guards is required.

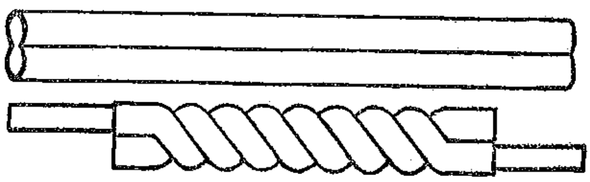
(3) JOINTS. (a) *General.* Joints in conductors shall be as few in number as practicable and where they are necessary they shall be mechanically strong and well made and provide ample electrical contact. The latter requirement is to be regarded as met by a contact area not less than double the conducting cross-sectional area of the conductor.

Note: The following suggestions are offered in regard to the construction of joints in conductors.

1. Sections of cable conductor are preferably connected together by unravelling 6 inches or more of the ends and making a solderless wrapped joint. An alternative is found in couplings of malleable metal No. 14 AWG (0.064 inch) in thickness, 3 inches in length, and of semi-tubular form with projections on the interior which, when the coupling is crimped, become embedded in the cable.

2. Sections of tube conductor may be connected together by dowel-type screw joints with the dowels secured to the tube by rivets or by screw sleeve couplings.

3. Lengths of circular cross-section conductor may be connected together by the Western Union Joint with or without solder, McIntire Sleeves, or by screw couplings. Lengths of rectangular cross-section conductors (ribbon) may be connected together by overlapping and riveting.



McIntire Sleeve Joint
Above: Sleeve. Below: Completed Joint

4. Lengths of star-section conductor may be connected together by means of screw joints formed from lugs of metal crimped over or formed on the end of the conductor.

5. Branch conductors are best connected to main conductors by joints similar to those used in main conductors, except that they may be in T or Y form.

6. Elevation rods are best attached to cables by means of crimped joints of malleable metal, similar to those described in the first paragraph of this note, except that they should be in T form, and connect to the elevation rod by means of a dowel or screw coupling.

7. Elevation rods on forms of conductor other than cable may be attached in the same manner as branch rods, or by an equivalent means.

(b) *Mechanical strength.* On structures exceeding 60 feet in height, joints shall be so constructed that their mechanical strength in tension as shown by laboratory tests is not less than 50% of that of the smallest of the several sections of conductor which are joined together.

(c) *Electrical resistance.* Joints shall be so made that they have an electrical resistance not in excess of that of 2 feet of conductor.

(4) FASTENERS. (a) Conductors shall be securely attached to the building or other object upon which they are placed. Fasteners in general shall be substantial in construction, not subject to breakage and shall be, with the nails, screws, or other means by which they are fixed, of the same material as the conductor, or of such nature that there will be no serious tendency towards electrolytic corrosion in the presence of moisture because of contact between the different parts.

(b) Fasteners shall be so spaced as to give adequate support to the conductor, generally not over 4 feet apart.

Note 1. The firmness with which conductors are attached goes far toward determining their period of usefulness and security. Insecure fasteners not only lead to a reduction of the protective values of an installation but detract from its appearance and necessitate repeated repairs.

Note 2. Conductors may be secured to wood surfaces by means of metal bands or straps, screw-shank fasteners, or an equivalent means. Strap or band fasteners should be made, if of copper, from sheet metal not less than No. 20 AWG (0.032 inch) in thickness and not less than ⅝ inch wide; or if of aluminum, from sheet metal not less than No. 16 AWG (0.050 inch) in thickness and not less than ¼ inch wide; with screw or nail holes surrounded by an ample width of material. Screw-shank fasteners should be provided with a fork of substantial construction which can be closed by bending. The screw-shank itself should be at least the equivalent in size of a No. 10 wood screw 1.5 inches long.

Note 3. Conductors may be secured to brick and stone surfaces by means of screw-shank fasteners in the form of an expansion screw, by drive-shank fasteners having the shank ridged or barbed to grip the hole when driven, or by fan-shank fasteners to be laid in the walls as they are built.

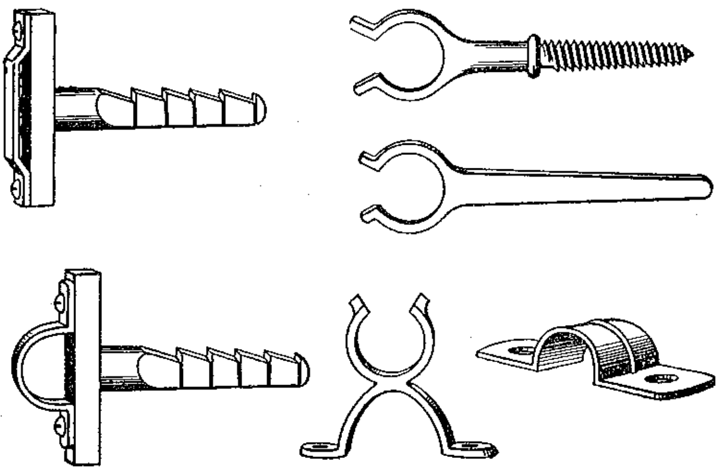
Note 4. Either the expansion screw or drive-shank should be not less than ⅜ inch in diameter and 2 inches in length, or of a type that will withstand a pull of at least 100 pounds. The fan-shank should be approximately ½ inch wide at its narrowest place, 1/10 inch thick and 3 inches long.

Note 5. Where screws are used they should be not smaller than No. 6, ¾ inch long. Nails should be not smaller in size than 4d standard. Copper-clad nails may be used with copper fasteners and galvanized nails with galvanized fasteners.

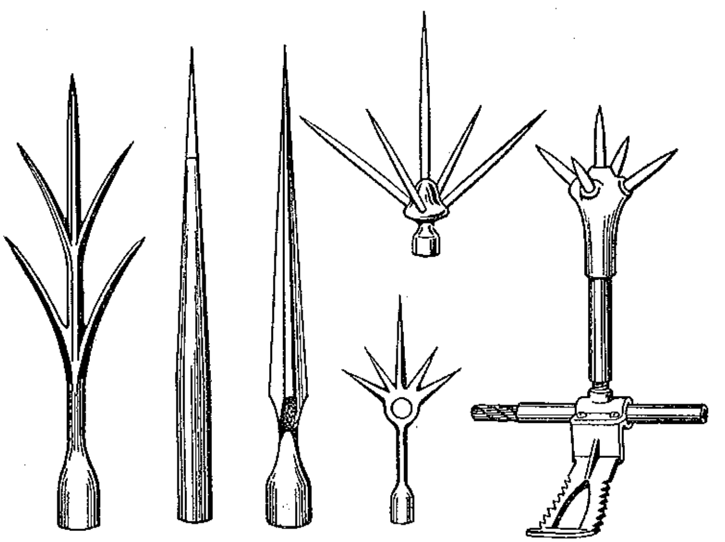
Note 6. Fasteners may also be leaded into masonry or brick work.

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

E 161.02 Points and elevation rods. (1) ATTACHMENT OF POINTS. Separate points are not required, but if used shall be of substantial construction and be securely attached to the elevation rods by screw or slip joints. The conducting cross-sectional area of the base shall be at least equivalent to the conducting cross-sectional area of the elevation rod.



Fasteners and Supports



Air Terminals

(2) ELEVATION RODS. (a) *Size.* Elevation rods shall be at least the equivalent in weight and stiffness of a copper tube having an outside diameter of ⅝ inch and a wall thickness of No. 20 AWG (0.032 inch).

(b) *Form.* Elevation rods may be of any form of solid or tubular cross-section.

(c) *Height.* The height of an elevation rod shall be such as to bring the tip not less than 10 inches above the object to be protected.

Note: On flat surfaces a greater height than 10 inches is desirable but the height need not exceed 5 feet. In most cases the proper height for an elevation rod between the limits just mentioned will depend upon the character of the object to be protected. The proper height may also be taken as depending somewhat on the contour of the object being protected; a spire, for instance, does not require so high an elevation rod as a silo having a peaked but much less sloping roof.

(3) BRACES FOR ELEVATION RODS. (a) *Use.* Elevation rods shall be amply secured against overturning either by attachment to the object to be protected or by means of substantial tripod or other braces which shall be permanently and rigidly attached to the building.

(b) *Materials.* The material from which braces are constructed shall be at least the equivalent in strength and stiffness of ¼ inch round iron, and with the nails or screws used in erecting, shall comply with the requirements of section E 161.01 (1) MATERIALS as to resistance to corrosion or protection against corrosion.

(c) *Form and construction.* Braces shall be assembled by means of riveted joints or other joints of equivalent strength. Preference should be given to tripod or 4-legged braces and when in place the feet should be spread until the distance between them approximates ⅓ the height of the brace.

(d) *Guides.* Where elevation rods are more than 24 inches high, braces shall have guides for holding the elevation rod at 2 points located approximately as follows: The lower at a distance above the foot of the rod equal to ⅓ of its height, the upper at a distance above the lower equal to ¼ the height of the rod.

Note 1. Where elevation rods are 24 inches high or less, braces with a single guide may be used, holding the rod approximately midway of its height. Ten-inch elevation rods may be braced by means of substantial footings.

Note 2. Where elevation rods are to be attached to house chimneys they can be secured either by means of expansion screw fasteners or a band surrounding the chimney. On horizontal masonry or brick work, holes may be drilled and the rod set in cement. On woodwork lag-screws or strap fasteners may be used. Bracing in each case may be accomplished according to circumstances, but it is important that a good mechanical job be done to prevent overturning of the air terminal by the wind.

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

E 161.03 Prevention of deterioration. (1) GENERAL. Precaution shall be taken in every instance to provide against any undue tendency towards deterioration due to local conditions.

(2) CORROSION. (a) Where any part of a protective system is exposed to the direct action of chimney gases or other corrosive gases, it shall be protected by a continuous covering of lead 1/16 inch or more in thickness.

(b) Aluminum parts, including fasteners and anchors, shall be protected from direct contact with concrete or mortar wherever such concrete or mortar is wet or damp, or may become intermittently wet or damp.

(3) MECHANICAL INJURY. Where any part of a protective system is exposed to mechanical injury it shall be protected by covering it with molding or tubing preferably made of wood or non-magnetic material. If metal tubing is used the conductor shall be electrically connected to it at its upper end.

(4) USE OF ORNAMENTS. The use of small ornaments such as glass balls attached to elevation rods is not objectionable but elevation rods shall not be made to support vanes or ornaments having in any plane a wind-resistance area in excess of 20 square inches.

Note: Twenty square inches of area as a maximum for an ornament represents approximately the wind resistance area of a 5-inch glass ball. Where heavy or large ornaments are desired they should be provided with a separate support.

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

E 161.04 Air terminals and conductors. (1) GENERAL. Air terminals shall be provided for all structural parts that are likely to receive, and be damaged by, a stroke of lightning.

(2) PROJECTIONS. In the case of projections such as gables, chimneys, and ventilators, the air terminal shall be placed on, or attached to, the object to be protected where practicable, otherwise within 2 feet of it.

(3) RIDGES, PARAPETS, AND EDGES OF FLAT ROOFS. Along ridges, parapets, and edges of flat roofs, air terminals shall be spaced at intervals not exceeding 25 feet.

(4) METAL PROJECTIONS AND PARTS OF BUILDINGS. Metal projections and parts of buildings such as ventilators, smokestacks, and other objects, that are likely to receive, but not be appreciably damaged by, a stroke of lightning, need not be provided with air terminals, but shall be securely bonded to the lightning conductor with metal of the same weight per unit length as the main conductor.

Note 1. Parts of structures most likely to be struck by lightning are those which project above surrounding parts such as chimneys, ventilators, flagpoles, towers, water-tanks, spires, steeples, deck-railings, shaft-houses, gables, skylights, dormers, ridges and parapets.

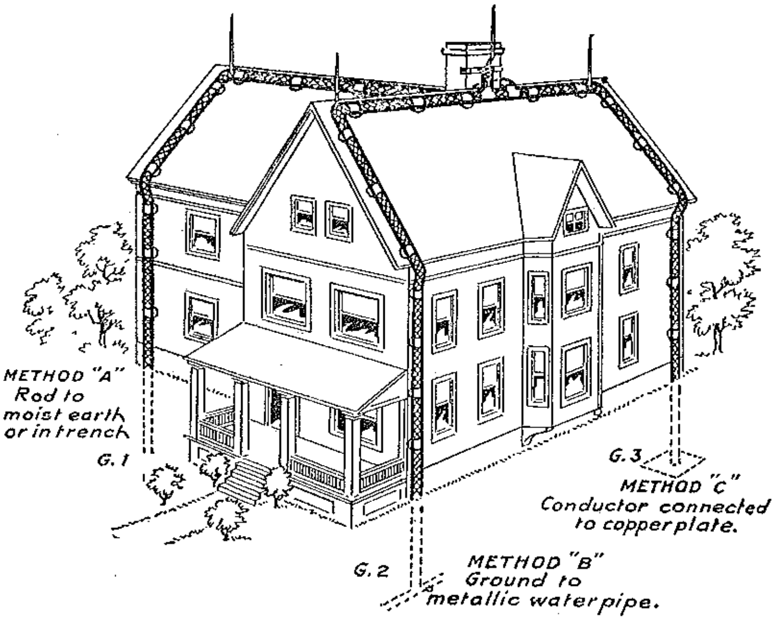
Note 2. The edge of the roof is the part most likely to be struck on flat-roofed buildings. On large flat and gently sloping roofs it is desirable to erect air terminals at points of intersection of lines dividing the surface into rectangles not exceeding 50 feet in length.

Note 3. In parts of some buildings relatively thin layers of brick, stone, tile or similar masonry material have been laid on top of structural steel. Lightning then has to break through the brick, stone, etc., to reach the steel, and this may result in fragments of brick, stone, etc., being thrown down into the street. Such construction should be avoided, but where already existing, the situation may be improved by covering the masonry with a metallic sheathing, which in turn is connected to the lightning protective system.

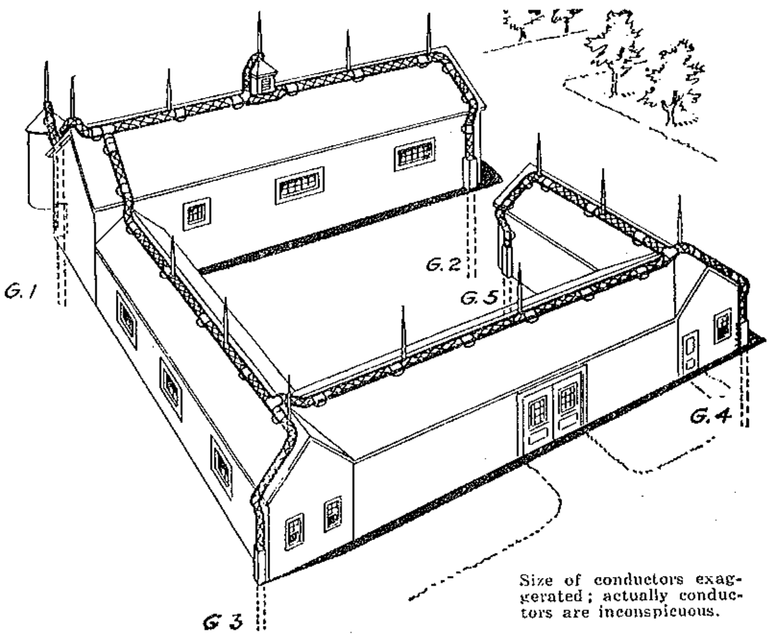
(5) COURSING OF CONDUCTORS. Conductors shall in general be coursed over the roofs and down the corners and sides of buildings in such a way as to constitute as nearly as local conditions will permit, an enclosing network.

(6) ROOF CONDUCTORS. (a) Roof conductors shall be coursed along contours, such as ridges, parapets and edges of flat roofs, and where necessary over flat surfaces, in such a way as to join each air terminal to all the rest.

(b) Roof conductors surrounding decks, flat surfaces, and flat roofs, shall be connected to form a closed loop.



Typical Installation on Large Dwelling
(Size of Conductors exaggerated in the drawing)



Typical Installation on Barn Group

(7) DOWN CONDUCTORS. Down conductors shall preferably be coursed over the extreme outer portions of buildings, such as corners, due consideration being given to the best places for making ground connections, and to the location of air terminals.

(8) OBSTRUCTIONS. Horizontal conductors shall be coursed around chimneys, ventilators, and similar obstructions in a horizontal plane and without abrupt turns.

(9) BENDS. No bend in a conductor which embraces a portion of a building such as an eave, shall have a radius of less than 8 inches. The angle of any turn shall not exceed 90° and conductors shall everywhere preserve a downward or approximately horizontal course.

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

E 161.05 Metal-roofed and metal-clad buildings. The materials and equipment required by this rule for the protection of metal-roofed or metal-roofed and clad buildings, shall comply with the requirements of sections E 161.01 to E 161.04, inclusive.

(1) METAL NOT CONTINUOUS. Buildings which are roofed, or roofed and clad, with metal in the form of sections insulated from one another, or so applied that they are not in electrical contact, shall be treated in the same manner as are buildings composed of non-conducting materials.

(2) METAL CONTINUOUS. When buildings are roofed or roofed-and-clad, with all-metal sheets made electrically continuous by means of an interlocking or other contact acceptable to the administrative authority, or by bonding, the following modifications may be made to the requirements of sections E 161.02 to E 161.08, inclusive.

(a) Air terminals need be provided only on chimneys, ventilators, gables, and other projections, such as are likely to receive and be damaged by a stroke of lightning. Projections that are likely to receive, but not be damaged by a stroke of lightning need not be provided with air terminals, but shall be securely bonded to the roof.

(b) Roof conductors may be dispensed with, and elevation rods, if used connected to the roof by soldered joints, or securely bolted joints, having an area of contact of not less than 3 square inches. If the roof metal is in small sections, connection shall be made to at least 4 of the sections.

(c) Down conductors shall be connected to the edges of roofs, or to the lower edges of metal siding, by soldered or bolted joints having an area of contact of at least 3 square inches. If the metal is in small sections, connection shall be made to at least 4 of the sections.

(d) The roof metal should have adequate thickness (See section E 171.02) to prevent a hole being burned in the metal in case of a direct stroke to the roof, which could cause a fire if flammable material were stored below.

(3) METAL ROOF NOT ELECTRICALLY CONTINUOUS WITH METAL SIDING. The siding shall be connected to the roof at each corner, and down conductors shall be connected to the lower part of metal siding, in the manner specified in subsection (2) above, with a connection between roof and siding directly above the down conductor in every case, and the down conductor grounded as specified in section E 161.08.

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

E 161.06 Number of down conductors. (1) MINIMUM. There shall be not less than 2 down conductors on any type of buildings, and these shall be run so as to be as widely separated as practicable. The following rules shall apply as to additional down conductors.

Note: In deciding upon the location and number of down conductors it should be kept in mind that it is very desirable to have at least 2 paths in parallel, and well separated, from the foot or near the foot of each air terminal to ground. This causes a stroke upon any air terminal to find a divided path the impedance of which is less than that offered by a single path and affords increased protection. The obstruction, or impedance, offered to the passage of the stroke is nearly in inverse proportion to the number of parallel paths if they are well separated.

(2) RECTANGULAR STRUCTURES. (a) On rectangular structures having gable, hip, or gambrel roofs, and exceeding 110 feet in length, there shall be at least one additional down conductor for each additional 50 feet of length, or fraction thereof.

(b) On rectangular structures having French, flat, or sawtooth roofs, and exceeding 300 feet in perimeter, there shall be at least one additional down conductor for each additional 100 feet of perimeter or fraction thereof.

(3) IRREGULAR-SHAPED STRUCTURES. (a) On an ell or T-shaped structure there shall be at least one additional down conductor; on an H-shaped structure at least 2 additional down conductors; and on a wing-built structure at least one additional down conductor for each wing.

(b) On irregular-shaped structures the total number of down conductors shall in every case be sufficient to make the average distance between them along the perimeter not greater than 100 feet.

(4) STRUCTURES EXCEEDING 60 FEET IN HEIGHT. On structures exceeding 60 feet in height there shall be at least one additional down conductor for each additional 60 feet of height, or fraction thereof, except that the application of this rule shall not cause down conductors to be placed about the perimeter of a structure at intervals of less than 50 feet.

(5) METAL-ROOFED AND METAL-CLAD BUILDINGS. The number of down conductors and ground connections for metal-roofed and metal-clad buildings shall be determined in the same manner as for buildings composed of non-conducting materials, i.e. according to the requirements of sections (1), (2), (3) and (4) above.

(6) DEAD ENDS. Additional down conductors shall be installed where necessary to avoid "dead ends", or branch conductors ending at air terminals, which exceed 16 feet in length, except that single down conductors descending flagpoles, spires, and similar structures which are adjuncts of buildings shall not be regarded as "dead ends" but shall be treated as air terminals.

Note 1. Dead ends arise where an air terminal is placed on the peak of a dormer, or in some similar situation, and in the interest of economy is connected only to the nearest conductor, which usually is at the nearest ridge. A stroke on such an air terminal must traverse a single conductor until it reaches the ridge conductor where the path divides. The foregoing rule allows 16 feet for the length of this single conductor. Where greater lengths are encountered the conductor must be extended from the air terminal to ground.

Note 2. It is advisable to install additional down conductors at places along runs of roof conductors where the roof conductor descends into low places between parts of buildings as it may in the case of an H-shaped structure where the end wings are higher than the connecting portion.

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

E 161.07 Interconnection of metallic masses. (1) INTERCONNECTION OR GROUNDING. Metallic masses about buildings which are a permanent portion of the structure, or are permanently installed within or about it, shall, with the exception of those of comparatively small size, be made a part of the lightning-conductor system by interconnection with it, or be independently grounded, or both, depending upon their location with respect to the lightning conductors and their surroundings as more fully described in sections (2) to (8) inclusive of this rule.

Note: The object of interconnecting the metal parts of a building with the conductor is to prevent the damage from side flashes that has been found to occur, especially in the case of rather extensive metal objects that are nearby. The main principle to be observed in the prevention of such damage is to pick out on a building the places where side flashes are most likely to occur and provide metallic paths for them.

(2) EXTERIOR BODIES OF METAL. Metal situated wholly on the exterior of buildings shall be electrically connected to the conductor at its upper (or nearest) end, and if of considerable length, shall be grounded or electrically connected to the conductor at its lower (or farthest) end.

Note: Exterior bodies of metal include ornamental ridges, ventilators, roofs, valleys, gutters, down spouts, and structural iron. Connecting these into the lightning conductor system not only serves to prevent side flashes that cause damage, but makes the system a nearer approach to an enclosing network.

(3) INTERIOR BODIES OF METAL. Metal situated wholly in the interior of buildings which at any point comes within 6 feet of a lightning conductor, or metal connected thereto, shall be electrically interconnected with it, and if of considerable size or length shall be grounded at its lower or farther extremity within the building.

Note: Interior bodies of metal include radiators, piping systems, tanks, stationary machinery, stanchions, and various forms of structural metal. In general, experience has shown that side flashes are not likely to occur to bodies of metal of ordinary size located more than 6 feet from a conductor, whereas those that are nearer are likely to receive side flashes which may damage a building or set fire to it. Very long or very large bodies of metal may, however, be a menace at more than 6 feet. The side flashing to these nearby bodies is eliminated by interconnection but the rise of potential due to dynamic discharges is not, so interior grounding becomes necessary. Unless there are water pipes or their equivalent that may be used for interior grounding purposes there may be danger to persons and livestock about dwelling houses and barns. On this account where water pipes are not available it is advisable to avoid as far as practicable the necessity for interconnection of interior bodies of metal by keeping conductors more than 6 feet away from them—the farther the better.

(4) METAL BODIES PROJECTING THROUGH SIDES AND ROOFS. (a) Metal which projects through roofs, or through sides of buildings above the second floor, shall be bonded to the nearest conductor at the point where it emerges from the building and be grounded at its lower or extreme end within the building.

(b) Metal which projects through the sides of buildings below the second floor shall be treated as though it were wholly within the building.

Note: Metal projections through roofs and sides of buildings generally consist of soil pipes, metal flues, over-flow pipes of hot-water heating systems and isolated gravity-type water systems, hayfork tracks and ventilators. Hayfork tracks may be taken care of by connecting both ends to the conductor.

(5) INTERCONNECTION OF METALS ON OR WITHIN METAL-ROOFED AND METAL-CLAD BUILDINGS. (a) All parts of metal roofs, or roofs and sides, shall be securely bonded together.

(b) All interior metal parts or contents of considerable size or extent that are a permanent portion of a structure or are permanently installed within it, shall be independently grounded, and if within 6 feet of sides or roof or a down conductor shall be connected thereto.

Note: The necessity for interconnecting and grounding the metal contents of metal-roofed and metal-clad buildings arises from the fact that in the event of a discharge the potential of the metal covering, even though grounded, changes sufficiently with respect to nearby objects to cause side flashes, especially where the distance to be covered by the flash is short. Side flashes from the metal coverings of buildings are likely to be especially destructive or dangerous because of the large electrostatic capacity involved. The chances for such side flashes should be particularly considered in all buildings housing dusty operations, as flour mills. Care should be taken to ground ventilators projecting downward from roofs.

(6) METALLIC BODIES TO BE INDEPENDENTLY GROUNDED. Metallic bodies having any dimension exceeding 5 feet, and situated wholly within buildings, and which do not at any point come within 6 feet of a lightning conductor or metal connected thereto shall be independently grounded.

Note: It is generally safest to ground all metal within buildings that does not come close enough to a conductor to require interconnection with it, using an independent ground connection of any of the usual types, for the reason that it prevents sparks from accumulated static charges and from induction due to dynamic discharges.

(7) SUBSTITUTION FOR REGULAR CONDUCTORS. Extended metal parts of buildings shall not be substituted for regular conductors, except where they are permanently electrically continuous, and have a conducting cross-sectional area at least double that of the lightning conductor that would otherwise be used.

Note: In some cases of monumental structures and others where heavy and extensive metal parts are available they may well be used in place of conductors to avoid expense and sacrifice of appearance, there being no difference whether they are on the interior or exterior of the structure where used for down conductors.

(8) SIZE OF INTERCONNECTING AND BONDING WIRES. For bonding, interconnecting and independent grounding of metallic masses the conductor used shall be at least the equivalent in strength and conducting cross-sectional area of a No. 6 AWG copper wire, except where full-size lightning conductor is required by section E 161.04 (4).

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

E 161.08 Ground connections. (1) NUMBER. A ground connection shall be provided for each down conductor, preference being given to metal water pipes and other large underground metallic structures.

(2) DISTRIBUTION. Ground connections (and down conductors) shall be placed at as uniform intervals about a building as practicable, and grouping of ground connections on one side of a building avoided.

(3) MOISTURE. In making ground connections advantage should be taken of all permanently moist places where practicable, although such places should be avoided if wet with waste water which contains chemical substances especially corrosive to the metal with which the ground connection is made.

Note: Chemical substances especially corrosive to lightning conductor material are not ordinarily encountered in practice. They would usually be found about factories engaged in chemical processes.

(4) PERMANENCY. Ground connections shall in every case be thoroughly and permanently made, with due regard to the character of the surrounding soil.

(5) WATERPIPE GROUNDS. Where a metallic waterpipe enters a building at least one down conductor shall be connected to it, preferably at a point immediately outside of the foundation wall, by means of a substantial clamp to which the conductor can be attached by bolts or solder.

(6) GROUNDING ELECTRODES IN DEEP SOIL. Where the soil is moist clay, or other soil of similar character as to electrical resistivity, artificial grounding electrodes may be made by extending the rod itself into the ground a distance of not less than 10 feet. Where the soil is largely sand, gravel, or stones, more extensive artificial grounding electrodes shall be made by adding metal in the form of driven rods or pipes, or strips, plates, or lengths of conductor buried in trenches as in subsection (7). Where a grounding electrode consists of a driven rod or pipe, the length of the electrode shall be permanently marked upon it at the top.

(7) GROUNDING ELECTRODES IN SHALLOW SOIL. Where bed rock is near the surface, ground connections may be made by digging trenches radially from the building and burying in them the lowest ends of the down conductors or their equivalent in the form of metal strips or wires. Where the soil is very dry or will not permit digging to a depth of more than one foot, in addition to the conductors laid radially, a similar conductor shall be buried which encircles the structure to be protected and connects all of the down conductors together.

(8) TRENCHES. Trenches shall be long enough to accommodate 12 feet of conductor when laid straight, but need not be more than 3 feet in depth.

Note 1. Properly made ground connections are essential to the effective functioning of a lightning-conductor system and every effort should be made to provide ample contact with the earth. This does not necessarily mean that the resistance of the ground connection must be low, but rather that the distribution of metal in the earth or upon its surface in extreme cases, shall be such as to permit the dissipation of a stroke of lightning without damage.

Note 2. Low resistance is, of course, desirable, but not essential, as may be shown by the extreme case on the one hand of a building resting on moist clay soil, and on the other by a building resting on bare solid rock. In the first case if the soil is of normal resistivity or from 200 to 5000 ohm-centimeters, the resistance of a ground connection made by extending the conductor 10 feet into the ground will be from 20 to 50 ohms, and 2 such ground connections on a small rectangular building have been found by experience to be sufficient. Under these favorable conditions providing adequate means for collecting and dissipating the energy of a flash without serious chance of damage is a simple and comparatively inexpensive matter.

Note 3. In the second case it would be impossible to make a ground connection in the ordinary sense of the term because most kinds of rock are insulating, or at least of high resistivity, and in order to obtain the effect of grounding other and more elaborate means are necessary. The most effective means would be an extensive wire network laid on the surface of the rock surrounding the building, after the manner of counterpoise to a radio antenna, to which the down conductors, could be connected. The resistance to earth at some distant point of such an arrangement would be high but at the same time the potential distribution about the building would be substantially the same as though it were resting on conducting soil and the resulting protective effect also substantially the same.

Note 4. In general, the extent of the grounding arrangements will depend upon the character of the soil, ranging from simple extension of the conductor into the ground where the soil is deep and of high conductivity, to an elaborate buried network where the soil is very dry or of very poor conductivity. Where a network is required it should be buried if there is soil enough to permit it, as this adds to its effectiveness. Its extent will be determined largely by the judgment of the person planning the installation with due regard to the minimum requirements of this rule, which is intended to cover the ordinary run of cases that are likely to be encountered in practice, keeping in mind that as a rule the more extensive the underground metal available the more effective the protection.

Note 5. Some essential features of good practice in grounding for protection against lightning are as follows:

1. Where practicable each artificial ground connection should extend or have a branch which extends below and at least 2 feet away from the foundation walls of the building, as otherwise there is a chance of the wall being damaged.

2. The metal composing the ground connection should make contact with the soil from the surface downwards, for if contact is made below the surface there may be flashing at the surface with danger of burning off the conductor.

3. During a stroke of lightning on a system of conductors the grounding electrodes are to be thought of as the point through which the heavy current flows between the air terminals and the surface of the earth about the building and should, therefore, be distributed with the view of carrying this flow of current in the most advantageous manner. This will be generally realized by placing them at the outer extremities, such as the corners, and avoiding as far as possible the necessity for current flow under the building.

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

E 161.09 Radio installations and wires entering buildings. (1) WIRES ENTERING BUILDINGS. Wires entering buildings shall conform to requirements of the latest edition of the Wisconsin State Electrical Code which are applicable.

(2) METAL RADIO MASTS ON BUILDINGS. Metal radio masts on buildings shall be bonded to the nearest lightning conductor.

(3) WOODEN RADIO MASTS. Wooden radio masts which extend more than 6 feet above the ridge or highest parts of the building on which they are placed shall be treated in the same manner as flag poles.

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

E 161.10 Concealed installations. (1) FULL CONDUCTOR SYSTEMS. (a) The same requirements as for exposed systems apply to concealed systems. Conductors are coursed the same except that they may be under the roofing material, under the roof, behind the exterior wall facing or between the studs of walls.

(b) Groundings may be carried to the exterior at or below grade level and then made in the conventional manner according to soil conditions encountered. Groundings may also be placed in the basement below the basement slab but on outside walls only. Such groundings below basement slabs should be avoided at interior locations in the structure due to the fact that the soil in such locations will usually be dry.

(c) Chimney points and chimney conductors may be built into the masonry of the chimney or may be attached to the exterior of the chimney and then carried through the roof to the interior main conductor.

(d) Approved fittings and flashings shall be employed in making all through roof and through wall connections. Particular care should be employed on concealed installations to insure common grounding of all extended metallic parts such as the electric system, water system, furnace pipes or ducts, gas pipes, soil pipes, metal lathing, foil insulation, etc.

(2) STRUCTURAL STEEL SYSTEMS. (a) The structural steel framework of a building may be utilized as the main conductor of a light-

ning protection system provided it is electrically continuous or is made electrically continuous by bonding of non-electrically continuous sections. The electrical continuity may be measured by a comparison of ohms resistance to ground at ground level and at the top and other elevations of the structure. Electrically continuous reinforcing rods may also be considered as structural steel.

(b) Air terminals may be individually bonded to the framework through the roof or parapets or they may be joined together with an exterior conductor which shall be bonded to the framework in not less than the same number of places as there are groundings for the structure.

(c) Groundings shall be made from approximately every other steel column, around the perimeter, and in no case shall they average more than 60 feet apart.

(d) All bondings of air terminals, connecting conductors, and grounding tails shall be made to the steel with bonding plates having a surface contact of not less than 8 square inches. They shall be bolted, welded, brazed or securely clamped to a cleaned section of the steel.

(e) If the grounding locations are dry, such as in sand, gravel, or rock, a counterpoise, interconnected with each of the individual ground terminals shall be installed.

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

Chapter E 162

MISCELLANEOUS STRUCTURES

E 162.01 Spires, steeples, and flag poles. (1) GENERAL. The materials, equipment and ground connections required by the rules of this chapter for the protection of spires, steeples, and flag poles, shall comply with the requirements of chapter E 161.

(2) AIR TERMINALS. A single air terminal may be used, which elevates the tip a distance of not less than 10 inches above the uppermost point of the structure.

(3) DOWN CONDUCTORS. A single down conductor may be used, which, if the structure is isolated, shall be extended directly to a ground connection. If the structure is an adjunct of a building and near or touching the perimeter, the down conductor shall be extended directly to a ground connection, but shall also be connected to the lightning-conductor system on the building. If it is set well within the perimeter the descending conductor shall be connected to the nearest roof conductor.

(4) INTERCONNECTION OF METALS. Bells, clocks, structural iron, and other metallic masses shall be connected to the down conductor. If the length of a metallic body is comparable to the height of the structure, connection shall be made at the upper and lower extremities; otherwise connection may be made at the nearest point.

(5) GROUNDING OF METALLIC SPIRES AND FLAG POLES. Spires and flag poles composed entirely of or covered entirely with metal and resting on foundations of non-conducting material with the top so constructed as to receive a stroke of lightning without appreciable damage, need not be provided with air terminals or down conductors, but shall be grounded or connected to the nearest lightning conductor, or both, according as the structure is isolated, set within the perimeter of a building or near it, respectively.

Note: On spires and steeples exceeding 100 feet in height it is advisable to use more massive conductors and fastenings than on ordinary types of buildings in order to resist the extraordinary conditions found on tall structures.

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

E 162.02 Water towers, silos, and similar structures. (1) GENERAL. The materials, equipment, and ground connections required by the rules of this chapter for the protection of water towers, silos, and similar structures, shall comply with the requirements of chapter E 161.

Note: On structures exceeding 100 feet in height it is advisable to use more massive conductors and fastenings than on ordinary buildings in order to resist the extraordinary conditions found on tall structures, especially with regard to temperature effects and loading which may lead to alternate expansion and contraction.

(2) AIR TERMINALS. The number and location of air terminals shall in general comply with the requirements of section E 164.04, except

that on silos and other towers having roofs ending in a peak a single air terminal may be regarded as sufficient.

(3) CONDUCTORS. Where more than one air terminal is used they shall be connected together by a conductor which forms a closed loop about the structure near the top, or passes over it, as the contour of the roof may require. From this, or from the single air terminal if but one is used, at least 2 down conductors shall be extended directly to ground connections on opposite sides, if the structure is isolated. If it is an adjunct of a building, near or touching the perimeter, one down conductor shall be extended directly to a ground connection while the other may be connected to the lightning conductor system on the building. If it is set well within the perimeter both down conductors may be connected to the lightning-conductor system on the building. If the height of the structure exceeds 100 feet the down conductors should be cross-connected midway between top and bottom.

(4) INTERCONNECTION OF METALS. All metallic bodies of considerable size or extent, whether exterior or interior, shall be connected to the down conductors. If their length is comparable to the height of the structure they shall be connected to the down conductors at both ends; otherwise connection may be made at the nearest point.

Note: Metal objects about towers which are comparable in length with the height of the structure, consist usually of stairways, elevator guides, and drain pipes carrying water from the roof.

(5) GROUNDING OF METAL TOWERS AND WATER TANKS. Towers and tanks composed entirely of or covered entirely with metal and resting on foundations of non-conducting material, with the uppermost portion so constructed as to receive a stroke of lightning without appreciable damage, shall be grounded by means of 2 earth terminals on opposite sides of the structure.

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

E 162.03 Grain elevators. (1) GENERAL. The rules contained in chapter E 161, except as modified by subsections (2) and (3), shall apply to grain elevators, and to other structures in which combustible dusts may be produced in quantities sufficient to form explosive or ignitable mixtures with air or in which such dusts may accumulate on ledges or other surfaces in quantities sufficient to sustain smoldering fire.

(2) CONDUCTORS. Roof conductors and down conductors shall be of copper or aluminum cable conforming to section E 161.01.

Note: Due to the physical deformation of such structures through cycles of loading and unloading, it is necessary that conductors have sufficient flexibility to guard against breakage.

(3) INTERCONNECTION OF METALLIC MASSES. Interconnection of metallic masses shall conform to section E 161.07, except that all interior metallic masses having any dimension greater than 5 feet, and all metallic masses except those of comparatively small size, which are within 6 feet of grounded metallic masses including lightning conductors and metal connected thereto, shall be interconnected with each other and with the lightning conductors. Interconnected networks of interior metallic masses shall have at least one interior ground connection in addition to the lightning conductor grounds.

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

Chapter E 163

BUILDINGS CONTAINING BALED FLAMMABLE MATERIALS

Note: It has been found that lightning flashes occurring in the immediate vicinity of cotton or other fibrous materials of a flammable nature baled with metal ties may cause secondary discharges between the ties of sufficient intensity to cause ignition. To prevent fires of this type a greater degree of shielding is required than is afforded by the ordinary system of lightning rods. The required condition is inherent or readily realized in all-metal or metal-covered buildings, but in the case of other types made of non-conducting materials the nearest practicable approach to the necessary degree of shielding is found in a grounded network of sufficiently small mesh covering the roof. It has been found experimentally that the shielding effect of a network of given mesh increases with the height above the shielded object, also that the shielding effect decreases as the size of the mesh is increased. A mesh of 6 feet is a fair mean value if placed on or a few feet above the roof.

E 163.01 Methods and materials. The materials, equipment and ground connections required by the rules of this chapter shall comply with the requirements of chapters E 161 and E 162.

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

E 163.02 Metal-roofed and metal-clad buildings. Metal-roofed and metal-clad buildings shall be treated in the same manner as required in chapter E 161, section E 161.05.

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

E 163.03 Buildings of non-conducting materials. The effect of an electrostatic shield may be obtained by constructing on or above the roof a network of wires or cables and grounding it about the perimeter at the same intervals as required for metal-roofed buildings.

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

Chapter E 164

SMOKESTACKS AND CHIMNEYS

E 164.01 Metal smokestacks. (1) Metal smokestacks need no protection against lightning other than that afforded by their construction, except that they shall be properly grounded. If the construction of the foundation is not such as to provide ample electrical connection with the earth, ground connections shall be provided similar to those required for stacks made of materials other than metal as provided in section E 164.02 (7).

(2) Metal guy wires and cables shall be grounded at their lower ends.

Note: Metal guy wires or cables attached to steel anchor rods set in earth may be considered as sufficiently well grounded. Only those set in concrete or attached to buildings or non-conducting supports need attention.

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

E 164.02 Brick, hollow-tile, and concrete stacks. Where stacks of brick, hollow tile, concrete, or other material liable to damage by lightning are to be protected the following rules shall apply.

(1) CONDUCTORS. (a) Conductors shall be of copper of the grade required for commercial electrical work, generally designated as having 98% conductivity when annealed.

(b) The weight of the conductor shall be not less than 6 ounces per linear foot.

(c) The size of any wire in a cable shall be not less than No. 15 AWG (0.057 inch).

(d) The thickness of any tube wall shall be not less than No. 15 AWG (0.057 inch).

(e) The thickness of any web or ribbon shall be not less than No. 12 AWG (0.080 inch).

(2) FASTENERS. (a) Fasteners shall be of copper or copper alloy substantially as resistant to corrosion as the conductor itself, and must be strongly constructed. Each fastener must have a sufficiently tight grip to support its corresponding length of conductor.

(b) Fasteners shall be spaced close enough to give ample support to the conductor, generally not over 4 feet apart.

(3) AIR TERMINALS. (a) Air terminals shall be strongly constructed of the same grade of material as the conductor, or may be made of stainless steel, monel metal, or other equally corrosion-resistant metal; and shall be uniformly distributed about the rim of the stack at intervals not exceeding 8 feet.

(b) The height above the rim shall be not less than 30 inches.

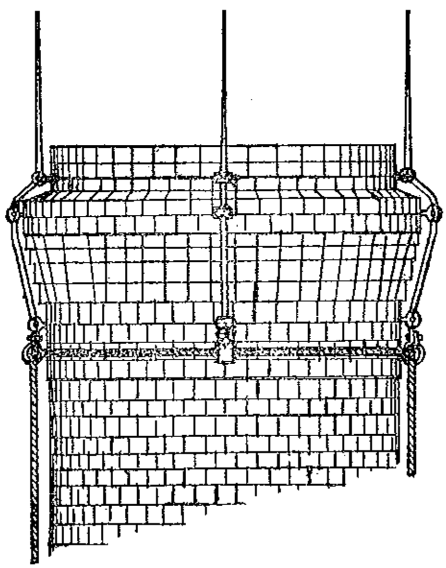
(c) They shall be secured to the top of the stack by means of expansion bolts or fan shank fasteners of substantial construction. The air terminals shall be electrically connected together by means of a metal ring or band which forms a closed loop about 2 feet below the top of the chimney. If there is a metal crown the air terminals should be connected thereto.

(4) DOWN CONDUCTORS. (a) At least 2 down conductors shall be provided on opposite sides of the stack, leading from the ring or crown at the top to the ground.

(b) On stacks exceeding 160 feet in height the down conductors shall be cross-connected approximately midway between top and bottom. Where a metal ladder is continuous from the rim to the ground, and the vertical members have a combined cross-section not less than twice that specified in section E 161.01 (2) (c), such members may be utilized as down conductors.

(5) LEAD COVERING. In order to prevent corrosion by gases, copper air terminals, conductors, and fasteners within 25 feet of the top of the stack shall have a continuous covering of lead at least 1/16 inch thick.

(6) JOINTS. Joints in conductors must be as few as practicable and of such construction as to show by laboratory tests a strength in tension of at least 50% of that of the conductor.



Typical Arrangement at Top of Stack

(7) GROUND CONNECTIONS. (a) Ground connections may be made in the manner prescribed for buildings. (See section E 161.08).

(b) If there is a water pipe nearby connection shall be made to it by means of a substantial clamp.

(8) PROTECTION AGAINST MECHANICAL INJURY. (a) Down conductors near the ground shall be protected against mechanical injury by means of wood molding or other non-magnetic material.

(b) If metal tubing is used for protective purposes the down conductor shall be electrically connected to it at its upper end.

(9) METAL LININGS. Where stacks have a metal lining extending part way up the lining shall be connected to the rod at its upper end and grounded at the bottom.

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

E 164.03 Reinforced-concrete stacks. (1) REINFORCING METAL. Stacks consisting partly or entirely of reinforced concrete shall comply with the requirements of section E 164.02, and in addition the reinforcing metal shall be electrically connected together and shall be electrically connected to the down conductors at the top and bottom of the concrete.

Note: In existing stacks whose reinforcement may not be electrically continuous, it is recommended that additional connections be made at points where the reinforcing rods are accessible.

(2) JOINTS. Joints between iron or steel and copper, within 25 feet of the chimney top shall be protected against corrosion by being coated with lead or imbedded in the concrete.

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

E 164.04 Vents emitting explosive dusts, vapors or gases. (1) Air terminals on capped or hooded vents emitting explosive dusts, vapors or gases should extend not less than 5 feet above the opening.

(2) When explosive dusts, gases or vapors are emitted under forced draft from open stacks, the air terminals should extend not less than 15 feet above the vent opening.

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

Chapter E 165

HANGARS, BALLOONS AND AIRSHIPS

E 165.01 Prevention of damage to hangars. Where buildings housing aircraft are to be protected against lightning the following rules shall apply.

Note: Buildings for the housing of aircraft require special attention in regard to protection against lightning because of the hazardous nature of their contents, and in the case of buildings for housing rigid airships, because of their great height and area. Permanent structures are usually all-steel, steel over wood frames, or asbestos on either wood or steel. For the protection of all-steel structures it is considered sufficient to ground the framework (as indicated in subsection (8) below), but for the protection of buildings of other forms of construction more extensive measures are necessary.

(1) MATERIALS. Materials used for the purposes of this chapter shall comply with the requirements of section E 161.01 (1) "Materials".

(2) CONDUCTORS. Conductors shall comply with the requirements of section E 161.01 (2).

Note: It is recommended that where existing conditions are especially severe with respect to weather or other causes, as may be the case with very large buildings for the housing of aircraft, more massive conductors be used than required by section E 161.01 (2).

(3) CONSTRUCTION AND INSTALLATION. The construction and installation of conductors where used shall comply with sections E 161.01 (3) and (4), sections E 161.02 and E 161.03.

(4) STRUCTURES WITH STEEL FRAMES. Where protection is provided for buildings with steel frames, all parts of which are securely bonded together, the air terminals may be connected to the steel frame at the nearest point and other conductors between air terminals and ground omitted. Where such connection is made the connecting conductor shall comply with the requirements of section E 161.01 (2), as to weight, and shall be secured in electrical contact with the frame by means of bolts and nuts. The steel frame shall be grounded as provided in section E 165.01 (8).

(5) CONSTRUCTION OF AIR TERMINALS. Air terminals shall be strongly constructed and shall be securely attached and braced against overturning.

Note 1. The following construction is suggested for air terminals on the roofs of steel-frame buildings. The elevation rod may consist of a length of "extra strong" galvanized-steel pipe not less than 0.75 inch internal diameter, or an equivalent aluminum, copper or copper-alloy tube, threaded at both ends, one to receive a threaded solid point 6 inches in length, and the other an attachment for securing the elevation rod to the roof. By "equivalent" is meant of equivalent strength and conductivity.

Note 2. This attachment should consist of a pair of wooden blocks bolted to the outer and inner surfaces of the wood sheathing and cut to fit the roof and afford horizontal parallel surfaces for mounting floor flanges. The roof and blocks should be drilled through at the hub of the flanges and the tube screwed through both flanges in a vertical position. The roofing should be laid on around the outer wooden block and copper or aluminum flashing applied.

(6) HEIGHT OF AIR TERMINAL. (a) Where air terminals are placed on projections the height shall be such as to bring the tip not less than 10 inches above the object to be protected. Where air terminals are placed near projections there shall be at least 4 inches of additional height above the object to be protected for each foot of separation.

(b) Where air terminals are spaced 25 feet or less apart on roof ridges or flat surfaces the height shall not be less than 4 feet 10 inches. For each additional foot of separation above 25 feet there shall be an increase in height of not less than 2 inches.

(c) Where air terminals are placed in rectangular arrangement as in subsection (7) the height shall be determined by the longest side of the rectangle.

(7) LOCATION OF AIR TERMINALS. Air terminals shall be provided for all structural parts that are likely to receive, and be damaged by, a stroke of lightning.

(a) In the case of projections the air terminal shall be placed on the object to be protected where practicable, otherwise it shall be attached to the roof as near by as practicable.

(b) Along ridges, parapets, and edges of both flat and pitched roofs, air terminals shall be erected at intervals not exceeding 25 feet.

(c) Flat and sloping surfaces, except as indicated below, shall be divided into rectangles having sides not exceeding 50 feet in length by drawing lines parallel to the edges of the roof, and air terminals erected at the intersection of these lines.

(d) On gambrel roofs only the portion above the breaks need be considered and is to be treated as a pitched roof.

(e) On mansard roofs only the flat portion need be considered and is to be treated as a flat roof.

(8) GROUND CONNECTIONS. Ground connections for lightning conductors shall comply with section E 161.08. Where the frame of the building is of steel it shall be permanently and effectively grounded as follows:

(a) If there is a water-pipe system entering the structure the frame shall be bonded to it at the point of entrance with a conductor secured to the pipe by means of a substantial clamp with a lug, and to the frame with a bolt and nut. In addition, artificial grounds shall be provided for the steel pedestals, columns, or roof trusses, at not less than half of the footings, and distributed as uniformly about the perimeter as practicable.

(b) If there is no water-pipe system available, an artificial ground shall be provided at each footing.

(c) Where the soil is deep, artificial grounds may be made by extending the grounding conductor into the soil a distance of at least 10 feet, by driving a pipe or rod to a depth at least 8 feet, or by burying to a depth of at least 6 feet a metal plate having an area of at least 4 square feet.

(d) Where the soil is shallow, grounds may be made by digging trenches radially from the building and burying in them a length of grounding conductor, or its equivalent in the form of a metal strip. In addition, a trench should be dug surrounding the building and a conductor laid in it which connects all of the grounding conductors together.

(e) Conductor for grounding purposes shall conform to section E 165.01 (2) above.

(f) Where galvanized-steel pipes are used they shall be standard "extra strong" and have a nominal internal diameter of not less than 0.75 inch.

(g) Where copper strips or plates are used they shall have a thickness of not less than No. 14 AWG (0.064 inch).

(h) Grounding conductors shall be attached to buried electrodes by means of soldered, riveted, welded, or bolted joints, and to the frame with bolts and nuts.

(i) Trenches for grounding purposes must be long enough to accommodate 12 feet of conductor when laid straight but need not be more than 3 feet in depth.

(9) INTERCONNECTION OF METALS. (a) Exterior metallic bodies such as roof flashings and down spouts shall be securely bonded to the lightning-conductor system. In the case of steel-frame buildings they shall be securely bonded to the frame, and all parts of the frame shall be securely bonded together.

(b) Interior metallic bodies, such as piping systems and machinery, shall be independently grounded and if within 10 feet of a lightning conductor shall be securely bonded thereto. In the case of steel-frame buildings, all interior metallic bodies within 10 feet of the walls shall be securely bonded to the frame.

(c) Where water pipes are available they shall be used in preference to other means for grounding interior bodies of metal. Where artificial grounds are necessary they shall be constructed in compliance with section E 161.08.

(d) For all bonding, interconnecting and grounding purposes the conductor used shall be at least the equivalent in strength and conducting cross-sectional area of a No. 6 AWG copper wire except where full-size lightning conductor is otherwise required. (See section E 161.07 and notes.)

(10) SPARK PREVENTION. Each structure, after its protective system is installed, shall be examined by competent authority with a view of determining whether all possible interior sources of sparks from a stroke of lightning on the building have been eliminated. If it appears that gaps between adjacent bodies of metal or between bodies of metal and ground, are likely to give rise to sparks, suitable bonds or ground connections shall be installed in such a manner as permanently and effectively to prevent them.

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

E 165.02 Prevention of damage to airships. To prevent damage from lightning and accumulation of static electricity, balloons and airships shall be treated as follows:

(1) CAPTIVE BALLOONS. Captive balloons shall be grounded through the metal cable and winch by means of a pipe or rod driven 6 feet in the ground, or its equivalent in metal buried in a trench.

(2) FREE BALLOONS AND AIRSHIPS. Free balloons and airships shall be provided with an effective grounding wire which is to be dropped just previous to landing, and a good ground contact made for carrying off such electrical charges as may have been accumulated by them while in the air.

(3) INTERCONNECTION OF METALLIC PARTS. All metal parts of lighter-than-aircraft shall be interconnected so that any charge that may accumulate may be distributed rather than remain concentrated.

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

Chapter E 166

SHIPS

E 166.01 Vessels to be protected. Vessels shall be protected as indicated below irrespective of the geographical area in which they operate.

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

E 166.02 Radio antennas. Radio antennas shall be provided with means for grounding during electrical storms.

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

E 166.03 Vessels with steel hulls and steel masts. If there is metallic contact between steel hulls and steel masts no further protection against lightning is necessary.

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

E 166.04 Vessels of other than steel construction. The grounding of radio antennas constitutes sufficient protection for vessels of other than steel construction, except where wooden masts or spars are employed, in which case all metal fittings such as trucks and bands shall be effectively and permanently grounded by means of 1 x 1/32 inch copper strips secured to spars by brass screws and led to the nearest grounded metal-hull structure. Similar grounding of metal fittings at the extremities of wooden masts and spars constitutes adequate protection where no radio antenna is installed.

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

E 166.05 Metal standing rigging and Jacob's ladders. Where metal standing rigging and Jacob's ladders are installed they shall be effectively grounded at the lower ends in all cases (i.e. whether the vessel is equipped with a radio antenna or not) except where such rigging or Jacob's ladders are broken up into insulated sections not over 10 feet in length for radio purposes by means of suitable insulators, in which case grounding at the lower ends is not necessary. Grounding shall be carried out by means of stranded wire shunts ¼ inch in diameter, around dead eyes, lanyards, shackles, rigging screws, thimbles, etc., these shunts to be stranded, laid around the bright rigging, then parcelled and sewed.

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

E 166.06 Ground connections. In vessels having a steel hull, the hull itself constitutes an adequate ground. In vessels having wooden hulls, ground connection shall be made by means of a copper plate not less than 36 square feet in area secured to the outside of the hull below the light water line.

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

Chapter E 167

TREES

E 167.01 Methods and materials

Note: The protection of trees against lightning has been done on an increasing scale during the last few years, especially trees of historical interest or of unusual value. The rules of this chapter for the installation of lightning conductors on trees are based on what appears to be the best information obtainable.

E 167.01 Methods and materials. Where it appears desirable to protect trees against lightning the following rules shall apply:

(1) CONDUCTORS. Conductors may be copper, copper-clad steel, aluminum or galvanized-iron and shall conform to the requirements of section E 161.01.

(2) COURSING OF CONDUCTORS. In general a single conductor shall be run from the highest part of the tree along the trunk to a ground connection. If the tree is forked, branch conductors shall be extended to the highest parts of the principal limbs. If the tree is very large 2 down conductors may be run on opposite sides of the trunk and interconnected near the top.

(a) The conductors should be extended as close as practicable to the highest part of the tree.

(3) ATTACHMENT OF CONDUCTORS. Conductors shall be securely attached to the tree in such a way as to allow for continued growth of the trunk, and for swaying in the wind, without danger of breakage.

Note 1. A suitable method is to place loose girdles of wire encased in flexible tubing about the tree and attach the conductors to them. As the tree grows it is necessary to loosen the girdles from time to time to prevent checking of the flow of sap.

Note 2. Another method is to use screw-shank fasteners of the same metal as conductors which hold the conductor at a distance of about 2 inches from the trunk. With growth the fasteners become embedded and are replaced with others.

Note 3. To allow for swaying of the tree in the wind the conductor should be attached with an appreciable amount of slack between points of support.

(4) GROUND CONNECTIONS. Grounds for conductors on trees shall be made as follows: From each conductor, descending the trunk of the tree, extend 3 or more radial conductors in trenches 12 inches deep, spaced at equal intervals about the base where practicable, to a distance of 10 to 25 feet, depending upon the size of the tree. If the roots are very extensive the radial conductors may well be extended more than 25 feet. It is desirable as a further protective measure to connect the outer ends of the radial conductors together with a conductor which encircles the tree at the same depth as the radial conductors. In very dry soil the network should be supplemented with driven pipes, rods, or buried plates at its outer extremities.

Note: The object of the shallow network is to pick up the ground current accompanying a lightning flash near the surface and at a distance from the trunk rather than among the roots, which are as susceptible to damage as the top.

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

Chapter E 168

LIVESTOCK IN FIELDS

Note: (1) The information on this subject is limited, but the best obtainable has been made use of in formulating the following rules. On account of the nature of the exposure it is not possible, of course, to eliminate the hazard entirely, but it is believed that if these rules are applied it can be much reduced.

(2) The loss of live stock by lightning is caused in large measure by herds drifting against ungrounded wire fences during thunderstorms and receiving a sufficient discharge to kill them, either from accumulated static electricity or from a stroke on the fence itself. The fences that give rise to the most trouble of this kind are those constructed with posts of poorly conducting material, such as wood or concrete. Fences built with metal posts set in earth are as safe from lightning as it is possible to make them, especially if the electrical continuity is broken as provided hereafter. Breaking the electrical continuity is very useful in that it prevents a lightning stroke from affecting the entire length of a fence, as it may if the stroke is direct and the fence continuous, even though grounded.

(3) Isolated trees in pastures where stock congregate seeking shade are also a source of loss. In pastures where shade is available from wooded areas of considerable size, isolated trees should be removed, or should be protected by suitable rodding as described in section E 168.03 below.

E 168.01 Grounding of wire fences. Where it appears desirable or necessary to mitigate the danger from wire fences constructed with posts of non-conducting material the following rules shall apply:

(1) IRON POSTS. Ground connections may be made by inserting at intervals galvanized-iron posts, such as are ordinarily used for farm fencing, and attaching in electrical contact all of the wires of the fence. If the ground is normally dry the intervals between metal posts shall not exceed 150 feet. If the ground is normally damp they may be placed 300 feet apart.

(2) IRON PIPE. A less expensive ground connection than subsection (1) may be made by driving a length of ½ or ¾ inch galvanized-iron pipe beside the fence and attaching the wires by ties of galvanized-iron wire. The spacing shall be the same as for the posts under subsection (1) above.

(3) DEPTH OF GROUNDS. Pipes or posts shall be extended into the ground at least 3 feet.

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

E 168.02 Breaking continuity of fence. In addition to grounding the fence its electrical continuity shall be broken by inserting insulating material in breaks in the wires at intervals of about 1000 feet. These insertions may be in the form of fence panels of wood or lengths of insulating material to the ends of which the wires can be attached.

Such lengths of insulating material may consist of strips of wood 2 x 2 x 24 inches, or their equivalent as far as insulating properties and mechanical strength are concerned.

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

E 168.03 Trees. Where a tree is isolated and the vicinity is much frequented by livestock, the danger from lightning can be reduced by installing a single conductor extending from the top of the tree, to a distance of at least 6 feet into the ground.

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

Chapter E 170

SCOPE, EXCEPTIONS, ETC.

PROTECTION OF STRUCTURES CONTAINING FLAMMABLE LIQUIDS AND GASES

Introduction

Note: Reduction of damage. Certain types of structures used for the storage of flammable liquids and gases are essentially self-protecting against damage due to lightning strokes. Protection of a greater or less degree may be secured in the case of others through the installation of various types of protective equipment, such as rods, masts, overhead ground wires, and by other means.

Sections E 160.01 through E 168.03 relate to the protection of buildings and miscellaneous property against lightning damage. Because of the nature of contents of the structures considered in the following, extra precautions must be taken. In these structures a small spark that would ordinarily cause little if any damage might cause the complete destruction of the structure due to explosion of its contents.

Fundamental principles of protection. Protection of structures and their contents from lightning involves the following principles:

(1) The storage of flammable liquids and gases in all-metal structures, essentially gastight.

(2) The closure or protection of vapor or gas openings against entrance of flame.

(3) The maintenance of containers in good condition, so far as potential hazards are concerned.

(4) The avoidance, so far as possible, of the accumulation of flammable air-vapor mixtures about such structures.

(5) The avoidance of spark gaps between metallic conductors at points where there may be an escape or accumulation of flammable vapors or gases.

(6) The location of structures not inherently self-protecting in positions of lesser exposure with regard to lightning. Elevated positions should be avoided.

(7) In connection with structures not inherently self-protecting, the establishment of zones of protection through use of grounded rods, masts, or the equivalent.

E 170.01 Scope and purpose. (1) This code applies to the protection of structures containing flammable liquids and gases from lightning or electric discharges. It applies particularly to structures containing alcohol, benzol, petroleum, petroleum products, turpentine, and other liquids which produce flammable air-vapor mixtures at atmospheric temperatures.

(2) This code is primarily intended to give fundamental information as to the kind of structures most suitable for the protection of their contents from lightning or electric discharges and to indicate ways of protecting such structures as are not inherently self-protecting.

(3) This code is concerned only with the prevention of fires or explosions from electric discharges and is not concerned with means of extinguishing fires when once started.

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

E 170.02 Interpretation and exceptions. This code shall be liberally construed. Exceptions from its literal requirements may be made if equivalent protection is otherwise secured. It is not intended that this code be interpreted as recommending the protection of the class of property to which it applies, but it shall constitute the standard where economic or other considerations make it appear that protection is necessary or desirable.

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

E 170.03 Mandatory and advisory requirements. The word "shall" where used is to be understood as mandatory and the word "should" as advisory. The word "may" is used in the permissive sense.

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

E 170.04 Terms and definitions. The following terms and definitions apply specifically to the structures, materials, and contents involved in sections E 170.01 through 172.07.

(1) VAPOR OPENINGS. These are openings through a tank shell or roof above the surface of the stored liquid. Such openings may be provided for tank breathing, tank gaging, fire fighting, or other operating purposes.

(2) FLAME PROTECTION OF VAPOR OPENINGS. Self-closing gage hatches, vapor seals, pressure-vacuum breather valves, flame arresters, or other reasonably effective means to minimize the possibility of flame entering the vapor space of a tank. Where such a device is used, the tank is said to be "flameproofed".

(3) CAGE. A system of wires or cables forming an essentially continuous mesh or network over a structure and roof, including the necessary conductors that are connected to the structure and to an adequate ground.

(4) CONE OF PROTECTION. The cone of protection provided by a grounded lightning rod or mast is that space adjacent to the rod or mast that is substantially immune to direct strokes of lightning. When overhead ground wires are used, the space protected is called a zone of protection or protected zone.

(5) FLASH POINT. Flash point is the minimum temperature at which a liquid will give off vapor in sufficient amount to form a flammable air-vapor mixture that can be ignited under specified conditions.

(6) GASTIGHT. Structures so constructed that gas or air can neither enter nor leave the structure except through vents or piping provided for the purpose.

(7) SPARK GAP. As used in this code, the term "spark gap" means any short air space between 2 conductors electrically insulated from or remotely electrically connected to each other.

(8) FLAMMABLE VAPORS. The vapors given off from a flammable liquid at and above its flash point.

(9) FLAMMABLE AIR-VAPOR MIXTURES. When flammable vapors are mixed with air in certain proportions, the mixture will burn rapidly when ignited. The combustion range for ordinary petroleum products, such as gasoline, is from 1½ to 6% of vapor by volume, the remainder being air.

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

Chapter E 171

PROTECTIVE MEASURES

E 171.01 Conductors, air terminals, and ground connectors. Conductors for protective systems shall be selected as to material, form, and size in accordance with sections E 160.01 through E 168.03. Details as to air terminals, down conductors, interconnection of metallic masses, and ground connections are also given in sections E 160.01 through E 168.03. Connections to ground and interconnections between metallic bodies should be as short and direct as possible.

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

E 171.02 Sheet steel. Experience in the petroleum industry demonstrates that the use of 3/16 inch steel roof sheets on tanks has been adequate. Sheet metal substantially less than 3/16 inch in thickness may be punctured by severe strokes and should be protected by suitable air terminals.

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

E 171.03 Rods, masts, and overhead ground wires. (1) The cone of protection of a grounded rod or mast of conducting material is conventionally taken as the space enclosed by a cone, which has its apex at the highest point of the rod or mast and a radius at the base which bears a relation to the height. This relation depends upon the height of the cloud above the earth relative to the height of the rod or mast. A radius of base HM equal to the height of the rod or mast in important cases, or up to twice the height in less important cases, has been found to be substantially immune to direct strokes of lightning. No part of the structure to be protected should extend outside of the cone of protection (figure A). If more than one rod or mast is used, the shielded region between them is somewhat greater than the total of the shielded regions of all of the rods or masts considered individually.

(2) Masts separate from the structure to be protected should be a minimum of 6 feet from the protected structure, and the clearance should be increased by one foot for every 10 feet of structure height above 50 feet to prevent side flashes. The masts shall be thoroughly grounded and connected at ground level to the grounding system of the structure to be protected.

(3) Where a suitable underground metallic water pipe serves the structure, the water pipe is ordinarily the common grounding electrode for all services and facilities which require grounding at the structure. If there is no water pipe or if the water pipe is not accessi-

ble, the separate grounding electrodes of the various services and facilities shall be bonded together and to the masts. If such separate grounding electrodes are not accessible, the minimum separation between the mast and the structure shall be increased to 10 feet for mast ground resistance of 10 ohms or less. As an alternative, a buried grounding conductor around the outside of the structure may be used and bonded to the mast ground to avoid larger separations.

(4) The zone of protection of overhead ground wires is conventionally taken as a triangular prism or wedge. One-half of the base of the wedge (HM) equal to the height of lowest point of the overhead ground wire in important cases, or up to twice the height in less important cases, has been found to be satisfactory (figure B). The supporting masts should have a clearance from the protected structure as under section E 171.03 (2). Ground wires should be of a size as indicated under section E 160.01. The material selected should be non-corrosive for the conditions existing at the site, and the rules of section E 160.01 should be observed.

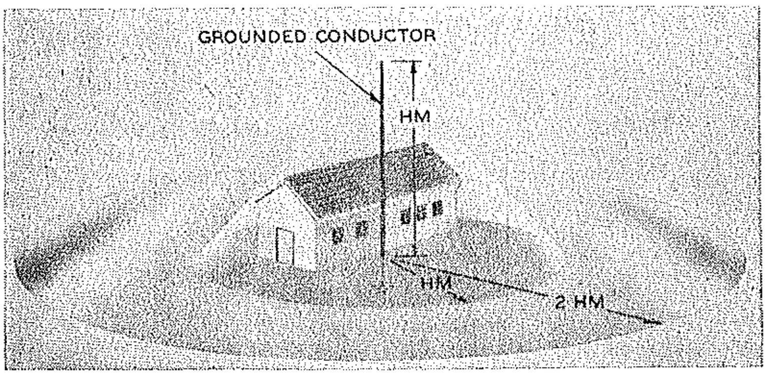


Figure A.

Cone of Protection Provided by a Vertical Grounded Conductor.

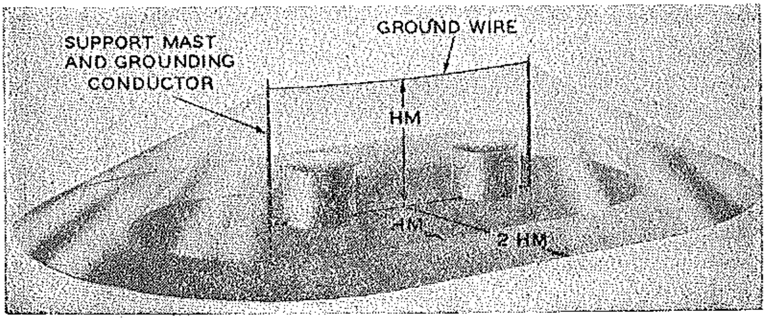


Figure B. HM = Height of Mast.

Zone of Protection Provided by a Horizontal Aerial Ground Wire.

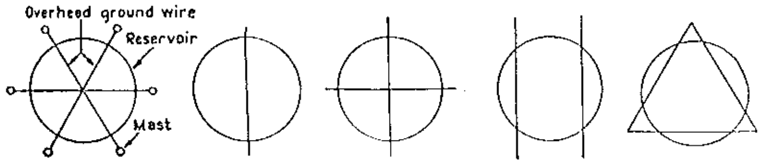


Figure C.

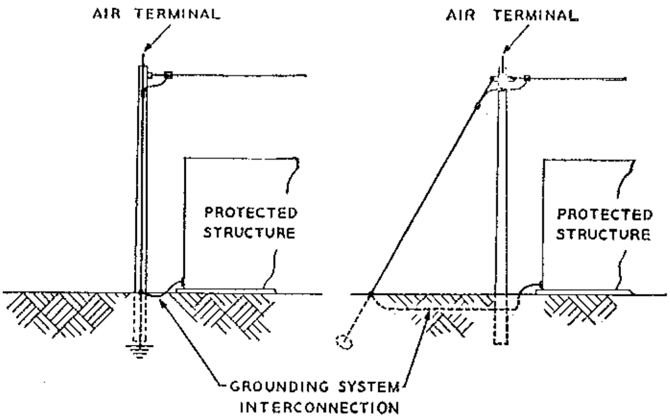


Figure D.

Alternate Grounding Method for Aerial Ground Wire Protection

(5) The minimum clearance between the overhead ground wires and the highest projection on the protected structure shall be 6 feet. For each 10 feet of lead between a point on the ground wire midway between the supporting masts and ground in excess of 60 feet, the clearance should be increased by one foot. These dimensions apply when the ground-wire system is interconnected with the grounding of the protective system in accordance with subsection (2). Where no interconnection is made the recommendations of subsection (2) apply. Variations in the ground-wire system design are shown in the plan view of figure C.

(6) Masts used either separately or with ground wires may be of wood. An approved type of air terminal shall be securely mounted to the top of the pole (see figure D) extending not less than 2 feet above the top of the pole and connected to ground electrodes. In case of an overhead ground-wire system, the pole guy wire may be used as the down conductor (see figure D). For metallic masts, the air terminal and the down conductor are not required, but the masts shall be grounded as described.

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

E 171.04 Ground resistance. (1) The resistance of ground rods driven in the earth and separated by distances of 10 feet or more will be reduced in approximate proportion to the number of rods in parallel.

(2) The resistance of a conductor buried in the ground decreases almost directly in proportion to the increase in length of the buried conductor. Such conductors are usually buried from 1 to 3 feet beneath the ground surface and running parallel with the ground surface.

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

E 171.05 Electrostatic shielding. The electrostatically induced voltage on isolated objects in the field of a storm cloud may cause sparks to ground when a lightning discharge occurs to some adjacent object. Isolated objects within a structure that is adequately shielded will themselves be electrostatically shielded. If the structure is not shielded or is only partially shielded, then the isolated objects should be grounded to prevent electrostatic sparks. For further discussion of the grounding of isolated internal objects see section E 161.07.

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

E 171.06 Flame protection of vapor openings. (1) Flame protectors of any type should be such as have been proved by adequate investigation and tests to be effective for the conditions under which they are installed and used.

(2) For pipe sizes larger than 4 inches, the effectiveness of flame protection employing screens on the Davy principle is questionable. Pressure relief valves that remain closed at pressure differentials of less than 1-inch head of water, and arresters in the forms of tubes, plates, and their equivalent, have been found to be reasonably effective flame protection devices.

(3) Flame protectors should be substantially encased and capable of withstanding the effect of cleaning and of flame and pressures without material distortion or injury.

(4) Where screens are used, they should be made of corrosion-resistant wire with a mesh of about 40 per inch. They should be protected so far as possible from mechanical injury.

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

Chapter E 172

PROTECTION OF SPECIFIC CLASSES OF STRUCTURES

E 172.01 Aboveground steel tanks containing flammable liquids at atmospheric pressures. The contents of steel tanks with steel roofs of riveted, bolted, or welded construction, with or without supporting members, used for the storage of flammable liquids, are considered to be reasonably well protected against lightning if the tanks conform to the following specifications:

(1) All joints between steel plates to be riveted, bolted, or welded.

(2) All pipes entering the tank to be metallically connected to the tank at the point of entrance.

(3) All vapor or gas openings to be closed or flameproofed, as described in section E 171.06 when the stored stock is a class I or class II flammable liquid.

(4) The metal tank and roof to have adequate thickness so that holes will not be burned through by lightning strokes (3/16 inch roof sheets on tanks when built have proved adequate).

(5) The roof to be continuously welded to the shell, or bolted, or riveted and caulked, to provide a gastight seam and electrical continuity.

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

E 172.02 Additional protection. In cases where additional protection is deemed to be justified, the following procedures are recommended:

(1) The internal structural supporting members shall be bolted, riveted, welded or otherwise metallically bonded to the tank roof at not more than 10-foot intervals. (Figure E.)

(a) Any bonding conductor between the expandable roof and the rigid supporting structure should be made as short as possible for electrical reasons, but should be sufficiently long to prevent snapping off due to mechanical motion of the roof. The conductor should be flexible and of a size not less than No. 1 AWG. The metal of the conductor should be corrosive resistant for the liquids and vapors existing in the tank.

(2) Provide an overhead ground-wire system or mast protection to prevent contact of direct strokes with the roof (see section E 171.03).

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

E 172.03 Floating roof tanks. (1) GENERAL. Floating roof tanks with hanger mechanisms, located within a vapor space have occasionally ignited at the seal during lightning storms even though there was no evidence of being struck. This may result from sparks that could occur in the pinned joints of the hanger mechanisms when bound charges on the roof are suddenly released by a nearby lightning stroke and return to earth through the hanger mechanism and tank shell.

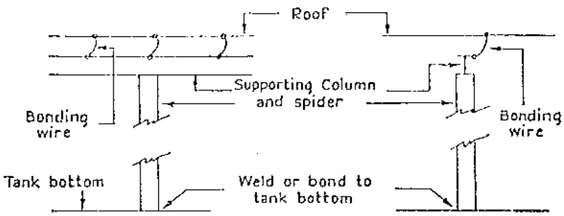


Figure E.

(2) PROTECTION. (a) Experience indicates that floating roof tanks without vapor spaces have not been subject to ignition, and protective measures need not be considered.

(b) In areas where lightning protection is deemed to be justified, floating roof tanks with hangers located within a vapor space may be protected as follows:

1. Bond the roof to the shoes of the seal at intervals not greater than 10 feet on the circumference of the tank, and

2. Break up the conductive paths through the hanger linkage by means of insulated joints or install short jumper bonds around each pinned joint of the hanger mechanism.

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

E 172.04 Steel tanks with non-metallic roofs. (1) Steel tanks with wooden or other non-metallic roofs are not considered to be self-protecting, even if the roof is essentially gastight and sheathed with thin metal and with all gas openings closed or flameproofed.

(2) Such tanks should be provided with air terminals of sufficient height and number to receive all strokes and keep them away from the roof. The air terminals should be thoroughly bonded to each other, to the metallic sheathing, if any, and to the tank. Isolated metal parts should be avoided or else bonded to the tank. In lieu of air terminals, any of the following may be used, conducting masts, suitably spaced around the tank; or overhead ground wires; or a combination of masts and overhead ground wires.

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

E 172.05 Grounding tanks. (1) Tanks should be well grounded to conduct away the current of direct strokes and avoid building up potential that may cause sparks to ground.

(2) Steel tanks that are in intimate contact with the ground, or aboveground steel tanks connected to extensive metallic piping, are sufficiently well grounded inherently.

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

E 172.06 Pressure storage of flammable liquids or gases. Aboveground storage tanks containing flammable liquids or liquefied petroleum gas under pressure do not require lightning protection.

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

E 172.07 Earthen containers. Earthen containers, lined or unlined, with or without roofs, may be protected by air terminals, separate masts, overhead ground wires, or a combination of these.

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

Part 5

ELECTRICAL AND COMMUNICATION EQUIPMENT AND WIRING INCLUDING GROUNDING

Chapter E 190

SCOPE AND APPLICATION OF RULES

E 190.01 Scope of rules. In part 5, the National Electrical Code has generally been followed. (The chapter numbers in the State Code correspond to the article numbers in the National Electrical Code). In some cases the rules differ from those in the National Electrical Code or are in addition thereto.

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

E 190.02 Application of rules. (1) GENERAL. (a) Except as otherwise specified hereafter, these rules, which have for their purpose the practical safeguarding of persons and buildings and their contents from electrical hazards arising from the use of electricity, apply to the electric and communication conductors and equipment installed in places of employment, within or on public and private buildings and other premises, including yards, carnival and parking lots, mines, trenches and tunnels, and industrial substations; also the conductors that connect the installations to a supply of electricity, and other outside conductors adjacent to the premises.

(b) These rules do not apply to installations employed by a railway, electric or communication utility in the exercise of its function as a utility where the installations are located outdoors or in quarters used exclusively for that purpose, but they do apply to wires used in such quarters to distribute a power supply for lighting, service outlets, and other utilization equipment.

(c) The rules do not apply to installations in ships, aircraft, railway cars or automotive equipment.

(d) Chapters E 190 through E 480 of part 5 of the code are of general application. Chapters E 500 through E 730 of part 5 apply to installations which involve special occupancies, special equipment or other special conditions. These chapters are supplementary to, or amendatory of, the general rules, and the latter apply under such circumstances except as so amended for the particular conditions. Chapters E 800 and E 810 govern the installation of communication systems. No other chapters of part 5 apply to such installations, except as they may be specifically referred to in chapters E 800 and E 810. Some tables and examples are included in chapter E 900.

Note 1. The provisions of this code constitute a minimum standard. Compliance therewith and proper maintenance will result in an installation reasonably free from hazard but not necessarily efficient or convenient. This code is to be regarded neither as a design specification nor an instruction manual for untrained persons. Good service and satisfactory results will often require larger sizes of wire, more branch circuits, and better types of equipment than the minimum which is here specified.

Note 2. It is recommended that architects, when drawing plans and specifications, make provision for ample raceways for wiring, spaces for equipment, and allowances for future increases in the use of electricity. In laying out an installation for constant-potential systems, provision should be made for distribution centers located in easily accessible places for convenience and safety of operation.

Note 3. It is elsewhere provided in this code that the number of wires and circuits confined in a single enclosure be varyingly restricted. It is strongly recommended that architects and others provide similar restrictions wherever practicable, to the end that the effects of breakdowns from short-circuits or grounds, even though resulting fire and similar damage is confined to wires, their insulation and enclosures, may not involve entire services to premises nor interruptions of essential and independent services.

(2) EQUIPMENT OF MORE THAN 600 VOLTS. (a) All electrical equipment and conductors of more than 600 volts shall comply with the rules applying to electrical supply stations, Part 1. (See section E 110.01.)

(b) If such equipment and conductors are installed in supply stations or other quarters accessible only to qualified persons, they need not comply with the rules of Part 5, but only with the rules of Part 1.

(c) If such equipment and conductors are not installed in supply stations or other quarters accessible only to qualified persons, they shall comply with the rules of Part 5 for equipment of over 600 volts (See chapter E 710) and also with the rules of Part 1. In addition, all current-carrying parts shall be either incased in effectively grounded metal cases or conduit, or otherwise suitably guarded to prevent access (or too close approach) to such current-carrying parts by any but qualified persons.

(3) EQUIPMENT ACCESSIBLE TO QUALIFIED PERSONS ONLY. Electrical equipment and conductors, if installed in supply stations or other quarters accessible only to qualified persons, may be installed in conformity with the rules applying to electrical supply stations (Part 1), 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 Part 5. (See section E 110.01).

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

Chapter E 195

GENERAL

E 195.01 Scope. This chapter includes provisions applicable generally in installations of electric wiring and equipment.

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

E 195.02 Approval. The conductors and equipment required or permitted by this code shall be acceptable only when approved. See definition of "approved" in chapter E 100.

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

E 195.03 Mandatory and advisory rules. Mandatory rules of this code are characterized by the use of the word "shall". Advisory rules are characterized by the use of the word "should", or are stated as recommendations of that which is advised but not required.

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

E 195.04 Examination and use of equipment. Materials, devices, fittings, apparatus and appliances designed for use under this code shall be judged chiefly with reference to the following considerations which also determine the classification by types, size, voltages, current capacities, and specific use.

(1) Except as otherwise permitted in this code, all electrical equipment shall be installed or used in the exact manner and for the exact purpose indicated by the manufacturer's instructions, markings or labels.

(2) Mechanical strength and durability, including, for parts designed to enclose and protect other equipment, the adequacy of the protection thus provided.

(3) Electrical insulation.

(4) Heating effects under normal conditions of use and also under abnormal conditions likely to arise in service.

(5) Arcing effects.

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

E 195.05 Voltages. Throughout this code the voltage considered shall be that at which the circuit operates.

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

E 195.06 Conductor gauges. Conductor sizes are given in American Wire Gauge (AWG).

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

E 195.07 Conductors. Conductors normally used to carry current shall be of copper unless otherwise provided in this code. Where conductor sizes are given in this code, they shall apply to copper conductors. Where other materials are used, the size shall be changed accordingly.

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

E 195.08 Wiring methods. (1) Only wiring methods recognized as suitable are included in this code. The recognized methods of wiring may be installed in any type of building or occupancy except as otherwise provided in this code.

(2) All conductors shall be guarded in an approved manner when brought closer to floor or platform than 8 feet, or when exposed to mechanical injury above that level.

(a) *Exception:* Trolley conductors, grounding conductors size No. 4 or larger, lightning arrester ground conductors, pendants, and portable cords are exempt from this rule.

(3) Bus-bars and other open bare ungrounded conductors which are elevated less than 8 feet above floor or platform, shall be enclosed by suitable guards.

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

E 195.09 Interrupting capacity. Devices intended to break current shall have an interrupting capacity sufficient for the voltage employed and for the current which must be interrupted.

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

E 195.10 Circuit impedance and other characteristics. The overcurrent protective devices, the total impedance and other characteristics of the circuit to be protected shall be so selected and coordinated as to permit the circuit protective devices used to clear a fault without the occurrence of extensive damage to the electrical components of the circuit. This fault may be assumed to be between 2 or more of the circuit conductors; or between any circuit conductor and the grounding conductor or enclosing metal raceway.

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

E 195.11 Deteriorating agencies. Unless approved for the purpose, no conductors or equipment shall be located in a damp or wet location; where exposed to gases, fumes, vapors, liquids or other agents having a deteriorating effect on the conductors or equipment; nor where exposed to excessive temperatures.

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

E. 195.12 Mechanical execution of work. Electrical equipment shall be installed in a neat and workmanlike manner.

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

E 195.13 Mounting of equipment. Electrical equipment shall be firmly secured to the surface on which it is mounted. Wooden plugs driven into holes in masonry, concrete, plaster or similar materials shall not be depended on for security.

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

E 195.14 Connections to terminals. (1) Connection of conductors to terminal parts shall insure a thoroughly good connection without damaging the conductors and shall be made by means of pressure connections (including set screw type), solder lugs or splices to flexible leads except that No. 8 or smaller solid conductors and No. 10 or smaller stranded conductors may be connected by means of clamps or screws with terminal plates having upturned lugs. Terminals for more than one conductor shall be of a type approved for the purpose.

(2) Because of different characteristics of copper and aluminum, devices such as pressure connectors and soldering lugs shall be suitable for the material of the conductor and shall be properly installed and used. Materials such as solder, fluxes, inhibitors, and compounds, where employed, shall be suitable for the use and shall be of a type which will not adversely affect the conductors, installation or equipment.

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

E 195.15 Splices. Conductors shall be spliced or joined with splicing devices approved for the use or by brazing, welding or soldering with a fusible metal or alloy. Soldered splices shall first be so spliced or joined as to be mechanically and electrically secure without solder and then soldered. All splices and joints and the free ends of conductors shall be covered with an insulation equivalent to that of the conductors.

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

E 195.16 Working space about electrical equipment. Sufficient access and working space shall be provided and maintained about all electrical equipment to permit ready and safe operation and maintenance of such equipment.

(1) HORIZONTAL DIMENSIONS. Except as elsewhere required or permitted in this code, the horizontal dimension of the working space in the direction of access to live parts, operating at not more than 600 volts, which are likely to require examination, adjustment, servicing or maintenance while alive, shall not be less than indicated in the following table. Distances are to be measured from the live parts if such are exposed or from the enclosure front or opening when such are enclosed.

Voltage to Ground	Minimum Clear Distance		
Condition	1	2	3
0-150	2½ ft.	2½ ft.	3 ft.
151-600	2½ ft.	3½ ft.	4 ft.

Where the "Conditions" are as follows:

1. Exposed live part on one side and no live or grounded part on the other side of the working space or exposed live parts on both sides effectively guarded by suitable wood or other insulating materials. Insulated wire or insulated bus bars operating at not more than 300 volts shall not be considered live parts.

2. Exposed live parts on one side and grounded parts on the other side. Concrete, brick or tile walls shall be considered as grounded.

3. Exposed live parts on both sides of the work space (not guarded as provided in Condition 1) with the operator between.

(a) *Exception No. 1.* Working space is not required in back of assemblies such as dead-front switchboards or control centers when there are no renewable or adjustable parts such as fuses or switches on the back and when all connections are accessible from other locations than the back.

(b) *Exception No. 2.* Smaller spaces may be permitted by the authority having jurisdiction where it is judged that the particular arrangement of the installation will provide adequate accessibility.

(2) CLEAR SPACES. Working space required by this section shall not be used as a passageway or for storage. When normally enclosed live parts are exposed for inspection or servicing, the working space, if adjacent to a passageway or general open space where other work is carried on shall be suitably guarded.

(3) ACCESS AND ENTRANCE TO WORKING SPACE. At least one entrance of sufficient area shall be provided to give access to the working space about electrical equipment.

(4) WORKING SPACE. In all cases where there are live parts normally exposed on the front of switchboards or control centers, the working space in front of such boards or panels shall be not less than 3 feet.

(5) ILLUMINATION. Adequate illumination shall be provided for all working spaces about switchboards and control centers.

(6) HEADROOM. The minimum headroom of working spaces about switchboards or control centers where there are live parts exposed at any time, shall be 6¼ feet.

Note: For higher voltages, see chapter E 710.

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

E 195.17 Guarding of live parts. (Not more than 600 Volts). (1) Except as elsewhere required or permitted by this code, live parts of electrical equipment operating at 50 volts or more shall be guarded against accidental contact by approved cabinets or other forms of approved enclosures, or any of the following means:

(a) By location in a room, vault, or similar enclosure which is accessible only to qualified persons.

(b) By suitable permanent, substantial partitions or screens so arranged that only qualified persons will have access to the space within reach of the live parts. Any openings in such partitions or screens shall be so sized and located that persons are not likely to come into accidental contact with the live parts or to bring conducting objects into contact with them.

(c) By a guard rail, provided the live parts operate at 600 volts or less and provided the location is such as to make contact with live parts unlikely.

(d) By location on a suitable balcony, gallery, or platform so elevated and arranged as to exclude unqualified persons.

(e) By elevation at least 8 feet above the floor or other working surface.

(2) In locations where electrical equipment would be exposed to physical damage, enclosures or guards shall be so arranged and of such strength as to prevent such damage.

(3) Entrances to rooms and other guarded locations containing exposed live parts shall be marked with conspicuous warning signs forbidding unqualified persons to enter.

Note: For motors see Wis. Adm. Code sections E 430.132 and E 430.133. For additional requirements at voltages over 600 see chapter E 710.

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

E 195.18 Arcing parts. Parts of electrical equipment which in ordinary operation produce arcs, sparks, flames or molten metal, shall be enclosed unless separated and isolated from all combustible material. For hazardous locations see Wis. Adm. Code chapters E 500-517, inclusive. For motors see section E 430.014.

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

E 195.19 Light and power from railway conductors. Circuits for lighting and power shall not be connected to any system containing trolley wires with a ground return, except in electric railway cars, car houses, power houses, or passenger and freight stations operated in connection with electric railways.

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

E 195.20 Insulation resistance. All wiring shall be so installed that when completed the system will be free from short-circuits and from grounds other than as provided in chapter E 250. In order that a reasonable factor of safety may be provided, the folowing table of insulation resistances is suggested as a guide where the insulation is subjected to test:

(1) For circuits of No. 14 or No. 12 wire, 1,000,000 ohms. For circuits of No. 10 or larger conductor, a resistance based upon the allowable ampacities of conductors as fixed in tables E 310.12 through E 310.15 as follows:

25 to 50 amperes, inclusive	250,000 ohms
51 to 100 amperes, inclusive	100,000 ohms
101 to 200 amperes, inclusive	50,000 ohms
201 to 400 amperes, inclusive	25,000 ohms
401 to 800 amperes, inclusive	12,000 ohms
Over 800 amperes	5,000 ohms

(2) The above values are to be determined with all switchboards, panelboards, fuseholders, switches, receptacles and overcurrent devices in place.

(3) Where climatic or other conditions are such that the wiring or equipment is exposed to excessive humidity, it may be necessary to modify the foregoing provisions.

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

E 195.21 Marking. The maker's name, trademark, or other identification shall be placed on all electrical equipment. Other markings shall be provided giving voltage, current, wattage, or other ratings as are prescribed elsewhere in this code.

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

E 195.22 Identification. Each disconnecting means required by this code for motors and appliances, and each service, feeder or branch circuit at the point where it originates, shall be legibly marked to indicate its purpose. The marking shall be of sufficient durability to withstand the environment involved.

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

E 195.23 Readily accessible. Disconnect switches and circuit breakers shall be readily accessible and have the center of the operating means in its highest position not more than 6½ feet above the floor or operating level, and it is recommended that it be at least 3 feet above this level. Fuses shall be readily accessible with the location of their midpoint governed by the same dimensions as for switches and circuit breakers. The operating means of disconnect switches and circuit breakers may function through rods or cables when the switches or breakers are located outside the above range. This requirement does not cover installations specifically exempted elsewhere in this code.

(1) EXCEPTION NO. 1. This section does not apply to switchboards, unit substations, motor control centers, or equipment exceeding 600 volts.

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

WIRING DESIGN AND PROTECTION

Chapter E 200

USE AND IDENTIFICATION OF GROUNDED CONDUCTORS

E 200.01 Scope. This chapter provides requirements for the use and identification of a grounded conductor in interior wiring systems. (See definitions of "grounded conductor" and "grounding conductor" in chapter E 100.)

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

E 200.02 General. All interior wiring systems shall have a grounded conductor which is continuously identified throughout the system except as follows:

(1) EXCEPTION NO. 1: A grounded conductor is not required in certain circuits or systems as provided in sections E 200.05, E 250.003, E 250.005, E 250.006, E 250.007, E 250.008, E 503.13, E 517.06, and E 680.04.

(2) EXCEPTION NO. 2: Continuous identification throughout a length of a conductor between terminals is not required for certain conductors under sections E 200.06 (1) and (2).

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

E 200.03 Connection to grounded system. No interior wiring shall be electrically connected to a supply system unless the latter contains, for any grounded conductor of the interior system, a corresponding conductor which is grounded.

Note: Electrically connected implies connection capable of carrying current as distinguished from connection through electromagnetic induction.

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

E 200.04 Circuits derived from auto-transformers. Branch circuits as described in chapter E 210 shall not be supplied through auto-transformers (transformers in which a part of the winding is common to both primary and secondary circuits) unless the system supplied has an identified grounded conductor which is solidly connected to a similar identified grounded conductor of the system supplying the auto-transformer.

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

E 200.05 Unidentified circuits. (1) Two-wire branch circuits and AC circuits of 2 or more conductors may be tapped from the ungrounded conductors of circuits having identified grounded neutrals. Switching devices in each tapped circuit shall have a pole in each ungrounded conductor. These poles shall manually switch together where the switching devices serve as the disconnecting means required by section E 422.23.

(a) *Exception:* For motor controllers see section E 430.084, and for heating equipment see section E 422.46.

(2) Polyphase circuits need not have one conductor grounded and identified, except as required by section E 250.005, but where one conductor is grounded it shall be identified.

(3) Other unidentified ungrounded systems or circuits may be used only by special permission.

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

E 200.06 Means of identification of grounded conductors. Identification for grounded conductors shall be as follows:

(1) Insulated conductors of No. 6 or smaller, except conductors of type M1 cable, shall have an outer identification of white or natural gray color as specified in section E 310.02 (7). The grounded conductors of type M1 cable shall be identified by distinctive marking at the terminals during the process of installation.

(2) Insulated conductors larger than No. 6 shall have an outer identification of white or natural gray color or shall be identified by distinctive white marking at terminals during process of installation.

(3) Where, on a 4-wire delta-connected secondary, the midpoint of one phase is grounded to supply lighting and similar loads, that phase conductor having the higher voltage to ground shall be indicated by tagging or other effective means at any point where a connection is to be made if the neutral conductor is present.

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

E 200.07 Identified conductor in grounded circuits only. Conductors having white or natural gray covering shall not be used other than as conductors for which identification is required by section E 200.02, except under the following conditions, and then only where they are, in other respects, suitable for use as ungrounded conductors in the circuit:

(1) EXCEPTION NO. 1: Identified conductors, rendered permanently unidentified by painting or other effective means at each outlet where the conductors are visible and accessible, may be used as unidentified conductors.

Note: The foregoing permits the use of 2-wire cable having one black and one white conductor on 2-wire circuits tapped from the outside legs of a 3-wire system or any 2 conductors of a multi-wire system where the identified conductor of the 2-wire cable is rendered permanently unidentified at terminals.

(2) EXCEPTION NO. 2: Cable containing an identified conductor may be used for single-pole, 3-way or 4-way switch loops where the connections are so made that the unidentified conductor is the return conductor from the switch to the outlet.

Note: This exception makes it unnecessary to paint the terminal of the identified conductor at the switch outlet.

(3) EXCEPTION NO. 3: A flexible cord, for connecting a portable appliance, having one conductor identified as required by section E 400.13 may be used even though there is no grounded conductor in the circuit supplying the outlet to which it is connected.

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

E 200.08 Connections to screw-shells. An identified conductor, where run to a screw-shell lampholder, shall be connected to the screw-shell.

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

E 200.09 Means of identification of terminals. The identification of terminals to which a grounded conductor is to be connected shall be by means of a metallic plated coating substantially white in color, such as nickel or zinc, or the terminals may be of material substantially white in color. The other terminals shall be of a readily distinguishable different color.

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

E 200.10 Identification of terminals. (1) DEVICE TERMINALS. All devices provided with terminals for the attachment of conductors and intended for connection to more than one side of the circuit shall have terminals properly marked for identification except as follows:

(a) *Exception No. 1:* Marking may be omitted where the electrical connection of a terminal intended to be connected to the grounded conductor is clearly evident.

(b) *Exception No. 2:* Single-pole devices. Devices to the terminals of which only one side of the line is connected need not have terminals marked for identification.

(c) *Exception No. 3:* Panelboards and devices. The terminals of lighting panelboards and of devices having a normal current rating of over 30 amperes need not be marked for identification, except as required in subsection (2) for polarized receptacles for attachment plugs and polarized attachment plugs.

(2) PLUGS AND RECEPTACLES. Two-wire polarized receptacles for attachment plugs and polarized attachment plugs shall have the terminal intended for connection to the grounded conductor marked for identification.

(a) *Exception No. 1:* Two-wire attachment plugs, unless of the polarity type, need not have their terminals marked for identification.

(b) *Exception No. 2:* Three-wire and four-wire receptacles and attachment plugs. Three-wire and four-wire receptacles and attachment plugs, other than those of the grounding type which are rated within the limits outlined and required under section E 210.21 (2), but on which one terminal may be used for the connection of either a grounding conductor or a grounded circuit conductor, shall have such a terminal marked to show other than a white or green finish.

(3) SCREW-SHELLS. In the case of devices with screw-shells, the identified terminal shall be the one connected to the screw-shell. This does not apply to screw-shells which serve as fuseholders.

(4) SCREW-SHELL DEVICES WITH LEADS. In the case of screw-shell devices with attached leads, the conductor attached to the screw-shell shall have white or natural gray finish. The outer finish of the other

conductor shall be of a solid color that will not be confused with the white or natural-gray finish which is to identify the grounded conductor.

(5) FIXED APPLIANCES. The terminals of fixed appliances need not be marked to indicate the proper connection to the grounded conductor unless a single-pole switch forms an integral part; then the terminal connected to the switch shall be the unidentified terminal.

(6) PORTABLE APPLIANCES. The terminals of portable appliances need not be marked for identification.

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

Chapter E 210

BRANCH CIRCUITS

E 210.01. Scope. The provisions of this chapter shall apply to branch circuits supplying lighting or appliance loads or combinations of such loads. Where motors, or motor-operated appliances, are connected to any circuit supplying lighting or other appliance loads, the provisions of both this chapter and chapter E 430 shall apply. Chapter E 430 shall apply where branch circuit supplies only motor loads.

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

E 210.02. Specific purpose branch circuit. The provisions applying to branch circuits referred to in the following table are exceptions to the provisions of this chapter or are supplementary thereto, and shall apply to branch circuits supplying the loads referred to therein:

Busways	Section E 364.08
Cranes and Hoists	Section E 610.42
Infra-red Industrial Heating Equipment	Section E 422.11
Inductive and Dielectric Heat Generating Equipment	Chapter E 665
Instruments	Section E 384.22
Motion Picture Studios and Similar Locations	Chapter E 530
Motors and Motor Controllers	Chapter E 430
Organs	Section E 650.06
Remote-Control, Low-Energy Power, Low-Voltage Power and Signal Circuits	Chapter E 725
Signs and Outline Lighting	Section E 600.06
Sound Recording and Reproduction	Section E 640.06
Space Heating; Panel and Embedded Types	Chapter E 422
Systems over 600 Volts	Chapter E 710
Systems under 50 volts	Chapter E 720
Theatres and Assembly Halls	Sections E 520.41, E 520.52 and E 520.62
Welders	Chapter E 630
X-ray Equipment	Section E 660.03

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

E 210.03 Classifications. Branch circuits recognized by this chapter shall be classified in accordance with the maximum permitted rating or setting of the overcurrent device, and the classification for other than individual branch circuits shall be 15, 20, 30, 40 and 50 amperes. When conductors of higher capacity are used for any reason, the rating or setting of the specified overcurrent device shall determine the circuit classification.

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

A. GENERAL PROVISIONS

E 210.04 Multi-wire branch circuits. Branch circuits recognized by this chapter may be installed as multi-wire circuits. (See section E 100.02 for definition).

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

E 210.05 Color code. (1) Where installed in raceways, as aluminum sheathed cable, as open work, or as concealed knob-and-tube work, the conductors of multi-wire branch circuits and two-wire branch circuits connected to the same system shall conform to the following color code. Three-wire circuits—one black, one white, one red; four-wire circuits—one black, one white, one red, one blue; five-wire circuits—one black, one white, one red, one blue, one yellow. Where more than one multi-wire branch circuit is carried through a single raceway the ungrounded conductors of the additional circuit may be of colors other than those specified. All circuit conductors of the same color shall be connected to the same ungrounded feeder conductor throughout the installation.

(a) *Exception:* Color coding is not required for electric range or clothes dryer circuits.

(2) Any conductor intended solely for grounding purposes shall be identified by a continuous green color or a continuous green color with a yellow stripe unless it be bare. Except for public highway traffic control, communications, metering, railway and railroad signal installations, branch circuit conductors and equipment lead wires to which branch circuit conductors attach having a continuous green color or a continuous green color with a yellow stripe shall not be used for other than grounding purposes.

Note 1: The above is not intended to prohibit the use of a conductor having a continuous green color or a continuous green color with a yellow stripe, insulation for internal wiring of equipment, except where such wiring serves as the lead wires to which the branch circuit conductors attach.

Note 2: See section E 200.07 for use of white or natural gray for grounded or neutral conductors.

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

E 210.06 Voltage. (1) VOLTAGE. The voltage to ground on branch circuits supplying lampholders, fixtures, or standard receptacles of 15-ampere or less rating shall not exceed 150 volts, except as follows:

(a) *Exception No. 1.* In industrial establishments or in stores where the conditions of maintenance and supervision assure that only competent individuals will service the lighting fixtures the voltage of branch circuits which supply only lighting fixtures that are equipped with mogul-base screw-shell lampholders or with lampholders of other types approved for the application, mounted not less than 8 feet from the floor, which do not have switch control as an integral part of the fixture shall not exceed 300 volts to ground;

(b) *Exception No. 2.* In industrial establishments, office buildings, schools, stores, and public and commercial areas of other buildings, such as hotels or transportation terminals, the voltage of branch circuits which supply only the ballasts for electric discharge lamps mounted in permanently installed fixtures, by other than screw-shell type lampholders, which do not have manual switch control as an integral part of the fixture shall not exceed 300 volts to ground. Where screw-shell type lampholders are used for electric discharge lamps the fixtures shall be installed not less than 8 feet from the floor;

(c) *Exception No. 3.* For infra-red industrial heating appliances as described in section E 422.11;

(d) *Exception No. 4.* In railway properties as described in section E 195.19.

(e) *Exception No. 5.* The branch circuits supplying the ballasts for electric discharge lamps mounted in permanently installed fixtures on poles for the illumination of areas such as highways, bridges, athletic fields, parking lots, at a height not less than 22 feet, or on other structures such as tunnels at a height not less than 18 feet, shall not exceed 500 volts between conductors when installed as provided in section E 730.07 (1).

(2) VOLTAGE BETWEEN CONDUCTORS—DWELLINGS. In dwelling occupancies, the voltage between conductors supplying lampholders of the screw-shell type, receptacles, or appliances, shall not exceed 150 volts, except as follows: Exception: The voltage between conductors may exceed 150 volts when supplying only:

(a) Permanently connected appliances,

(b) Portable appliances of more than 1,380 watts,

(c) Portable motor-operated appliances of ¼ horsepower or greater rating.

(3) VOLTAGE DROP. The size of the conductors for branch circuits as defined in chapter E 100 should be such that the voltage drop would not exceed 3% to the farthest outlet for power, heating, lighting, or combinations thereof. Providing further that the maximum total voltage drop for feeders and branch circuits should not exceed 5% over all.

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

E 210.07 Grounding receptacles. Receptacles and cord connectors equipped with grounding contacts shall have those contacts effectively grounded. The branch circuit or branch circuit raceway shall include or provide a grounding conductor to which the grounding contacts of the receptacle or cord connector shall be connected. The metal armor of type AC metal-clad cable, the sheath of aluminum sheathed cable, or a metallic raceway is acceptable as a grounding conductor. See section E 210.21(2) and sections E 250.045 and E 250.059.

(1) EXCEPTION: For extensions only in existing installations which do not have a grounding conductor in the branch circuit, the grounding conductor of a grounding type receptacle outlet may be grounded to a grounded cold water pipe near the equipment.

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

E 210.08 Heavy-duty lampholders. Heavy-duty lampholders referred to in this chapter shall include lampholders rated at not less than 750 watts.

(1) EXCEPTION: Admedium lampholders rated at 660 watts shall be considered to be heavy duty type.

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

B. SPECIFIC REQUIREMENTS

E 210.19 Conductors. Circuit conductors shall conform to the following:

(1) AMPACITY. Shall have an ampacity of not less than the rating of the branch circuit and not less than the maximum load to be served.

(2) Minimum size shall not be smaller than No. 8 for ranges of 8¾ kw or more rating, nor smaller than No. 14 for other loads.

(3) EXCEPTIONS: (a) *Exception No. 1.* Range loads. See note 5 of table E 220.05. Where the maximum demand of a range of 8¾ kw or more rating is computed according to column A of table E 220.05, the neutral conductor of a 3-wire branch circuit supplying a household electric range, a wall-mounted oven or a counter-mounted cooking unit may be smaller than the ungrounded conductors but shall have an ampacity at least 70% of the ampacity of the ungrounded conductors and shall not be smaller than No. 10.

Note: Cable assemblies with the neutral conductor smaller than the ungrounded conductor shall be so marked.

(b) *Exception No. 2. Tap conductors.* Tap conductors may be of less capacity than the branch circuit rating provided no tap conductor is of less capacity than the load to be served and provided the rating is not less than 20 amperes for 50 ampere circuits or 15 amperes for circuits rated less than 50 amperes and only where these tap conductors supply either:

1. Individual lampholders or fixtures with taps extending not longer than 18 inches beyond any portion of the lampholder or fixture, except as required in section E 410.65 (2) (b); or,
2. Individual outlets with taps not over 18 inches long; or,
3. Infra-red lamp industrial heating appliances.
4. Nonheating leads of snow and ice melting cables and mats.

(c) *Exception No. 3. Fixture wires and cords.* Fixture wires and cords may be of smaller size, but not less than the size specified in exception No. 3 of section E 240.05. See tables section E 400.09 (2) and section E 402.04.

(d) *Exception No. 4. Outlet devices.* Outlet devices may have less carrying capacity than the branch circuit rating, but not less than the types and ratings specified in sections E 210.21 (1)–(3).

(e) *Exception No. 5.* Where tap conductors supply electric ranges, wall-mounted electric ovens and counter-mounted electric cooking units from 50 ampere branch circuits they shall be of suitable capacity for the load to be served, not less than 20 amperes in rating and no longer than necessary for servicing the appliance.

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

E 210.20 Overcurrent protection. The rating or setting of overcurrent devices shall conform to the following:

(1) RATING. Shall not be in excess of the value specified in section E 240.05.

(a) *Exception: Tap conductors and fixture wires.* Tap conductors, fixture wires and cords as permitted in section E 210.19 (3) may be considered as protected by the circuit overcurrent device.

(2) SINGLE APPLIANCE. Shall not exceed 150% of the rating of the appliance, where the circuit supplies only a single appliance of 10-ampere or more rating.

(3) CONTINUOUS LOADS. Where loads other than motor loads will constitute continuous loads see section E 210.23 (2) and sections E 220.02 and E 240.02.

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

E 210.21 Outlet devices. Outlet devices shall have a rating not less than the load to be served and shall conform to the following:

(1) LAMPHOLDERS. Lampholders when connected to circuits having a rating of over 20 amperes shall be of the heavy duty type.

(2) RECEPTACLES. (a) Receptacles installed on 15 ampere and 20 ampere branch-circuits shall be of the grounding type and they shall be installed in accordance with section E 210.07. Grounding type receptacles which are of a type that reject nongrounding type attachment plugs or which are of the locking type may be used for specific purposes or in special locations.

(b) When grounding type receptacles are used as replacements for existing nongrounding types a grounding conductor installed in accordance with section E 250.057 shall be provided. If it is impractical to reach a source of ground a nongrounding type receptacle shall be used. The installation of grounding type outlets shall not be used as a requirement that all portable equipment be of the grounded type. See chapter E 250 for requirements for the grounding of portables.

(c) Receptacles required in Wis. Adm. Code section E 517.03 (4) are considered as meeting the requirements of this section.

(d) When connected to circuits having 2 or more outlets, receptacles shall conform to the following:

15-amp. circuits	Not over 15-amp. rating
20-amp. circuits	15 or 20-amp. rating
30-amp. circuits	30-amp. rating
40-amp. circuits	40 or 50-amp. rating
50-amp. circuits	50-amp. rating

(e) Receptacles connected to circuits having different voltages, frequencies or types of current (AC or DC) on the same premises shall be of such design that attachment plugs used on such circuits are not interchangeable.

(f) Grounding receptacles rated at 15 or 20 amperes and installed in circuits of less than 150 volts between conductors shall be approved for use only on potentials less than 150 volts. Grounding receptacles rated at 15 amperes and installed in circuits of 151 to 300 volts between conductors shall be approved for use only on potentials not less than 151 volts.

(g) Receptacles rated at 15 amperes connected to 15 or 20 ampere branch circuits serving 2 or more outlets shall not supply a total load in excess of 12 amperes for portable appliances. Receptacles rated at 20 amperes connected to 20 ampere branch circuits serving 2 or more outlets shall not supply a total load in excess of 16 amperes for portable appliances.

(3) CAPACITY OF RANGE RECEPTACLES. Capacity of range receptacles may be based on single range loads as computed from table E 220.05.

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

E 210.22 Receptacle outlets required. Receptacle outlets shall be installed as follows:

(1) GENERAL. Where portable cords are used, except where the attachment of cords by other means is specifically permitted.

Note: A cord connector that is supported by a permanently connected cord pendant is considered a receptacle outlet.

(2) DWELLING TYPE OCCUPANCIES. In every kitchen, dining room, breakfast room, living room, parlor, library, den, sun room, recreation room, family room and bedroom, receptacle outlets shall be installed so that no point along the floor line in any usable wall space is more than 6 feet, measured horizontally, from an outlet in that space including any wall space 3 feet wide or greater and the wall space occupied by sliding panels in exterior walls. The receptacle outlets shall, insofar as practicable, be spaced equal distances apart. Receptacle outlets on the floor shall not be counted as part of the required number of receptacles unless located within one foot of the wall. Receptacle outlets in fixtures and appliances shall not be counted as part of the required number of receptacles. At least one outlet shall be installed for the laundry.

(a) Outlets in other sections of the dwelling for special appliances such as laundry equipment shall be placed within 6 feet of the intended location of the appliance.

(3) OTHER OCCUPANCIES. Guest or sleeping rooms in hotels, motels, dormitories, rooming houses, homes for the aged and similar occupancies shall have receptacles installed in accordance with section E 210.22 (2).

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

E 210.23 Maximum load. The maximum load shall conform to the following:

(1) APPLIANCES CONSISTING OF MOTORS AND OTHER LOADS. Where a circuit supplies only motor operated appliance loads, chapter E 430 shall apply. For other than a portable appliance, the branch circuit size shall be calculated on the basis of 125% of motor load where the motor is larger than ⅛ hp plus the sum of the other loads.

(2) OTHER LOADS. The total load shall not exceed the branch circuit rating, and shall not exceed 80% of the rating when load will constitute a continuous load such as store lighting and similar loads. In computing the load of lighting units which employ ballasts, transformers or auto-transformers, the load shall be based on the total of the ampere rating of such units and not on the wattage of the lamps.

(a) *Exception No. 1.* When the assembly including the overcurrent device protecting the branch circuit is approved for continuous operation at 100 per cent of its rating, the total load may equal the branch circuit rating.

(b) *Exception No. 2.* Where branch circuits are derated in accordance with note 8 of tables E 310.12 through E 310.15 the derating factor for continuous loading shall not apply.

(c) *Exception No. 3.* Range loads. See note 5 of table E 220.5.

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

E 210.24 Permissible loads. Individual branch circuits may supply any loads. Branch circuits having 2 or more outlets may supply only loads as follows:

(1) 15 AND 20-AMPERE BRANCH CIRCUITS. Lighting units and/or appliances. The rating of any one portable appliance shall not exceed 80% of the branch circuit rating. The total rating of fixed appliances shall not exceed 50% of the branch circuit rating when lighting units or portable appliances are also supplied.

(2) 30-AMPERE BRANCH CIRCUITS. Fixed lighting units with heavy duty lampholders in other than dwelling occupancies; or appliances in any occupancy. The rating of any one portable appliance shall not exceed 24 amperes.

(3) 40-AMPERE BRANCH CIRCUITS. Fixed or stationary cooking appliances or fixed water heaters; or clothes dryers; in other than dwelling occupancies fixed lighting units with heavy-duty lampholders or infra-red heating units.

(4) 50-AMPERE BRANCH CIRCUITS. Fixed lighting units with heavy duty lampholders in other than dwelling occupancies; or fixed cooking appliances; or infra-red lamp industrial heating appliances.

Note 1: The term "fixed" as used in this section recognizes cord connections where otherwise permitted.

Note 2: Fixed outdoor electric snow melting and deicing installations may be supplied by any of the branch circuits described herein provided the circuit supplies no other load.

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

E 210.25 Table of requirements. The requirements for circuits having two or more outlets (other than the receptacle circuits of section E 220.03 (2)) as specifically provided for above are summarized in table E 210.25.

TABLE E 210.25

BRANCH CIRCUIT REQUIREMENTS

(Type FEP, FEPB, R, RW, RU, RUW, RH-RW, SA, T, TW, RH, RUH, RHW, RHH, THHN, THW, and THWN conductors in raceway or cable.)

CIRCUIT RATING	15 Amp.	20 Amp.	30 Amp.	40 Amp.	50 Amp.
CONDUCTORS: (Min. Size)					
Circuit Wires*	14	12	10	8	6
Taps	14	14	14	12	12
Fixture Wires and Cords	Refer to Section E 240.05, Exception No. 3				
OVERCURRENT PROTECTION	15 Amp.	20 Amp.	30 Amp.	40 Amp.	50 Amp.
OUTLET DEVICES: Lampholders permitted	Any Type	Any Type	Heavy Duty	Heavy Duty	Heavy Duty
Receptacle Rating	15 Max. Amp.	15 or 20 Amp.	30 Amp.	40 & 50 Amp.	50 Amp.
MAXIMUM LOAD	15 Amp.	20 Amp.	30 Amp.	40 Amp.	50 Amp.
PERMISSIBLE LOAD	Refer to Subsection E 210.24 (1)	Refer to Subsection E 210.24 (1)	Refer to Subsection E 210.24 (2)	Refer to Subsection E 210.24 (3)	Refer to Subsection E 210.24 (4)

*These ampacities are for copper conductors where derating is not required. See tables E 310.12 through E 310.15.

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

Chapter E 215

FEEDERS

E 215.01 Scope. This chapter deals with installation requirements for, and, the size of conductors in the feeders needed to supply power to branch circuits and, the loads as calculated under chapter E 220.

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

E 215.02 Conductor size. (1) Feeder conductors shall have a current rating not smaller than the feeder load as determined by section E 220.04. A 2-wire feeder supplying 2 or more 2-wire branch circuits or a 3-wire feeder supplying more than two 2-wire branch circuits, or 2 or more 3-wire branch circuits, shall not be smaller than 30 amperes. Where a feeder carries the total current supplied by the service-entrance conductors, such feeder, for services of 55 amperes and smaller, shall be of the same size as the service-entrance conductors.

Note: See section E 230.041 (1) for minimum size of feeders in multi-occupancy residential buildings.

(2) Where at any time it is found that feeder conductors are, or will be overloaded, the feeder conductors shall be increased in capacity to accommodate the actual load served.

Note: See examples Nos. 1 to 7 of chapter E 900.

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

E 215.03 Voltage drop. The size of the conductors for feeders should be such that the voltage drop for the load as computed by section E 220.04 would not be more than 3% for power, heating or lighting loads or combinations thereof. Providing further that the maximum total voltage drop for conductors for feeders and branch circuits should not exceed 5% overall.

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

E 215.04 Overcurrent protection. Feeders shall be protected against overcurrent in accordance with the provisions of chapter E 240.

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

E 215.05 Common neutral feeder. A common neutral feeder may be employed for 2 or 3 sets of 3-wire feeders, or 2 sets of 4-wire or 5-wire feeders. When in metal enclosures, all conductors of feeder circuits employing a common neutral feeder shall be contained within the same enclosure as provided in section E 300.20.

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

E 215.06 Diagram of feeders. If required by the administrative authority, a diagram showing feeder details shall be supplied previous to installation. This diagram should show: Area in square feet; load (before applying demand-factors); demand-factors selected; computed load (after applying demand-factors); and the size of conductors.

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

E 215.07 Installation requirements. Where a feeder supplies branch circuits in which grounding conductors are required, the feeder shall include or provide a grounding means to which the grounding conductor of the branch circuit shall be connected.

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

Chapter E 220

BRANCH CIRCUIT AND FEEDER CALCULATIONS

E 220.01 Scope. This chapter provides the basis for calculating the expected branch circuit and feeder loads and for determining the number of branch circuits required.

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

E 220.02 Calculation of branch circuit loads. (1) COMPUTATION. The load for branch circuits shall be computed in accordance with the provisions of this rule.

(2) WHEN MAXIMUM LOAD OF BRANCH CIRCUIT CONTINUES FOR LONG PERIOD OF TIME. Where in normal operation the maximum load will constitute a continuous load, such as store lighting and similar loads, the minimum unit loads specified in this section shall be increased by 25%.

(a) *Exception No. 1.* Where branch circuits are derated in accordance with note 8 of tables E 310.12 through E 310.15, the unit loads are not required to be increased by 25%.

(b) *Exception No. 2.* When the assembly including the overcurrent devices protecting the branch circuits and feeders are approved for operation at 100% of their rating the minimum unit loads need not be increased over those specified.

(3) GENERAL LIGHTING LOAD. (a) *In listed occupancies.* In the occupancies listed in table E 220.02(3)(a)2, a load of not less than the unit load specified shall be included for each square foot of floor area.

1. In determining the load on the "watts per square foot" basis, the floor area shall be computed from the outside dimensions of the building, apartment or area involved, and the number of floors; not including open porches, garages in connection with dwelling occupancies, nor unfinished spaces and unused spaces in dwellings unless adaptable for future use.

Note 1. The unit values herein are based on minimum load conditions and 100% power factor, and may not provide sufficient capacity for the installation contemplated.

Note 2. In view of the trend toward higher intensity lighting systems and increased loads due to more general use of fixed and portable appliances, each installation should be considered as to the load likely to be imposed and the capacity increased to insure safe operation.

Note 3. Where electric discharge lighting systems are to be installed, high power-factor type should be used or the conductor capacity may need to be increased.

(b) *In other occupancies.* In other occupancies, a load of not less than the unit load specified in subsection (4) shall be included for each outlet.

(4) OTHER LOADS. For lighting other than general illumination and for appliances other than motors, a load of not less than the unit load specified below shall be included for each outlet.

*Outlets supplying specific appliances and other loads	Amp. rating of appliance
Outlets supplying heavy-duty lampholders	5 amperes
‡Other outlets	1½ amperes

* For motors, see sections E 430.022 and E 430.024.

‡ This provision shall not be applicable to receptacle outlets connected to the circuit specified in section E 220.03 (2) nor to receptacle outlets provided for the connection of stationary equipment as provided for in section E 400.03.

TABLE E 220.02 (3) (a) 2

GENERAL LIGHTING LOADS BY OCCUPANCIES

Type of Occupancy	Unit Load per Sq. Ft. (Watts)
Armories and Auditoriums	1
Banks	2
Barber Shops and Beauty Parlors	3
Churches	1
Clubs	2
Court Rooms	2
*Dwellings (other than hotels)	3
Garages—Commercial (storage)	½
Hospitals	2
*Hotels and Motels, including apartment houses without provisions for cooking by tenants	2
Industrial, Commercial (loft) Buildings	2
Lodge Rooms	1½
Office Buildings	5
Restaurants	2
Schools	3
Stores	3
Warehouses, Storage	¼
In any of the above occupancies except single-family dwellings and individual apartments of multi-family dwellings:	
Assembly Halls and Auditoriums	1
Halls, Corridors, Closets	½
Storage Spaces	¼

*All receptacle outlets of 15-ampere or less rating in single-family and multi-family dwellings and in guest rooms of hotels and motels except those connected to the receptacle circuits specified in section E 220.02 (2) may be considered as outlets for general illumination, and no additional load need be included for such outlets. The provisions of section E 220.02 (4) shall apply to all other receptacle outlets.

(5) EXCEPTIONS. The minimum load for outlets specified in subsection (4) shall be modified as follows:

(a) *Exception No. 1. Ranges.* For household electric ranges, the branch circuit load may be computed in accordance with table E 220.05.

(b) *Exception No. 2. Show-window lighting.* For show-window lighting a load of not less than 200 watts for each linear foot of show-window, measured horizontally along its base, may be allowed in lieu of the specified load per outlet.

(c) *Exception No. 3. Multi-outlet assemblies.* Where fixed multi-outlet assemblies are employed, each 5 feet or fraction thereof of each separate and continuous length shall be considered as one outlet of not less than 1½ ampere capacity; except in locations where a number of appliances are likely to be used simultaneously, when each one foot or fraction thereof shall be considered as an outlet of not less than 1½ amperes. The requirements of this rule are not applicable to dwellings or the guest rooms of hotels.

(d) *Exception No. 4. Telephone exchanges.* Shall be waived for manual switchboards and switching frames in telephone exchanges.

(6) EXISTING INSTALLATIONS. Additions to existing installations shall conform to the following:

(a) *Dwelling occupancies.* New circuits or extensions to existing circuits may be determined in accordance with subsection (3) or (4); except that portions of existing structures not previously wired, or additions to the building structure, either of which exceeds 500 square feet in area, shall be determined in accordance with subsection (3).

(b) *Other than dwelling occupancies.* When adding new circuits or extensions to existing circuits in other than dwelling occupancies, the provisions of subsection (3) or (4) shall apply.

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

E 220.03 Branch circuits required. Branch circuits shall be installed as follows:

(1) LIGHTING AND APPLIANCE CIRCUITS. (a) For lighting, and for appliances, including motor-operated appliances, not specifically provided for in section E 220.03 (2), branch circuits shall be provided for a computed load not less than that determined by section E 220.02.

(b) The number of circuits shall be not less than that determined from the total computed load and the capacity of circuits to be used. In every case the number shall be sufficient for the actual load to be served, and the branch circuit loads shall not exceed the maximum loads specified in section E 210.23.

(c) Where the load is computed on a "watts per square foot" basis, the total load, in so far as practical, shall be evenly proportioned among the branch circuits according to their capacity.

Note 1. When lighting units to be installed operate at other than 100% power factor, see section E 210.23 (2) for maximum ampere load permitted on branch circuits.

Note 2. For general illumination in dwelling occupancies, it is recommended that not less than one branch circuit be installed for each 500 square feet of floor area in addition to the receptacle circuits called for in section E 220.03 (2).

See examples No. 1, 1(a), 1(b), 1(c), and 4, chapter E 900.

(2) RECEPTACLE CIRCUITS, DWELLING OCCUPANCIES. (a) For the small appliance load in kitchen, laundry, pantry, family room, dining room and breakfast room of dwelling occupancies, 2 or more 20 ampere branch circuits in addition to the branch circuits specified in subsection (1) shall be provided for all receptacle outlets in these rooms, and such circuits shall have no other outlets.

(b) Receptacle outlets supplied by at least 2 appliance receptacle branch circuits shall be installed in the kitchen.

(c) Receptacle outlets installed solely for the support of and the power supply for electric clocks may be installed on lighting branch circuits.

Note: A 3-wire 115/230 volt branch circuit is the equivalent of two 115 volt receptacle branch circuits.

(3) FIXED APPLIANCES. Fixed appliances exceeding ⅛ hp or 300 watts rating shall not be connected to lighting branch circuits. Where an air conditioner sleeve is provided in a building wall, an outlet within 4 feet of the sleeve location shall be provided. If a circuit is not run to the outlet, a raceway shall be provided. When the air conditioner is added it shall be supplied by a separate circuit. A receptacle outlet installed for an air conditioner shall not be counted as one of the receptacles required by section E 210.22 (2).

(4) OTHER CIRCUITS. For specific loads not otherwise provided for in subsections (1), (2), or (3), branch circuits shall be as required by other rules of the code.

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

E 220.04 Calculation of feeder loads. The computed load of a feeder shall be not less than the sum of all branch circuit loads supplied by the feeder, as determined by section E 220.02, subject to the following provisions:

(1) GENERAL LIGHTING. The demand factors listed in subsection (2) may be applied to that portion of the total branch circuit load computed for general illumination. These demand factors shall not be applied in determining the number of branch circuits for general illumination supplied by the feeders.

Note 1. See subsections E (8) and (9).

Note 2. The demand factors herein are based on minimum load conditions and 100% power factor, and in specific instances may not provide sufficient capacity for the installation contemplated. In view of the trend toward higher intensity lighting systems and increased loads due to more general use of fixed and portable appliances, each installation should be considered as to the load likely to be imposed and the capacity increased to insure safe operation. Where electric discharge lighting systems are to be installed, high power-factor type should be used or the conductor capacity may need to be increased.

TABLE SECTION E 220.04 (2)

CALCULATION OF FEEDER LOADS BY OCCUPANCIES

Type of Occupancy	Portion of Lighting Load to which Demand Factor Applies (wattage)	Feeder Demand Factor
Dwellings—Other than Hotels	First 3,000 or less at Next 3,001 to 120,000 at Remainder over 120,000 at	100% 35% 25%
*Hospitals	First 50,000 or less at Remainder over 50,000 at	40% 20%
*Hotels and Motels—Including Apartment Houses without provision for cooking by tenants	First 20,000 or less at Next 20,001 to 100,000 at Remainder over 100,000 at	50% 40% 30%
Warehouses (Storage)	First 12,500 or less at Remainder over 12,500 at	100% 50%
All Others	Total Wattage	100%

*The demand factors of this table shall not apply to the computed load of sub-feeders to areas in hospitals, hotels and motels where entire lighting is likely to be used at one time; as in operating rooms, ballrooms, or dining rooms.

(3) SHOW-WINDOW LIGHTING. For show-window lighting, a load of not less than 200 watts shall be included for each linear foot of show-window measured horizontally along its base.

(4) MOTORS. For motors, a load computed according to the provisions of sections E 430.024, E 430.025, and E 430.026 shall be included.

(5) NEUTRAL FEEDER LOAD. The neutral feeder load shall be the maximum unbalance of the load determined by section E 220.04. The maximum unbalanced load shall be the maximum connected load between the neutral and any one ungrounded conductor; except that the load thus obtained shall be multiplied by 140% for 5-wire, 2-phase systems. For a feeder supplying household electric ranges, wall-mounted ovens and counter-mounted cooking units, the maximum unbalanced load shall be considered as 70% of the load on the ungrounded conductors, as determined in accordance with section E 220.05. For 3-wire DC or single-phase AC, 4-wire 3-phase and 5-wire 2-phase systems, a further demand factor of 70% may be applied to that portion of the unbalanced load in excess of 200 amperes. There shall be no reduction of the neutral capacity for that portion of the load which consists of electric discharge lighting. See examples 1, 1 (a), 1 (b), 1 (c), 2, 3, 4 and 5, chapter E 900. In dwelling occupancies where a 100 ampere minimum service is required [subsection E 230.041 (1)], the neutral may be two sizes smaller than the ungrounded conductors when of the same material.

(6) FIXED ELECTRICAL SPACE HEATING. The computed load of a feeder supplying fixed electrical space heating equipment shall be the total connected load on all branch circuits.

(a) *Exception No. 1.* Where reduced loading of the conductors results from units operating on duty-cycle, intermittently, or from all units not operating at one time, the administrative authority may grant permission for feeder conductors to be of a capacity less than 100%, provided the conductors are of sufficient capacity for the load so determined.

(b) *Exception No. 2.* Subsection (6) does not apply when feeder capacity is calculated in accordance with optional method in section E 220.07 for one-family residences.

(7) NON-COINCIDENT LOAD. In adding the branch circuit loads to determine the feeder load, the smaller of two dissimilar loads may be omitted from the total where it is unlikely that both of the loads will be served simultaneously.

(8) SMALL APPLIANCES. The computed branch circuit load for receptacle outlets in other than dwelling occupancies, for which the allowance is not more than 1½ amperes per outlet, may be included with the general lighting load and subject to the demand factors in subsection (1).

Dwelling Occupancies

Note: The requirements in following sections E 220.04 (9)–(12) apply to dwelling type occupanicies and are supplemental to sections E 220.04 (1)—(8).

(9) SMALL APPLIANCES—DWELLING OCCUPANCIES. In single-family dwellings, in individual apartments of multi-family dwellings having

provisions for cooking by tenants, and in each hotel suite having a serving pantry, a feeder load of not less than 1500 watts for each 2-wire circuit installed as required by section E 220.03 (2) shall be included for small appliances (portable appliances supplied from receptacles of 15 or 20 ampere rating) in pantry and breakfast-room, dining room, kitchen and laundry. Where the load is subdivided through 2 or more feeders, the computed load for each shall include not less than 1500 watts for each 2-wire circuit for small appliances. These loads may be included with the general lighting load and subject to the demand factors in section E 220.04.

(10) ELECTRIC RANGES. The feeder load for household electric ranges and other cooking appliances, individually rated more than 1¾ kw, may be calculated in accordance with section E 220.05.

Note: In order to provide for possible future installation of ranges of higher ratings, it is recommended that where ranges of less than 8¾ kw ratings or wall-mounted ovens and counter-mounted cooking units are to be installed, the feeder capacity be not less than the maximum demand value specified in column A of table E 220.05.

(a) Where a number of single-phase ranges are supplied by a 3-phase, 4-wire feeder, the current shall be computed on the basis of the demand of twice the maximum number of ranges connected between any two phase wires.

Note: See example 7, chapter E 900.

(11) FIXED ELECTRICAL APPLIANCES (OTHER THAN RANGES, WALL-MOUNTED OVENS, COUNTER-MOUNTED COOKING UNITS, CLOTHES DRYERS, AIR CONDITIONING EQUIPMENT OR SPACE HEATING EQUIPMENT). Where 4 or more fixed electrical appliances other than electric ranges, wall-mounted ovens, counter-mounted cooking units, clothes dryers, air conditioning equipment or space heating equipment are connected to the same feeder in a single or multi-family dwelling, a demand factor of 100% for the largest individual load and 75% for the balance may be applied to the fixed appliance load.

(12) SPACE HEATING AND AIR COOLING. In adding branch circuit loads for space heating and air cooling in dwelling occupancies, the smaller of the 2 loads may be omitted from the total where it is unlikely that both of the loads will be served simultaneously.

Note: Permanently installed bathroom heating units are considered fixed appliances and must be included in the load of section (11).

(13) ELECTRIC CLOTHES DRYERS. Where provisions are made for installing one or more electric clothes dryers, a feeder load of 5,000 watts or the nameplate rating of the appliance, whichever is larger, shall be included for each dryer, subject to the demand factors of table E 220.06.

(14) AIR CONDITIONERS. Where provisions are made for installing one or more air conditioning units, a feeder load of 1,000 watts or the nameplate rating of the appliance, whichever is larger, shall be included for each unit.

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

TABLE E 220.05

DEMAND LOADS FOR HOUSEHOLD ELECTRIC RANGES, WALL-MOUNTED OVENS, COUNTER-MOUNTED COOKING UNITS AND OTHER HOUSEHOLD COOKING APPLIANCES OVER 1¾ kw RATING

Column A to be used in all cases except as otherwise permitted in Note 4 below.

NUMBER OF APPLIANCES	Maximum Demand (See Notes)	Demand Factors (See Note 4)	
	COLUMN A (Not over 12 kw Rating)	COLUMN B (Less than 3½ kw Rating)	COLUMN C (3½ kw to 8¾ kw Rating)
1	8 kw	80%	80%
2	11 kw	75%	65%
3	14 kw	70%	55%
4	17 kw	66%	50%
5	20 kw	62%	45%
6	21 kw	59%	43%
7	22 kw	56%	40%
8	23 kw	53%	36%
9	24 kw	51%	35%
10	25 kw	49%	34%
11	26 kw	47%	32%
12	27 kw	45%	32%
13	28 kw	43%	32%
14	29 kw	41%	32%
15	30 kw	40%	32%
16	31 kw	39%	28%
17	32 kw	38%	28%
18	33 kw	37%	28%
19	34 kw	36%	28%
20	35 kw	35%	28%
21	36 kw	34%	26%
22	37 kw	33%	26%
23	38 kw	32%	26%
24	39 kw	31%	26%
25	40 kw	30%	26%
26–30	(15 kw plus 1 kw	30%	24%
31–40	for each range)	30%	22%
41–50	(25 kw plus ¾	30%	20%
51–60	kw for each	30%	18%
61 and over	range)	30%	16%

Note 1. Over 12 kw to 27 kw ranges all of same kw rating. For ranges, individually rated more than 12 kw but not more than 27 kw, the maximum demand in Column A shall be increased 5% for each additional kw of rating or major fraction thereof by which the rating of individual ranges exceeds 12 kw.

Note 2. Over 12 kw to 27 kw ranges of unequal ratings. For ranges individually rated more than 12 kw and of different ratings but none exceeding 27 kw an average value of rating shall be calculated by adding together the ratings of all ranges to obtain the total connected load (using 12 kw for any range rated less than 12 kw) and dividing by the total number of ranges; and then the maximum demand in Column A shall be increased 5% for each kw or major fraction thereof by which this average value exceeds 12 kw.

Note 3. The branch circuit load for a commercial range shall be the nameplate rating of the range. The following demand factors may be used to determine the feeder load for commercial cooking appliances: One or two appliances—100%, three appliances—90%, four appliances—80%, and five or more appliances—60%.

Note 4. Over 1¾ kw to 8¾ kw In lieu of the method provided in Column A, loads rated more than 1¾ kw but not more than 8¾ kw may be considered as the sum of the nameplate ratings of all the loads, multiplied by the demand factors specified in Columns B or C for the given number of loads.

Note 5. Branch circuit load. Branch circuit load for one range may be computed in accordance with Table E 220.05. The branch circuit load for one wall-mounted oven or one counter-mounted cooking unit shall be the nameplate rating of the appliance.

Note 5. Branch circuit load. Branch circuit load for one range may be computed in accordance with table E 220.05. The branch circuit load for one wall-mounted oven or one counter-mounted cooking unit shall be the nameplate rating of the appliance. The branch circuit load for a counter-mounted cooking unit and not more than 2 wall-mounted ovens, all supplied from a single branch circuit and located in the same room shall be computed by adding the nameplate rating of the individual appliances and treating this total as equivalent to one range.

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

TABLE E 220.06

DEMAND FACTORS FOR HOUSEHOLD ELECTRIC CLOTHES DRYERS

Number of Dryers	Demand Factor (per cent)
1	100
2	100
3	100
4	100
5	80
6	70
7	65
8	60
9	55
10	50
11-13	45
14-19	40
20-24	35
25-29	32.5
30-34	30
35-39	27.5
40 up	25

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

E 220.07 Optional calculation. For single-family dwellings and individual apartments of multi-family dwellings where the total load of each dwelling unit is supplied by one 3-wire, 100 ampere or larger feeder or set of service entrance conductors, the following percentages may be used in lieu of the method of determining feeder (and service) loads detailed in section E 220.04.

TABLE E 220.07

(1) OPTIONAL CALCULATION FOR ONE-FAMILY RESIDENCE

LOAD (in kw or kva)	Per Cent of Load
Air conditioning and cooling including heat pump compressors (see E 220.04(12))	100%
Central electrical space heating (see E 220.04(12))	100%
Less than 4 separately controlled electrical space heating units (see subsection E 220.04(12))	100%
First 10 kw of all other load	100%
Remainder of other load	40%

(2) All other load shall include 1500 watts for each 20 ampere appliance outlet circuit (section E 220.03 (2)); lighting and portable appliances at 3 watts per square foot; all fixed appliances, (including 4 or more separately controlled space heating units [see section E 220.04 (12)], ranges, wall-mounted ovens and counter-mounted cooking units) at nameplate rated load (kva for motors and other low power-factor loads). See examples 1 (b) and 1 (c) of chapter E 900.

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

Chapter E 230

SERVICES

A. GENERAL REQUIREMENTS

E 230.001 Scope. The provisions of this chapter shall apply to the conductors and equipment for control and protection of services—circuits that conduct electric power from the supply system or plant to the premises to be served.

Note: For over 600 volts see section E 230.100.

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

E 230.002 Number of services to a building. In general, a building or other premises served shall be supplied through only one set of service conductors, except as follows:

(1) EXCEPTION NO. 1. FIRE PUMPS. Where a separate service is required for fire pumps.

(2) EXCEPTION NO. 2. EMERGENCY LIGHTING. Where a separate service is required for emergency lighting and power purposes.

(3) EXCEPTION NO. 3. MULTIPLE-OCCUPANCY BUILDINGS. (a) By special permission, in multiple-occupancy buildings where there is no available space for service equipment accessible to all the occupants.

(b) Multiple-occupancy buildings that do not have individual occupancy above the second floor and which have service conductors run to each occupancy may have 2 or more separate sets of service-entrance conductors tapped from one drop, or 2 or more sub-sets of service-entrance conductors tapped from a single set of main service conductors. See section E 230.075 and section E 230.090 (1) (d).

(4) EXCEPTION NO. 4. CAPACITY REQUIREMENTS. Additional services may be installed because of capacity requirements in accordance with the following table:

Service Rating	Number of Services Permitted
0– 400 amperes	1
401– 800 amperes	2
801–1200 amperes	3

Note 1: Where 2 services are permitted, one must be of at least 400 ampere rating. Where 3 services are permitted, 2 must be of at least 400 ampere rating.

Note 2: For services above 1200 ampere rating and 3 in number, the pattern established by the above table and Note 1 is to be continued.

(5) EXCEPTION NO. 5. BUILDINGS OF LARGE AREA. Two or more sets of service conductors may be installed for the same class of service for the same consumer if located more than 150 feet apart (measured in a straight line), provided that all electrical wiring supplied by each service has no common raceway or connection with any other service.

(6) EXCEPTION NO. 6. DIFFERENT CHARACTERISTICS OR CLASSES OF USE. Where additional services are required for different voltages, frequency, or phase, or different classes of use. Different classes of use could be because of needs for different characteristics, or because of rate schedule as in the case of controlled water heater service.

Note: On a farm or any place that must depend partially or wholly on a local motor-driven pump for fire protection, it is advisable to connect that motor in such a way that the opening of other than its own circuit protection will not interrupt service to the pump.

(7) EXCEPTION NO. 7. MULTI-STORY BUILDINGS. In multi-story buildings supplied through 2 or more transformers, one service will be permitted per floor provided that all electrical wiring supplied by each service has no common raceway or connection with any other service. More than one service per floor is permitted under the conditions outlined in sections E 230.002 (4) and (5).

Note: The provisions of section E 230.002 (7) EXCEPTION No. 7 are not intended to prohibit interconnecting transformer secondaries.

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

E 230.003 Supply to a building from another. No overhead service, no underground service and no service from an isolated plant shall supply one building from another, unless such buildings are under single occupancy or management. Conductors in conduit or duct encased on all sides by concrete or brick masonry not less than 2 inches thick, shall be considered outside the building. See section E 230.076.

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

B. INSULATION AND SIZE OF SERVICE CONDUCTORS

E 230.004 Insulation of service conductors. Service conductors shall have an insulating covering which will normally withstand exposure to atmospheric and other conditions of use and which shall prevent any detrimental leakage of current to adjacent conductors, objects, or the ground.

(1) EXCEPTION. GROUNDED CONDUCTOR. In the case of service conductors that have a nominal voltage to ground of not more than 300 volts, a grounded service conductor without an insulating covering may be installed.

Note 1. For service drops, see section E 230.022.

Note 2. For service entrance conductors, see section E 230.040.

Note 3. For underground services, see section E 230.030.

Note 4. For farmstead service conductors, see Wis. Adm. Code section E 560.03.

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

E 230.005 Size of service conductors. Service conductors shall have adequate ampacity to safely conduct the current for the loads supplied without a temperature rise detrimental to the insulating covering of the conductors, and shall have adequate mechanical strength.

Note: Minimum sizes are given in the following references:
For service drops, see section E 230.023.
For service entrance conductors, see section E 230.041.
For underground service conductors, see section E 230.031.

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

C. SERVICE DROPS

E 230.021 Number of drops. No building shall be supplied through more than one service drop, except for the purposes listed in section E 230.002.

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

E 230.022 Service drop conductors. (1) In multiple-conductor cables, conductors shall be covered with rubber, thermoplastic, thermosetting or other suitable insulation, except a grounded conductor may be uninsulated where the maximum voltage to ground of any conductor is not over 300 volts.

(2) All open individual conductors shall be insulated or covered.

Note: Conductors having extruded covering used for service drops have the same ampacities as covered conductors listed in tables E 310.13 and E 310.15.

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

E 230.023 Minimum size of service drop conductors. (1) Conductors shall be of sufficient size to carry the load and shall not be smaller than No. 8 copper or equivalent except for limited load as in section

E 230.041 (4), where they may be not smaller than No. 12 and shall then be of hard drawn copper or equivalent.

(2) Conductors to a building from a pole on which a meter or disconnecting means is installed shall be considered as a service drop and installed accordingly. The clearance to ground of these conductors shall be in accordance with Wis. Adm. Code section E 730.18.

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

E 230.024 Clearance of service drop. Service drops shall not be readily accessible and, for voltages not in excess of 600 volts, shall conform to the following: Subsections (1)–(5) inclusive. For clearance of conductors of over 600 volts, see Wis. Adm. Code section E 123.03 in Volume 1.

(1) CLEARANCE OVER ROOF. 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 volts and the pitch of the roof is greater than 3 inches per foot, the clearance may be not less than 3 feet. Where the service conduit extends through a roof, the service drop conductors, if operating at less than 300 volts between conductors, may have a clearance of not less than 18 inches vertically above the roof providing such conductors do not extend more than 45 inches across the roof.

(2) CLEARANCE FROM PLATFORMS AND GROUND. Conductors shall have a clearance of not less than 10 feet from any platform, porch, fire escape or other projection from which they might be reached. For clearance of conductors from the ground see Wis. Adm. Code sections E 123.03 in volume 1 and E 730.18.

(3) CLEARANCE FROM BUILDING OPENINGS. Conductors shall have a clearance of not less than 36 inches from windows, doors, porches, fire escapes, or similar locations. The clearance from windows refers only to those portions of windows which are normally capable of being opened. Conductors run above a window are considered inaccessible from that window. No clearance is required from windows consisting of glass blocks or fixed panes which cannot be opened.

(4) CLEARANCE FROM 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 the voltage is 300 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.

(5) CLEARANCE FROM WELLS. A horizontal clearance of at least ¾ the required vertical clearance of the conductor shall be maintained between open conductors and wells.

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

E 230.025 Supports over buildings. Where practicable, conductors passing over a building shall be supported on structures which are independent of the building. Where necessary to attach conductors to roof they shall be supported on substantial structures.

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

E 230.026 Point of attachment to buildings. (1) The point of attachment of a service drop to a building or other structure shall be not less than 10 feet above finished grade and shall be at a height to permit a minimum clearance for service drop conductors of 10 feet above sidewalks and 18 feet above driveways, alleys and public roads. The attachment should not be more than 30 feet above ground unless a greater height is necessary for proper clearance. Where it is impractical to get the point of attachment high enough to obtain the above clearances, the clearance over residential driveways may be reduced, provided a clearance of 10 feet over sidwalks, 18 feet over alleys and public roads, and a minimum of 12 feet over residential driveways is obtained.

(2) In the event a mast type riser is required to attain the required height, it shall be of such construction and so supported that it will withstand the strain imposed by the service drop. Raceway fittings shall be of a type approved for the purpose.

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

E 230.027 Means of attachment. Multiple-conductor cables used for service drops shall be attached to buildings or other structures by fittings approved for the purpose. Open conductors shall be attached to non-combustible, nonabsorptive insulators securely attached to the building or other structure or by fittings approved for the purpose.

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

D. UNDERGROUND SERVICES

E 230.030 Insulation; underground service conductors. (1) Underground conductors up to the point of attachment to service equipment shall be covered with rubber, cambric, thermoplastic, paper or other approved insulating material, except:

(a) *Exception No. 1.* Uninsulated grounded neutral conductors of aluminum or copper may be installed underground when part of an approved cable assembly.

(b) *Exception No. 2.* Bare grounded neutral conductors of copper may be installed underground in duct or conduit.

(2) Insulated service conductors installed underground, or in concrete slabs or masonry in direct contact with earth, shall be lead-covered or of other types specially approved for the purpose.

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

E 230.031 Size of underground service conductors. (1) SIZE OF UNDERGROUND SERVICE LATERAL. Conductors shall be of sufficient size to carry the load and shall not be smaller than No. 8 copper or the equivalent except for limited load as in section E 230.041 EXCEPTION No. 4 the conductors shall not be smaller than No. 12 copper or equivalent. The underground service lateral shall not extend into a building in a raceway longer than 3 feet.

(2) SIZE OF UNDERGROUND SERVICE ENTRANCE CONDUCTORS. Same as required for overhead service entrance conductors. See section E 230.041.

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

E 230.032 Protection against damage. (1) IN THE GROUND. Underground service conductors shall be protected against physical damage by being installed in duct, conduit, in cable of one or more conductors approved for the purpose, or by other approved means. See section E 310.01 (2) and sections E 310.05 and E 310.06. Also see Wis. Adm. Code chapter E 129 in volume 1 of the Wisconsin State Electrical Code.

(2) ON POLES. Where underground service conductors are carried up a pole the mechanical protection shall be installed to a point at least 8 feet above the ground. Such mechanical protection may be provided by the use of approved cable, pipe, or other approved means.

(3) WHERE ENTERING BUILDING. Underground service conductors shall have mechanical protection in the form of rigid or flexible conduit, electrical metallic tubing, auxiliary gutters, the metal tape of an approved service cable, or other approved means. The mechanical protection shall extend to the enclosure for the service equipment unless the service switch is installed on a switchboard, in which case a bushing shall be provided which, except where lead-covered conductors are used, shall be of the insulating type.

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

E 230.033 Raceway seal. Where a service raceway or duct enters from an underground distribution system, the end within the building shall be sealed with suitable compound so as to prevent the entrance of moisture or gases. Spare or unused ducts shall also be sealed.

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

E 230.034 Grounding raceways and cable sheaths. See section E 230.063.

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

E 230.035 Termination at service equipment. See section E 230.042, exception No. 3, and section E 230.053.

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

E. SERVICE-ENTRANCE CONDUCTORS

E 230.040 Insulation of service-entrance conductors. (1) Service-entrance conductors extending along the exterior of or entering buildings or other structures shall be rubber-covered or thermoplastic-covered if in raceways, or in cables approved for the purpose, except a grounded conductor may be uninsulated where the maximum voltage to ground of any conductor is not over 300 volts.

(a) Where only on the exterior of the building or other structure the conductors shall be insulated or covered.

(2) Open individual conductors which enter the building or other structure shall be rubber-covered or thermoplastic-covered.

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

E 230.041 Size of service-entrance conductors, overhead system and underground system. Service-entrance conductors shall have sufficient ampacity to carry the load as determined by Wis. Adm. Code chapter E 220 and in accordance with tables E 310.12, E 310.13, E 310.14

and E 310.15. Service-entrance conductors shall not be smaller than No. 6 except:

(1) EXCEPTION No. 1. For single-family residences requiring more than three 2-wire branch circuits or having an area of more than 500 square feet (external dimensions) and for multi-occupancy buildings requiring more than three 2-wire branch circuits, the service shall be a minimum of 100 amperes, 3-wire or 4-wire, and each unit requiring more than two 2-wire branch circuits shall have a 3-wire service. Services or feeders to each unit of multi-occupancy residential buildings shall be a minimum of 50 amperes. For neutral size on 100 ampere services in dwelling occupancies, see section E 220.04 (5).

(2) EXCEPTION No. 2. For installations consisting of not more than two 2-wire branch circuits they shall not be smaller than No. 8.

(3) EXCEPTION No. 3. By special permission due to limitations of supply source or load requirements they shall not be smaller than No. 8.

(4) EXCEPTION NO. 4. For installations to supply only limited loads of a single branch circuit, such as small polyphase power, controlled water heaters and the like, they shall not be smaller than the conductors of the branch circuit and in no case smaller than No. 12.

(5) EXCEPTION No. 5. The neutral conductor which shall have an ampacity in conformity with section E 220.04 (5), but shall not be smaller than the ungrounded conductors when these are No. 8 or smaller.

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

E 230.042 Service-entrance conductors without splice. Service-entrance conductors shall be without splice except as follows:

(1) EXCEPTION No. 1. Clamped or bolted connections in a meter enclosure are permitted.

(2) EXCEPTION No. 2. Taps to main service conductors are permitted as provided in section E 230.002 (3) (b) or to individual sets of service equipment as provided in section E 230.070.

(3) EXCEPTION No. 3. A connection is permitted, when properly enclosed, where an underground service conductor enters a building and is to be extended to the service equipment or meter in another form of approved service raceway or service cable.

(4) EXCEPTION No. 4. A connection is permitted where service conductors are extended from a service drop to an outside meter location and returned to connect to the service entrance conductors of an existing installation.

(5) EXCEPTION No. 5. For extending existing services, special permission to make splices in fittings of the service run and to extend existing wire size may be granted.

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

E 230.043 Other conductors in service raceway. Conductors other than service conductors, grounding conductors, or control conductors from time switches having overcurrent protection, shall not be installed in the same service raceway or service entrance cable.

Note 1. Water heater leads are to be considered as service entrance conductors.

Note 2. Where a meter is located on a pole the wires to and from the meter may be installed in the same raceway if service equipment is provided at each building supplied from this pole.

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

F. INSTALLATION OF SERVICE-ENTRANCE CONDUCTORS

E 230.044 Wiring methods. Service-entrance conductors extending along the exterior, or entering buildings or other structures may be installed as separate conductors, in cables approved for the purpose, or enclosed in rigid conduit, or, for circuits not exceeding 600 volts, in electrical metallic tubing, wireways, auxiliary gutters, or as busways.

(1) Service-entrance conductors shall not be run within the hollow spaces of frame buildings unless provided with overcurrent protection at their outer end.

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

E 230.045 Conductor considered outside building. Conductors in conduit or duct placed under at least 2 inches of concrete beneath a building, or within a building and enclosed by concrete or brick not less than 2 inches thick shall be considered outside the building.

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

E 230.046 Mechanical protection. Individual open conductors or cables other than approved service-entrance cables, shall not be installed within 8 feet of the ground or where exposed to physical damage. Service-entrance cables, where liable to contact with awnings, shutters, swinging signs, installed in exposed places in driveways, near coal chutes or otherwise exposed to physical damage, shall be of the protected type or be protected by conduit, electrical metallic tubing or other approved means.

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

E 230.047 Individual open conductors exposed to weather. Individual open conductors exposed to weather shall be supported on insulators, racks, brackets, or other means, placed at intervals not exceeding 9 feet and separating the conductors at least 6 inches from each other and 2 inches from the surface wired over; or at intervals not exceeding 15 feet if they maintain the conductors at least 12 inches apart. For 300 volts or less, conductors may have a separation of not less than 3 inches where supports are placed at intervals not exceeding 4½ feet and conductors are not less than 2 inches from the surface wired over. Weatherproof conductors on exterior of buildings shall have a clearance from the ground of not less than 8 feet, and a clearance from windows, doors, porches, etc., of not less than 3 feet. Conductors run above the top level of a window are considered out of reach from that window.

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

E 230.048 Individual open conductors not exposed to weather. Individual open conductors not exposed to the weather may be supported on glass or porcelain knobs placed at intervals not exceeding 4½ feet and maintaining the conductors at least one inch from the surface wired over and a separation of at least 2½ inches between conductors.

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

E 230.049 Individual conductors entering buildings. Individual conductors entering buildings shall pass inward and upward through slanting noncombustible, nonabsorptive insulating tubes, or shall enter through roof bushings, and shall conform to the provisions of chapter E 324. Drip loops shall be formed on the conductors before entering tubes.

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

E 230.050 Service cables. Service cables of a type not approved for mounting in contact with a building shall have insulating supports at intervals not exceeding 15 feet, and maintaining a distance of at least 2 inches from the surface wired over. Service cables mounted in contact with the building shall be supported at intervals not exceeding 4½ feet.

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

E 230.051 Service head. Service raceways shall be equipped with a raintight service head. Service cables, unless continuous from pole to service equipment or meter, shall be equipped with an approved raintight service head, or be formed in a gooseneck, taped and painted or taped with self-sealing weather-resistant thermoplastics and held securely in place by its connection to service-drop conductors below the gooseneck or by a fitting approved for the purpose. Drip loops shall be formed on individual conductors. To prevent the entrance of moisture, service-entrance conductors shall be connected to the service-drop conductors below the level of the service head or the termination of service-entrance cable sheaths. Where service heads are used, conductors of opposite polarity shall be brought out through separately bushed holes. 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.

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

E 230.052 Enclosing raceways made raintight. When rigid metal raceways are installed where exposed to weather the raceways shall be made raintight and arranged to drain.

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

E 230.053 Terminating raceway at service equipment. Where conduit, electrical metallic tubing, or service cable is used for service conductors, the inner end shall enter a terminal box or cabinet, or be made up directly to an equivalent fitting, enclosing all live metal parts, except that where the service disconnecting means is mounted on a switchboard having exposed bus-bars on the back, the raceway may be equipped with a bushing which shall be of the insulating type unless lead-covered conductors are used.

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

E 230.054 Grounding service raceways and cable armor. See section E 230.063.

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

G. SERVICE EQUIPMENT

E 230.060 Hazardous locations. Service equipment installed in hazardous locations shall comply with the requirements of Wis. Adm. Code chapters E 500 to E 517 inclusive.

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

H. GROUNDING AND GUARDING

E 230.062 Guarding. Live parts of service equipment shall be enclosed so that they will not be exposed to accidental contact, unless mounted on a switchboard, panelboard or controller accessible to qualified persons only and located in a room or enclosure free from easily ignitible material. Such an enclosure shall be provided with means for locking or sealing doors giving access to live parts.

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

E 230.063 Grounding and bonding. Service equipment shall be grounded as follows:

(1) EQUIPMENT. The enclosure for service equipment shall be grounded in the manner specified in chapter E 250, unless (a) the voltage does not exceed 150 volts to ground and such enclosures are (b) isolated from conducting surfaces, and (c) unexposed to contact by persons or materials that may also be in contact with other conducting surfaces.

(2) RACEWAYS. Service raceways, and the metal sheath of service cables, shall be grounded. Conduit and metal pipe from underground supply shall be considered sufficiently grounded where containing lead-sheathed cable bonded to a continuous underground lead-sheathed cable system.

(3) FLEXIBLE CONDUIT. Where a service run of rigid metal raceway is interrupted by flexible metal conduit, the sections of rigid metal raceway thus interrupted shall be bonded together by a copper conductor not smaller than No. 8, using clamps or other approved means. The conductor and bonding devices shall be protected from physical damage. Where the flexible conduit runs to the service cabinet, similar bonding shall be installed between the cabinet and the rigid raceway.

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

J. DISCONNECTING MEANS

E 230.070 General. (For multiple occupancy buildings see also section E 230.075.)

(1) DISCONNECTION FROM SERVICE CONDUCTORS. (a) Means shall be provided for disconnecting all conductors in the building or other structure from the service conductors. The disconnecting means for each set of service conductors shall consist of:

1. A single main disconnecting means for single occupancy buildings or other structures or,

2. A single main disconnecting means for each metered service in each occupancy of a multi-occupancy building having service conductors run to each occupancy or,

3. A single main disconnecting means for each metered service up to and including 6 or,

4. Not more than 6 switches or 6 circuit-breakers where the combined rating of the service disconnecting means exceeds 400 amperes or,

5. Not more than 6 switches or 6 circuit-breakers for each farm service entrance, whether on a pole or in separate buildings except for the residence which shall have a single main disconnecting means.

6. Not more than 6 switches or 6 circuit-breakers for additions to existing services installed prior to the effective date of this code.

Note: Main disconnects for fire pumps, emergency lighting or fire alarm systems shall not be counted as disconnecting means so far as the limit of the number of disconnecting means is concerned.

(b) For services operating at not to exceed 250 volts and capacities up to and including 100 amperes, the service switch and service fuses, when not a part of a switchboard, shall be of the accessible fuse or dead front type in which the fuses are dead when accessible and no live parts are exposed to accidental contact.

(2) LOCATION. The disconnecting means shall be located at a readily accessible point nearest to the entrance of the conductors, either inside or outside the building or other structure. See Wis. Adm. Code sections E 195.16 and E 230.045.

(3) APPROVAL. The disconnecting means shall be of a type approved for service equipment and for prevailing conditions.

(4) TYPES PERMITTED. The disconnecting means for ungrounded conductors shall consist of either:

(a) A manually operable switch or circuit-breaker equipped with a handle or other suitable operating means positively identified and marked for mechanical operation by hand.

(b) An electrically operated switch or circuit-breaker provided the switch or circuit-breaker can be opened by hand in event of a failure of the power supply and the open and closed positions are clearly indicated to the operator. In addition to the normal operating means, a push-button type of electrical remote control may be used to trip or open the service disconnecting means, but not to close it.

(5) EXTERNALLY OPERABLE. An enclosed service switch or circuit-breaker shall be externally operable. See definition section E 100.02 (88).

(6) INDICATING. The disconnecting means shall plainly indicate whether it is in the open or closed position.

(7) SWITCH AND CIRCUIT-BREAKER. Where more than one switch or circuit-breaker is permitted by subsection (1), they shall be in a common enclosure or in a group of separate enclosures.

(8) SIMULTANEOUS OPENINGS. The disconnecting means shall simultaneously disconnect all ungrounded conductors.

(9) DISCONNECTION OF GROUNDED CONDUCTOR. Where the switch or circuit-breaker does not interrupt the grounded conductor, other

means shall be provided in the service cabinet or on the switchboard for disconnecting the grounded conductor from the interior wiring.

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

E 230.071 Rating of service equipment. (1) The service disconnecting means shall have a rating not less than the load to be carried determined in accordance with chapter E 220. In general the service disconnecting means shall have a rating of not less than 60 amperes where a switch is used, and not less than 50 amperes where a circuit-breaker is used, except:

(a) *Exception No. 1.* For single-family residences requiring more than three 2-wire branch circuits, or having an area of more than 500 square feet (external dimensions) and for multi-occupancy buildings requiring more than three 2-wire branch circuits, the service equipment shall have a rating of not less than 100 amperes, 3-wire.

(b) *Exception No. 2.* For installations consisting of not more than two 2-wire branch circuits a service equipment of 30 ampere minimum rating may be used.

(c) *Exception No. 3.* For installations consisting of a single branch circuit a circuit-breaker of 15 or 20 ampere rating may be used.

(2) Where multiple switches or circuit breakers are used in accordance with section 230.070 (1), the combined rating shall not be less than required for a single switch or breaker.

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

E 230.072 Connection to terminals. The service conductors shall be attached to the disconnecting means by pressure connectors, clamps or other approved means, except that connections which depend upon solder shall not be used.

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

E 230.073 Connections ahead of disconnecting means. Service fuses, meters, high-impedance shunt circuits (such as potential coils of meters, etc.), supply conductors for time switches, surge protective capacitors, instrument transformers, lightning arresters and circuits for emergency systems, fire pump equipment, fire and sprinkler alarms as provided in section E 230.094, may be on the supply side of the disconnecting means. Taps from service conductors to supply time switches, circuits for emergency lighting, etc., shall be installed in accordance with section E 230.044 and disconnecting means shall be installed as required in section E 230.070.

Note: For detailed service provisions for fire alarm, sprinkler supervisory, or watchman systems, see appropriate standards of the National Fire Protection Association.

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

E 230.074 Safeguarding emergency supply. Where an emergency supply is provided to feed the conductors controlled by the service disconnecting means, the disconnector shall be of a design that will open all ungrounded conductors from the usual supply before connection is made to the emergency supply, unless agreed upon arrangements have been made for parallel operation and suitable automatic control equipment provided. See Wis. Adm. Code chapter E 700.

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

E 230.075 Multiple occupancy. In a multiple occupancy building, each ocupant shall have access to his disconnecting means. A multiple occupancy building having individual occupancy above the second floor shall have service equipment grouped in a common accessible place. Multiple occupancy buildings that do not have individual occupancy above the second floor may have service conductors run to each occupancy in accordance with section E 230.002 (3) (b).

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

E 230.076 More than one building. In a property comprising more than one building under single management, the conductors supplying each building served shall be provided with a readily accessible means, within or adjacent to the building, of disconnecting all ungrounded conductors from the source of supply. In garages and outbuildings on residential property the disconnecting means may consist of a snap switch, suitable for use on branch circuits, including switch controls at more than one point.

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

K. OVERCURRENT PROTECTION

E 230.090 Where required. Each ungrounded service-entrance conductor shall have overcurrent protection.

(1) UNGROUNDED CONDUCTOR. Such protection shall be provided by an overcurrent device in series with each ungrounded service conductor, having a rating or setting not higher than the allowable ampacity of the conductor, except as follows:

(a) *Exception No. 1.* For motor-starting currents, ratings in conformity with section E 430.052, E 430.062, or E 430.063 may be used.

(b) *Exception No. 2.* Circuit-breakers may have a rating or setting in conformity with sections E 240.05 (1) and E 240.05 (2), and section E 240.07; fuses shall conform to requirements of section E 240.06.

(c) *Exception No. 3.* Not more than 6* sets of overcurrent devices may serve as the overcurrent device.

(d) *Exception No. 4.* In a multiple-occupancy building each occupant shall have access to his overcurrent protective devices. A multiple-occupancy building having individual occupancy above the second floor shall have service equipment grouped in a common accessible place, the overcurrent protection consisting of not more than 6* sets of overcurrent devices. Multiple-occupancy buildings that do not have individual occupancy above the second floor may have service conductors run to each occupancy in accordance with section E 230.002 (3) (b) and each such service may have not more than 6* sets of overcurrent devices.

Note: A set of overcurrent devices is all the devices required to protect all the ungrounded conductors of a circuit.

(2) NOT IN GROUNDED CONDUCTOR. No overcurrent device shall be inserted in a grounded service conductor except a circuit-breaker which simultaneously opens all conductors of the circuit.

* Main disconnects for fire-pumps, emergency lighting or fire alarm systems shall not be counted as disconnecting means so far as the limit of the number of disconnecting means is concerned.

(3) MORE THAN ONE BUILDING. In a property comprising more than one building under single management, the ungrounded conductors supplying each building served shall be protected by overcurrent devices, which may be located in the building served or in another building on the same property, provided they are accessible to the occupants of the building served.

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

E 230.091 Location. The service overcurrent device shall be an integral part of the service disconnecting means or shall be located immediately adjacent thereto, unless located at the outer end of the entrance.

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

E 230.092 Location of branch-circuit overcurrent devices. Where the service overcurrent devices are locked or sealed, or otherwise not readily accessible, branch-circuit overcurrent devices shall be installed on the load side, shall be mounted in an accessible location and shall be of lower rating than the service overcurrent device.

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

E 230.093 Protection of specific circuits. Where necessary to prevent tampering, an automatic overcurrent device protecting service conductors supplying only a specific load such as a water heater, may be locked or sealed where located so as to be accessible.

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

E 230.094 Relative location of overcurrent device and other service equipment. The overcurrent device shall protect all circuits and devices except as follows:

(1) The service switch may be placed on the supply side.

(2) High impedance shunt circuits (such as potential coils of meters, etc.), lightning arresters, surge protective capacitors, and instrument transformers, may be connected and installed on the supply side of the service disconnecting means as permitted in section E 230.073.

(3) Circuits for emergency supply and time switches may be connected on the supply side of the service overcurrent device where separately provided with overcurrent protection.

(4) Circuits used only for the operation of fire alarm, other protective signalling systems, or the supply to fire pump equipment may be connected on the supply side of the service overcurrent device where separately provided with overcurrent protection.

(5) Meters for alternating current service not in excess of 600 volts, provided the service contains a grounded conductor and the cases and enclosures of such meters are grounded by connection to the grounded circuit conductor (see section E 250.061) or to a common system and equipment ground electrode (see section E 250.054); or meters for alternating current service not containing a grounded service conductor and not in excess of 300 volts.

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

L. SERVICES EXCEEDING 600 VOLTS

E 230.100 Scope. Service conductors and equipment used on circuits exceeding 600 volts shall comply with the applicable provisions of the preceding rules of this chapter and with the following rules which are additions to or modifications of the preceding rules.

Note 1. Secondary conductors, not the primary conductors, are regarded as constituting the service conductors to the building proper in the following cases:

a. Where step-down transformers are located outdoors.

b. Where step-down transformers are located in a separate building from the one served.

c. Where step-down transformers are located in the building served in a transformer vault conforming to the requirements of sections E 450.41 through E 450.48 or in any other enclosure under the sole control of the supply company.

d. For emergency purposes only, where the transformer primary disconnecting means is in a locked enclosure, accessible to authorized personnel alone.

Note 2: Except for the cases listed in Note 1, the primary conductors are the service conductors.

Note 3: In no case will the provisions of this chapter apply to equipment not directly connected to service conductors, and consequently will not apply to equipment in vaults under the sole control of the supply company.

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

E 230.101 Service-entrance conductors. (1) CONDUCTOR SIZE. Service conductors shall be not smaller than No. 6 unless in cable. Conductors in cable shall be not smaller than No. 8.

(2) WIRING METHODS. In locations accessible to other than qualified persons service-entrance conductors of more than 600 volts shall be installed in rigid conduit, or as multiple conductor cable approved for the purpose.

(3) OPEN WORK. If open work is employed where not accessible to other than qualified persons, the service conductors shall be rigidly supported on glass, porcelain or other insulators approved for the purpose, which will keep them at least 8 inches apart, except at terminals of equipment. They shall be not less than 2 inches from the surfaces wired over and for voltages exceeding 2,500 not less than 3 inches.

(4) SUPPORTS. Service conductors and their supports, including insulators, shall have strength and stability sufficient to insure maintenance of adequate clearance with abnormal currents in case of short circuits.

(5) GUARDING. Open wires shall be guarded where accessible to unqualified persons.

(6) SERVICE CABLE. Where cable conductors emerge from a metal sheath or raceway, the insulation of the conductors shall be protected from moisture and physical damage by a pothead or other approved means.

(7) DRAINING RACEWAYS. Unless conductors specifically approved for the purpose are used, raceways embedded in masonry, or exposed to the weather, or in wet locations shall be arranged to drain.

(8) OVER 15,000 VOLTS. Where the voltage exceeds 15,000 volts between conductors they shall enter either metal enclosed switchgear

or a transformer vault conforming to the requirements of Wis. Adm. Code sections E 450.41 through E 450.48.

(9) CONDUCTOR CONSIDERED OUTSIDE BUILDING. Conductors in conduit or duct placed under at least 2 inches of concrete beneath a building, or within a building and enclosed by concrete or brick not less than 2 inches thick shall be considered outside the building.

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

E 230.102 Warning signs. High voltage signs shall be posted where unauthorized persons might come in contact with live parts.

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

E 230.103 Disconnecting means. The circuit-breaker or the alternatives for it specified in section E 230.106 will constitute the disconnecting means required by section E 230.070 (1) (a). The disconnecting means shall be capable of being closed on a fault within the maximum interrupting rating of the overcurrent protection.

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

E 230.104 Isolating switches. Isolating switches shall be provided as follows:

(1) Air-break isolating switches shall be installed between oil switches or air or oil circuit-breakers used as service switches and the supply conductor, except where such equipment is mounted on removable truck panels or metal-enclosed switchgear units which cannot be opened unless the circuit is disconnected, and which, when removed from the normal operating position, automatically disconnect the circuit-breaker or switch from all live parts.

(2) When the fuses used with non-automatic oil switches in accordance with section E 230.106 are of a type that may be operated as a disconnect switch, they may serve as the isolating switch when they completely disconnect the oil switch and all service equipment from the source of supply.

(3) Air-break isolating switches shall be accessible to qualified attendants only. They shall be arranged so that a grounding connection on the load side can readily be made. Such grounding means need not be provided for duplicate isolating switches, if any, installed and maintained by the supply company.

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

E 230.105 Equipment in secondaries. Where the primary service equipment supplies one or more transformers whose secondary windings connect to a single set of mains, and the primary load-interrupter switch or circuit-breaker is capable of being opened and closed from a point outside the transformer vault, the disconnecting means and overcurrent protection may be omitted from the secondary circuit provided the primary fuse of circuit-breaker is rated or set to protect the secondary circuit.

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

E 230.106 Overcurrent protection. Overcurrent devices shall be provided in accordance with the following:

(1) IN VAULT OR CONSISTING OF METAL-ENCLOSED SWITCHGEAR. Where the service equipment is installed in a transformer vault

meeting the provisions of Wis. Adm. Code sections E 450.41 through E 450.48 or consists of metal-enclosed switchgear, the requirements for overcurrent protection and disconnecting means may be fulfilled by the following:

(a) A nonautomatic oil switch, oil fuse cutout, air load-interrupter switch, or other approved switch, capable of interrupting the rated circuit load, and suitable fuses may be used.

(b) An automatic trip circuit-breaker of suitable current carrying and interrupting capacity with an overcurrent unit in each ungrounded conductor may be used.

(c) A switch capable of interrupting the no-load current of the transformer supplied through the switch and suitable fuses may be used, provided the switch is interlocked with a single switch or circuit breaker on the secondary circuit of the transformer so that the primary switch cannot be opened when the secondary circuit is closed.

(d) Vaults shall conform to the provisions of Wis. Adm. Code sections E 450.41 through E 450.48.

(e) Metal-enclosed switchgear shall consist of a substantial metal structure and a sheet metal enclosure. Barriers between adjacent switchgear units and internal metal barriers shall be not less than ⅛ inch of metal or No. 11 U.S.S. gage. All other covers, panels and doors shall be not less than No. 14 U.S.S. gage. Where installed over a wood floor, suitable protection thereto shall be provided.

(2) NOT IN VAULT OR NOT CONSISTING OF METAL-ENCLOSED SWITCHGEAR. Where the service equipment is not in a vault or metal-enclosed switchgear, the requirements for the overcurrent protection and disconnecting means may be fulfilled by the following:

(a) Air load-interrupter switches, or other approved switches, capable of interrupting the rated circuit load may be used with suitable fuses on a pole or elevated structure outside the building provided the switch may be operated by persons using the building.

(b) On circuits of any voltage, an automatic trip circuit-breaker of suitable ampacity and interrupting capacity with an overcurrent unit in each ungrounded conductor may be used. The circuit-breaker shall be located outside the building as near as practicable to where the service conductors enter the building. The location may be on a pole, roof, foundation, or other structure.

(3) FUSES. Fuses used as permitted in subsections (1) and (2) shall have an interrupting rating at least equal to the maximum short-circuit current possible in the circuit.

(4) CIRCUIT BREAKERS. Circuit breakers shall be free to open in case the circuit is closed on an overload. This can be accomplished by means such as trip-free breakers or by multiple breakers having an operating handle per pole. A service circuit breaker shall indicate clearly whether it is open or closed, and shall be capable of interrupting the maximum short-circuit current to which it may be subjected.

(5) ENCLOSED OVERCURRENT DEVICES. The restriction to 80% of rating for an enclosed overcurrent device on continuous loads shall

not apply to overcurrent devices installed in services operating at over 600 volts.

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

E 230.107 Lightning arresters. Lightning arresters installed in accordance with the requirements of chapter E 280 shall be placed on each ungrounded overhead service conductor on the supply side of the service equipment, when called for by the administrative authority.

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

Chapter E 240

OVERCURRENT PROTECTION

A. INSTALLATION

E 240.01 Scope. This chapter provides the general requirements for the application of overcurrent protective devices.

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

E 240.02 Purpose of overcurrent protection. Overcurrent protection for conductors and equipment is provided for the purpose of opening the electric circuit if the current reaches a value which will cause an excessive or dangerous temperature in the conductor or conductor insulation.

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

E 240.03 Protection of equipment. Equipment shall be protected against overcurrent as specified in the references in the following table:

Equipment	Chapter No.
Appliances	E 422
Capacitors	E 460
Cranes and Hoists	E 610
Emergency Systems	E 700
Generators	E 445
Inductive and Dielectric Heat Generating Equipment	E 665
Machine Tools	E 670
Motion Picture Studios and Similar Locations	E 530
Motors and Motor Controllers	E 430

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

E 240.04 Time-delay overcurrent protection. Circuit-breakers and plug fuses installed in residential occupancies on circuits of 20 amperes or less shall be of the time-delay type.

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

E 240.05 Overcurrent protection of conductors. Conductors shall be protected in accordance with their ampacities as given in tables E 310.12 through E 310.15, except as follows:

(1) EXCEPTION NO. 1. RATING OF NONADJUSTABLE OVERCURRENT PROTECTION OF 800 AMPERES OR LESS. When the standard ampere ratings of fuses and nonadjustable circuit breakers do not correspond with the allowable ampacities of conductors. the next higher standard rating may be used.

(2) EXCEPTION NO. 2. ADJUSTABLE-TRIP CIRCUIT BREAKERS. Adjustable-trip circuit-breakers of the thermal trip, magnetic time-delay trip or instantaneous-trip types shall be set to operate at not more than 125% of the allowable ampacity of the conductor.

Note: The effect of the temperature on the operation of thermally-controlled circuit-breakers should be taken into consideration in the application of such circuit-breakers when they are subjected to extremely low or extremely high temperatures.

(3) EXCEPTION NO. 3. FIXTURE WIRES AND CORDS. Fixture wire or flexible cord, sizes No. 16 or No. 18, and tinsel cord shall be considered as protected by 20-ampere overcurrent devices. Fixture wires of the sizes permitted for taps in section E 210.19 (3) (b) shall be considered as protected by the overcurrent protection of the 30-ampere and 50-ampere branch circuits of chapter E 210. Flexible cord approved for use with specific appliances shall be considered as protected by the overcurrent device of the branch circuit of chapter E 210 when conforming to the following:

20 ampere circuits, No. 18 cord and larger.

30 ampere circuits, cord of 10 amperes capacity and over.

50 ampere circuits, cord of 20 amperes capacity and over.

(4) EXCEPTION NO. 4. MOTOR CIRCUITS. The conductors supplying motors and motor-operated appliances shall be considered as protected by the overcurrent protective devices specified in Wis. Adm. Code sections E 430.032, E 430.034, E 430.052, E 430.053 and E 430.062.

(5) EXCEPTION No. 5. REMOTE CONTROL. Except as provided in Wis. Adm. Code chapter E 725, the conductors of the control circuits of remote-control switches shall be considered as protected from overcurrent by overcurrent devices that are not of the so-called time-lag type and are rated or set at not more than 500% of the ampacity of the remote-control conductors, as specified in tables E 310.12 through E 310.15.

(6) EXCEPTION No. 6. Public highway traffic signal circuits whose conductors are not overloaded may be protected by overcurrent devices rated or set at not more than 200% of the carying capacity of the conductors, as specified in tables E 310.12 through E 310.15.

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

E 240.06 Fuses. (1) If the allowable ampacity of a conductor does not correspond to the rating of a standard-size fuse, the next larger size or rating of fuse may be used only where the rating is 800 amperes or less.

(2) Standard ampere ratings for fuses are 15, 20, 25, 30, 35, 40, 45, 50, 60, 70, 80, 90, 100, 110, 125, 150, 175, 200, 225, 250, 300, 350, 400, 450, 500, 600, 800, 1000, 1200, 1600, 2000, 2500, 3000, 4000, 5000, and 6000. Fuses with ampere rating other than the standard rating listed may be used when they are of an ampere rating smaller than those included in the standard list.

(3) Plug fuses and fuseholders shall not be used in circuits exceeding 125 volts between conductors except in circuits supplied from a system having a grounded neutral and no conductor in such circuits operating at more than 150 volts to ground.

(4) Cartridge fuses and fuseholders rated at 300 volts shall not be used in circuits exceeding 300 volts between conductors except in circuits supplied from a system having a grounded neutral and no conductor in such circuits operating at more than 300 volts to ground.

(5) The screw-shell of plug-type fuseholders shall be connected to the load side of the circuit.

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

E 240.07 Non-adjustable-trip circuit breakers. (1) Non-adjustable-trip circuit breakers, except as otherwise permitted in Note 10 to tables E 310.12 through E 310.15 shall be rated in accordance with the ampacity of the conductor. When the allowable ampacity of a conductor does not correspond to the rating of a standard-size circuit-breaker, the next larger size or rating of circuit-breaker may be used only where the rating is 800 amperes or less.

(2) Standard ampere ratings for circuit-breakers are 15, 20, 30, 40, 50, 60, 70, 100, 125, 150, 175, 200, 225, 250, 300, 350, 400, 500, 600, 700, 800, 1000, 1200 and 1600.

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

E 240.08 Thermal devices. Thermal cutouts, thermal relays and other devices not designed to open short-circuits, shall not be used for protection of conductors against overcurrent due to short-circuits or grounds but may be used to protect motor branch circuit conductors from overload if protected in accordance with section E 430.040.

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

E 240.09 Feeders at supply stations. Each conductor of a constant-potential circuit entering or leaving a supply station, except grounded neutral conductors, shall be protected from excessive current by a circuit-breaker, or by an equivalent device of approved design. Such protective devices shall be located as near as practicable to the point where the conductors enter or leave the building. For the outgoing circuits not connected with other sources of power, the protective devices may be placed on the supply side of transformers or similar devices.

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

E 240.11 Ungrounded conductors. (1) An overcurrent device (fuse or overcurrent trip unit of a circuit-breaker) shall be placed in each ungrounded conductor. The number and position of the overcurrent units such as trip coils or relays shall be as given in table E 240.28.

(2) Circuit-breakers shall open all ungrounded conductors of the circuit, except as follows:

(a) *Exception:* Individual single-pole circuit-breakers may be used for the protection of each conductor of ungrounded 2-wire circuits, each ungrounded conductor of 3-wire direct-current or single-phase circuits, or for each ungrounded conductor of lighting or appliance branch circuits connected to 4-wire 3-phase systems, or 5-wire 2-phase systems, provided such lighting or appliance circuits are supplied from a system having a grounded neutral and no conductor in such circuits operates at a voltage greater than permitted in section E 210.06.

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

E 240.12 Grounded conductor. No overcurrent device shall be placed in any permanently grounded conductor, except as follows:

(1) EXCEPTION No. 1. Where the overcurrent device simultaneously opens all conductors of the circuit.

(2) EXCEPTION No. 2. For motor-running protection as provided in Wis. Adm. Code sections E 430.036 and E 430.037.

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

E 240.13 Change in size of grounded conductor. Where a change occurs in the size of the ungrounded conductor, a similar change may be made in the size of the grounded conductor.

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

E 240.14 Fuses in multiple. For the protection of conductors having allowable ampacities exceeding the rated capacity of the largest approved cartridge type fuse in section E 240.23 (1) (a), such cartridge fuses arranged in multiple may be used, provided as few fuses as possible are used and the fuses are of the same type, characteristics, and rating and provided the fuseholder terminals are mounted on a single continuous pair of bus-bars, or have an equivalent arrangement that will eliminate any potential difference between the terminals of the fuses.

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

B. LOCATION

E 240.15 Location in circuit. Overcurrent devices shall be located at the point where the conductor to be protected receives its supply, except as follows:

(1) EXCEPTION NO. 1. SERVICE CONDUCTORS. An overcurrent protective device for service conductors may be located as specified in section E 230.091.

(2) EXCEPTION NO. 2. SMALLER CONDUCTOR PROTECTED. Where the overcurrent device protecting the larger conductors also protects the smaller conductors in accordance with tables E 310.12 through E 310.15.

(3) EXCEPTION NO. 3. BRANCH CIRCUITS. Taps to individual outlets and circuit conductors supplying a single household electric range shall be considered as protected by the branch circuit overcurrent devices when in accordance with the requirements of sections E 210.19 and E 210.20.

(4) EXCEPTION NO. 4. FEEDER TAPS. A conductor tapped from a feeder shall be considered as properly protected from overcurrent when installed in accordance with sections E 210.25, E 364.08 and E 430.058.

(5) EXCEPTION NO. 5. FEEDER TAPS NOT OVER 10 FEET LONG. Where (a) the smaller conductor has an ampacity of not less than the sum of the allowable ampacities of the conductors of the one or more circuits or loads supplied, and (b) the tap is not over 10 feet long and does not extend beyond the switchboard, panelboard or control devices which it supplies, and (c) except at the point of connection to the feeder, the tap is enclosed in conduit, electrical metallic tubing, or in metal gutters when not a part of the switchboard or panelboard.

(6) EXCEPTION NO. 6. FEEDER TAPS NOT OVER 25 FEET LONG. Where the smaller conductor has an ampacity at least one-third that of the conductor from which it is supplied, and provided the tap is suitably protected from physical damage, is not over 25 feet long, and terminates in a single circuit-breaker or set of fuses which will limit the load on the tap to that allowed by tables E 310.12 through E 310.15. Beyond this point the conductors may supply any number of circuit-breakers or sets of fuses. Where feeders are at a greater elevation than 25 feet, this distance may be increased to 50 feet.

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

E 240.16 Location in premises. Overcurrent devices shall be located where they will be:

(1) Readily accessible, except as provided in Wis. Adm. Code sections E 230.091 and E 230.092 for service equipment, E 364.11 for busways, E 600.06 (4) for signs, E 610.42 for cranes and hoists, and for outdoor overhead lighting. See section E 195.23.

(2) Not exposed to physical damage.

(3) Not in the vicinity of easily ignitible material.

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

C. ENCLOSURES

E 240.17 Enclosures for overcurrent devices. (1) GENERAL. Overcurrent devices shall be enclosed in cutout boxes or cabinets, unless a part of a specially approved assembly which affords equivalent protection, or unless mounted on switchboards, panelboards or controllers located in rooms or enclosures free from easily ignitible material and dampness. The operating handle of a circuit-breaker may be accessible without opening a door or cover.

(2) DAMP OR WET LOCATIONS. Enclosures for overcurrent devices in damp or wet locations shall be of a type approved for such locations and shall be mounted so there is at least one-fourth inch air space between the enclosure and the wall or other supporting surface.

(3) VERTICAL POSITION. Enclosures for overcurrent devices shall be mounted in a vertical position unless in individual instances this is shown to be impracticable.

(4) ROSETTES. Fuses shall not be mounted in rosettes.

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

D. DISCONNECTING AND GUARDING

E 240.18 Disconnection of fuses and thermal cutouts before handling. Disconnecting means shall be provided on the supply side of all fuses or thermal cutouts in circuits of more than 150 volts to ground and cartridge fuses in circuits of any voltage, where accessible to other than qualified persons, so that each individual circuit containing fuses or thermal cutouts can be independently disconnected from the source of electrical energy, except as provided in section E 230.073 and except that a single disconnecting means may be used to control a group of circuits each protected by fuses or thermal cutouts under the conditions described in section E 430.112.

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

E 240.19 Arcing or suddenly-moving parts. Arcing or suddenly-moving parts shall comply with the following:

(1) LOCATION. Fuses and circuit-breakers shall be so located or shielded that persons will not be burned or otherwise injured by their operation.

(2) SUDDENLY-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 being struck by them, shall be guarded or isolated.

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

E. PLUG FUSES AND FUSEHOLDERS

E 240.20 Plug fuses of the Edison-base type. Plug fuses of the Edison-base type shall conform to the following:

(1) CLASSIFICATION. Plug fuses of this type shall be classified at not over 125 volts, 0 to 30 amperes.

(2) LIVE PARTS. Fuses and fuseholders when installed and assembled together shall have no live parts exposed.

(3) MARKING. Plug fuses of 15 amperes rating or less shall be distinguished from those of larger rating by an hexagonal opening in the cap through which the mica or similar window shows, or by some other prominent hexagonal feature such as the form of the top or cap itself, or an hexagonal recess or projection in the top or cap.

Note: Plug fuses of the Edison-base type are recognized in this code only as a replacement item in existing installations.

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

E 240.21 Fuseholders for plug fuses. Fuseholders for plug fuses of 30 amperes or less shall not be installed unless they comply with section E 240.22 or are made to comply with section E 240.22 by the insertion of an adapter.

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

E 240.22 Plug fuses and fuseholders of type S. Where type S plug fuses are to be used as the overcurrent device required by this code, the fuses and fuseholders shall conform to the following requirements:

(1) CLASSIFICATION. Plug fuses and fuseholders of type S shall be classified at not over 125 volts; 0 to 15 amperes, 16 to 20 amperes, and 21 to 30 amperes.

(2) USE OF FUSES IN A FUSEHOLDER OF A DIFFERENT CLASSIFICATION. Fuses of the 16 to 20 ampere and the 21 to 30 ampere classification shall not be usable with fuseholders or adapters of a lower ampere classification.

(3) FUSEHOLDERS AND ADAPTERS. Fuses, fuseholders, and adapters shall be so designed that a fuse other than a type S fuse cannot be used in a fuseholder or adapter designed for type S fuses.

(4) TAMPERABILITY. Fuses, fuseholders and adapters shall be so designed as to be subject to tampering or bridging only with difficulty.

(5) ADAPTERS TO BE NON-REMOVABLE. Fuse adapters shall be so designed that when once inserted in a fuseholder they cannot be removed.

(6) INTERCHANGEABILITY. Fuses, fuseholders and adapters of various manufacturers shall be interchangeable with each other, and the plugs with adapters shall be suitable for use in the Edison-base type fuseholder.

(7) PLUG TYPE. Fuses and fuseholders shall be of the plug type.

(8) AMPERE RATING. Each fuse, fuseholder and adapter shall be marked with its ampere rating.

(9) MARKING. Fuses of the 0 to 15 ampere rating shall be distinguished from those of larger rating by an hexagonal opening in the cap through which the mica or similar window shows, or some other prominent hexagonal feature such as the form of the top or cap itself, or an hexagonal recess or projection in the top or cap.

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

F. CARTRIDGE FUSES AND FUSEHOLDERS

E 240.23 Cartridge fuses and fuseholders. Cartridge fuses and fuseholders shall conform to the following:

(1) CLASSIFICATION. (a) 0–600 ampere cartridge fuses and fuseholders shall be classified as regards current and voltage as follows:

Not over 250 volts Amperes	Not over 300 volts Amperes	Not over 600 volts Amperes
0– 30	0–15	0– 30
31– 60	16–20	31– 60
61–100	21–30	61–100
101–200	31–60	101–200
201–400	----------	201–400
401–600	----------	401–600

(b) 601–6000 ampere cartridge fuses and fuseholders shall be classified at 600 volts as follows:

601– 800	1601–2000	3001–4000
801–1200	2001–2500	4001–5000
1201–1600	2501–3000	5001–6000

Note: There are no 250 volt ratings over 600 amperes, but 600 volt fuses may be used for lower voltages.

(2) NON-INTERCHANGEABLE–0–6000 AMPERE CARTRIDGE FUSEHOLDERS. Fuseholders shall be so designed that it will be difficult to put a fuse of any given class into a fuseholder which is designed for a current lower, or voltage higher, than that of the class to which it belongs. Fuseholders for current limiting fuses shall not permit insertion of fuses which are not current limiting.

(3) MARKING. Fuses shall be plainly marked with the ampere rating, the voltage rating, the current-limitation where it applies, and the name or trademark of the maker. The marking shall be either by direct printing on the fuse barrel or by means of an attached label.

(4) Fuse reducers shall not be used except as permitted by the authority having jurisdiction.

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

G. LINK FUSES AND FUSEHOLDERS

E 240.24 Link fuses and fuseholders. Link fuses and fuseholders shall be used only by special permission and shall conform to the following:

(1) MOUNTING. Link fuses shall be mounted on approved fuseholders.

(2) DIMENSIONS. Link fuses and fuseholders shall have the following dimensions in inches:

Amperes Capacity	Minimum Separation of Nearest Metal Parts of Opposite Polarity	Minimum Break Distance
Not over 125 volts		
601–1500	1½	1½
Not over 250 volts		
601–1500	2¾	2

(a) For 3-wire systems, link fuses, and fuseholders shall have the break distance required for circuits of the potential of the outside wires, except that in 125–250 volt systems with grounded neutral the fuses and fuseholders in 2-wire, 125 volt branch circuits may have the spacing specified for not over 125 volts.

(3) SPACING. A space shall be maintained between the fuse terminals of link fuses of the same polarity of at least ½ inch for voltages up to 125, and of at least ¾ inch for voltages from 126 to 250. This is the minimum distance allowable and greater separation shall be provided where practicable.

(4) MATERIAL. Contact surfaces on tops of link fuses shall be of copper or aluminum having good electrical connections with the fusible part of the strip.

(5) MINIMUM RATING. Link fuses and fuseholders shall be used only in sizes rated at more than 600 amperes, and only by special permission.

(6) MARKING. Link fuses shall be stamped with 80% of the maximum current which they can carry indefinitely.

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

H. CIRCUIT-BREAKERS

E 240.25 Circuit-breakers. Circuit-breakers shall conform to the following:

(1) METHOD OF OPERATION. In general, circuit-breakers shall be capable of being closed and opened by hand without employing any other source of power, although normal operation may be by other power such as electrical, pneumatic, and the like. Large circuit-breakers which are to be closed and opened by electrical, pneumatic, or other power shall be capable of being closed by hand for maintenance purposes and shall also be capable of being tripped by hand under load without the use of power.

(2) TYPE OF OPERATION. Circuit-breakers of the 0–30 ampere class should be of the time-delay type.

(3) INJURY TO OPERATOR. Circuit-breakers shall be arranged and mounted so that their operation is not likely to injure the operator.

(4) INDICATION. Circuit-breakers shall indicate whether they are in the open or closed position.

(5) NON-TAMPERABLE. An air circuit-breaker, used for the branch circuits described in chapter E 210, shall be of such design that any alteration of its trip point (calibration), or in the time required for its operation, will be difficult.

(6) MARKING. Circuit breakers shall be marked with their rating in such a manner that the marking will be durable and visible after installation except that it may be necessary to remove a trim or cover. The ampere rating of circuit breakers rated 100 amperes or less and 600 volts or less shall be molded, stamped, etched, or similarly marked into the handle or the escutcheon area of the circuit breaker. Each circuit breaker intended to interrupt fault currents greater than 10,000 amperes shall have its interrupting rating shown on the label or on the product.

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

E 240.27 Current limiting overcurrent protective device. A current limiting overcurrent protective device is a device which, when interrupting a specified circuit, will consistently limit the short-circuit current in that circuit to a specified magnitude substantially less than that obtainable in the same circuit if the device were replaced with a solid conductor having comparable impedance.

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

TABLE E 240.28

NUMBER OF OVERCURRENT UNITS, SUCH AS TRIP COILS OR RELAYS, FOR PROTECTION OF CIRCUITS

(See diagrams 1 to 19 following this table)

(See section E 240.11 for the overcurrent protection of conductors in general, section E 230.090 for services, and section E 430.037 for motors)

SYSTEMS	*Number and Location of Overcurrent Units
2-Wire, Single-phase A.C. or D.C. Ungrounded.	Two (one in each conductor. Diagram 1).
2-wire, Single-phase, A.C. or D.C., One Wire Grounded.	One (in ungrounded conductor. Diagram 2).
2-Wire, Single-phase A.C. or D.C., Mid-point Grounded.	Two (one in each conductor. Diagram 3).
2-Wire, Single-phase A.C. Derived from 3-Phase, with Ungrounded Neutral.	Two (one in each conductor. Diagram 4).
2-Wire, Single-phase. Derived from 3-Phase, Grounded Neutral System by Using Outside Wires of 3-Phase Circuit.	Two (one in each conductor. Diagram 5).
3-Wire, Single-phase, A.C. or D.C. Ungrounded Neutral.	Three (one in each conductor. Diagram 6).
3-Wire, Single-phase A.C. or D.C. Grounded Neutral.	Two (one in each conductor except neutral conductor. Diagram 7).
3-Wire, 2-Phase, A.C. Common Wire Ungrounded.	Three (one in each conductor. Diagram 8).
3-Wire, 2-Phase, A.C., Common Wire Grounded.	Two (one in each conductor except common conductor. Diagram 9).
4-Wire, 2-Phase Ungrounded, Phases Separate.	Four (one in each conductor. Diagram 10).
4-Wire, 2-Phase, Grounded Neutral, or 5-Wire, 2-Phase, Grounded Neutral.	Four (one in each conductor except neutral conductor. Diagrams 11 and 12).
3-Wire, 3-Phase, Ungrounded.	Three (one in each conductor. Diagram13**).
3-Wire, 3-Phase, 1 Wire Grounded.	Two (one in each ungrounded conductor. Diagram 14).
3-Wire, 3-Phase, Grounded Neutral.	Three (one in each conductor. Diagram 15**).
3-Wire, 3-Phase, Mid-point of One Phase Grounded.	Three (one in each conductor. Diagram 17**).
4-Wire, 3-Phase, Grounded Neutral.	Three (one in each ungrounded conductor. Diagram 18**).
4-Wire, 3-Phase, Ungrounded Neutral.	Four (one in each conductor. Diagram 19).

Notes to Table E 240.28

*1. An overcurrent unit may consist of a series overcurrent tripping device or the combination of a current transformer and a secondary overcurrent tripping device. Either 2 or 3 secondary overcurrent tripping devices may be used with 3 current transformers on a 3-phase system similar to those shown in diagrams 15 and 18.

**2. When 3 current transformers are used instead of 3 series overcurrent tripping devices shown in diagrams 13, 15, 17 and 18, the secondary tripping devices may consist of 3 secondary overcurrent tripping devices or 2 secondary overcurrent tripping devices with a residual current tripping device of a lower range. See diagram 16.

3. Where standard devices are not available with 3 or 4 overcurrent units as required in the table, it is permissible to substitute 2 overcurrent units and one fuse where 3 overcurrent units are called for, 2 overcurrent units and 2 fuses where 4 overcurrent units are called for. The fuse or fuses are to be placed in the conductors not containing an overcurrent unit. This practice, however, of substituting fuses for overcurrent units is to be discouraged for obvious reasons.

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

DIAGRAMS E 240.29

Diagrams 1 to 19 showing number of overcurrent units such as trip coils or relays for the protection of circuits as required by table E 240.28.

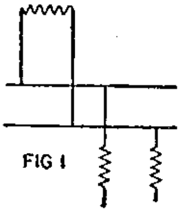


FIG 1

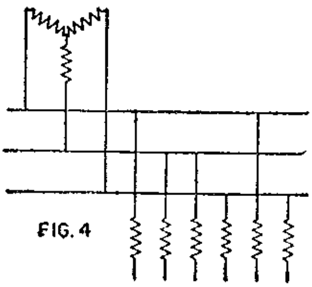


FIG. 4

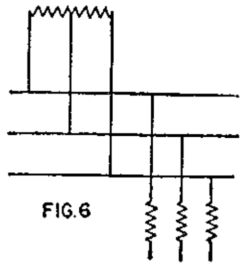


FIG. 6

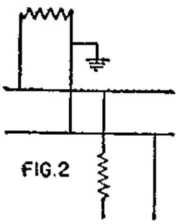


FIG. 2

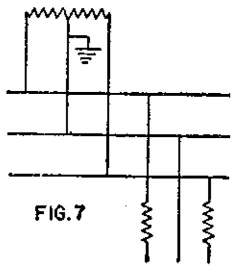


FIG. 7

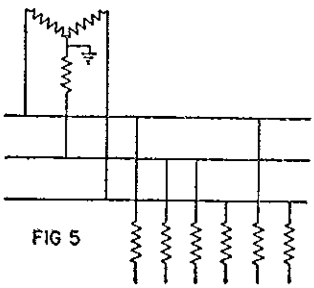


FIG 5

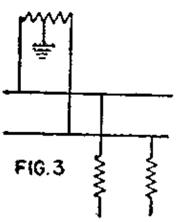


FIG. 3

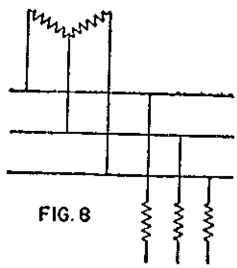


FIG. 8

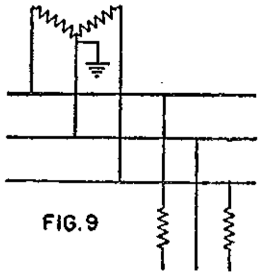


FIG. 9

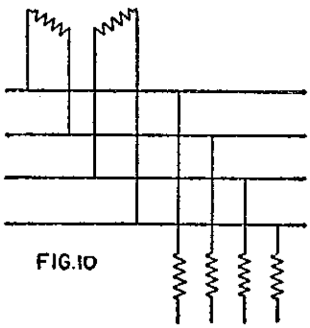


FIG. 10

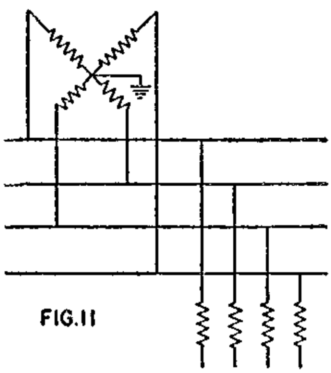


FIG. 11

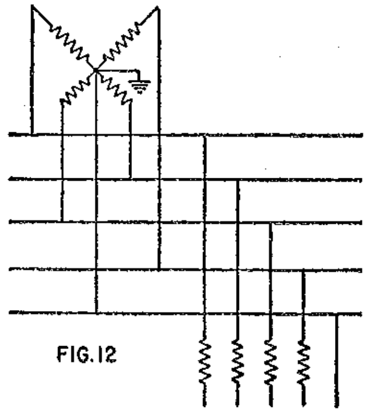


FIG. 12

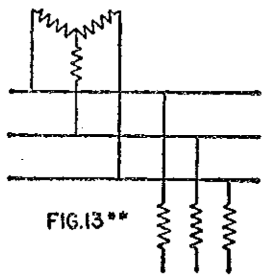


FIG. 13**

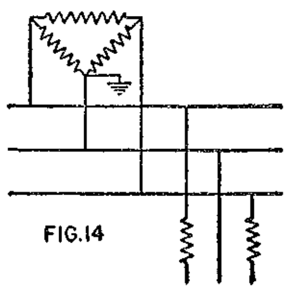


FIG. 14

** See Note 2 of Table E 240.28.

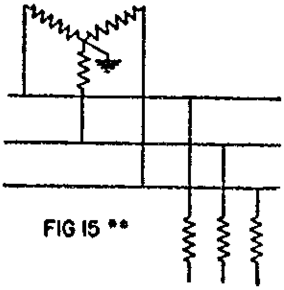


FIG 15 **

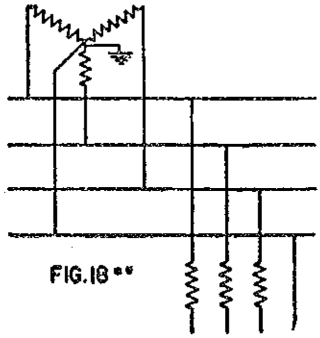


FIG.18 **

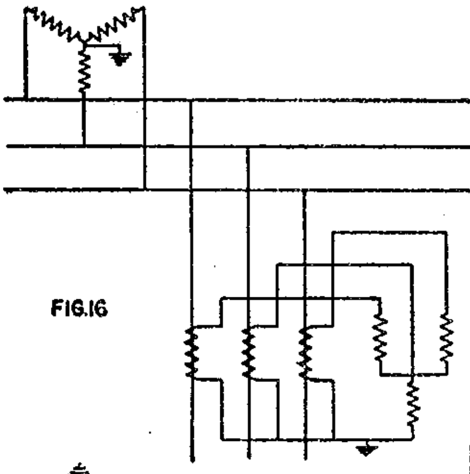


FIG.16

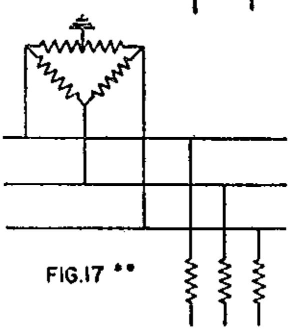


FIG.17 **

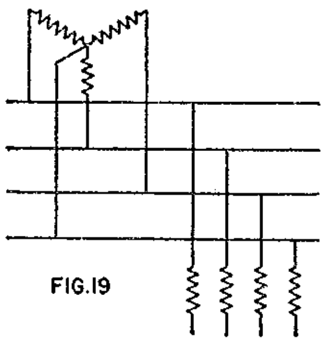


FIG.19

** See Note 2 of Table E 240.28.

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

E 240.30 Supplementary overcurrent protection. Where supplementary overcurrent protection is utilized in connection with appliances or other utilization equipment to provide individual protection for specific components or internal circuits within the equipment itself, this does not abrogate any of the requirements applicable to branch circuits and is not to be used as a substitute for branch-circuit protection.

Note: It is not the intent of the above requirement that supplementary overcurrent protective devices be subject to the accessibility requirements as given elsewhere in this code for branch circuit overcurrent protective devices.

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

Chapter E 250

GROUNDING

A. GENERAL

E 250.001 Scope. This chapter treats of protection of electric installations by grounding. Insulation, isolation and guarding are suitable alternatives under certain conditions. See section E 195.17.

(1) SYSTEMS AND CIRCUITS. Circuits are grounded for the purpose of limiting the voltage upon 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.

(2) EXPOSED CONDUCTOR ENCLOSURES. Exposed conductive materials enclosing electric conductors are grounded for the purpose of preventing a potential above ground on the enclosures.

(3) EXPOSED EQUIPMENT ENCLOSURES. Exposed conductive materials enclosing electric equipment, or forming a part of such equipment, are grounded for the purpose of preventing a potential above ground on the equipment.

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

E 250.002 Other chapters. In other chapters, applying to particular cases of installation of conductors and equipment, there are requirements that are in addition to those of this chapter or are modifications of them:

	Chapter	Section
Appliances	E 422	E 422.12
Branch Circuits	E 210	E 210.05 E 210.06
Communications Circuits	E 800	
Conductors	E 200 E 310	 E 310.02
Cranes and Hoists	E 610	
Fixtures and Lighting Equipment	E 410	E 410.91 E 410.92 E 410.93 E 410.94 E 410.95 E 410.96
Flexible Cords	E 400	E 400.13 E 400.14
Generators	E 445	E 445.08
Grounding Receptacles (Outlets)	E 210	E 210.07 E 210.21 E 210.22
Hazardous Locations	E 500-517	
Inductive and Dielectric Heat Generating Equipment	E 665	
Less than 50 V	E 720	
Lighting Fixtures	E 410	
Metal Working Machine Tools	E 670	
Mobile Homes	E 550	
Motion Picture Studios	E 530	E 530.19 E 530.66
Motors and Controllers	E 430	
Organs	E 650	
Outlets, Switch and Junction Boxes, and Fittings	E 370	E 370.04 E 370.15
Radio and Television	E 810	
Receptacles and Attachments Plugs	E 410	E 410.55 E 410.56
Remote Control Circuits	E 725	E 725.21
Room Air Conditioners	E 422	E 422.61
Services	E 230	
Service Equipment	E 230	E 230.063
Signs and Outline Lighting	E 600	
Sound Recording Equipment	E 640	E 640.04
Swimming Pools	E 680	
Switchboards	E 384	E 384.11
Switches	E 380	E 380.01 E 380.12
Theaters and Assembly Halls	E 520	E 520.81
Transformers	E 450	E 450.08
Travel Trailers	E 551	
X-ray Equipment	E 660	

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

B. CIRCUIT AND SYSTEM GROUNDING

E 250.003 Two-wire direct-current systems. A two-wire direct-current system supplying interior wiring, and operating at not more than 300 volts between conductors, shall be grounded, unless such system is used for supplying industrial equipment in limited areas and the circuit is equipped with a ground detector.

Note: It is recommended that 2-wire direct-current systems operating at more than 300 volts between conductors be grounded when 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 2-wire direct-current systems be not grounded when the voltage to ground of either conductor would exceed 300 volts after grounding. See section E 250.022.

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

E 250.004 Three-wire direct-current systems. The neutral conductor of all 3-wire direct-current systems supplying interior wiring shall be grounded. See section E 250.022.

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

E 250.005 Alternating-current systems. Secondary alternating-current systems supplying interior wiring, and interior alternating-current wiring systems, except those covered in sections E 250.006, E 250.007 and E 250.008, shall be grounded when they can be so grounded that the maximum voltage to ground does not exceed 300 volts. Where a service conductor is uninsulated in accordance with section E 230.004, the system shall be grounded.

Note 1: Higher voltage systems may be grounded.

Note 2: It is recommended that ungrounded systems supplying industrial equipment and operating at more than 300 volts and less than 600 volts be equipped with ground detectors.

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

E 250.006 Furnace circuits. Electric furnace circuits need not be grounded.

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

E 250.007 Electric crane circuits. Circuits for electric cranes operating over combustible fibers in Class III hazardous locations shall not be grounded. See section E 503.13.

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

E 250.008 Circuits of less than 50 volts. Circuits of less than 50 volts need not be grounded, except as follows:

(1) Where supplied by transformers from systems of more than 150 volts to ground, except as provided in subsection E 250.045 (4).

(2) Where supplied by transformers from ungrounded systems.

(3) Where run overhead outside buildings.

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

C. LOCATION OF GROUNDING CONNECTIONS

E 250.021 Current over grounding conductors. The grounding of wiring systems, circuits, arresters, cable armor, conduit, or other metal raceways as a protective measure shall be so arranged that 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. Where an objectionable flow of current occurs over a grounding conductor, due to the use of multiple grounds, (1) one or more of such grounds shall be abandoned, or (2) their location shall be changed, or (3) the continuity of the conductor between the grounding connections shall be suitably interrupted, or (4) other means satisfactory to the administrative authority shall be taken to limit the current.

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

E 250.022 Grounding connection for direct-current systems. Direct-current systems which are to be grounded shall have the grounding connection made at one or more supply stations but not at individual services nor elsewhere on interior wiring.

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

E 250.023 Grounding connections for alternating-current systems. (1) Secondary alternating-current circuits which are to be grounded shall have a connection to a grounding electrode at each individual service, except as provided for in section E 250.021. The connection shall be made on the supply side of the service disconnecting means. Each secondary distribution system which is grounded shall have at least one additional connection to a grounding electrode at the transformer or supply system. No connection to a grounding electrode shall be made to the grounded circuit conductor on the load side of the service disconnecting means, except as provided for in section E 250.024.

(2) Where the secondary system is grounded at any point, the grounded conductor shall be run to each individual service. The grounded conductor shall terminate within the service equipment at the point where the equipment grounding conductor originates. This conductor shall be not smaller than the required grounding conductor specified in table E 250.094 (1).

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

E 250.024 Two or more buildings supplied by a single service. (1) Where more than one building is supplied by the same service, the grounded circuit conductor of the wiring system of any building utilizing one branch circuit supplied from such service may be connected to a grounding electrode at such building, and in the case of any building housing equipment required to be grounded or utilizing 2 or more branch circuits supplied from such service, and in the case of a building housing live stock, shall be so connected.

(2) When a metal raceway system is used in any such building supplied from a single service and this metal raceway or any connected non-current carrying metal part is accessible from any grounded surface, the metal raceway system and the neutral conductor shall be bonded together and connected to an approved ground electrode at the entrance to the building.

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

E 250.025 Conductor to be grounded. For alternating-current interior wiring systems the conductor to be grounded shall be as follows:

(1) Single-phase, 2-wire: the identified conductor;

(2) Single-phase, 3-wire: the identified neutral conductor;

(3) Multi-phase systems having one wire common to all phases: the identified common conductor;

(4) Multi-phase systems having one phase grounded: the identified conductor;

(5) Multi-phase systems in which one phase is used as in (2): the identified neutral conductor. One phase only can be grounded. See chapter E 200.

Note: The identified conductor is commonly known as "the white wire."

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

E 250.026 Isolated systems. For an interior wiring system or circuit which is required to be grounded and which is 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, on the supply side of the first switch controlling the system. See fine print note after section E 200.03.

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

D. ENCLOSURE GROUNDING

E 250.032 Service conductor enclosures. Service raceways, service cable sheaths or armoring, when of metal, shall be grounded.

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

E 250.033 Other conductor enclosures. Metal enclosures for conductors shall be grounded, except they need not be grounded in runs of less than 25 feet which are free from probable contact with ground, grounded metal, metal lath or conductive thermal insulation and which, where within reach from grounded surfaces, are guarded against contact by persons.

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

E 250.034 Spacing from lightning rods. Metal enclosures of conductors shall, wherever practicable, be kept at least 6 feet away from lightning rod conductors. Where it is not practicable to secure 6 feet separation, they shall be bonded together.

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

E. EQUIPMENT GROUNDING

E 250.042 Fixed and stationary equipment; general. Under any of the following conditions, exposed, noncurrent-carrying metal parts of fixed and stationary equipment, which are liable to become energized, shall be grounded:

(1) Where equipment is supplied by means of metal-clad wiring;

(2) Where equipment is located in a wet location and is not isolated;

(3) Where equipment is located within reach of a person who can make contact with any grounded surface or object;

(4) Where equipment is located within reach of a person standing on the ground;

(5) Where equipment is in a hazardous location; see chapters E 500–E 517 inclusive;

(6) Where equipment is in electrical contact with metal or metal lath;

(7) Where equipment operates with any terminal at more than 150 volts to ground, except as follows:

(a) Enclosures for switches or circuit-breakers where accessible to qualified persons only;

(b) Metal frames of electrically-heated devices, exempted by special permission, in which case the frames shall be permanently and effectively insulated from ground;

(c) Transformers mounted on wooden poles at a height of more than 8 feet from the ground.

Note: See section E 103.04 (2), in volume 1.

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

E 250.043 Fixed and stationary equipment; specific. Exposed, non-current-carrying metal parts of the following kinds of equipment, regardless of voltage, shall be grounded:

(1) Frames of motors as specified in section E 430.142;

(2) Controller cases for motors, except lined covers of snap switches;

(3) Electric equipment of elevators and cranes;

(4) Electric equipment in garages, theatres and motion picture studios, except pendent lampholders on circuits of not more than 150 volts to ground;

(5) Motion-picture projection equipment;

(6) Electric signs and associated equipment, unless these are inaccessible to unauthorized persons and are also insulated from ground and from other conductive objects;

(7) Generator and motor frames in an electrically operated organ, unless the generator is effectively insulated both from ground and from the motor driving it;

(8) Switchboard frames and structures supporting switching equipment, except that frames of direct-current, single-polarity switchboards need not be grounded where effectively insulated.

(9) Equipment supplied by class 1 and class 2 remote control and signaling circuits where part B of this chapter requires those circuits to be grounded.

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

E 250.044 Non-electrical equipment. The following metal parts shall be grounded:

(1) Frames and tracks of electrically operated cranes;

(2) The metal frame of a non-electrically driven elevator car to which electric conductors are attached;

(3) Hand-operated metal shifting ropes or cables of electric elevators;

(4) Metal enclosures such as partitions, grill work, etc., around equipment carrying voltages in excess of 750 volts between conductors, unless in substations or vaults under the sole control of the supply company.

Note: Where extensive metal in or on buildings may become energized and is subject to personal contact, adequate bonding and grounding will provide additional safety.

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

E 250.045 Portable equipment. Under any of the following conditions, exposed non-current carrying metal parts of portable equipment, which are liable to become energized, shall be grounded:

(1) In hazardous locations (see Wis. Adm. Code chapters E 500 to E 517);

(2) When operated at more than 150 volts to ground, except:

(a) Motors, where guarded;

(b) Metal frames of electrically-heated appliances exempted by section E 422.12.

(3) In residential occupancies. (a) clothes-washing, clothes-drying, and dish-washing machines, sump pumps, and (b) portable, hand held, motor operated tools and appliances of the following types: drills, hedge clippers, lawn mowers, wet scrubbers, sanders and saws.

1. *Exception:* Such tools and appliances protected by an approved system of double insulation, or its equivalent, need not be grounded. Where such an approved system is employed the equipment shall be distinctively marked.

Note: Portable tools or appliances not provided with special insulating or grounding protection are not intended to be used in damp, wet or conductive locations.

(4) In other than residential occupancies, (a) portable equipment used in damp or wet locations, or by persons standing on the ground, on concrete or metal floors or working inside of metal tanks or boilers, and (b) portable tools which are likely to be used in wet and conductive locations shall be grounded except that they need not be grounded where supplied through an insulating transformer with ungrounded secondary of not over 50 volts.

1. *Exception:* Such tools protected by an approved system of double insulation, or its equivalent, need not be grounded. Where such an approved system is employed, the equipment shall be distinctly marked and where the conditions of maintenance and supervision assure that the proper grounding of the tool will be maintained (as, for example, on some factory production lines) it is recommended that grounded type tools be used.

Note: It is recommended that the frames of all portable motors which operate at more than 50 volts to ground be grounded.

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

E 250.046 Spacing from lightning rods. Metal frames and enclosures of electric equipment shall, wherever practicable, be kept at least 6 feet away from lightning rod conductors. Where it is not practicable to secure 6 feet separation, they shall be bonded together. See sections E 250.034 and E 250.086.

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

F. METHODS OF GROUNDING

E 250.051 Effective grounding. The path to ground from circuits, equipment, and conductor enclosures shall (1) be permanent and continuous and (2) shall have ample ampacity to conduct safely any currents liable to be imposed on it, and (3) shall have impedance sufficiently low to limit the potential above ground and to facilitate the operation of the overcurrent devices in the circuit.

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

E 250.052 Location of system ground connection. The grounding conductor may be connected to the grounded conductor of the wiring system at any convenient point on the premises on the supply side of the service disconnecting means.

Note: It is recommended that high capacity services have the grounding conductor connected to the grounded conductor of the system within the service entrance equipment enclosure.

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

E 250.053 Common use of grounding conductor. The grounding conductor of a wiring system shall also be used for grounding equipment, conduit and other metal raceways or enclosures for conductors, including service conduit or cable sheath and service equipment.

(1) EXCEPTION: The grounding connection as covered in the exception in section E 210.07 may be made to a grounded cold water pipe near the equipment.

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

E 250.054 Common grounding electrode. Where the alternating-current system is connected to a grounding electrode in or at a building as specified in sections E 250.023 and E 250.024, the same electrode shall be used to ground conductor enclosures and equipment in or on that building.

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

E 250.055 Underground service cable. Where served from a continuous underground metal-sheathed cable system, the sheath or armor of underground service cable metallically connected to the underground system, or underground service conduit containing a metal-sheathed cable bonded to the underground system, need not be grounded at the building and may be insulated from the interior conduit or piping.

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

E 250.056 Short sections of raceway. Isolated sections of metal raceway or cable armor, where required to be grounded, shall preferably be grounded by connecting to other grounded raceway or armor, but may be grounded in accordance with section E 250.057.

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

E 250.057 Fixed equipment. (1) Metal boxes, cabinets and fittings, or non-current-carrying metal parts of other fixed equipment, where metallically connected to grounded cable armor or metal raceway, are considered to be grounded by such connection.

(2) Where not so connected they may be grounded in one of the following ways:

(a) By a grounding conductor run with circuit conductors; this conductor may be uninsulated, but where it is provided with an individual covering, the covering shall be fiished in a continuous green color or a continuous green color with a yellow stripe.

(b) By a separate grounding conductor installed the same as a grounding conductor for conduit and the like;

(c) By a grounding conductor in the supply cord, when cord connected as permitted in section E 400.03;

(d) By special permission, other means for grounding fixed equipment may be used.

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

E 250.058 Equipment on structural metal. (1) Electric equipment, secured to and in contact with the grounded structural metal frame of a building, shall be deemed to be grounded.

(2) Metal car frames supported by metal hoisting cables attached to or running over sheaves or drums of elevator machines shall be deemed to be grounded where the machine is grounded in accordance with this code.

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

E 250.059 Portable equipment. Non-current-carrying metal parts of portable equipment may be grounded in any one of the following ways:

(1) By means of the metal enclosure of the conductors feeding such equipment, provided an approved grounding type attachment plug is used, one fixed contacting member being for the purpose of grounding the metal enclosure, and provided, further, that the metal enclosure of the conductors is attached to the attachment plug and to the equipment by connectors approved for the purpose;

(a) *Exception:* The grounding contacting member of grounding type attachment plugs on the power supply cord of hand-held tools or hand-held appliances may be of the movable self-restoring type.

Note: Attachment plug caps are not intended to be used as terminations for metal-clad cable or flexible metal conduit.

(2) By means of a grounding conductor run with the power supply conductors in a cable assembly or flexible cord that is properly terminated in an approved grounding-type attachment plug having a fixed grounding contacting member. The grounding conductor in a cable assembly may be uninsulated; but where an individual covering is provided for such conductors it shall be finished a continuous green color or a continuous green color with a yellow stripe.

(a) *Exception:* The grounding contacting member of grounding type attachment plugs on the power supply cord of hand-held tools or hand-held appliances may be of the movable self-restoring type.

(3) A separate flexible wire or strap, insulated or bare, protected as well as practicable against physical damage may be used only by special permission except where a part of an approved portable equipment.

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

E 250.060 Frames of electric ranges and electric clothes dryers. Frames of electric ranges and electric clothes dryers shall be grounded by any of the means provided for in sections E 250.057 and E 250.059 or where served by 120/240 volt, 3-wire branch circuits, they may be grounded by connection to the grounded circuit conductors, provided the grounded circuit conductors are not smaller than No. 10 AWG. The frames of wall-mounted ovens and counter-mounted cooking units shall be grounded and may be grounded in the same manner as electric ranges.

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

E 250.061 Grounding equipment to circuit conductor. The grounded service conductor on the supply side of the service disconnecting means may be used for grounding meter housing and service equipment and metallic enclosures and guards. The grounded circuit conductor on the load side of the service disconnecting means shall not be used for grounding equipment, cable armor, or metal raceways except as provided in section E 250.057 (2) (d), and in section E 250.060.

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

G. BONDING

E 250.071 Bonding at service equipment. The electrical continuity of the grounding circuit for the following equipment and enclosures shall be assured by one of the means given in section E 250.072.

(1) The service raceways or service cable armor or sheath, except as provided in subsection E 230.063 (2) and section E 250.055;

(2) All service equipment enclosures containing service entrance conductors, including meter fittings, boxes or the like, interposed in the service raceway or armor;

(3) Any conduit or armor which forms part of the grounding conductor to the service raceway.

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

E 250.072 Continuity at service equipment. Electrical continuity at service equipment shall be assured by one of the following means:

(1) Bonding equipment to the grounded service conductor in a manner provided in section E 250.113;

(2) Threaded couplings and threaded bosses on enclosures with joints shall be made up wrench tight where rigid conduit is involved;

(3) Threadless couplings made up tight for rigid conduit and electrical metallic tubing;

(4) Bonding jumpers meeting the other requirements of this chapter. Bonding jumpers shall be used around concentric or eccentric knockouts which are punched or otherwise formed so as to impair the electrical connection to ground.

(5) Other devices (not locknuts and bushings) approved for the purpose.

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

E 250.073 Metal armor or tape of service cable. With service cable having an uninsulated grounded service conductor in continuous electrical contact with its metallic armor or tape, the metal covering is considered to be adequately grounded.

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

E 250.074 Bonding at grounding-type receptacles. Grounding continuity between a grounded outlet box and the grounding circuit of the receptacle shall be established by means of a bonding jumper between the outlet box and the receptacle grounding terminal.

(1) EXCEPTION No. 1: When the box is surface-mounted, direct metal-to-metal contact between the device yoke and the box may be used to establish the grounding circuit.

(2) EXCEPTION NO. 2: Contact devices or yokes designed and approved for the purpose may be used in conjunction with the supporting screws to establish the grounding circuit between the device yoke and flush-type boxes installed in walls.

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

E 250.075 Continuity at other enclosures. The electrical continuity of metallic raceway systems and cable armor that are to serve as grounding conductors shall be assured. At points where raceway or armor connects to metal enclosures, any non-conducting coating which might interrupt such continuity shall be removed unless fittings are used which are so designed that such removal is unnecessary.

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

E 250.076 Voltages exceeding 250 volts. The electrical continuity of metal raceway or metal sheathed cable which contains any conductor other than service entrance conductors of more than 250 volts to ground shall be assured by one of the methods specified in sections E 250.072 (2)-(5), or by one of the following methods:

(1) Threadless fittings, made up tight, with conduit or armored cable;

(2) Two locknuts, one inside and one outside of boxes and cabinets.

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

E 250.077 Loosely-jointed metal raceways. Expansion joints and telescoping sections of raceways shall be made electrically continuous by bonding jumpers or other approved means. Metal trough raceways used in connection with sound recording and reproducing, made up in sections, shall contain a grounding conductor to which each section shall be bonded.

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

E 250.078 Hazardous locations. In hazardous locations, regardless of the voltage involved, the electrical continuity of metallic raceway, boxes and the like, shall be assured by one of the methods specified in subsections E 250.072 (2)-(5).

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

E 250.079 Bonding jumpers. Bonding jumpers shall conform to the following:

(1) MATERIAL AND SIZE. Bonding jumpers shall be of copper or other corrosion-resistant material and shall be of sufficient size to have current-carrying capacity not less than is required in table E 250.094 (1).

(2) ATTACHMENT. Bonding jumpers shall be attached to cabinets and the like in a manner provided in section E 250.113; where used between grounding electrodes or around water meters and the like, they shall be attached in a manner provided for in section E 250.114.

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

H. GROUNDING ELECTRODES

E 250.081 Water pipe. A metallic underground water piping system, either local or supplying a community, shall always be used as the grounding electrode where such a piping system is available. If the buried portion of the metallic piping system is less than 50 feet excluding well casings, or has a resistance to ground of more than 3 ohms, the piping system ground shall be augmented by at least 2 grounding electrodes recognized in section E 250.082 and section E 250.083 wherever the circuit or non-current carrying parts are required to be grounded. The interior metallic cold water piping system shall always be bonded to the one or more grounding electrodes.

Note: Expanding use of nonmetallic piping for water systems and insulating couplings on metallic water systems makes it more important that water piping within a building be adequately grounded without depending on connections to an outside piping system. The interior piping system should be electrically continuous. Bonding to gas, sewer, hot water piping and metallic air ducts within the premises will provide additional safety.

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

E 250.082 Other available electrodes. Where a water system as described in section E 250.081 is not available, the grounding connection may be made to any of the following if the resistance to ground is less than 3 ohms or the metal is supplemented by 2 electrodes of the type recognized in section E 250.083:

(1) The metal frame of the building, if effectively grounded;

(2) Other local metallic underground systems, such as piping, tanks and the like. Gas piping shall not be used.

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

E 250.083 Made electrodes. Where electrodes described in sections E 250.081 and E 250.082 are not available, the grounding electrode shall consist of a driven pipe, driven rod, buried plate or other device approved for the purpose and conforming to the following requirements:

(1) PLATE ELECTRODES. Each plate electrode shall present not less than 2 square feet of surface to exterior soil. Electrodes of iron, or steel plates shall be at least ¼ inch in thickness. Electrodes of non-ferrous metal shall be at least 0.06 inch in thickness.

(2) PIPE ELECTRODES. Electrodes of pipe or conduit shall be not smaller than of the ¾ inch trade size and, where of iron or steel, shall have the outer surface galvanized or otherwise metal-coated for corrosion protection.

(3) ROD ELECTRODES. Electrodes of rods of steel or iron shall be at least ⅝ inch in diameter. Approved rods of non-ferrous materials or their approved equivalent used for electrodes shall be not less than ½ inch in diameter.

(4) INSTALLATION. Electrodes should, as far as practicable, be imbedded below permanent moisture level. Except where rock bottom is encountered, pipes or rods shall be driven to a depth of at least 8 feet regardless of size or number of electrodes used. Pipes or rods when less than standard commercial length shall preferably be of one piece. Such pipes or rods shall have clean metal surfaces and shall not be covered with paint, enamel or other poorly conducting materials. Where rock bottom is encountered at a depth of less than 4 feet, electrodes shall be buried in a horizontal trench, and where pipes or rods are used as the electrode they shall comply with subsections (2) and (3) and shall not be less than 8 feet in length. Each elec-

trode shall be separated at least 6 feet from any other electrode, including those used for signal circuits, radio, lightning rods, or any other purpose.

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

E 250.084 Resistance. If the resistance to ground of an underground piping or metallic system is more than 3 ohms, 2 made electrodes must be added to the grounding system. If a single made electrode does not have a resistance to ground of less than 25 ohms, 2 made electrodes shall be installed. The distance between made electrodes shall be at least 6 feet.

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

E 250.085 Railway tracks. Rails or other grounded conductors of electric railway circuits shall not be used (1) as a ground for other than railway lightning arresters and railway equipment, conduit, armored cable, metal raceway, and the like, where other effective grounds are available; and (2) in no case shall such rails or other grounded conductors of railway circuits be used for grounding interior wiring systems other than those supplied from the railway circuit itself.

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

E 250.086 Use of lightning rods. Lightning rod conductors and driven pipes, rods or other made electrodes used for grounding lightning rods, shall not be used in lieu of the made grounding electrodes required by this chapter for grounding wiring systems and equipment. The foregoing provision shall not be taken to forbid the bonding together of the several made electrodes that are respectively provided for electric wiring systems and equipment, for communication systems, and for lightning protection. See section E 800.31 (2) (e).

Note: It is recommended that all separate electrodes be bonded together to limit potential differences betwwen them and between their associated wiring systems.

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

J. GROUNDING CONDUCTORS

E 250.091 Material. The material for the grounding conductors shall be as follows:

(1) FOR SYSTEM OR COMMON GROUNDING CONDUCTOR. The grounding conductor of a wiring system shall be of copper or other corrosion-resistant material. The conductor may be solid or stranded, insulated or bare. Except in cases of bus-bars, the grounding conductor shall be without joint or splice throughout its length. Where the grounding conductor is not of copper, its electrical resistance per linear foot shall not exceed that of the allowable copper conductor for such a purpose.

(2) FOR CONDUCTOR ENCLOSURES AND EQUIPMENT ONLY. The grounding conductor for equipment and for conduit and other metal raceways or enclosures for conductors, may be a conductor of copper or other corrosion-resistant material, stranded or solid, insulated or bare, a bus-bar or a rigid conduit, steel pipe, electrical metallic tubing or the armor of type AC metal-clad cable, except that under condi-

tions favorable to corrosion, a suitable corrosion-resistant material shall be used. Where conduit is used as a grounding conductor, all joints and fittings shall be made wrench tight.

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

E 250.092 Installation. Grounding conductors shall be installed as follows:

(1) SYSTEM OR COMMON GROUNDING CONDUCTOR. A grounding conductor. No. 4 or larger, may be attached to the surface on which it is carried without the use of knobs, tubes or insulators. It need not have protection unless exposed to severe physical damage. A No. 6 grounding conductor, which is free from exposure to physical damage, may be run along the surface of the building construction without metal covering or protection, where it is rigidly stapled to the construction; otherwise, it shall be in conduit, electrical metallic tubing or cable armor. Grounding conductors smaller than No. 6 shall be in conduit, electrical metallic tubing, cable armor, wireways, auxiliary gutters or any other approved raceways. Metallic enclosures for grounding conductors shall be electrically continuous from the point of attachment to cabinets or equipment to the grounding electrode, and shall be securely fastened to the ground clamp or fitting. Where rigid metallic conduit or steel pipe is used as protection for a grounding conductor, the installation shall comply with the requirements of Wis. Adm. Code chapter E 346; where electrical metallic tubing is used, the installation shall comply with the requirements of chapter E 348. Aluminum grounding conductors shall not be used where in direct contact with masonry or the earth or where subject to corrosive conditions. Where used outside, aluminum grounding conductors shall not be installed within 18 inches of the earth.

(2) CONDUCTOR ENCLOSURES AND EQUIPMENT ONLY. A grounding conductor for conductor enclosures and equipment only shall meet the requirements of section E 250.092 (1), except that where smaller than No. 6, as permitted by section E 250.095, it need not be armored or installed in a raceway where run through the hollow spaces of a wall or partition or otherwise run so as not to be subject to physical damage.

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

E 250.093 Direct-current systems. The carrying capacity of the grounding conductor for a direct-current supply system or generator shall not be less than that of the largest conductor supplied by the system, except that where the grounded circuit conductor is a neutral derived from a balancer winding or a balancer set protected in accordance with requirements of section E 445.04 (4), the size of the grounding conductor shall not be less than that of the neutral conductor. The grounding conductor shall in no case be smaller than No. 8 copper.

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

E 250.094 Alternating-current systems. (1) SERVICE AND COMMON GROUNDING CONDUCTOR FOR GROUNDED SYSTEMS. Where the wiring system is grounded, the size of the grounding conductor for an alternating current system or for a common grounding conductor shall not be less than is given in table E 250.094 (1), except that where connected to made electrodes (as in section E 250.083), that portion of the grounding conductor which is the sole connection between the grounding electrode and the grounded system conductor need not be larger than No. 6 copper wire or its equivalent in ampacity. The grounding conductor for an underground service shall be sized the same as required for an equivalent overhead service.

(2) SERVICE EQUIPMENT GROUNDING CONDUCTOR FOR UNGROUNDED SYSTEMS. Where the wiring system is ungrounded, the size of a grounding conductor for a service raceway, for the metal sheath or armor of a service cable, and for service equipment shall not be less than is given in table E 250.094 (2), except that where connected to made electrodes (as in section E 250.083) that portion of the grounding conductor which is the sole connection between the grounding electrode and the service equipment need not be larger than No. 6 copper wire or its equivalent in ampacity. The grounding conductor for an underground service shall be sized the same as required for an equivalent overhead service.

TABLE E 250.094 (1)

SERVICE AND COMMON GROUNDING CONDUCTORS FOR GROUNDED SYSTEMS

Size of Largest Service Conductors or Equivalent for Multiple Conductors		Size of Grounding Conductor AWG No.	
COPPER	ALUMINUM	COPPER	ALUMINUM*
2 or smaller	0 or smaller	8	6
1 or 0	2/0 or 3/0	6	4
2/0 or 3/0	4/0 or 250 MCM	4	2
Over 3/0 to 350 MCM	Over 250 MCM to 500 MCM	2	0
Over 350 MCM to 600 MCM	Over 500 MCM to 900 MCM	0	3/0
Over 600 MCM to 1100 MCM	Over 900 MCM to 1750 MCM	2/0	4/0
Over 1100 MCM	Over 1750 MCM	3/0	250 MCM

*See installation restrictions in Section E 250.092 (1)

TABLE E 250.094 (2)

SERVICE EQUIPMENT GROUNDING CONDUCTOR FOR UNGROUNDED SYSTEMS

Size of Largest Service Conductor or Equivalent for Multiple Conductors		Size of Grounding Conductor AWG No. or Trade Size (Inch)			
Copper	Aluminum	Copper	Aluminum	Conduit or Pipe	Electrical Metallic Tubing
2 or smaller	0 or smaller	8	6	½	½
1 or 0	2/0 or 3/0	6	4	½	1
2/0 or 3/0	4/0 or 250	4	2	¾	1¼
Over 3/0 to 350 MCM	Over 250 MCM to 500 MCM	2	0	¾	1¼
Over 350 MCM to 600 MCM	Over 500 MCM to 900 MCM	0	3/0	1	2
Over 600 MCM to 1100 MCM	Over 900 MCM to 1750 MCM	2/0	4/0	1	2
Over 1100 MCM	Over 1750 MCM	3/0	250 MCM	1	2

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

E 250.095 Interior raceway and equipment. The size of the grounding conductor for conduit, cable sheath or armor, and other metal raceways or enclosures for conductors, and for equipment, shall be not less than given in table E 250.095. For ratings above 1200 amperes, the size of the grounding conductor shall be increased proportionately. See Wis. Adm. Code section E 384.03 (3).

TABLE E 250.095

SIZES OF CONDUCTORS FOR GROUNDING INTERIOR RACEWAY AND EQUIPMENT

Rating or Setting of Automatic Overcurrent Device in Circuit Ahead of Equipment, Conduit, etc., Not Exceeding (Amperes)	Size of Grounding Conductor			
	Copper Wire No.	Aluminum* Wire No.	Conduit or Pipe (Inch)	Metallic Tubing (Inch)
20	16**	14**	½	½
30	14	12	½	½
40	12	10	½	½
60	10	8	½	½
100	8	6	½	½
200	6	4	½	1
400	3	1	¾	1¼
600	1	00	¾	1¼
800	0	000	1	2
1000	00	0000	1	2
1200	000	250 MCM	1	2

*See installation restrictions in section E 250.092 (1).

**Permissible only when part of an approved cable assembly.

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

E 250.096 Portable and pendent equipment. For grounding portable or pendent equipment, the conductors of which are protected by fuses or circuit-breakers rated or set at not exceeding 20 amperes, No. 18 copper wire may be used. Conductors of Nos. 16 or 18 copper which are used for grounding portable equipment shall be part of an approved flexible cord assembly. For grounding portable or pendent equipment protected at more than 20 amperes, table E 250.095(1) shall be followed.

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

E 250.097 Outline lighting. Isolated non-current-carrying metal parts of outline lighting systems may be bonded together by a No. 14 conductor protected from physical damage, where a conductor complying with section E 250.095 is used to ground the group.

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

E 250.098 Common raceway. A grounding conductor may be run in the same metal raceway with other conductors of the system to which it is connected.

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

E 250.099 Continuity. No automatic cutout or switch shall be placed in the grounding conductor of an interior wiring system unless the opening of the cutout or switch disconnects all sources of energy.

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

K. GROUNDING CONDUCTOR CONNECTIONS

E 250.111 To raceway or cable armor. The point of connection of the grounding conductor to interior metal raceways, cable armor and the like shall be as near as practicable to the source of supply and shall be so chosen that no raceway or cable armor is grounded through a run of smaller size than is called for in section E 250.095.

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

E 250.112 To electrode. The grounding connection to the electrode shall be located as follows:

(1) TO WATER PIPES. For residential occupancies, the system or common grounding conductors shall be attached to a water piping system on the street side of the water meter where the meter is located within the building. If the meter is located outside, the point of connection shall be the closest accessible point to where the water system enters the building. For other than residential occupancies the point of attachment shall be on the street side of the water meter or on a cold water pipe of adequate ampacity as near as practicable to the water service entrance to the building. Where the source of the water supply is from a driven well in the basement of the premises, the connection shall be made as near as practicable to the well. Where practicable, the point of attachment shall be accessible. Where 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 street side of the water meter or the pipe entrance which contain insulating sections or are liable to become disconnected, as at meters, valves and service unions. Whenever a metallic water system becomes available within the building, the service ground shall be connected to it.

(2) TO OTHER ELECTRODES. The grounding conductor shall be attached to other electrodes permitted in sections E 250.082 and E 250.083 at a point which will assure a permanent ground. Where practicable the point of attachment shall be accessible.

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

E 250.113 Attachment to circuits and equipment. The grounding conductor, bond, or bonding jumper shall be attached to circuits, conduits, cabinets, equipment, and the like, which are to be grounded, by means of suitable lugs, pressure connectors, clamps, or other approved means, except that connections which depend upon solder shall not be used.

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

E 250.114 Continuity and attachment of branch circuit grounding conductors to boxes. Where more than one grounding conductor of a branch circuit enters a box, all such conductors shall be in good electrical contact with each other and the arrangement shall be such that the disconnection or removal of a receptacle, fixture, or other device fed from the box will not interfere with or interrupt the grounding continuity.

(1) METALLIC BOXES. A connection shall be made between the one or more grounding conductors and a metallic box by means of a

grounding screw which shall be used for no other purpose, or an approved grounding device.

(2) NONMETALLIC BOXES. One or more grounding conductors brought into a nonmetallic outlet box shall be so arranged that a connection can be made to any fitting or device in that box which requires grounding.

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

E 250.115 Attachments to electrodes. The grounding conductor shall be attached to the grounding electrode by means of (1) an approved bolted clamp of cast bronze or brass or of plain or malleable cast iron, or (2) a pipe fitting, plug, or other approved device, screwed into the pipe or into the fitting, or (3) other equally substantial approved means. The grounding conductor shall be attached to the grounding fitting by means of suitable lugs, pressure connectors, clamps, or other approved means, except that connections which depend upon solder shall not be used. Not more than one conductor shall be connected to the grounding electrode by a single clamp or fitting, unless the clamp or fitting is of a type approved for such use.

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

E 250.116 Ground clamps. For the grounding conductor of a wiring system the sheet-metal-strap type of ground clamp is not considered adequate unless the strap is attached to a rigid metal base which, when installed, is seated on the water pipe, or other electrode and the strap is of such material and dimensions that it is not liable to stretch during or after installation.

Note: Ground clamps for use on copper water tubing and copper, brass, or lead pipe should preferably be of copper, and those for use on galvanized or iron pipe should preferably be of galvanized iron and so designed as to avoid physical damages to pipe. Ground clamps used with aluminum grounding conductors should be approved for the purpose.

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

E 250.117 Protection of attachment. Ground clamps or other fittings, unless approved for general use without protection, shall be protected from ordinary physical damage (1) by being placed where they are not liable to be damaged or (2) by being enclosed in metal, wood, or equivalent protective covering.

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

E 250.118 Clean surfaces. Where a non-conductive protective coating, such as paint or enamel, is used on the equipment, conduit, couplings or fittings, such coating shall be removed from threads and other contact surfaces in order to insure a good electrical connection.

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

L. INSTRUMENT TRANSFORMERS, RELAYS, ETC.

E 250.121 Instrument transformer circuits. The secondary circuits of current and potential instrument transformers shall be grounded where the primary windings are connected to circuits of 300 volts or more to ground, and, where on switchboards, shall be grounded irrespective of voltage, except that such circuits need not be grounded where the primary windings are connected to circuits of 750 volts or less and no live parts or wiring are exposed or accessible to other than qualified persons.

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

E 250.122 Instrument transformer cases. Cases or frames of instrument transformers shall be grounded where accessible to other than qualified persons, except that cases or frames of current transformers, the primaries of which are not over 150 volts to ground and which are used exclusively to supply current to meters, need not be grounded.

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

E 250.123 Cases of instruments, meters and relays; operating voltage 750 or less. Instruments, meters and relays which operate with windings or working parts at 750 volts or less shall be grounded as follows:

(1) NOT ON SWITCHBOARDS. Instruments, meters and relays not located on switchboards, which operate with windings or working parts at 300 volts or more to ground, and accessible to other than qualified persons, shall have the cases and other exposed metal parts grounded;

(2) ON DEAD FRONT SWITCHBOARDS. Instruments, meters and relays (whether operated from current and potential transformers, or connected directly in the circuit) on switchboards having no live parts on the front of the panels shall have the cases grounded;

(3) ON LIVE FRONT SWITCHBOARDS. Instruments, meters and relays (whether operated from current and potential transformers, or connected directly in the circuit) on switchboards having exposed live parts on the front of panels shall not have their cases grounded. Mats of insulating rubber or other suitable floor insulation, shall be provided for the operator where the voltage to ground exceeds 150.

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

E 250.124 Cases of instruments, meters and relays; operating voltage over 750. Where instruments, meters and relays have current-carrying parts over 750 volts to ground, they shall be isolated by elevation or protected by suitable barriers, grounded metal or insulating covers or guards. Their cases shall not be grounded, except as follows:

(1) In electrostatic ground detectors the internal ground segments of the instrument are connected to the instrument case and grounded; the ground detector shall be isolated by elevation.

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

E 250.125 Instrument grounding conductor. The grounding conductor for secondary circuits of instrument transformers and for instrument cases shall not be smaller than No. 12 where of copper; where of other metal, it shall have equal conductance. Cases of instrument transformers, instruments, meters and relays which are mounted directly on grounded metal surfaces of enclosures or grounded metal switchboard panels shall be considered to be grounded and no additional grounding conductor will be required.

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

M. LIGHTNING ARRESTERS

E 250.131 On secondary services; 750 volts or less. Where a lightning arrester is installed on a secondary service, the connections to the service conductors and to the grounding conductor shall be as short as practicable. The grounding conductor may be (1) the grounded service conductor, or (2) the common grounding conductor, or (3) the service equipment grounding conductor. The bonding or grounding conductor shall be of copper not smaller than No. 14 or of equivalent corrosion-resistant material.

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

E 250.132 On primary circuits. The grounding conductor of a lightning arrester protecting a transformer which supplies a secondary distribution system may be interconnected as follows:

(1) METALLIC INTERCONNECTION. A metallic interconnection may be made to the secondary neutral provided that, in addition to the direct grounding connection at the arrester:

(a) The grounded conductor of the secondary has elsewhere a grounding connection to a continuous metallic underground water piping system. However, in urban water pipe areas where there are at least 4 waterpipe connections on the neutral and not less than 4 such connections in each mile of neutral, the metallic interconnection may be made to the secondary neutral with omission of the direct grounding connection at the arrester.

(b) The grounded conductor of the secondary system is part of a multi-grounded neutral system, of which the primary neutral has at least 4 ground connections in each mile of line in addition to a ground at each service.

(2) THROUGH SPARK GAP. Where the secondary is not grounded as in subsection (1), but is otherwise grounded as in sections E 250.082 and E 250.083, such interconnection, where made, shall be through a spark gap having a 60-cycle breakdown voltage of at least twice the primary circuit voltage but not necessarily more than 10 kv, and there shall be at least one other ground on the grounded conductor of the secondary not less than 20 feet distant from the lightning arrester grounding electrode.

(3) BY SPECIAL PERMISSION. Except as above provided, interconnection of the arrester ground and the secondary neutral may be made only by special permission.

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

Chapter E 280

LIGHTNING ARRESTERS

A. INDUSTRIAL STATIONS

E 280.01 Where required. Lightning arresters shall be provided in industrial stations in locations where thunderstorms are frequent and adequate protection against lightning is not otherwise provided.

Note: For lightning arresters in hazardous locations, see chapters E 500–E 517.

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

E 280.02 Number required. A lightning arrester shall be connected to each ungrounded overhead conductor entering or leaving the station, except that where there is more than one circuit, a single set of arresters may be installed on the station bus where means are provided to protect circuits that may remain disconnected from the bus.

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

E 280.03 Where connected. The arrester shall be connected on the line side of all connected station apparatus.

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

B. OTHER OCCUPANCIES

E 280.11 Utilization equipment. Lightning arresters installed for the protection of utilization equipment may be installed either inside or outside the building or enclosure containing the equipment to be protected. Arresters, unless isolated by elevation or made otherwise inaccessible to unqualified persons, shall be enclosed, and where the operating voltage of the circuit exceeds 750 volts between conductors they shall be inaccessible to unqualified persons.

Note: Secondary lightning protection devices may reduce damage to wiring and equipment caused by lightning disturbances. See section E 502.03.

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

C. GENERAL

E 280.21 Location; indoors. Arresters installed indoors shall be located well away from other equipment, passageways and combustible parts of buildings, and where containing oil shall be separated from other equipment by walls meeting the requirements of section E 450.42.

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

E 280.22 Location; outdoors. Where arresters containing oil are located outdoors, provision shall be made to drain away any accumulation of oil.

Note: Oil may be drained away by ditches and drains or the oil may be absorbed and danger of spreading removed by paving the yard with cinders or other absorbent material to a depth of several inches.

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

E 280.23 Connections; size and material. The connections between the arrester and the line wire or bus, and between arrester and ground shall be of copper wire or cable or the equivalent, and, except as provided on secondary services in section E 250.131, shall not be smaller than No. 6, and shall be made as short and as straight as practicable, avoiding as far as possible all bends and turns, especially sharp bends.

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

E 280.24 Insulation. Lightning-protection accessories such as gap electrodes, and choke coils where used, shall have an insulation from ground or from other conductors at least equal to the insulation required at other points of the circuit.

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

E 280.25 Switch for isolating arrester. Where isolating switches or disconnecting devices are used, they shall withstand, in full open position, a voltage test between live parts 10% in excess of the maximum voltage test they will withstand to ground.

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

E 280.26 Grounding. Lightning arresters shall be grounded in the manner prescribed in chapter E 250.

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

WIRING METHODS AND MATERIALS

Chapter E 300

WIRING METHODS—GENERAL REQUIREMENTS

E 300.01 Scope. (1) The provisions herein apply to the electrical and mechanical requirements for the various methods of installing fixed electrical conductors for electric light, heat and power and certain signal systems.

(2) The provisions of this chapter shall apply to all wiring installations, except for remote-control, including low voltage relay switching, low-energy power and signal systems as provided in chapter E 725, and communication systems as provided in chapter E 800.

(3) On premises where a continuous underground metallic water-piping network system is not available as a grounding electrode, and where it is not practicable otherwise to secure a ground of permanently low resistance, the use of a wiring method which does not employ metal enclosures for the wires is recommended, unless the character or occupancy of the building is such as to require the use of a metal-enclosed wiring system.

(4) The provisions of this chapter are not intended to apply to the conductors which form an integral part of equipment such as motors, motor controllers and the like.

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

E 300.02 Voltage limitations. Wiring methods specified herein may be used for voltages not exceeding 600, unless specifically limited in some chapter. They may be used for voltages over 600 where specifically permitted elsewhere in this code.

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

E 300.03 Conductors of different systems. (1) Conductors of light and power systems of 600 volts or less may occupy the same enclosure, without regard to whether the individual circuits are alternating-current or direct-current, only where all conductors are insulated for the maximum voltage of any conductor within the enclosure.

(a) Where A.C. and D.C. lighting or power conductors occupy the same enclosure, the D.C. conductors shall be marked "D.C." at all places of access.

(2) Conductors of light and power systems of over 600 volts shall not occupy the same enclosure with conductors of light and power systems of 600 volts or less.

(3) Secondary wiring to electric discharge lamps of 1,000 volts or less, insulated for the secondary voltage involved, may occupy the same fixture enclosure as the branch circuit conductors.

(4) Primary leads of electric discharge lamp ballasts, insulated for the primary voltage of the ballast, when contained within the individual wiring enclosure may occupy the same fixture enclosure as the branch circuit conductors.

(5) Excitation, control, relay and ammeter conductors used in connection with any individual motor or starter may occupy the same enclosure as the motor circuit conductors.

(6) Conductors of signal or radio systems shall not occupy the same enclosure with conductors of light or power systems except as permitted for sound recording in section E 640.06; for remote-control, low-energy power and signal circuits in sections E 725.16 and E 725.42; and communication systems in sections E 800.03 and E 800.21.

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

E 300.04 Protection against physical damage. Where subject to physical damage, conductors shall be adequately protected.

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

E 300.05 Protection against corrosion. Metal raceways, cable armor, boxes. cable sheathing, cabinets, metallic elbows, couplings and fittings shall be of material suitable for the environment in which they are to be installed.

(1) Ferrous raceways, cable armor, boxes, cable sheathing, cabinets, metallic elbows, couplings and fittings shall be suitably protected against corrosion inside and outside (except threads at joints) by a coating of approved corrosion resistant material such as zinc, cadmium, or enamel. Where protected from corrosion solely by enamel, they shall not be used out of doors or in wet locations as described in (3) below.

(2) Unless made of materials judged suitable for the condition, or unless corrosion protection approved for the condition is provided, ferrous or non-ferrous metallic raceways, cable armor, boxes, cable sheathing, cabinets, elbows, couplings and fittings shall not be installed in concrete or in direct contact with the earth, or in areas subject to severe corrosive influences.

(3) In portions of dairies, laundries, canneries, and other indoor wet locations, and in locations where walls are frequently washed or where there are surfaces of absorbent materials, such as damp paper or wood, the entire wiring system, including all boxes, fittings, con-

duits and cable used therewith, shall be mounted so that there is at least one-quarter inch air space between it and the wall or supporting surface.

Note: Meat-packing plants, tanneries, hide cellars, casing rooms, glue houses, fertilizer rooms, salt storage, some chemical works, metal refineries, pulp mills, sugar mills, round houses, some stables, and similar locations are judged to be occupancies where severe corrosive conditions are likely to be present.

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

E 300.06 Raceways exposed to different temperatures. (1) SEALING. Where portions of an interior raceway system are exposed to widely different temperatures, as in refrigerating or cold-storage plants, provision shall be made to prevent circulation of air from a warmer to a colder section through the raceway.

(2) EXPANSION JOINTS. Expansion joints for runs of raceway shall be provided where required to compensate for thermal expansion and contraction.

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

E 300.07 Underground runs. (1) Conductors run underground shall comply with the provisions of Wis. Adm. Code section E 230.032 as far as mechanical protection is concerned.

(2) Underground cable run under a building shall be in a raceway that is extended beyond the outside wall of the building.

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

E 300.08 Through studs, joists and rafters. (1) Where exposed or concealed wiring conductors in insulating tubes or cables are installed through bored holes in studs, joists or similar wood members, holes shall be bored at the approximate centers of wood members, or at least 2 inches from the top edge.

(2) Where there is no objection because of weakening the building structure, metal-clad or non-metallic sheathed cable, aluminum sheathed cable and type MI cable may be laid in notches in the studding or joists when the cable at those points is protected against the driving of nails into it by having the notch covered with a steel plate at least $\frac{1}{16}$ inch in thickness before building finish is applied.

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

E 300.09 Grounding metal enclosures. Metal raceways, boxes, cabinets, cable armor and fittings shall be grounded if and as prescribed in chapter E 250.

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

E 300.10 Electrical continuity of metal raceways and enclosures. Metal raceways, cable armor, and other metal enclosures for conductors, shall be metallically joined together into a continuous electrical conductor, and shall be so connected to all boxes, fittings and cabinets as to provide effective electrical continuity. Raceways and cable assemblies shall be mechanically secured to boxes, fittings, cabinets and other enclosures, except as provided for non-metallic boxes in section E 370.07.

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

E 300.11 Secured in place. Raceways, cable assemblies, boxes, cabinets and fittings shall be securely fastened in place, unless otherwise provided for specific purposes elsewhere in this code.

Note: See chapter E 318 for Continuous Rigid Cable Supports.

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

E 300.12 Mechanical continuity; raceways and cables. Raceways and cable assemblies shall be continuous from outlet to outlet and from fitting to fitting.

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

E 300.13 Mechanical continuity; conductors. Conductors shall be continuous between outlets, devices, etc., and, except as permitted for auxiliary gutters in section E 374.08, and for wireways in section E 362.06, there shall be no splice or tap within a raceway itself.

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

E 300.14 Free length of conductors at outlets and switch points. At least 6 inches of free conductor shall be left at each outlet and switch point for the making up of joints or the connection of fixtures or devices, except where conductors are intended to loop without joints through lampholders, receptacles and similar devices.

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

E 300.15 Boxes. Except as permitted in sections E 336.11 and E 410.60, a box shall be installed at each outlet, switch, or junction point of conduit, electrical metallic tubing, surface metal raceway, metal-clad cable, aluminum sheathed cable, non-metallic sheathed cable or type MI cable, and at each outlet and switch point of concealed knob-and-tube work.

(1) EXCEPTION: Straight through splice joints for MI cables are permitted without a box provided the splice is accessible and a fitting approved for the purpose is used.

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

E 300.16 Raceway or cable to open or concealed wiring. (1) A box or terminal fitting having a separately bushed hole for each conductor shall be used wherever a change is made from conduit, electric metallic tubing, non-metallic sheathed cable, metal-clad cable, aluminum sheathed cable, or type MI cable and surface metal raceway wiring to open wiring or to concealed knob-and-tube work. A fitting used for this purpose shall contain no taps or splices and shall not be used at fixture outlets.

(2) A bushing may be used in lieu of a box or terminal fitting at ends of conduit or electrical metallic tubing where conductors leave the conduit or tubing behind a switchboard, or where more than 4 conductors leave the conduit or tubing at control apparatus or in similar locations, in which case the conductors shall be bunched, taped and painted with insulating paint. Such a bushing shall be of the insulating type except for lead-covered conductors.

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

E 300.17 Number of conductors in raceway. In general the percentage of the total interior cross-sectional area of a raceway occupied by conductors shall not be more than will permit a ready installation or withdrawal of the conductors and dissipation of the heat generated without injury to the insulation of the conductors. See the following rules of this code: conduit, Wis. Adm. Code: section E 346.06; electric metallic tubing, section E 348.06; flexible metal conduit, section E 350.03; surface metal raceways, section E 352.04;

underfloor raceways, section E 354.05; cellular metal floor raceways, section E 356.05; structural raceways, E 357.06; cellular concrete floor raceways, section E 358.09, wireways, section E 362.05; auxiliary gutters, section E 374.05; theaters, section E 520.05; signs, section E 600.21 (4); sound recording, sections E 640.03 and E 640.04; and remote-control, low-energy power, low-voltage power and signal circuits chapter E 725.

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

E 300.18 Inserting conductors in raceways. (1) Raceways shall first be installed as a complete raceway system without conductors, except those raceways exposed and having a removable cover or capping.

(2) As far as possible, conductors shall not be inserted until the interior of the building has been physically protected from the weather, and all mechanical work on the building which is likely to injure the conductors has been completed.

(3) Pull wires, if to be used, shall not be installed until the raceway system is in place.

(4) Cleaning agents or materials used as lubricants that might have a deleterious effect on conductor coverings shall not be used.

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

E 300.19 Supporting conductors in vertical raceways. (1) Conductors in vertical raceways shall be supported at intervals not greater than those specified in the following table:

		Conductors	
		Aluminum	Copper
No. 18 to No. 8	Not greater than	100 feet	100 feet
No. 6 to No. 0	Not greater than	200 feet	100 feet
No. 00 to No. 0000	Not greater than	180 feet	80 feet
211,601 CM to 350,000 CM	Not greater than	135 feet	60 feet
350,001 CM to 500,000 CM	Not greater than	120 feet	50 feet
500,001 CM to 750,000 CM	Not greater than	95 feet	40 feet
Above 750,000 CM	Not greater than	85 feet	35 feet

(2) One of the following methods of support, or a method of equal effectiveness is recommended:

(a) By clamping devices constructed of or employing insulating wedges inserted in the ends of the conduits. With cables having varnished cambric or thermoplastic insulation it may also be necessary to clamp the conductor.

(b) By inserting boxes at the required intervals in which insulating supports are installed and secured in a satisfactory manner to withstand the weight of the conductors attached thereto, the boxes being provided with covers.

(c) In junction boxes, by deflecting the cables not less than 90 degrees and carrying them horizontally to a distance not less than twice the diameter of the cable, the cables being carried on 2 or more insulating supports, and additionally secured thereto by tie wires if desired. When this method is used cables shall be supported at intervals not greater than 20% of those mentioned in the preceding tabulation.

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

E 300.20 Induced currents in metal enclosures. (1) When conductors carrying alternating current are installed in metal enclosures they shall be so arranged as to avoid heating the surrounding metal by induction. To accomplish this all phase conductors and the neutral, where one is used, shall be grouped together.

(a) *Exception:* In the case of circuits supplying vacuum or electric discharge lighting systems or signs, or X-ray apparatus, the currents carried by the conductors are so small that the inductive heating effect may be ignored where these conductors are placed in metal enclosures or pass through metal.

(2) When a single conductor of a circuit passes through metal with magnetic properties the inductive effect shall be minimized by:

(a) Cutting slots in the metal between the individual holes through which the individual conductors pass, or

(b) Passing all the conductors in the circuit through an insulating wall sufficiently large for all of the conductors of the circuit.

Note: Aluminum being a nonmagnetic metal, there will be no heating due to eddy currents. However, induced currents will be present. These are not considered of sufficient magnitude to require grouping of conductors or special treatment in passing conductors through aluminum wall sections.

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

E 300.21 Prevention of spread of fire. Electrical installations shall be so made that the possible spread of fire through fire-stopped partitions, hollow spaces, fire walls or fire partitions, vertical shafts, ventilating or air-handling ducts is reduced to a minimum.

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

E 300.22 Wiring in ventilating and exhaust ducts. (1) Where it is necessary to run a wiring system through air handling ducts or plenum chambers, the wiring method shall be rigid conduit, electrical metallic tubing, flexible steel conduit with lead-covered conductors, type ACL metal-clad cable with fittings suitable for the location, type MI mineral insulated-metal sheathed cable, or type ALS aluminum sheathed cable. The terminals of circuits of such wiring systems shall be so located that it will not be necessary to install motors or control equipment in the ducts, except for temperature and humidity control. Raceways shall not interfere with the operation of automatic fire dampers in ducts.

(a) *Exception No. 1.* The above provisions shall not apply to integral fan systems specifically approved for the purpose.

(b) *Exception No. 2.* It is not the intent of this section to include habitable rooms or areas of a building, the prime purpose of which is not air handling. It may, however, include false ceiling space, hollow spaces in the wall, and the like if used for air handling purposes.

(c) *Exception No. 3.* In ventilating systems used solely for data processing systems the wiring method shall be rigid conduit, electrical metallic tubing, flexible steel conduit with lead-covered conductors, type ACL metal-clad cable with fittings approved for the purpose, type MI mineral insulated-metal sheathed cable, type ALS aluminum sheathed cable, or flexible cords or cables specifically approved as a part of the data processing system, when such cords or cables may be used in conformance with other sections of this code.

(2) No wiring system of any type shall be installed in ducts used for dust, loose stock, vapor removal or ventilation of commercial type cooking equipment.

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

E 300.23 Temporary wiring. (1) Suitable disconnecting switches or plug connectors shall be installed to permit the disconnection of all conductors of the temporary circuit by a single operation.

(2) No bare conductors nor earth returns shall be used for the wiring of any temporary circuit.

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

Chapter E 310

CONDUCTORS FOR GENERAL WIRING

E 310.01 General. (1) The purpose of this chapter is to assure that conductors have mechanical strength, insulation, and ampacity adequate for the particular conditions under which they are to be used.

(2) Conductors shall be insulated, except when covered or bare conductors are specifically permitted in this code.

(3) The provisions of this chapter are not intended to apply to conductors which form an integral part of equipment such as motors, motor controllers, and the like, or which are provided for elsewhere in this code.

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

E 310.02 Application and construction. (1) CONDUCTOR APPLICATION. Conductor insulations as specified in the following table E 310.02 (1) may be installed for any of the wiring methods recognized herein, except as otherwise provided for in the table or in section E 310.03, or as otherwise specified in this code. They are suitable for 600 volts unless otherwise specified.

(2) CONDUCTOR CONSTRUCTION. Insulated conductors for use at 600 volts or less shall conform to the provisions of table E 310.02 (2).

TABLE E 310.02 (1)
CONDUCTOR APPLICATION

Trade Name	Type Letter	Max. Operating Temp.	Application Provisions
Rubber-Covered Fixture Wire	*RF-1	60°C 140°F	Fixture wiring. Limited to 300 V.
Solid or 7-Strand	*RF-2	60°C 140°F	Fixture wiring, and as permitted in E 310.08.
Rubber-Covered Fixture Wire	*FF-1	60°C 140°F	Fixture wiring. Limited to 300 V.
Flexible Stranding	*FF-2	60°C 140°F	Fixture wiring, and as permitted in E 310.08.
Heat-Resistant Rubber-Covered Fixture Wire	*RFH-1	75°C 167°F	Fixture wiring. Limited to 300 V.
Solid or 7-Strand	*RFH-2	75°C 167°F	Fixture wiring, and as permitted in E 310.08.

*Fixture wires are not intended for installation as branch circuit conductors nor for the connection of portable or stationary appliances.

TABLE E 310.02 (1)—Continued

Trade Name	Type Letter	Max. Operating Temp.	Application Provisions
Heat-Resistant Rubber-Covered Fixture Wire	*FFH-1	75°C 167°F	Fixture wiring. Limited to 300 V.
Flexible Stranding	*FFH-2	75°C 167°F	Fixture wiring, and as permitted in E 310.08.
Thermoplastic Covered Fixture Wire—Solid or Stranded	*TF	60°C 140°F	Fixture wiring, and as permitted in section E 310.08, and for circuits as permitted in Chapter E 725.
Thermoplastic-Covered Fixture Wire—Flexible Stranding	*TFF	60°C 140°F	Fixture wiring, and as permitted in section E 310.08, and for circuits as permitted in Chapter E 725.
Fluorinated Ethylene Propylene	*PF	200°C 392°F	Fixture wiring, and as permitted in section E 310.08.
Fixture Wire, Solid or 7-Strand	*PGF	200°C 392°F	Fixture wiring, and as permitted in section E 310.08.
Fluorinated Ethylene Propylene	*PFF	150°C 302°F	Fixture wiring, and as permitted in section E 310.08.
Fixture Wire, Flexible Stranding	*PGFF	150°C 302°F	Fixture wiring, and as permitted in section E 310.08.
Cotton-Covered, Heat-Resistant, Fixture Wire	*CF	90°C 194°F	Fixture wiring. Limited to 300 V.
Asbestos-Covered Heat-Resistant. Fixture Wire	*AF	150°C 302°F	Fixture wiring. Limited to 300 V. and Indoor Dry Location.
Silicone Rubber Insulated Fixture Wire	*SF-1	200°C 392°F	Fixture wiring. Limited to 300 V.
Solid or 7-Strand	*SF-2	200°C 392°F	Fixture wiring, and as permitted in E 310.08.
Silicone Rubber Insulated Fixture Wire	*SFF-1	150°C 302°F	Fixture wiring. Limited to 300 V.
Flexible Stranding	*SFF-2	150°C 302°F	Fixture wiring, and as permitted in E 310.08.
Code Rubber	R	60°C 140°F	Dry Locations.
Heat-Resistant Rubber	RH	75°C 167°F	Dry Locations.
Heat-Resistant Rubber	RHH	90°C 194°F	Dry Locations.
Moisture-Resistant Rubber	RW	60°C 140°F	Dry and wet locations. For over 2000 volts, insulation shall be ozone-resistant.
Moisture and Heat-Resistant Rubber	RH-RW	60°C 140°F 75°C 167°F	Dry and wet locations. For over 2000 volts, insulation shall be ozone-resistant. Dry locations. For over 2000 volts, insulation shall be ozone-resistant.
Moisture and Heat-Resistant Rubber	RHW	75°C 167°F	Dry and wet locations. For over 2000 volts, insulation shall be ozone-resistant.
Latex Rubber	RU	60°C 140°F	Dry locations.

*Fixture wires are not intended for installation as branch circuit conductors nor for the connection of portable or stationary appliances.

TABLE E 310.02 (1)—Continued

Trade Name	Type Letter	Max. Operating Temp.	Application Provisions
Heat-Resistant Latex Rubber	RUH	75°C	Dry locations.
Moisture-Resistant Latex Rubber	RUW	60°C 140°F	Dry and wet locations.
Thermoplastic	T	60°C 140°F	Dry locations.
Moisture-Resistant Thermoplastic	TW	60°C 140°F	Dry and wet locations.
Heat-Resistant Thermoplastic	THHN	90°C 194°F	Dry locations.
Moisture and Heat-Resistant Thermoplastic	THW	75°C 167°F	Dry and wet locations.
Moisture and Heat-Resistant Thermoplastic	THWN	75°C 167°F	Dry and wet locations.
Mineral Insulation (Metal Sheathed)	MI	85°C 185°F	Dry and wet locations with Type O termination fittings.
		250°C 482°F	For special application.
Thermoplastic and Asbestos	TA	90°C 194°F	Switchboard wiring only.
Silicone-Asbestos	SA	90°C 194°F	Dry locations — max. operating temperature for special applications 125°C.
Thermoplastic and Fibrous Outer Braid	TBS	90°C 194°F	Switchboard wiring only.
Varnished Cambric	V	85°C 185°F	Dry locations only. Smaller than No. 6 by special permission.
Asbestos and Varnished Cambric	AVA	110°C 230°F	Dry locations only.
Asbestos and Varnished Cambric	AVL	110°C 230°F	Dry and wet locations.
Asbestos and Varnished Cambric	AVB	90°C 194°F	Dry locations only.
Synthetic Heat Resistant	SIS	90°C 194°F	Switchboard wiring only.
Fluorinated Ethylene Propylene	FEP or FEPB	90°C 194°F	Dry locations.
		200°C 392°F	Dry locations—special applications.
Asbestos	A	200°C 392°F	Dry locations only. In raceways, only for leads to or within apparatus. Limited to 300 V.
Asbestos	AA	200°C 392°F	Dry locations only. Open wiring. In raceways, only for leads to or within apparatus. Limited to 300 V.
Asbestos	AI	125°C 257°F	Dry locations only. In raceways, only for leads to or within apparatus. Limited to 300 V.
Asbestos	AIA	125°C 257°F	Dry locations only. Open wiring. In raceways, only for leads to or within apparatus.
Paper		95°C 185°F	For underground service conductors, or by special permission.

TABLE E 310.02 (2)
CONDUCTOR INSULATIONS

Trade Name	Type Letter	Insulation	Thickness of Insulation	Outer Covering
Heat-Resistant Latex Rubber	RUH	90% Unmilled, Grainless Rubber	14–10 .... 18 Mils 8–2 .... 25 Mils	Moisture-resistant, flame-retardant, non-metallic covering
Moisture-Resistant Latex Rubber	RUW	90% Unmilled, Grainless Rubber	14–10 .... 18 Mils 8–2 .... 25 Mils	Moisture-resistant, flame-retardant, non-metallic covering
Thermoplastic	T	Flame Retardant, Thermoplastic Compound	14–10 .... 2/64 Inch 8 .... 3/64 Inch 6–2 .... 4/64 Inch 1–4/0 .... 5/64 Inch 213–500 .... 6/64 Inch 501–1000 .... 7/64 Inch 1001–2000 .... 8/64 Inch	None
Moisture-Resistant Thermoplastic	TW	Flame-Retardant, Moisture-Resistant Thermoplastic	14–10 .... 2/64 Inch 8 .... 3/64 Inch 6–2 .... 4/64 Inch 1–4/0 .... 5/64 Inch 213–500 .... 6/64 Inch 501–1000 .... 7/64 Inch 1001–2000 .... 8/64 Inch	None
Moisture and Heat-Resistant Thermoplastic	THW	Flame-Retardant, Moisture and Heat-Resistant Thermoplastic	14–10 .... 3/64 Inch 8–2 .... 4/64 Inch 1–4/0 .... 5/64 Inch 213–500 .... 6/64 Inch 501–1000 .... 7/64 Inch 1001–2000 .... 8/64 Inch	None
Moisture and Heat-Resistant Thermoplastic	THWN	Flame-Retardant, Moisture and Heat-Resistant Thermoplastic	14–12 .... 15 Mils 10 .... 20 Mils 8–6 .... 30 Mils 4–2 .... 40 Mils 1–4/0 .... 50 Mils 250–500 MCM .... 60 Mils	Nylon Jacket
Thermoplastic and Asbestos	TA	Thermoplastic and Asbestos	Th'pl'. Asb. 14–8 .... 20 Mils 20 Mils 6–2 .... 30 Mils 25 Mils 1–4/0 .... 40 Mils 30 Mils	Flame-retardant, non-metallic covering

TABLE E 310.02 (2)—Continued

Trade Name	Type Letter	Insulation	Thickness of Insulation	Outer Covering
Heat-Resistant Thermoplastic	THHN	Flame-Retardant Heat-Resistant Thermoplastic	14–12 ..... 15 Mils 10 ..... 20 Mils 8–6 ..... 30 Mils 4–2 ..... 40 Mils 1–4/0 ..... 50 Mils 250–500 MCM ..... 60 Mils	Nylon Jacket
Silicone-Asbestos	SA	Silicone Rubber	14–10 ..... 3/64 Inch 8–2 ..... 4/64 Inch 1–4/0 ..... 5/64 Inch 213–500 ..... 6/64 Inch 501–1000 ..... 7/64 Inch 1001–2000 ..... 8/64 Inch	Asbestos or glass
Thermoplastic and Fibrous Braid	TBS	Thermoplastic	14–10 ..... 2/64 Inch 8 ..... 3/64 Inch 6–2 ..... 4/64 Inch 1–4/0 ..... 5/64 Inch	Flame-retardant, non-metallic covering
Synthetic Heat-Resistant	SIS	Heat-Resistant Rubber	14–10 ..... 2/64 Inch 8 ..... 3/64 Inch 6–2 ..... 4/64 Inch 1–4/0 ..... 5/64 Inch	None
Mineral Insulated Metal-Sheathed	MI	Magnesium Oxide	16–4 ..... 50 Mils 3–250 MCM ..... 55 Mils	Copper
Fluorinated Ethylene Propylene	FEP	Fluorinated Ethylene Propylene	14–10 ..... 20 Mils 8–2 ..... 30 Mils	None
	FEPB	Fluorinated Ethylene Propylene	14–8 ..... 14 Mils	Glass braid
			6–2 ..... 14 Mils	Asbestos braid
Varnished Cambric	V	Varnished Cambric	14–8 ..... 3/64 Inch 6–2 ..... 4/64 Inch 1–4/0 ..... 5/64 Inch 213–500 ..... 6/64 Inch 501–1000 ..... 7/64 Inch 1001–2000 ..... 8/64 Inch	Non-metallic covering or lead sheath

Note: The non-metallic covering over individual rubber-covered conductors of aluminum sheathed cable and of lead-sheathed or multiple-conductor cable is not required to be flame retardant. For metal-clad cable, see section E 334.04. For non-metallic-sheathed cable, see section E 336.02. For type UF cable, see section E 339.01. For aluminum sheathed cable, see section E 331.09.

TABLE E 310.02 (2)—Continued

Trade Name	Type Letter	Insulation	Thickness of Insulation (Dimen. in Mils)					Outer Covering
				1st Asb.	VC	AVA 2nd Asb.	AVL 2nd Asb.	
Asbestos and Varnished Cambric	AVA and AVL	Impregnated Asbestos and Varnished Cambric	14–8 (solid only)	--	30	20	25	AVA—asbestos braid or glass AVL—lead sheath
			14–8	10	30	15	25	
			6–2	15	30	20	25	
			1–4/0	20	30	30	30	
			213–500	25	40	40	40	
			501–1000	30	40	40	40	
			1001–2000	30	50	50	50	
Asbestos and Varnished Cambric	AVB	Impregnated Asbestos and Varnished Cambric				VC	Asb.	
			18–8			30	20	Flame-retardant, cotton braid (switchboard wiring)
			6–2			40	30	
			1–4/0			40	40	
					Asb.	VC	2nd Asb.	
			14–8		10	30	15	Flame-retardant, cotton braid
			6–2		15	30	20	
			1–4/0		20	30	30	
			213–500		25	40	40	
			501–1000		30	40	40	
			1001–2000		30	50	50	
Asbestos	A	Asbestos	14				30 Mils	Without asbestos braid
			12–8				40 Mils	
Asbestos	AA	Asbestos	14				30 Mils	With asbestos braid or glass
			12–8				30 Mils	
			6–2				40 Mils	
			1–4/0				60 Mils	
Code	R	Code Rubber	14–12				2/64 Inch	*Moisture-resistant, flame-retardant, non-metallic covering
			10				3/64 Inch	
			8–2				4/64 Inch	
			1–4/0				5/64 Inch	
			213–500				6/64 Inch	

*Outer covering is not required over rubber insulations which have been specifically approved for the purpose.

TABLE E 310.02 (2)—Continued

Trade Name	Type Letter	Insulation	Thickness of Insulation	Outer Covering
			501–1000 — 7/64 Inch 1001–2000 — 8/64 Inch	
Heat-Resistant	RH RHH	Heat-Resistant Rubber	**14–12 — 2/64 Inch 10 — 3/64 Inch 8–2 — 4/64 Inch 1–4/0 — 5/64 Inch 213–500 — 6/64 Inch 501–1000 — 7/64 Inch 1001–2000 — 8/64 Inch	*Moisture-resistant, flame-retardant, non-metallic covering
Moisture-Resistant	RW	Moisture-Resistant Rubber	14–10 — 3/64 Inch 8–2 — 4/64 Inch 1–4/0 — 5/64 Inch 213–500 — 6/64 Inch 501–1000 — 7/64 Inch 1001–2000 — 8/64 Inch	*Moisture-resistant, flame-retardant, non-metallic covering
Moisture and Heat Resistant	RH-RW RHW	Moisture and Heat Resistant Rubber	14–10 — 3/64 Inch 8–2 — 4/64 Inch 1–4/0 — 5/64 Inch 213–500 — 6/64 Inch 501–1000 — 7/64 Inch 1001–2000 — 8/64 Inch	*Moisture-resistant, flame-retardant, non-metallic covering
Asbestos	AI	Impregnated Asbestos	14 — 30 Mils 12–8 — 40 Mils	Without asbestos braid
Asbestos	AIA	Impregnated Asbestos	Sol. / Str. 14 — 30 Mils / 30 Mils 12–8 — 30 Mils / 40 Mils 6–2 — 40 Mils / 60 Mils 1–4/0 — 60 Mils / 75 Mils 213–500 — / 90 Mils 501–1000 — / 105 Mils	With asbestos braid or glass
Paper		Paper		Lead sheath

*Outer covering is not required over rubber insulations which have been specifically approved for the purpose.
**For 14–12 sizes RHH shall be 3/64 inch thickness insulation.

(3) MARKING. Insulated wires, cables and cords of all kinds except paper-insulated wire shall have a continuous distinctive marking so that their maker may be readily identified. All wires, cables and cords shall also be plainly tagged or marked as follows:

(a) The maximum working voltage for which the wire was tested or approved. This may be omitted for asbestos-covered switchboard wires.

(b) The words "National Electrical Code Standard," or "NEC Std."

(c) Name of the manufacturing company, and, if desired, trade name of the wire.

(d) Month and year when manufactured.

(e) The proper type letter for the particular style of wire or cable as given in the following sections.

(4) SURFACE MARKING. (a) A durable marking on the surface shall be provided at intervals not exceeding 24 inches showing the name of the manufacturer or a significant abbreviation thereof, type letter or letters as specified in chapter E 310, table E 310.02 (2) and chapters E 336, E 338 and E339, the size AWG, or circular mils and the maximum voltage on the following types of wire and cable rated 600 volts or less:

1. Single conductors only, rubber insulated and thermoplastic insulated for general wiring.

2. Nonmetallic sheathed cable.

3. Service-entrance cable.

4. Underground feeder and branch circuit cable.

(b) All other types of wire and cable, flexible cords, fixture wires, switchboard wires, and any of the above types with a metallic covering are not required to have a marking on the surface.

(5) CLASSIFICATION. In addition to the type letters specified in table E 310.02 (2), the following letters shall apply:

(a) A type letter or letters used alone indicates a single insulated conductor.

(b) The letter "D" used as a suffix indicates a twin wire with 2 insulated conductors laid parallel under an outer non-metallic covering.

(c) The letter "M" used as a suffix indicates an assembly of 2 or more insulated conductors twisted together under an outer non-metallic covering.

(d) The letter "L" used as a suffix indicates an outer covering of lead.

(e) *Voltage.* Type letters, when used alone, indicate conductors for use at not more than 600 volts. Conductors for use at higher voltages shall be indicated by adding numerical suffixes to the type letters as follows:

10—for use at not more than 1000 volts.

20—for use at not more than 2000 volts.

30—for use at not more than 3000 volts.

40—for use at not more than 4000 volts.

50—for use at not more than 5000 volts.

Note: The working voltages referred to in the table are the operating voltages between phases of single and 2-phase systems, and 3-phase systems with grounded or ungrounded neutral.

(f) All NEC standard conductors shall be examined and tested at the factory and, if approved, shall be labeled before shipment.

(6) IDENTIFICATION OF INSULATION. All rubber-insulated conductors and all thermoplastic-insulated conductors, No. 14 and larger, shall have a readily recognizable durable marking to indicate the grade of insulation; except that single-conductor, code-rubber insulated conductors having a lead sheath; and multi-conductor cables, armored cable, and non-metallic-sheathed cable having code-rubber or non-moisture-resistant thermoplastic-insulated conductors, need not be so marked.

(7) IDENTIFIED CONDUCTORS. (a) Single insulated conductors of No. 6 or smaller. intended for use as identified conductors of circuits shall have an outer identification of a white or natural gray color. Twin and twisted-pair conductors and three-conductor cables shall have one conductor, and four-conductor cables shall have at least one conductor identified in this manner.

1. Exception No. 1. Multiple-conductor varnished cloth insulated cables.

2. Exception No. 2. Fixture wire as outlined below.

3. Exception No. 3. Mineral insulated-metal sheathed cable.

(b) For fixture wires the identification shall be as above, or by means of stripes or by the means described in sections E 400.13 (1), (2), (3), (4) and (5).

Note: Wires having their outer covering finished to show a white or natural gray color but having colored tracer threads in the braid, identifying the source of manufacture, are considered as meeting the provisions of this section.

(8) SINGLE CONDUCTORS, intended for use as unidentified conductors, and conductors other than the identified conductor in multi-conductor cables, shall be finished to show a color or combination of colors other than, and contrasting with, white or natural gray. The colors contrasting with white or natural gray, may be provided by means of an approved stripe or stripes on black conductors. For identification requirements for conductors larger than No. 6 see section E200.06 (2).

(9) INSULATION THICKNESS; OVER 600 VOLTS. The thickness of insulation for conductors for use at over 600 volts shall conform to tables E 310.02 (9) (a) through E 310.02 (9) (d):

TABLE E 310.02 (9) (a)

THICKNESS OF RUBBER INSULATION FOR RUBBER-COVERED WIRE AND CABLE, IN 64THS OF AN INCH

Conductor Size AWG or MCM	Classification				
	R 10 RH 10 RW 10 RHW 10	R 20 RH 20 RW 20 RHW 20	RW 30** RH-RW 30** RHW 30**	RW 40** RH-RW 40** RHW 40**	RW 50** RH-RW 50** RHW 50**
14–12	4	5	----	----	----
10– 8*	4	5	7	9	10*
6–2	5	6	8	9	10
1–4/0	6	7	8	9	10
213–500	7	8	9	10	11
501–1000	8	9	9	10	11
1001–2000	9	9	10	11	12

*No. 8 AWG is the minimum conductor size for 5000 volts operation.
**Shall be of approved ozone-resistant type for operation at voltages over 2000.

TABLE E 310.02 (9) (b)

THICKNESS OF VARNISHED-CAMBRIC INSULATION FOR SINGLE-CONDUCTOR CABLE, IN 64THS OF AN INCH

Conductor Size AWG or MCM	For Voltages Not Exceeding				
	1000	2000	3000	4000	5000
14	4	----	----	----	----
12	4	5	----	----	----
10	4	5	6	----	----
8–2	4	5	6	7	9
1–4/0	5	6	6	7	9
213–500	6	6	7	8	10
501–1000	7	7	7	8	10
1001–2000	8	8	8	9	10

TABLE E 310.02 (9) (c)

THICKNESS OF VARNISHED-CAMBRIC INSULATION FOR MULTIPLE-CONDUCTOR CABLE, IN 64THS OF AN INCH

Conductor Size AWG or MCM	For Voltages Not Exceeding									
	1000		2000		3000		4000		5000	
	C	B	C	B	C	B	C	B	C	B
14	4	0	----	----	----	----	----	----	----	----
12	4	0	5	0	----	----	----	----	----	----
10	4	0	5	0	5	2	----	----	----	----
8–2	4	0	5	0	5	2	6	3	6	4
1–4/0	5	0	6	0	6	2	6	3	6	4
213–500	6	0	6	0	6	2	6	3	7	4
501–1000	6	2	6	2	6	3	6	4	7	4
1001–2000	7	2	7	2	7	3	7	4	7	5

Note: The thickness given in columns headed "C" are for the insulation on the individual conductors. Those given in the columns headed "B" are for the thickness of the overall belt of insulation.

TABLE E 310.02 (9) (d)

THICKNESS OF ASBESTOS AND VARNISHED-CAMBRIC INSULATION FOR SINGLE-CONDUCTOR CABLE, TYPES AVA, AVB AND AVL, IN MILS

Conductor Size AWG or MCM	1st Wall Asbestos	Varnished Cambric					2nd Wall Asbestos
	For Voltages Not Exceeding						
	1000–5000	1000	2000	3000	4000	5000	1000–5000
14–2	15	45	60	80	100	120	25
1–4/0	20	45	60	80	100	120	30
213–500	25	45	60	80	100	120	40
501–1000	30	45	60	80	100	120	40
1001–2000	30	55	75	95	115	140	50

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

E 310.03 Insulating materials. (1) The rubber insulations include those made from natural and synthetic rubber, neoprene and other vulcanizable materials.

(2) Thermoplastic insulation may stiffen at temperatures below minus 10° C. (14° F.) and care should be used in its installation at such temperatures. It may be deformed when subject to pressure; care should be taken in its installation, as for example, at bushings, or points of support. See Wis. Adm. Code section E 373.06 (2).

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

E 310.04 Temperature limitations. No conductor shall be used under such conditions that its temperature, even when carrying current, will exceed the temperature specified in table E 310.02 (1) for the type of insulation involved.

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

E 310.05 Wet locations. Insulated conductors used underground, in concrete slabs or other masonry in direct contact with earth, in wet locations, or where condensation or accumulation of moisture within the raceway is likely to occur, shall be moisture-resistant, rubber-covered (type RW); moisture-and heat-resistant (type RH-RW); moisture-and heat-resistant, rubber-covered (type RHW); moisture-resistant latex rubber (type RUW); moisture-resistant, thermoplastic-covered (type TW); moisture-and heat-resistant, thermoplastic-covered (type THW); moisture-and heat-resistant thermoplastic (type THWN); lead covered; aluminum sheathed cable (type ALS); mineral insulated-metal sheathed (type MI); or of a type approved for the purpose.

Note: Such conductors are not suitable for direct burial in the earth unless of a type specifically approved for the purpose.

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

E 310.06 Buried conductors. Cables of one or more conductors for direct burial in the earth shall be type USE, except that branch circuit and feeder cable may be type UF. Where single conductor cables are installed, all conductors of each service, feeder, sub-feeder or branch circuit, including the neutral conductor, shall be run continuously in the same trench or raceway. Supplementary mechanical protection, such as a covering board, concrete pad, raceway, etc., may be required by the administrative authority. See section E 339.03 (3).

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

E 310.07 Corrosive conditions. Conductors exposed to oils, greases, vapors, gases, fumes, liquids or other substances having a deleterious effect upon the conductor or insulation shall be of a type approved for the purpose.

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

E 310.08 **Minimum size of conductors.** Conductors, whether solid or stranded, shall not be smaller than No. 14, except for printing press control circuits; as provided for flexible cords in section E 400.07; for fixture wire in section E 410.18; for fractional horsepower motors in section E 430.022; for cranes and hoists in section E 610.14; and for remote-control, low-energy power, low voltage power and signal circuits in section E 725.13.

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

E 310.09 **Stranded conductors.** Except when used as bus bars or in type MI cable, conductors No. 6 and larger, installed in raceways shall be stranded.

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

E 310.10 **Conductors in multiple.** Conductors in sizes smaller than 1/0 shall not be run in multiple. Conductors in size 1/0 and larger may be run in multiple provided the arrangement is such as to assure equal division of total current among all conductors involved. All of the multiple conductors shall be of the same length, of the same conductor material, circular-mil area, same insulation type and terminated in the same manner. Where run in separate raceways or cables, the raceways or cables shall have the same physical characteristics.

Note: When conductors are used in multiple, space in enclosures should be given consideration.

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

E 310.11 **Ampacity reduction factors.** Where more than 3 conductors are installed in a raceway or assembled into one or more cables the ampacity of each conductor shall be reduced in accordance with note 8 to tables E 310.12 through E 310.15.

Note: The maximum continuous ampacities of copper conductors are given in table E 310.12 and E 310.13. The ampacities of aluminum conductors are given in tables E 310.14 and E 310.15.

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

Notes to Tables E 310.12 through E 310.15

1. *Explanation of tables.* For explanation of type letters, and for recognized size of conductors for the various conductor insulations, see sections E 310.02 and E 310.03. For installation requirements, see sections E 310.01 through E 310.07, and the various chapters of this code. For flexible cords see tables E 400.09 and E 400.11.

2. *Application of tables.* For open wiring on insulators and for concealed knob-and-tube work, the allowable ampacities of tables E 310.13 and E 310.15 shall be used. For all other recognized wiring methods, the allowable ampacities of tables E 310.12 and E 310.14 shall be used, unless otherwise provided in this code.

3. *Aluminum conductors.* For aluminum conductors, the allowable ampacities shall be in accordance with tables E 310.14 and E 310.15.

4. *Bare conductors.* Where bare conductors are used with insulated conductors, their allowable ampacity shall be limited to that permitted for the insulated conductors of the same size.

5. *Type MI cable.* The temperature limitation on which the current-carrying capacities of type MI cable are based, is determined by the insulating materials used in the end seal. Termination fittings incorporating unimpregnated organic insulating materials are limited to 85°C. operation.

6. *Ultimate insulation temperature.* In no case shall conductors be associated together in such a way with respect to the kind of circuit, the wiring method employed, or the number of conductors, that the limiting temperature of the conductors will be exceeded.

7. *Use of conductors with higher operating temperatures.* Where the room temperature is within 10° C. of the maximum allowable operating temperature of the insulation, it is desirable to use an insulation with a higher maximum allowable operating temperature; although insulation can be used in a room temperature approaching its maximum allowable operating temperature lim't if the current is reduced in accordance with the correction factors for different room temperatures.

8. *More than 3 conductors in a raceway or cable.* Tables E 310.12 and E 310.14 give the allowable ampacities for not more than 3 conductors in a raceway, or cable. Where the number of conductors in a raceway or cable exceeds 3, the allowable ampacity of each conductor shall be reduced as shown in the following table:

Number of Conductors	Per Cent of Values in Tables E 310.12 and E 310.14
4 to 6	80
7 to 24	70
25 to 42	60
43 and above	50

Exception No. 1. When conductors of different systems, as provided in section E 300.03 are installed in a common raceway the derating factors shown above apply to the number of Power and Lighting (chapters E 210, E 215, E 220 and E 230) conductors only.

Exception No. 2. The derating factors of sections E 210. 23 (2) and E 220.02 (2) do not apply when the above derating factors are also required.

Exception No. 3. The derating factors shown above do not apply to branch circuits supplying an individual residential occupancy.

a. Where the number of conductors in a raceway or cable exceeds 3, or where single conductors or multi-conductor cables are stacked or bundled without maintaining spacing as required in chapter E 318 and are not installed in raceways, the individual ampacity of each conductor shall be reduced as shown in the above table.

9. *Use of type RH–RW rubber insulated wire.* Where type RH–RW rubber insulated wire is used in wet locations the allowable ampacities shall be those of column 2 in tables E 310.12 through E 310.15. Where used in dry locations the allowable ampacities shall be those of column 3 in tables E 310.12 through E 310.15.

10. *Overcurrent protection.* Where the standard ratings and settings of overcurrent devices do not correspond with the ratings and settings allowed for conductors, the next higher standard rating and setting may be used except as limited in section E 240.05.

11. *Neutral conductor.* A neutral conductor which carries only the unbalanced current from other conductors, as in the case of normally balanced circuits of 3 or more conductors, shall not be counted in determining ampacities as provided for in Note 8.

a. In a 3-wire circuit consisting of 2 phase wires and the neutral of a 4-wire, 3 phase WYE connected system, a common conductor carries approximately the same current as the other conductors and is not therefore considered as a neutral conductor.

12. *Voltage drop.* The allowable ampacities in tables E 310.12 through E 310.15 are based on temperature alone and do not take voltage drop into consideration.

13. *Deterioration of insulation.* It should be noted that even the best grades of rubber insulation will deteriorate in time, so eventually will need to be replaced.

14. *Aluminum sheathed cable.* The ampacities of type ALS cables are determined by the temperature limitation of the insulated conductors incorporated within the cable. Hence the ampacities of aluminum sheathed cable may be determined from the columns in tables E 310.12 and E 310.14 applicable to the type of insulated conductors employed within the cable. See note 9.

TABLE E 310.12

ALLOWABLE AMPACITIES OF INSULATED COPPER CONDUCTORS

Not More than Three Conductors in Raceway or Cable or Direct Burial
(Based on Room Temperature of 30°C. 86°F.)

Size	Temperature Rating of Conductor. See Table E 310.02 (1)					
AWG MCM	60°C (140°F)	75°C (167°F)	85–90°C (185°F)	110°C (230°F)	125°C (257°F)	200°C (392°F)
14	15	15	25*	30	30	30
12	20	20	30*	35	40	40
10	30	30	40*	45	50	55
8	40	45	50	60	65	70
6	55	65	70	80	85	95
4	70	85	90	105	115	120
3	80	100	105	120	130	145
2	95	115	120	135	145	165
1	110	130	140	160	170	190
0	125	150	155	190	200	225
00	145	175	185	215	230	250
000	165	200	210	245	265	285
0000	195	230	235	275	310	340
250	215	255	270	315	335	----------
300	240	285	300	345	380	----------
350	260	310	325	390	420	----------
400	280	335	360	420	450	----------
500	320	380	405	470	500	----------
600	355	420	455	525	545	----------
700	385	460	490	560	600	----------
750	400	475	500	580	620	----------
800	410	490	515	600	640	----------
900	435	520	555	----------	----------	----------
1000	455	545	585	680	730	----------
1250	495	590	645	----------	----------	----------
1500	520	625	700	785	----------	----------
1750	545	650	735	----------	----------	----------
2000	560	665	775	840	----------	----------
CORRECTION FACTORS, ROOM TEMPERATURES OVER 30°C. 86°F.						
C. F.						
40 104	.82	.88	.90	.94	.95	----------
45 113	.71	.82	.85	.90	.92	----------
50 122	.58	.75	.80	.87	.89	----------
55 131	.41	.67	.74	.83	.86	----------
60 140	----------	.58	.67	.79	.83	.91
70 158	----------	.35	.52	.71	.76	.87
75 167	----------	----------	.43	.66	.72	.86
80 176	----------	----------	.30	.61	.69	.84
90 194	----------	----------	----------	.50	.61	.80
100 212	----------	----------	----------	----------	.51	.77
120 248	----------	----------	----------	----------	----------	.69
140 284	----------	----------	----------	----------	----------	.59

These ampacities relate only to conductors described in table E 310.02 (1).

*The ampacities for types FEP, FEPB, RHH, and THHN conductors for sizes AWG 14, 12 and 10 shall be the same as designated for 75°C conductors in this table.

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

TABLE E 310.13

ALLOWABLE AMPACITIES OF INSULATED COPPER CONDUCTORS

Single Conductor in Free Air
(Based on Room Temperature of 30°C. 86° F.)

Size AWG	Temperature Rating of Conductor. See Table E 310.02 (1)						
	60°C (140°F)	75°C (167°F)	85-90°C (185°F)	110°C (230°F)	125°C (257°F)	200°C (392°F)	Bare and Covered Conductor
14	20	20	30*	40	40	45	30
12	25	25	40*	50	50	55	40
10	40	40	55*	65	70	75	55
8	55	65	70	85	90	100	70
6	80	95	100	120	125	135	100
4	105	125	135	160	170	180	130
3	120	145	155	180	195	210	150
2	140	170	180	210	225	240	175
1	165	195	210	245	265	280	205
0	195	230	245	285	305	325	235
00	225	265	285	330	355	370	275
000	260	310	330	385	410	430	320
0000	300	360	385	445	475	510	370
250	340	405	425	495	530	----------	410
300	375	445	480	555	590	----------	460
350	420	505	530	610	655	----------	510
400	455	545	575	665	710	----------	555
500	515	620	660	765	815	----------	630
600	575	690	740	855	910	----------	710
700	630	755	815	940	1005	----------	780
750	655	785	845	980	1045	----------	810
800	680	815	880	1020	1085	----------	845
900	730	870	940	----------	----------	----------	----------
1000	780	935	1000	1165	1240	----------	965
1250	890	1065	1130	----------	----------	----------	----------
1500	980	1175	1260	1450	----------	----------	1215
1750	1070	1280	1370	----------	----------	----------	----------
2000	1155	1385	1470	1715	----------	----------	1405

CORRECTION FACTORS, ROOM TEMPERATURES OVER 30°C. 86°F.

C. F.							
40 104	.82	.88	.90	.94	.95	----------	----------
45 113	.71	.82	.85	.90	.92	----------	----------
50 122	.58	.75	.80	.87	.89	----------	----------
55 131	.41	.67	.74	.83	.86	----------	----------
60 140	----------	.58	.67	.79	.83	.91	----------
70 158	----------	.35	.52	.71	.76	.87	----------
75 167	----------	----------	.43	.66	.72	.86	----------
80 176	----------	----------	.30	.61	.69	.84	----------
90 194	----------	----------	----------	.50	.61	.80	----------
100 212	----------	----------	----------	----------	.51	.77	----------
120 240	----------	----------	----------	----------	----------	.69	----------
140 284	----------	----------	----------	----------	----------	.59	----------

These ampacities relate only to conductors described in table E 310.02 (1).

*The ampacities for types FEP, FEPB, RHH and THHN conductors for szie AWG 14 12 and 10 shall be the same as designated for 75°C conductors in this table.

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

TABLE E 310.14

ALLOWABLE AMPACITIES OF INSULATED ALUMINUM CONDUCTORS

Not More than Three Conductors in Raceway or Cable or Direct Burial (Based on Room Temperature of 30°C. 86°F..)

Size AWG MCM	Temperature Rating of Conductor. See Table E 310.02 (1)					
	60°C (140°F)	75°C (167°F)	85–90°C (185°F)	110°C (230°F)	125°C (257°F)	200°C (392°F)
12	15	15	25**	25	30	30
10	25	25	30**	35	40	45
8	30	40	40**	45	50	55
6	40	50	55	60	65	75
4	55	65	70	80	90	95
3	65	75	80	95	100	115
*2	75	90	95	105	115	130
*1	85	100	110	125	135	150
*0	100	120	125	150	160	180
*00	115	135	145	170	180	200
*000	130	155	165	195	210	225
*0000	155	180	185	215	245	270
250	170	205	215	250	270	—
300	190	230	240	275	305	—
350	210	250	260	310	335	—
400	225	270	290	335	360	—
500	260	310	330	380	405	—
600	285	340	370	425	440	—
700	310	375	395	455	485	—
750	320	385	405	470	500	—
800	330	395	415	485	520	—
900	355	425	455	—	—	—
1000	375	445	480	560	600	—
1250	405	485	530	—	—	—
1500	435	520	580	650	—	—
1750	455	545	615	—	—	—
2000	470	560	650	705	—	—
CORRECTION FACTORS, ROOM TEMPERATURES OVER 30°C. 86°F.						
C. F.						
40 104	.82	.88	.90	.94	.95	—
45 113	.71	.82	.85	.90	.92	—
50 122	.58	.75	.80	.87	.89	—
55 131	.41	.67	.74	.83	.86	—
60 140	—	.58	.67	.79	.83	.91
70 158	—	.35	.52	.71	.76	.87
75 167	—	—	.43	.66	.72	.86
80 176	—	—	.30	.61	.69	.84
90 194	—	—	—	.50	.61	.80
100 212	—	—	—	—	.51	.77
120 248	—	—	—	—	—	.69
140 284	—	—	—	—	—	.59

These ampacities relate only to conductors described in table E 310.02 (1). For three wire, single phase service and sub-service circuits, the allowable ampacity of RH, RH-RW, RHH, RHW, and THW aluminum conductors shall be for sizes #2–100 Amp., #1–110 Amp., #1/0–125 Amp., #2/0–150 Amp., #3/0–170 Amp. and #4/0–200 Amp.

*The ampacities for types RHH and THHN conductors for sizes AWG 12, 10 and 8 shall be the same as designated for 75°C conductors in this table.

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

TABLE E 310.15

ALLOWABLE AMPACITIES OF INSULATED ALUMINUM CONDUCTORS

Single Conductor in Free Air
(Based on Room Temperature of 30°C. 86°F.)

Size AWG MCM	Temperature Rating of Conductor. See Table E 310.02 (1)						
	60°C (140°F)	75°C (167°F)	85°–90°C (185°F)	110°C (230°F)	125°C (257°F)	200°C (392°F)	Bare and Covered Conductor
12	20	20	30*	40	40	45	30
10	30	30	45*	50	55	60	45
8	45	55	55*	65	70	80	55
6	60	75	80	95	100	105	80
4	80	100	105	125	135	140	100
3	95	115	120	140	150	165	115
2	110	135	140	165	175	185	135
1	130	155	165	190	205	220	160
0	150	180	190	220	240	255	185
00	175	210	220	255	275	290	215
000	200	240	255	300	320	335	250
0000	230	280	300	345	370	400	290
250	265	315	330	385	415	----------	320
300	290	350	375	435	460	----------	360
350	330	395	415	475	510	----------	400
400	355	425	450	520	555	----------	435
500	405	485	515	595	635	----------	490
600	455	545	585	675	720	----------	560
700	500	595	645	745	795	----------	615
750	515	620	670	775	825	----------	640
800	535	645	695	805	855	----------	670
900	580	700	750	----------	----------	----------	725
1000	625	750	800	930	990	----------	770
1250	710	855	905		----------	----------	
1500	795	950	1020	1175	----------	----------	985
1750	875	1050	1125		----------	----------	
2000	960	1150	1220	1425	----------	----------	1165
CORRECTION FACTORS, ROOM TEMPERATURES OVER 30°C. 86°F.							
C. F.							
40 104	.82	.88	.90	.94	.95	----------	----------
45 113	.71	.82	.85	.90	.92	----------	----------
50 122	.58	.75	.80	.87	.89	----------	----------
55 131	.41	.67	.74	.83	.86	----------	----------
60 140	----------	.58	.67	.79	.83	.91	----------
70 158	----------	.35	.52	.71	.76	.87	----------
75 167	----------	----------	.43	.66	.72	.86	----------
80 176	----------	----------	.30	.61	.69	.84	----------
90 194	----------	----------	----------	.50	.61	.80	----------
100 212	----------	----------	----------	----------	.51	.77	----------
120 248	----------	----------	----------	----------	----------	.69	----------
140 284	----------	----------	----------	----------	----------	.59	----------

These ampacities relate only to conductors described in table E 310.02 (1).

*The ampacities for types RHH and THHN conductors for sizes AWG 12, 10 and 8 shall be the same as designated for 75°C conductors in this table.

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

Chapter E 318

CONTINUOUS RIGID CABLE SUPPORTS

E 318.01 Definition. (1) A continuous rigid cable support is a unit or an assembly of units or sections, and associated fittings, made of metal or other noncombustible materials forming a continuous rigid structure used to support cables. Continuous rigid cable supports include ladders, troughs, channels, and other similar structures.

(2) It is not the intent of this chapter to require that cables be supported by continuous rigid cable supports or to recognize the use of conductors described in chapter E 310 in continuous rigid cable supports for general wiring.

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

E 318.02 Use. (1) Continuous rigid cable supports may be used as the mechanical support for only the following wiring methods under the conditions detailed in the chapter for each wiring method:

(a) Mineral-insulated metal-sheathed cables, (Wis. Adm. Code chapter E 330), (b) Aluminum sheathed cable, (chapter E 331), (c) Metal-clad cable, (chapter E 334), (d) Nonmetallic sheathed cable, (chapter E 336), (e) Service entrance cables, (chapter E 338), (f) Underground feeder and branch circuit cable, (chapter E 339), (g) Any approved conduit or raceway with its contained conductors.

(2) Continuous rigid cable supports may be used as the mechanical support for factory-assembled, multiconductor control, signal, and power cables, which are specifically approved for installation in continuous rigid cable supports in fire-resistive or non-combustible construction, but shall not be used (a) in hoistways, (b) where the cables supported are subject to severe physical damage, (c) in areas having readily combustible contents as determined by the authority enforcing this code. Continuous rigid cable supports may be used to support cables in hazardous locations when the cables are specifically approved for such use. (Refer to Wis. Adm. Code sections E 501.04, E 502.04 and E 503.03.)

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

E 318.03 Construction. Continuous rigid cable supports shall be approved for the purpose and shall comply with the following:

(1) Shall have suitable strength and rigidity to provide adequate support for all contained wiring.

(2) Shall not present sharp edges, burrs or projections injurious to the insulation or jackets of the wiring.

(3) If made of metal, shall be adequately protected against corrosion or shall be made of corrosion-resistant material.

(4) Shall have side rails or equivalent structural members.

(5) Shall include fittings for changes in direction and elevation of runs.

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

E 318.04 Installation. (1) Continuous rigid cable supports shall be installed as a complete support system.

(2) Each run of continuous rigid cable support shall be complete before the installation of cables.

(3) Continuous rigid cable supports shall be mechanically connected to any enclosure or raceway into which the cables contained in the continuous rigid cable support extend or terminate.

(4) In portions of runs where additional physical protection is required, noncombustible covers or enclosures providing the required protection shall be used.

(5) Installations involving different electrical systems shall comply with section E 300.03 and where separation is required, the separation shall be a solid noncombustible partition or compartment. Where cables, as permitted by section E 318.02 (2) are installed in the same continuous rigid cable support as the cables permitted by section E 318.02 (1), the requirements of this section shall apply.

(6) When continuous rigid cable supports are installed in tiers, the minimum vertical clearance between tiers shall be 12 inches.

(7) Continuous rigid cable supports may extend transversely through partitions or walls, other than fire walls, provided the section of the support within the wall is continuous and unventilated. See section E 300.21.

(8) Continuous rigid cable supports may extend vertically through dry floors and platforms provided the continuous rigid cable support is totally enclosed where it passes through the floor or platform opening and for a distance of 6 feet above the floor or platform to provide protection from physical injury. See section E 300.21.

(9) Continuous rigid cable supports may extend vertically through floors and platforms in wet locations where (a) there are curbs or other suitable means to prevent water flow through the floor or platform opening and (b) the continuous rigid cable support is totally enclosed where it passes through the floor or platform opening and for a distance of 6 feet above the floor or platform to provide protection from physical injury. See section E 300.21.

(10) Cable splices and cable taps shall be made only in junction boxes or fittings approved for the purpose.

(11) In other than horizontal runs, and where side rails do not provide adequate containment of the cables, they shall be fastened securely to transverse members of the continuous rigid cable support.

(12) Where continuous rigid cable supports are located adjacent to one another an adequate working space of 24 inches minimum should be maintained on one side of each continuous rigid cable support, or where grouped in rows adjacent to each other a minimum working space of 32 inches should be maintained over each continuous rigid cable support.

(13) A minimum vertical clearance of 6 inches should be maintained from the top of the continuous rigid cable support to all ceilings, beams, and other obstructions.

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

E 318.05 Grounding. All metal sections of continuous rigid cable supports and fittings shall be bonded and effectively grounded to provide a continuous circuit for fault current. A continuous rigid cable support system shall not be used either as a grounded circuit conductor or as an equipment grounding conductor. See Wis. Adm. Code section E 250.033.

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

E 318.06 Ampacity. The ampacities of cables installed in continuous rigid cable supports shall be as follows:

(1) Where cables containing not more than three current-carrying conductors are installed in ventilated continuous rigid cable supports and spacing is maintained at from one-quarter to one cable diameter, the factors of table E 318.06 (1) shall be applied to the ampacities of the cables used.

TABLE E 318.06 (1)

FACTORS FOR CABLES WITH MAINTAINED SPACING

Number of Cables	Horizontally					
	1	2	3	4	5	6
Vertically						
1	1.00	0.93	0.87	0.84	0.83	0.82
2	0.89	0.83	0.79	0.76	0.75	0.74
3	0.80	0.76	0.72	0.70	0.69	0.68
4	0.77	0.72	0.68	0.67	0.66	0.65
5	0.75	0.70	0.66	0.65	0.64	0.63
6	0.74	0.69	0.64	0.63	0.62	0.61

(2) The ampacities of cables shall be in accordance with the requirements of note 8 of Notes to tables E 310.12 through E 310.15 where (a) cables are not spaced, (b) spacing is maintained between cables of more than three current-carrying conductors, or (c) unventilated continuous rigid cable supports are used.

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

Chapter E 320

OPEN WIRING ON INSULATORS

E 320.01 Definition. Open wiring is a wiring method using cleats, knobs, tubes and flexible tubing for the protection and support of insulated conductors run in or on buildings, and not concealed by the building structure.

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

E 320.02 Use. (1) Open wiring on insulators may be used for exposed work, either inside or outside building; in dry or wet locations; where subject to corrosive vapors such as covered by chapter E 480; for services as covered by chapter E 230, provided the requirements of this chapter are satisfied.

(2) Open wiring on insulators shall not be used (a) in commercial garages, (b) in theaters, (c) in motion-picture studios, (d) in hoistways, and (e) in hazardous locations, except in storage compartments of class III locations as provided in subsection E 503.03 (2).

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

E 320.03 Other chapters. In addition to the provisions of this chapter, open wiring shall conform to the other applicable provisions of this code. See especially chapters E 300 and E 730.

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

E 320.04 Conductors. The type of conductors shall conform to chapter E 310. Only single conductors shall be used.

(1) The allowable ampacities of insulated conductors as shown in chapter E 310 shall apply to open wiring on insulators.

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

E 320.05 Supports. (1) Conductors shall not be in contact with any object other than their insulating supports. They shall be rigidly supported on noncombustible, non-absorptive insulating material as follows:

(a) Under ordinary circumstances, supports for wiring over flat surfaces shall be not more than 4½ feet apart. Where the conductors are likely to be disturbed, the distance between supports shall be shortened sufficiently to provide adequate support for conductors;

(b) Conductors shall be supported within 6 inches of a tap;

(c) Conductors shall not be dead ended at a rosette, lampholder, or receptacle unless the last support is within 12 inches of the device.

(2) The following exceptions to the provisions of subsection E 320.05 (1) may be permitted:

(a) *Exception No. 1.* For use of non-metallic flexible tubing, see section E 320.07.

(b) *Exception No. 2.* Conductors of No. 8 or larger installed in the open, across open spaces where not likely to be disturbed, may be supported at distances not greater than 15 feet provided that approved noncombustible, non-absorptive insulating separators assuring not less than 2½ inch separation between conductors, are installed at intervals of not over 4½ feet.

(c) *Exception No. 3.* In buildings of mill construction where not likely to be disturbed, feeders in the open, not smaller than No. 8, may be separated about 6 inches and installed direct from timber to timber being supported from each timber only.

(3) When nails are used to mount knobs they shall not be smaller than 10 penny. When screws are used to mount knobs, or when nails or screws are used to mount cleats, they shall be of a length sufficient to penetrate the wood to a depth equal to at least one-half the height of the knob and fully the thickness of the cleat. Cushion washers shall be used with nails.

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

E 320.06 **Conductor separation.** Open conductors shall be separated as follows:

(1) For voltage not exceeding 300 volts between conductors, 2½ inches from each other and shall be separated from the surface wired over at least ½ inch in dry locations.

(2) For voltages of 301 to 600 volts between conductors, 4 inches from each other and shall be separated from surface wired over at least 1 inch.

(3) In damp or wet locations, a separation of at least 1 inch from the surface wired over shall be maintained for all voltages.

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

E 320.07 Flexible non-metallic tubing. In dry locations, when not exposed to severe physical damage, conductors may be separately encased in flexible tubing. Tubing shall be in continuous length not exceeding 15 feet, and secured to the surface wired over by straps spaced not exceeding 4½ feet apart.

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

E 320.08 Tie wires. No. 8 or larger conductors supported on solid knobs shall be securely tied thereto. Tie wires shall have a covering equivalent to conductors which they confine.

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

E 320.09 Passing through walls and floors. Open conductors shall be separated from contact with walls, floors, timbers or partitions through which they pass by tubes or bushings of noncombustible, non-absorptive insulating material. Where the bushing is shorter than the hole, a waterproof sleeve of non-inductive material shall be inserted in the hole and an insulating bushing slipped into the sleeve at either end in such a manner as to keep the conductors absolutely out of contact with the sleeve. Each conductor must be carried through a separate tube or sleeve.

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

E 320.10 Separation from metal work. Open conductors shall be separated at least 2 inches from metallic conduit, piping, or other conducting material, and from any exposed lighting, power or signal conductor, or shall be separated therefrom by a continuous and firmly fixed non-conductor additional to the insulation of the conductor. Where any insulating tube is used, it shall be secured at the ends. Deviation from this requirement may, when necessary, be allowed by the administrative authority.

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

E 320.11 Separation from piping in damp locations. Open conductors located close to water pipes or tanks, or in other damp locations, shall be so placed that an air space will be permanently maintained between them and pipes which they cross. Where practicable, conductors shall be installed over, rather than under, pipes upon which moisture is likely to gather or which may leak.

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

E 320.12 Protection from physical damage. Where open conductors cross ceiling joists and wall studs, and are exposed to physical damage, they shall be protected by one of the following methods. Conductors within 8 feet from the floor shall be considered exposed to physical damage.

(1) By guard strips not less than ⅞ inch in thickness and at least as high as the insulating supports, placed on each side of and close to the wiring.

(2) By a substantial running board at least ½ inch thick back of the conductors with side protections. Running boards shall extend at least 1 inch outside the conductors, but not more than 2 inches and the protecting sides shall be at least 2 inches high and at least ⅞ inch thick.

(3) By boxing made as above and furnished with cover kept at least 1 inch away from the conductors within. Where protecting vertical conductors on side walls the boxing shall be closed at the top and the holes through which the conductors pass shall be bushed.

(4) By rigid metal conduit or electrical metallic tubing, in which case the rules of Wis. Adm. Code chapter E 346 or E 348 shall apply; or by metal piping, in which case the conductors shall be encased in continuous lengths of approved flexible tubing. The conductors passing through metal enclosures shall be so grouped that current in both directions is approximately equal.

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

E 320.13 In accessible attics. Conductors in unfinished attics or roof spaces shall be installed in accordance with the provisions of section E 324.08.

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

E 320.14 Entering spaces subject to dampness, wetness or corrosive vapors. Conductors entering or leaving locations subject to dampness, wetness or corrosive vapors shall have drip loops formed on them and shall then pass upward and inward from the outside of buildings, or from the damp, wet, or corrosive location, through noncombustible, non-absorptive insulating tubes. See also Wis. Adm. Code sections E 230.049 and E 730.21.

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

E 320.15 Switches. (1) Surface-type snap switches shall be mounted in accordance with the provisions of section E 380.10. Metal boxes are not required. See section E 380.03.

(2) Other types of switches shall be installed in accordance with the provisions of section E 380.03.

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

Chapter E 324

CONCEALED KNOB-AND-TUBE WORK

E 324.01 Definition. Concealed knob-and-tube wiring is a wiring method using knobs, tubes and flexible non-metallic tubing for the protection and support of insulated conductors concealed in hollow spaces of walls and ceilings of buildings.

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

E 324.02 Use. Concealed knob-and-tube work may be used in the hollow spaces of walls and ceilings. It shall not be used (1) in commercial garages, (2) in theaters, except as provided in section E 520.04, (3) in motion-picture studios, nor (4) in hazardous locations.

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

E 324.03 Other chapters. In addition to the provisions of this chapter, concealed knob-and-tube wiring shall conform to the other applicable provisions of this code. See especially Wis. Adm. Code chapter E 300.

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

E 324.04 Conductors. Only single conductors shall be used. The ampacity and type of conductor shall conform to chapter E 310.

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

E 324.05 Supports. Conductors shall be supported at intervals not exceeding 4½ feet by knobs or tubes of noncombustible, non-absorptive, insulating material. There shall be a knob within 6 inches from each tap. Tie wires shall comply with E 320.08. Where such support is impracticable and the conductors are in a dry location, they may be fished when separately enclosed in flexible non-metallic tubing extending in continuous lengths from one support to the next or to a box, or from one box to another.

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

E 324.06 Conductor separation. (1) Conductors shall be separated at least 3 inches and maintained at least 1 inch from the surface wired over.

(2) At distributing centers, meters, outlets, switches or other places where space is limited and the 3 -inch separation cannot be maintained, each conductor shall be encased in a continuous length of flexible tubing.

(3) Where practicable, conductors shall be run singly on separate timbers or studding.

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

E 324.07 Separation from other objects and protection. Conductors shall be separated from other conductors and objects as follows:

(1) The provisions as to rigid supporting and clearance from foreign wires and other objects, as specified for open wiring in sections E 320.09, E 320.10, E 320.11, and E 320.15, shall be complied with.

(2) Conductors passing through cross timbers in plastered partitions shall be protected by an additional noncombustible, non-absorptive insulating tube extending at least 3 inches above the timber.

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

E 324.08 In unfinished attics and roof spaces. Conductors in unfinished attics or roof spaces shall comply with the following:

(1) Conductors in unfinished attics and roof spaces shall be run through or on the sides of joists, studs and rafters, except in attics and roof spaces having head room at all points of less than 3 feet in buildings completed before the wiring is installed.

(2) Where conductors in accessible unfinished attics or roof spaces reached by stairway or permanent ladder are run through bored holes in floor joists or through bored holes in studs or rafters within 8 feet of the floor or floor joists, such conductors shall be protected by substantial running boards extending at least 1 inch on each side of the conductors and securely fastened in place.

(3) Where carried along the sides of rafters, studs or floor joists, neither running boards nor guard strips will be required.

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

E 324.09 Boxes of insulating material. Non-metallic outlet boxes may be used as provided in sections E 370.03 and E 370.07.

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

E 324.10 Switches. See sections E 380.03 and E 380.10.

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

Chapter E 328

BARE-CONDUCTOR FEEDERS

E 328.01 Use. By special permission, bare conductors installed in accordance with the provisions of Wis. Adm. Code sections E 300.01 to E 300.22 inclusive, and in accordance with the provisions of sections E 328.02 to E 328.07 inclusive, may be used for feeders only. Such bare conductors may be installed only in a chase, channel or shaft of noncombustible material in a building of fire-resistive construction; and only where the voltage between conductors does not exceed 600 volts. Bare conductors shall not be used in damp or wet locations, nor in any hazardous location, nor where subject to corrosive vapor, except in storage-battery rooms as provided in section E 480.07.

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

E 328.02 Size and capacity of copper conductors. The maximum permissible current shall be 1000 amperes per square inch of cross-sectional area of conductor in unventilated enclosures, and 1200 amperes per square inch in ventilated enclosures. These provisions are not intended to apply to equipment such as controls and switchgear.

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

E 328.03 Branch taps. Branch taps from bare-conductor feeders may be installed as specified in section E 240.15; provided that the mechanical protection specified by exceptions No. 5 and 6 of section E 240.15 shall not be required for that portion of the conductor located in the chase, channel or shaft.

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

E 328.04 Accessibility. The conductors shall not be accessible to other than qualified persons.

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

E 328.05 Supports. Conductors shall be supported as follows: (1) Conductors shall be supported on noncombustible, non-absorptive insulating supports of adequate mechanical strength.

(2) Conductors shall be so supported that a separation between conductors, and between conductors and ground, of not less than that specified in section E 384.26 will be maintained under all conditions of operation.

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

E 328.06 Fire cutoffs. Where floors are pierced, suitable cutoffs against vertical travel of fire shall be provided. See also section E 300.21.

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

E 328.07 Special safeguards. In addition to the provisions of the preceding rules, the administrative authority may require other safeguards in view of special conditions that may be met in a particular installation.

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

Chapter E 330

MINERAL INSULATED-METAL SHEATHED CABLE

Type MI

A. GENERAL

E 330.01 Definition and construction. For the purpose of this chapter, mineral insulated-metal sheathed type MI cable is a cable in which one or more electrical conductors are insulated with a highly compressed refractory mineral insulation and enclosed in a liquidtight and gastight metallic tube sheathing. It shall be used with approved fittings for terminating and connecting to boxes, outlets and other equipment.

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

E 330.02 Use. Mineral insulated-metal sheathed cable may be used for services, feeders and branch circuits in both exposed and concealed work, in dry or wet locations; in class I, class II, and class III hazardous locations as noted in the appropriate chapters; for under plaster extensions as provided in Wis. Adm. Code chapter E 344; and embedded in plaster finish on brick or other masonry. It may be used where exposed to weather or continuous moisture, for underground runs and embedded in masonry, concrete or fill, in buildings in course of construction or where exposed to oil, gasoline, or other conditions not having a deteriorating effect on the metal sheath. The sheath of mineral insulated-metal sheathed cable exposed to destructive corrosive conditions, such as some types of cinder fill, shall be protected by materials suitable for those conditions.

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

E 330.03 Other chapters. In addition to the provisions of this chapter, the installation of mineral insulated-metal sheathed cable shall comply with the other applicable provisions of this code. See especially chapter E 300.

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

B. INSTALLATION

E 330.04 Supports. Mineral insulated-metal sheathed cable shall be securely supported by approved staples, straps, hangers or similar fittings, so designed and installed as not to injure the cable. Cable shall be secured at intervals not exceeding 6 feet except where cable is fished.

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

E 330.05 Through studs, joists and rafters. See Wis.. Adm. Code section E 300.08.

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

E 330.06 Wet locations. See section E 300.05.

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

E 330.07 Bends. All bends shall be so made that the cable will not be damaged and the radius of the curve of the inner edge of any bend shall be not less than 5 times the diameter of the cable.

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

E 330.08 Terminating seal. At all points where mineral insulated-metal sheathed cable terminates an approved seal shall be provided immediately after stripping to prevent entrance of moisture into the mineral insulation. The conductors extending beyond the sheath shall be insulated with an approved insulating material.

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

E 330.09 Fittings. When type MI cable is connected to boxes or equipment, the fittings shall be approved for the conditions of service. When single conductor type MI cables enter metal boxes through separate openings, refer to section E 300.20.

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

E 330.10 Insulation resistance. The completed wiring system shall be tested for insulation resistance in accordance with section E 195.20.

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

C. CONSTRUCTION SPECIFICATIONS

E 330.11 General. Type MI cable for 600 volts shall conform to the following:

(1) CONDUCTORS. The conductors are solid copper and have cross sectional areas corresponding to the standard American Wire Gauge sizes.

(2) INSULATION. The insulation is a highly compressed refractory mineral which provides proper spacing for the conductors.

(3) OUTER SHEATH. The outer sheath shall be of a continuous copper construction to provide mechanical protection and a moisture seal, and an adequate path for grounding purposes.

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

Chapter E 331

ALUMINUM SHEATHED CABLE

Type ALS

A. GENERAL

E 331.01 Definition and construction. Aluminum sheathed type ALS cable is factory assembled cable consisting of one or more insulated conductors enclosed in an impervious, continuous, closely fitting tube of aluminum. It shall be used with approved fittings for terminating and connecting to boxes, outlets and other equipment.

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

E 331.02 Use. (1) Aluminum sheathed cable may be used in both exposed and concealed work, in dry or wet locations. The sheath of aluminum sheathed cable exposed to destructive corrosive conditions such as environments containing strong chlorides or caustic alkalis, or where vapors of chlorine or hydrochloric acid are present or where the cable is installed underground, shall be protected by materials suitable for those conditions. See section E 300.05.

(2) Aluminum sheathed cable and fittings shall not be embedded or buried directly in concrete or used in areas subject to severe corrosive influences unless suitable supplemental corrosion protection is provided.

Note: See section E 310.06.

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

E 331.03 Other chapters. In addition to the provisions of this chapter, the installation of aluminum sheathed cable shall comply with the other applicable provisions of this code. See especially chapter E 300.

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

B. INSTALLATIONS

E 331.04 Supports. Aluminum sheathed cable shall be securely supported by staples, straps, hangers, or similar fittings so designed and installed as not to injure the cable. Cable shall be secured at intervals not exceeding 6 feet except where the cable is fished.

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

E 331.05 Through studs, joists and rafters. See section E 300.08.

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

E 331.06 Wet locations. See section E 300.05.

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

E 331.07 Bends. All bends shall be so made that the cable will not be damaged and the radius of the curve on the inner edge of any bend shall be not less than:

(1) Ten times the external diameter of the sheath for cable not more than ¾ inch in external diameter.

(2) Twelve times the external diameter of the sheath for cable more than ¾ inch but not more than 1½ inches in external diameter; and

(3) Fifteen times the external diameter of the sheath for cable more than 1½ inches in external diameter.

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

E 331.08 Fittings. When aluminum sheathed cable is connected to boxes or equipment, the fittings shall be approved for the conditions of service. When single conductor aluminum sheathed cables enter metal boxes through separate openings refer to section E 300.20.

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

C. CONSTRUCTION

E 331.09 General. Type ALS cable shall conform to the following:

(1) CONDUCTORS. The conductors shall be copper or electrical conductor (EC) grade aluminum, solid or stranded.

(2) INSULATION. The insulation shall be a type listed in table E 310.02(2).

(3) INSULATION COVERING. The covering over the insulation shall be the same as permitted for lead sheathed cable or multiple conductor cable.

(4) OUTER SHEATH. The outer sheath shall be of a continuous closely fitting tube of aluminum to provide mechanical protection, a moisture seal and an adequate path for equipment grounding purposes and shall conform with provisions of section E 331.02. The sheath shall not be used as a current-carrying conductor.

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

Chapter E 334

METAL-CLAD CABLE

Type MC and AC Series

E 334.01 Definition. A metal-clad cable is a fabricated assembly of insulated conductors and one or more adequate grounding conductors in a flexible metallic enclosure. See section E 334.04.

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

E 334.02 Voltage. See Wis. Adm. Code section E 300.02. For systems in excess of 600 volts see chapter E 710.

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

E 334.03 Marking. The provisions of section E 310.02 shall apply, except that AC cable shall have ready identification of the maker by distinctive external markers in the cable sheath throughout its entire length.

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

E 334.04 Construction. Metal-clad cable shall be an approved cable of type MC or AC series, with acceptable metal covering. The insulated conductors shall conform with section E 334.05.

(1) TYPE MC. Type MC cables are power cables limited in size, for the voltages of this chapter, to conductors of No. 4 AWG and larger for copper and No. 2 AWG and larger for aluminum. The metal enclosures shall be either a covering of interlocking metal tape, or an impervious, close fitting, corrugated tube. Supplemental protection of an outer covering of corrosion-resistant material shall be required where such protection is needed. See section E 300.05. One or more grounding conductors shall be incorporated under the metallic covering. The total cross-section of the grounding conductor shall be approximately equal to one-half the cross-section of one phase conductor.

(2) TYPE AC. Type AC cables are branch circuit and feeder cables with armor of flexible metal tape. Cables of the AC type, except ACL, shall have an internal bonding strip of copper or aluminum, in intimate contact with the armor for its entire length.

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

E 334.05 Conductors. Conductors for metal-clad cable shall conform with the following:

(1) TYPE MC. For cables of type MC, insulated conductors shall be of a type listed in table E 310.02(2) for rubber, thermoplastic, varnished cloth, asbestos-varnished cloth, or of a type especially approved for the purpose.

(2) TYPE AC. For cables of type AC, insulated conductors shall be of a type listed in table E 310.02(2). In addition, the conductors shall have an overall moisture-resistant and fire-retardant fibrous covering; for type ACT, a moisture-resistant fibrous covering is required only on the individual conductors.

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

E 334.06 Use. Except where otherwise specified elsewhere in this code, and where not subject to physical damage, metal-clad cable may be installed for branch circuits and feeders in both exposed and concealed work as follows:

(1) TYPE MC. This type of power cable may be used in partially protected areas, such as in continuous rigid cable supports and the like, in dry locations and when any of the following conditions are met it may be used in wet locations:

(a) The metallic covering is impervious to moisture.

(b) A lead sheath or moisture impervious jacket is provided under the metal covering.

(c) The insulated conductors under the metallic covering are approved for use in wet locations.

Note: See section E 300.05.

(2) TYPE AC. Metal-clad cable of the AC type may be used in dry locations; for underplaster extensions as provided in chapter E 344; and embedded in plaster finish on brick or other masonry, except in damp or wet locations. This cable may be run or fished in the air voids of masonry block or tile walls; where such walls are exposed or subject to excessive moisture or dampness or are below grade line, type ACL cable shall be used. This cable shall contain lead-covered conductors (type ACL), if used where exposed to the weather or to continuous moisture, for underground runs and embedded in masonry, concrete or fill in buildings in course of construction, or where exposed to oil, or other conditions having a deteriorating effect on the insulation. Type AC metal-clad cable shall not be used where prohibited elsewhere in this code, including (a) in theatres, except as provided in section E 520.04; (b) in motion-picture studios; (c) in any hazardous locations; (d) where exposed to corrosive fumes or vapors; (e) on cranes or hoists, except as provided in section E 610.11 Exception No. 3; (f) in storage battery rooms; or (g) commercial garages where prohibited in chapter E 511.

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

E 334.07 Other chapters. In addition to the provisions of this chapter, metal-clad cable shall conform to other applicable provisions of this code. See especially chapter E 300.

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

E 334.08 Supports. Metal-clad cable shall be secured by approved staples, straps, hangers or similar fittings so designed and installed as not to injure the cable.

(1) Type MC cable shall be secured at intervals not exceeding 6 feet, and within 2 feet from every box or fitting, except where cable is fished. Cable may be installed on metal racks, trays, troughs, or continuous rigid cable supports, grounded as required by chapter E 250. The cables shall be separated from each other by a distance of not less than ¼ of a cable diameter. There shall be no more than one layer of cables on a rack or other support member; each cable so installed shall be supported at intervals not exceeding 6 feet and within 2 feet from every box or fitting, and each cable shall be attached to the support at intervals of not more than 10 feet horizontally and 2 feet vertically.

(2) Type AC cable shall be secured at intervals of not exceeding 4½ feet and within 12 inches from every outlet box or fitting, except where cable is fished and except lengths of not over 24 inches at terminals where flexibility is necessary.

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

E 334.09 Bends. All bends shall be so made that the cable will not be injured, and the radius of the curve of the inner edge of any bend shall not be less than 7 times the diameter of type MC cable nor 5 times the diameter of type AC cable.

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

E 334.10 Boxes and fittings. (1) At all points where type MC metal-clad cable terminates, suitable fittings designed for use with the particular wiring cable and the conditions of service, shall be used.

(2) At all points where the armor of AC cable terminates, a fitting shall be provided to protect wires from abrasion, unless the design of the outlet boxes or fittings is such as to afford equivalent protection, and in addition, an approved insulating bushing or its equivalent approved protection shall be provided between the conductors and the armor. The connector or clamp by which the armored cable is fastened to boxes or cabinets shall be of such design that the insulating bushing or its equivalent will be visible for inspection. This bushing is not required with lead-covered cables which will be so installed that the lead sheath will be visible for inspection. Where change is made from metal-clad cable to another cable or raceway wiring methods, a box shall be installed at junction point as required in section E 300.15.

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

E 334.11 Through studs, joists and rafters. See section E 300.08.

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

E 334.12 Exposed work. Exposed runs of cable shall closely follow the surface of the building finish or of running boards, except:

(1) Lengths of not more than 24 inches at terminals where flexibility is necessary.

(2) Where suitably supported in accordance with section E 334.08(1).

(3) On the underside of floor joists in basements where supported at each joist and so located as not to be subject to physical damage.

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

E 334.13 In accessible attics. Type AC cables in accessible attics or roof spaces shall be installed as follows:

(1) Where run across the top of floor joists, or within 7 feet of floor or floor joists across the face of rafters or studding, in attics and roof spaces which are accessible, the cable shall be protected by substantial guard strips which are at least as high as the cable. Where this space is not accessible by permanent stairs or ladders, protection will only be required within 6 feet of the nearest edge of scuttle hole or attic entrance.

(2) Where cable is carried along the sides of rafters, studs or floor joists, neither guard strips nor running boards shall be required.

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

Chapter E 336

NON-METALLIC SHEATHED CABLE

Types NM and NMC

E 336.01 Definition. A non-metallic sheathed cable is an assembly of 2 or more insulated conductors having an outer sheath of moisture-resistant, flame-retardant, non-metallic material.

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

E 336.02 Construction. Nonmetallic sheathed cable shall be an approved type NM or NMC in sizes No. 14 through 2 AWG with copper conductors and in sizes No. 12 through 2 with aluminum conductors. In addition to the insulated conductors, the cable may have an approved size of uninsulated or bare conductor for grounding purposes only.

(1) TYPE NM. The conductors shall comply with the requirements for the type of conductor used. Overall fibrous coverings shall have a flame-retardant and moisture-resistant finish.

(2) TYPE NMC. The cable shall be of a type approved for the purpose. The over-all covering shall be flame-retardant, moisture-resistant, fungus-resistant and corrosion-resistant.

(3) MARKING. In addition to the provisions of Wis. Adm. Code chapter E 310, the cable shall carry distinctive marker on exterior for its entire length, specifying cable type, and the name of the manufacturing company.

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

E 336.03 Use. Non-metallic sheathed cable may be installed for both exposed and concealed work as follows:

(1) TYPE NM. This type of non-metallic sheathed cable may be installed for both exposed and concealed work in normally dry locations. It may be installed or fished in air voids in masonry block or tile walls where such walls are not exposed or subject to excessive moisture or dampness. Type NM cable shall not be installed where exposed to corrosive fumes or vapors; nor shall it be embedded in masonry, concrete, fill or plaster; nor run in shallow chase in masonry or concrete and covered with plaster or similar finish.

(2) MOISTURE AND CORROSION-RESISTANT TYPE NMC. This type of non-metallic sheathed cable may be installed for both exposed and concealed work in dry, moist, damp or corrosive locations, and in

outside and inside walls of masonry block or tile. Where embedded in plaster or run in a shallow chase in masonry walls and covered with plaster within 2 inches of the finished surface, it shall be protected against damage from nails by a cover of corrosion-resistant coated steel at least 1/16 inch in thickness and ¾ inch wide in the chase or under the final surface finish.

(3) USES NOT PERMISSIBLE FOR EITHER TYPE NM OR NMC NON-METALLIC SHEATHED CABLE. These types shall not be used as: (a) Service-entrance cable, (b) in commercial garages, (c) in theaters except as provided in section E 520.04, (d) in motion picture studios, (e) in storage battery rooms, (f) in hoistways, (g) in any hazardous location, (h) embedded in poured cement, concrete or aggregate.

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

E 336.04 Other chapters. In addition to the provisions of this chapter, installations of non-metallic sheathed cable shall conform to the other applicable provisions of this code. See especially chapter E 300.

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

E 336.05 Supports. Non-metallic sheathed cable shall be secured by approved staples, straps, or similar fittings, so designed and installed as not to injure the cable. Cable shall be secured in place at intervals not exceeding 4½ feet and within 12 inches from every cabinet, box or fitting, except that in concealed work in finished buildings or finished panels for prefabricated buildings where such supporting is impracticable, the cable may be fished between points of access.

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

E 336.06 Exposed work; general. In exposed work, except as provided in sections E 336.08 and E 336.09, the cable shall be installed as follows:

(1) The cable shall closely follow the surface of the building finish or of running boards.

(2) It shall be protected from physical damage where necessary, by conduit, pipe, guard strips or other means. Where passing through a floor the cable shall be enclosed in rigid metal conduit or metal pipe extending at least 6 inches above the floor.

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

E 336.07 Through studs, joists and rafters. See section E 300.08.

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

E 336.08 In unfinished basements. Where the cable is run at angles with joists in unfinished basements, assemblies not smaller than two No. 6 or three No. 8 conductors may be secured directly to the lower edges of the joists; smaller assemblies shall either be run through bored holes in the joists or on running boards. Where run parallel to joists, cable of any size shall be secured to the sides or face of the joists.

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

E 336.09 In accessible attics. Cable in accessible attics or roof spaces shall also conform with section E 334.13.

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

E 336.10 Bends. Bends in cable shall be so made, and other handling shall be such, that the protective coverings of the cable will not be injured, and no bend shall have a radius less than 5 times the diameter of the cable.

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

E 336.11 Devices of insulating material. (1) Switch, outlet, and tap devices of insulating material may be used without boxes in exposed cable wiring, and for concealed work for rewiring in existing buildings where the cable is concealed and fished. Openings in such devices shall form a close fit around the outer covering of the cable and the device shall fully enclose that part of the cable from which any part of the covering has been removed.

(2) Where connections to conductors are by binding screw terminals, there shall be available as many terminals as conductors, unless cables are clamped within the structure and terminals are of a type approved for multiple conductors.

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

E 336.12 Boxes of insulating material. Non-metallic outlet boxes approved for the purpose may be used as provided in section E 370.03.

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

Chapter E 338

SERVICE-ENTRANCE CABLE

Types SE and USE

E 338.01 Definition. Service-entrance cable is a conductor assembly provided with a suitable overall covering, primarily used for services and of the following types. When consisting of two or more conductors, one may be without individual insulation.

(1) Type ASE, having inherent protection against mechanical abuse and a flame-retardant, moisture-resistant covering.

(2) Type SE, having a flame-retardant, moisture-resistant covering, but not required to have inherent protection against mechanical abuse.

(3) Type USE, recognized for underground use, having a moisture-resistant covering, but not required to have a flame-retardant covering or inherent protection against mechanical abuse.

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

E 338.02 Use as service-entrance conductors. Service entrance cable used as service-entrance conductors shall be installed as required by chapter E 230.

(1) Type USE service-entrance cable used as service conductors in direct earth burial shall be buried not less than 24 inches below the surface, when supplementary protection from physical injury, such as a covering board, concrete pad, raceway, etc. is not provided.

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

E 338.03 Use as branch circuit or feeders. (1) Service-entrance cables may be used in interior wiring systems where all of the circuit conductors of the cable are of the rubber-covered or thermoplastic type.

(2) Service entrance cables without individual insulation on the grounded circuit conductor shall not be used as a branch circuit or as a feeder within a building, except a cable which has a final nonmetallic outer covering and when supplied by alternating current at not exceeding 150 volts to ground, may be used: (a) As a branch circuit to supply only a range, wall-mounted oven, counter-mounted cooking unit, or clothes dryer, or (b) as a feeder to supply only other buildings on the same premises. It shall not be used as a feeder terminating within the same building in which it originates.

Note: The above provisions do not intend to deny the use of service entrance cable for interior use when the fully insulated conductors are used for circuit wiring and the uninsulated conductor is used for equipment grounding purposes.

(3) Service-entrance cable used to supply appliances shall not be subject to conductor temperatures in excess of the temperature specified for the type of insulation involved.

(4) Type USE service-entrance cable used as branch circuit or feeder conductors in direct earth burial shall be buried not less than 18 inches below the surface, when supplementary protection from physical injury, such as a covering board, concrete pad, raceway, etc. is not provided.

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

E 338.04 Installation methods. (1) In addition to the provisions of this chapter, service-entrance cable used for interior wiring shall comply with the applicable provisions of chapter E 300.

(2) Unarmored cable shall be installed in accordance with the applicable provisions of chapter E 336.

(3) Cables through studs, joists and rafters shall be installed as required in section E 300.08.

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

E 338.05 Marking. Service-entrance cable shall conform with the marking required in section E 310.02. Cable with the neutral conductor smaller than the ungrounded conductors shall be so marked.

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

Chapter E 339

UNDERGROUND FEEDER AND BRANCH CIRCUIT CABLE

Type UF

E 339.01 Description and marking. (1) DESCRIPTION. Underground feeder and branch circuit cable shall be an approved type UF cable in sizes No. 14 to No. 4/0 AWG, inclusive. The conductors shall be types TW, RHW, or other conductors approved for the purpose. In addition to the insulated conductors, the cable may have an approved size of uninsulated or bare conductor for grounding purposes only. The overall covering shall be flame-retardant, moisture-resistant, fungus-resistant and corrosive-resistant, and suitable for direct burial in the earth.

(2) MARKING. In addition to the provisions of section E 310.02 the cable shall have a distinctive marking on the exterior for its entire length specifying cable type.

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

E 339.02 Other chapters. In addition to the provisions of this chapter, installations of underground feeder and branch circuit cable (type UF) shall comply with other applicable provisions of this code. See especially chapter E 300 and subsection E 310.02 (2).

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

E 339.03 Use. (1) Underground feeder and branch circuit cable may be used underground, including direct burial in the earth, as feeder or branch circuit cable when provided with overcurrent protection of the rated current-carrying capacity as required in section E 339.04.

(2) Where single conductor cables are installed, all cables of the feeder circuit, sub-feeder circuit, or branch circuit, including the neutral conductor, if any, shall be run together in the same trench or raceway.

(3) A minimum depth of 18 inches shall be maintained for conductors and cables buried directly in the earth, when supplementary protection from physical injury such as a covering board, concrete pad, raceway, etc., is not provided.

(4) Type UF cable may be used for interior wiring in wet, dry, or corrosive locations under the recognized wiring methods of this code, and when installed as non-metallic sheathed cable it shall conform with the installation provisions of chapter E 336 and shall be of the multiple conductor type, except where recognized under the provisions of section E 422.44.

(5) This type of cable shall not be used: (a) as service-entrance cables; (b) in commercial garages; (c) in theaters except as provided in Wis. Adm. Code section E 520.04; (d) in motion picture studios; (e) in storage battery rooms; (f) in hoistways; (g) in any hazardous location; (h) embedded in poured cement, concrete or aggregate, except where recognized in chapter E 422; (1) when exposed to direct rays of the sun, unless approved for the purpose.

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

E 339.04 Overcurrent protection. Overcurrent protection shall be provided in accordance with provisions of section E 240.05.

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

E 339.05 Rated ampacity. The ampacities of conductors in type UF cable shall be according to tables E 310.12 and E 310.14.

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

Chapter E 342

NON-METALLIC EXTENSIONS

E 342.01 Description. Non-metallic extensions are an assembly of 2 insulated conductors within a non-metallic jacket or an extruded thermoplastic covering. The classification covers surface extensions for mounting directly on the surface of walls or ceilings.

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

E 342.02 Other chapters. In addition to the provisions of this chapter, non-metallic extensions shall conform to other applicable provisions of this code.

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

E 342.03 Use permitted. Non-metallic extensions may be used only where all of the following conditions are met:

(1) The extension is from an existing outlet on a 15 or 20 ampere branch circuit in conformity with the requirements of chapter E 210.

(2) The extension is run exposed and in a dry location.

(3) For non-metallic surface extensions, the building or space is occupied for residential or office purposes.

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

E 342.04 Use prohibited. Non-metallic extensions shall not be installed:

(1) In unfinished basements, attics, or roof spaces.

(2) Where voltage between conductors exceeds 150 volts.

(3) Where subject to corrosive vapors.

(4) Where run through a floor or partition, or outside the room in which it originates.

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

E 342.05 Splices and taps. Extensions shall consist of a continuous unbroken length of the assembly, without splices, and without exposed conductors between fittings. Taps may be made where approved fittings completely covering the tap connections are used. Receptacle type tap connectors shall be of the locking type.

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

E 342.06 Fittings. Each run shall terminate in a fitting which covers the end of the assembly. All fittings and devices shall be of a type approved for the purpose.

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

E 342.07 Installation. Non-metallic extensions shall be installed in conformity with the following requirements:

(1) One or more extensions may be run in any direction from an existing outlet, but not on the floor or within 2 inches from the floor.

(2) Non-metallic surface extensions shall be secured in place by approved means at intervals not exceeding 8 inches, except that where connection to the supplying outlet is made by means of an attachment plug the first fastening may be placed 12 inches or less from the plug. There shall be at least one fastening between each 2 adjacent outlets supplied. An extension shall be attached only to woodwork or plaster finish, and shall not be in contact with any metal work or other conductive material except with metal plates on receptacles.

(3) A bend which reduces the normal spacing between the conductors shall be covered with a cap to protect the assembly from physical damage.

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

Chapter E 344

UNDERPLASTER EXTENSIONS

E 344.01 Use. An underplaster extension installed as permitted by this chapter, may be used only for extending an existing branch circuit in a building of fire-resistive construction.

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

E 344.02 Materials. Such extensions shall be run in rigid or flexible conduit, type AC metal-clad cable, electrical metallic tubing, type MI cable or metal raceways approved for the purpose. Standard sizes of conduit, cable, tubing and raceways shall be used except that for a single conductor only conduit or tubing having not less than $\frac{5}{16}$ inch inside diameter, single-conductor type AC metal-clad cable or single conductor type MI cable may be used.

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

E 344.03 Box and fittings. See chapter E 370.

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

E 344.04 Installation. An underplaster extension shall be laid on the face of masonry or other material and buried in the plaster finish of ceilings or walls. The methods of installation of the raceway or cable for such extension shall be as specified elsewhere in this code for the particular type of material used.

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

E 344.05 Extension to another floor. No such extension shall extend beyond the floor on which it originates unless installed in a standard size of rigid metal conduit, electrical metallic tubing, type AC metal-clad cable, or MI cable.

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

Chapter E 346

RIGID METAL CONDUIT

Note: Where conduit is threaded in the field, it is assumed that a standard conduit cutting die providing ¾ inch taper per foot will be employed.

E 346.01 Use. (1) Rigid metal conduit may be used under all atmospheric conditions and occupancies, except that ferrous raceways and fittings protected from corrosion solely by enamel may be used only indoors and in occupancies not subject to severe corrosive influences. Where practicable dissimilar metals in contact anywhere in the system shall be avoided to eliminate the possibility of galvanic action.

(2) Unless made of a material judged suitable for the condition, or unless corrosion protection approved for the condition is provided, ferrous or non-ferrous metallic conduit, elbows, couplings, and fittings shall not be installed in concrete or in direct contact with the earth, or in areas subject to severe corrosive influences.

Note: See section E 300.05 for limitation in the use of ferrous raceways and fittings protected from corrosion solely by enamel.

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

E 346.02 Other chapters. Installations of rigid metal conduit shall comply with the provisions of the applicable rules of chapter E 300.

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

A. INSTALLATION

E 346.03 Cinder fill. Conduit, unless of corrosion-resistant material suitable for the purpose shall not be used in or under cinder fill where subject to permanent moisture unless protected on all sides by a layer of non-cinder concrete at least 2 inches thick or unless the conduit is at least 18 inches under the fill.

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

E 346.04 Wet locations. All supports, bolts, straps, screws, etc., shall be of corrosion-resistant materials or protected against corrosion by approved corrosion-resistant materials.

Note: See section E 300.05.

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

E 346.05 Minimum size. No conduit smaller than ½ inch, electrical trade size, shall be used, except as provided for underplaster extensions in chapter E 344, and for enclosing the leads of motors as permitted in section E 430.145 (2).

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

E 346.06 Number of conductors in conduit. The number of conductors permitted in a single conduit shall be as follows:

(1) NEW WORK. (a) Where conductors are all of the same size, use tables 1 and 2 of Wis. Adm. Code chapter E 900.

(b) Where conductors are of various sizes to be used in combination, use tables 3 and 4 of chapter E 900 and the dimensions of column 3 of table 5 of chapter E 900. Where bare conductors are permitted by other sections of this code, the dimensions for bare conductors in table 8 of chapter E 900 may be used.

(2) REWIRING EXISTING CONDUITS. (a) For rewiring existing conduits where conductors are all of the same size use tables 1, 1A and 1B of chapter E 900.

(b) Where conductors are of various sizes to be used in combination use tables 3 and 4 of chapter E 900 and the dimensions of column 3, 5, or 7 of table 5, chapter E 900.

(3) BARE CONDUCTORS. Where bare conductors are permitted by other sections of this code, the dimensions for bare conductors in table 8 of chapter E 900 may be used.

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

E 346.07 Reaming. All cut ends of conduits shall be reamed to remove rough edges.

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

E 346.08 Bushings. Where a conduit enters a box or other fitting, a bushing shall be provided to protect the wire from abrasion unless the design of the box or fitting is such as to afford equivalent protection. See section E 373.06 (2) for the protection of conductors at bushings.

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

E 346.09 Couplings. (1) Threadless couplings and connectors used with conduit shall be made tight. Where installed in wet places or where buried in masonry, concrete or fill shall be of a type to prevent water from entering the conduit.

(2) Running threads shall not be used on conduit for connection at couplings.

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

E 346.10 Bends; how made. Bends of rigid conduit shall be so made that the conduit will not be injured, and that the internal diameter of the conduit will not be effectively reduced. The radius of the curve of the inner edge of any field bend shall not be less than shown in table E 346.10.

TABLE E 346.10
RADIUS OF CONDUIT BENDS

Size of Conduit	Conductors Without Lead Sheath	Conductors With Lead Sheath
½ in.	4 in.	6 in.
¾ in.	5 in.	8 in.
1 in.	6 in.	11 in.
1¼ in.	8 in.	14 in.
1½ in.	10 in.	16 in.
2 in.	12 in.	21 in.
2½ in.	15 in.	25 in.
3 in.	18 in.	31 in.
3½ in.	21 in.	36 in.
4 in.	24 in.	40 in.
5 in.	30 in.	50 in.
6 in.	36 in.	61 in.

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

E 346.11 Bends; number in one run. A run of conduit between outlet and outlet, between fitting and fitting, or between outlet and fitting shall not contain more than the equivalent of 4 quarter bends (360 degrees, total), including those bends located immediately at the outlet or fitting.

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

E 346.12 Supports. See section E 300.11.

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

E 346.13 Boxes and fittings. See chapter E 370.

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

B. CONSTRUCTION SPECIFICATIONS

E 346.14 General. Rigid metal conduit shall conform to the following:

(1) Rigid conduit as shipped shall be in standard lengths of 10 feet including coupling, one coupling to be furnished with each length. Each length shall be reamed and threaded on each end. For specific applications or uses, lengths shorter or longer than 10 feet, with or without couplings, may be shipped.

(2) Steel conduit shall have an interior coating of a character and appearance so as to readily distinguish it from ordinary pipe commonly used for other than electrical purposes.

(3) Nonferrous conduit of corrosion-resistant material shall have suitable markings.

(4) Each length shall be clearly and durably identified in every 10 feet with the manufacturer's name or trademark and type of material.

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

Chapter E 347

RIGID NON-METALLIC CONDUIT

E 347.01 Description. The provisions of this chapter shall apply to a type of conduit and fittings of suitable non-metallic material which is resistant to moisture and chemical atmospheres. For use above ground, it shall also be flame retardant, resistant to impact and crushing, shall resist distortion due to heat under conditions likely to be encountered in service and shall be resistant to low temperature and sunlight effects. For use underground, the material shall be acceptably resistant to moisture and corrosive agents and shall be of sufficient strength to withstand abuse, such as by impact and crushing, in handling and during installation. Where intended for direct burial, without encasement in concrete, the material shall also be capable of withstanding continued loading which is likely to be encountered after installation.

Note: Materials which have been recognized as having suitable physical characteristics when properly formed and treated include fiber, asbestos cement, soapstone, rigid polyvinyl chloride, and high density polyethylene for underground use and rigid polyvinyl chloride for use above ground.

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

E 347.02 Use permitted. Rigid nonmetallic conduit and fittings approved for the purpose may be used under the following conditions and where the potential is 600 volts or less except as noted in Wis. Adm. Code section E 347.03.

(1) Underground if encased in not less than 2 inches of concrete.

(2) Direct earth burial if of a type approved for the purpose and if buried not less than 18 inches below the surface.

(3) In concrete walls, floors and ceilings.

(4) In locations subject to severe corrosive influences as set forth in section E 300.05 and where subject to chemicals for which the materials are specifically approved.

(5) Cinder fill.

(6) Wet Locations. In portions of dairies, laundries, canneries or other wet locations and in locations where walls are frequently washed, the entire conduit system including boxes and fittings used therewith shall be so installed and equipped as to prevent water from entering the conduit. All supports, bolts, straps, screws, etc., shall be of corrosion-resistant materials or protected against corrosion by approved corrosion-resistant materials.

(7) In dry and damp locations not prohibited by section E 347.03.

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

E 347.03 Use prohibited. Rigid nonmetallic conduit shall not be used:

(1) Less than 8 feet above ground outdoors unless protected against physical damage.

(2) In hazardous locations except as covered in section E 514.08.

(3) In the concealed spaces of combustible construction.

(4) For the support of fixtures or other equipment.

(5) Where subject to physical damage.

(6) Where subject to ambient temperatures exceeding those for which the conduit had been tested.

(7) For conductors whose insulation temperature limitations would exceed those for which the conduit had been tested.

(8) For potentials exceeding 600 volts unless encased in not less than 2 inches of concrete.

(9) In the sunlight unless approved for the purpose.

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

E 347.04 Other chapters. Installation of rigid non-metallic conduit shall comply with provisions of the applicable sections of chapter E 300.

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

A. INSTALLATIONS

E 347.05 Trimming. All cut ends shall be trimmed inside and outside to remove rough edges.

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

E 347.06 Joints. All joints between lengths of conduit and between conduit and couplings, fittings and boxes shall be made by a method specifically approved for the purpose.

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

E 347.08 Supports. See section E 300.11.

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

E 347.09 Expansion joints. Expansion joints for rigid non-metallic conduit shall be provided where required to compensate for thermal expansion and contraction.

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

E 347.10 Minimum size. No conduit smaller than ½ inch electrical trade size shall be used.

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

E 347.11 Number of conductors. The number of conductors permitted in a single conduit shall be as follows:

(1) NEW WORK: (a) Where conductors are all of the same size, tables 1 and 2 of chapter E 900.

(b) Where conductors are of various sizes to be used in combination, use tables 3 and 4 of Wis. Adm. Code chapter E 900 and the dimensions of conductors in column 3 of table 5 of chapter E 900.

Where bare conductors are permitted by other sections of this code, the dimensions for bare conductors in table 8 of chapter E 900 may be used.

(c) When equipment grounding is required by chapter E 250, a separate grounding conductor shall be installed in the conduit.

(2) REWIRING EXISTING CONDUITS: For rewiring existing conduits, the allowable fill may be determined from tables 3 and 4 of chapter E 900 using the dimensions from table 5 of chapter E 900.

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

E 347.12 Bushings. Where a conduit enters a box or other fitting, a bushing or adapter shall be provided to protect the wire from abrasion unless the design of the box or fitting is such as to provide equivalent protection. See section E 373.06 (2) for the protection of conductors at bushings.

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

E 347.13 Bends, how made. Bends of rigid non-metallic conduit shall be so made that the conduit will not be injured and that the internal diameter of the conduit will not be effectively reduced. Field bends shall be made only with bending equipment specifically approved for the purpose, and the radius of the curve of the inner edge of such bends shall be not less than shown in table E 346.10.

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

E 347.14 Bends, number in one run. A run of conduit between outlet and outlet, between fitting and fitting or between outlet and fitting shall not contain more than the equivalent of 4 quarter bends (360°) total including those bends located immediately at the outlet or fitting.

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

E 347.15 Boxes and fittings. See chapter E 370.

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

B. CONSTRUCTION SPECIFICATIONS

E 347.16 General. Rigid nonmetallic conduit shall conform to the following:

(1) Rigid nonmetallic polyvinyl chloride conduit as shipped shall be in standard lengths of 10 feet including couplings, one coupling to be furnished with each length. For specific applications or uses, lengths shorter or longer than 10 feet with or without couplings may be shipped.

(2) High density polyethylene conduit as shipped shall be in standard lengths of 10 feet. One threaded coupling shall be furnished with each threaded length of high density polyethylene conduit. For specific applications or uses, lengths shorter or longer than 10 feet with or wiithout couplings may be shipped.

(3) Each length of nonmetallic conduit shall be clearly and durably marked at least every ten feet with the manufacturer's name, trade name, or trademark, nominal trade size, and type of material.

(4) For conduit recognized for use above ground these markings shall be permanent. For conduit limited to underground use only, these markings shall be sufficiently durable to remain legible until the material is installed.

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

Chapter E 348

ELECTRICAL METALLIC TUBING

E 348.01 Use. (1) Electrical metallic tubing may be used for both exposed and concealed work. Electrical metallic tubing protected from corrosion solely by enamel shall not be used. Electrical metallic tubing shall not be used (a) where during installation or afterwards, it will be subject to severe physical damage; (b) in cinder concrete or fill where subject to permanent moisture unless protected on all sides by a layer of non-cinder concrete at least 2 inches thick or unless the tubing is at least 18 inches under the fill. Where practicable, the use of dissimilar metals throughout the system shall be avoided to eliminate the possibility of galvanic action.

(2) Unless made of material judged suitable for the condition, or unless corrosion protection approved for the condition is provided, ferrous or nonferrus electrical metallic tubing, elbows, couplings and fittings shall not be installed in concrete or in direct contact with the earth, or in areas subject to severe corrosive influences.

Note: See section E 300.05 for limitation in the use of ferrous raceways and fittings protected from corrosion solely by enamel.

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

E 348.02 Other chapters. Installations of electrical metallic tubing shall comply with the provisions of the applicable rules of chapter E 300.

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

A. INSTALLATION

E 348.04 Wet locations. All supports, bolts, straps, screws, etc. shall be of corrosion-resistant materials or protected against corrosion by approved corrosion-resistant materials.

Note: See section E 300.06.

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

E 348.05 Minimum and maximum sizes. No tubing smaller than ½ inch, electrical trade size, shall be used except as provided for underplaster extensions in chapter E 344 and for enclosing the leads of motors as permitted in section E 430.145 (2). The maximum size of tubing shall be the 4-inch electrical trade size.

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

E 348.06 Number of conductors in tubing. One tubing shall not contain more conductors than as provided in section E 346.06.

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

E 348.07 Threads. Tubing shall not be coupled together nor connected to boxes, fittings, or cabinets by means of threads in the wall of the tubing, except by fittings approved for the purpose. Threads shall not be of the standard pipe thread dimensions.

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

E 348.08 Couplings and connectors. Threadless couplings and connectors used with tubing shall be made up tight. Where buried in masonry or concrete, they shall be concrete-tight type, or where installed in wet locations, shall be of the rain-tight type.

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

E 348.09 Bends; how made. Bends in the tubing shall be so made that the tubing will not be injured and that the internal diameter of the tubing will not be effectively reduced. The radius of the curve of the inner edge of any field bend shall not be less than shown in table E 346.10.

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

E 348.10 Bends; number in one run. A run of electrical metallic tubing between outlet and outlet, between fitting and fitting, or between outlet and fitting, shall not contain more than the equivalent of 4 quarter bends (360 degrees, total), including those bends located immediately at the outlet or fitting.

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

E 348.11 Reaming. All cut ends of electrical metallic tubing shall be reamed to remove rough edges.

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

E 348.12 Supports. See section E 300.11.

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

E 348.13 Boxes and fittings. See chapter E 370.

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

B. CONSTRUCTION SPECIFICATIONS

E 348.14 General. Electrical metallic tubing shall conform to the following:

(1) CROSS SECTION. The tubing, and elbows and bends for use with the tubing, shall have a circular cross-section.

(2) FINISH. Tubing shall have such a finish or treatment of outer surfaces as will provide an approved durable means of readily distinguishing it, after installation, from rigid conduit.

(3) CONNECTORS. Where the tubing is coupled together by threads, the connector shall be so designed as to prevent bending of the tubing at any part of the thread.

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

Chapter E 350

FLEXIBLE METAL CONDUIT

E 350.01 Other chapters. Installations of flexible metal conduit shall comply with the appropriate (or applicable) provisions of Wis. Adm. Code chapters E 300, E 334, and E 346.

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

E 350.02 Use. Flexible metal conduit shall not be used (1) in wet locations, unless conductors are of the lead-covered type or of other type specially approved for the conditions; (2) in storage-battery rooms; (3) in any hazardous location except as permitted in subsection E 501.04(2) and sections E 502.04 and E 503.03; nor (4) where rubber-covered conductors are exposed to oil, gasoline, or other materials having a deteriorating effect on rubber.

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

E 350.03 Minimum size. No flexible metal conduit less than ½ inch electrical trade size shall be used except (1) as permitted for underplaster extensions by Wis. Adm. Code section E 334.02; (2) as permitted for motors by section E 430.145 (2); (3) for connections not over 48 inches in length, or longer on approved assemblies, to equipment where the use of ½ inch or larger size flexible metal conduit is not practicable, in which case flexible metal conduit of ⅜ inch electrical trade size may be used; and (4) in existing building where permitted by the authority enforcing the code.

TABLE E 350.03

Size AWG	Maximum Number of Conductors in ⅜″ Flexible Metal Conduit		
	Types RF-32, R, RH	Type RW-RHW	Types TF, T, TW, RU, RUF, RUW
18	4	----------	8
16	3	----------	6
14	3	2	5
12	2	2	4
10	----------	----------	3

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

E 350.04 Securing flexible metal conduit. When flexible metal conduit is installed it shall be secured by approved means at intervals not exceeding 4½ feet and within 12 inches on each side of every outlet box or fitting, except where flexible conduit is fished or where flexibility is necessary.

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

Chapter E 351

LIQUID-TIGHT FLEXIBLE METAL CONDUIT

E 351.01 Purpose. Liquid-tight flexible metal conduit is not intended as a general purpose raceway material. The provisions of this chapter shall apply to a type of flexible conduit having an outer liquid-tight jacket and employed with suitable terminal fittings approved for the purpose.

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

E 351.02 Use. The use of this wiring material shall be restricted as follows:

(1) For the connection of motors or portable equipment where flexibility of connection is required.

(2) Liquid-tight flexible metal conduit shall not be used under the following conditions: (a) where subject to physical damage; (b) where in contact with rapidly moving parts; (c) under conditions such that its temperature, with or without enclosed conductors carrying current, is above 60°C. (140°F.); (d) in any hazardous location, except as described in section E 501.04 (2), sections E 502.04 and E 503.03, unless it is specially approved for such use.

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

E 351.03 Maximum size. The maximum size of liquid-tight flexible metal conduit shall not exceed 3 inch electrical trade size.

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

E 351.04 Conductor size. The maximum size of conductor installed in liquid-tight flexible metal conduit shall not exceed the following values:

Trade Size of Conduit	Size of Conductor
3/8 inch	16 Awg
1/2 inch	12 Awg
3/4 inch	8 Awg
1 inch	6 Awg
1 1/4 inch	2 Awg
1 1/2 inch	1 Awg
2 inch	00 Awg
2 1/2 inch	0000 Awg
3 inch	350 MCM

Liquid-tight flexible metallic conduit in sizes 1½ inch and larger shall be bonded in accordance with section E 250.079 unless specifically approved for use without a separate bond.

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

Chapter E 352

SURFACE METAL RACEWAYS

E 352.01 Use. Surface metal raceway may be installed in dry locations. It shall not be used (1) where concealed, except that metal raceways approved for the purpose may be used for underplaster extensions; (2) where subject to severe physical damage unless approved for the purpose; (3) where the voltage is 300 volts or more between conductors unless the metal has a thickness of not less than .040 inches; (4) where subject to corrosive vapors; (5) in hoistways; nor (6) in any hazardous location.

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

E 352.02 Other chapters. Installations of surface metal raceways shall comply with the applicable provisions of chapter E 300.

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

A. INSTALLATION

E 352.03 Size of conductors. No conductor larger than that for which the raceway is designed shall be installed in surface metal raceway.

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

E 352.04 Number of conductors in raceways. The number of conductors installed in any raceway shall be no greater than the number for which the raceway is designed.

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

E 352.05 Extension through walls and floors. Except in multi-outlet assemblies, raceways may be extended through dry walls, dry partitions and dry floors, if in unbroken lengths where passing through.

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

E 352.06 Combination raceways. Where combination metal raceways are used both for signal and for lighting and power circuits, the different systems shall be run in separate compartments, identified by sharply contrasting colors of the interior finish, and the same relative position of compartments shall be maintained throughout the premises.

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

B. CONSTRUCTION SPECIFICATIONS

E 352.07 General. Surface metal raceways shall be of such construction as will distinguish them from other raceways. Surface metal raceways and their elbows, couplings, and similar fittings shall be so designed that the sections can be electrically and mechanically coupled together, while protecting the wires from abrasion. Holes for screws or bolts inside the raceway shall be so designed that when screws or bolts are in place their heads will be flush with the metal surface.

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

Chapter E 353

MULTI-OUTLET ASSEMBLY

E 353.01 Other articles. Installations of multi-outlet assembly shall comply with applicable provisions of Wis. Adm. Code chapter E 300. See definition in chapter E 100.

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

E 353.02 Use. Multi-outlet assembly may be installed in dry locations. It shall not be installed (1) where concealed, except that the back and sides of metal multi-outlet assembly may be surrounded by the building finish; (2) where subject to severe physical damage unless approved for the purpose; (3) where the voltage is 300 volts or more between conductors unless assembly is of metal having a thickness of not less than .040 inches; (4) where subject to corrosive vapors; (5) in hoistways nor (6) in any hazardous locations.

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

E 353.03 Metal multi-outlet assembly through dry partitions. Metal multi-outlet assembly may be extended through (not run within) dry partitions, providing arrangemests are made for removing the cap or cover on all exposed portions and no outlet is located within the partitions.

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

Chapter E 354

UNDERFLOOR RACEWAYS

E 354.01 Other chapters. Installations of underfloor raceways shall comply with the applicable provisions of chapter E 300.

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

E 354.02 Use. Underfloor raceways may be installed beneath the surface of concrete or other flooring material, or in office occupancies where laid flush with the concrete floor and covered with linoleum or equivalent floor covering. Underfloor raceways shall not be installed (1) where subject to corrosive vapors nor (2) in any hazardous location. Unless made of a material judged suitable for the condition, or unless corrosion protection approved for the condition is provided, ferrous or nonferrous metallic underfloor raceways, junction boxes, and fittings shall not be installed in concrete or in direct contact with the earth, or in areas subject to severe corrosive influences.

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

E 354.03 Covering. Raceway coverings shall conform to the following:

(1) RACEWAYS NOT OVER 4 INCHES WIDE. Half-round raceways not over 4 inches in width, and, except as permitted in (3) of this rule, flat-top raceways not over 4 inches in width, shall have not less than ¾ inches of concrete or wood above the raceway.

(2) RACEWAYS 4 INCHES WIDE BUT NOT OVER 8 INCHES WIDE. Flat top raceways 4 inches wide with a minimum of 1 inch spacing between raceways shall be covered with concrete to a depth of not less than 1 inch. Raceways spaced less than 1 inch apart shall be covered with concrete to a depth of 1½ inches.

(3) RACEWAYS FLUSH WITH CONCRETE. Approved flush raceways with removable covers may be laid flush with the floor surface. Such approved raceways shall be so designed that the cover plates will provide adequate mechanical protection and rigidity equivalent to junction box covers.

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

E 354.04 Size of conductors. No conductor larger than that for which the raceway is approved shall be installed in underfloor raceways and the largest size conductor allowed shall be 500,000 cm.

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

E 354.05 Number of conductors in raceway. The combined cross-sectional area of all conductors shall not exceed 40% of the interior area of the raceway; except that where the raceway contains only armored cable or non-metallic sheathed cable, these requirements shall not apply.

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

E 354.06 Splices and taps. Splices or taps shall be made only in junction boxes. For the purposes of this section, so-called loop wiring (continuous unbroken conductor connecting the individual outlets) is not considered to be a splice or tap.

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

E 354.07 Discontinued outlets. When an outlet is abandoned, discontinued, or removed, the sections of circuit conductors supplying the outlet shall be removed from the raceway. No splices or reinsulated conductors such as would be the case with abandoned outlets on loop wiring, shall be allowed in raceways.

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

E 354.08 Laid in straight lines. Underfloor raceways shall be laid so that a straight line from the center of one junction box to the center of the next junction box will coincide with the center line of the raceway system. Raceways shall be firmly held in place to prevent disturbing this alignment during construction.

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

E 354.09 Markers at ends. At every end of line of raceway, and at other locations where the location of the raceway is not apparent, a suitable number of markers shall be installed extending through the floor for future location of inserts for system identification.

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

E 354.10 Dead ends. Dead ends of raceways shall be closed.

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

E 354.11 Low points. Where practicable, raceways and their fittings shall be so arranged as to avoid low points that may form traps for water.

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

E 354.12 Fittings at angles. Where raceways are run at other than right angles, special fittings shall be provided.

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

E 354.13 Junction boxes. Junction boxes shall be leveled to the floor grade and sealed against the entrance of water. Junction boxes used with metal raceways shall be metal and shall be electrically continuous with the raceways.

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

E 354.14 Inserts. Inserts shall be leveled to the floor grade and sealed against the entrance of water. Inserts used with metal raceways shall be metal and shall be electrically continuous with the raceways. Inserts set in or on fiber raceways before the floor is laid shall be mechanically secured to the raceway. Inserts set in fiber raceways after the floor is laid shall be screwed into the raceway. In cutting through the raceway wall and setting inserts, chips and other dirt shall not be allowed to fall into the raceway, and tools shall be used which are so designed as to prevent the tool from entering the raceway and injuring conductors that may be in place.

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

E 354.15 **Connections to cabinets and wall outlets.** Connections between raceways and distribution centers and wall outlets shall be made by means of rigid or flexible metal conduit or by means of fittings specially approved for the purpose.

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

Chapter E 356

CELLULAR METAL FLOOR RACEWAYS

E 356.01 Definitions. For the purposes of this chapter, a "cellular metal floor raceway" shall be defined as the hollow spaces of cellular metal floors, together with suitable fittings, which may be approved as enclosures for electrical conductors; a "cell" shall be defined as a single, enclosed tubular space in a cellular metal floor member, the axis of the cell being parallel to the axis of the metal floor member; a "header" shall be defined as a transverse raceway for electrical conductors, providing access to predetermined cells of a cellular metal floor, thereby permitting the installation of electrical conductors from a distribution center to the cells.

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

E 356.02 Use. Conductors shall not be installed in cellular metal floor raceways (1) where subject to corrosive vapor; (2) in any hazardous location; nor (3) in commercial garages, except for supplying ceiling outlets or extensions to the area below the floor but not above. No electric conductors shall be installed in any cell or header which contains a pipe for steam, water, air, gas, drainage, or other service than electrical.

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

E 356.03 Other chapters. Installations of conductors in the raceways of cellular metal floor shall comply with the applicable provisions of Wis. Adm. Code chapter E 300.

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

A. INSTALLATION

E 356.04 Size of conductors. No conductor larger than No. 0 shall be installed, except by special permission.

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

E 356.05 Number of conductors in raceway. The total cross-sectional area of all conductors in a header or in an individual cell shall not exceed 40% of the cross-sectional area of the header or cell in which they are located; except that where the raceway contains only type AC metal-clad cable or nonmetallic sheathed cable, these requirements shall not apply.

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

E 356.06 Splices and taps. Splices and taps shall be made only in header access units or junction boxes.

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

E 356.07 Discontinued outlets. When an outlet is discontinued, the conductors supplying the outlet shall be removed from the raceway.

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

E 356.08 Markers. A suitable number of markers shall be installed extending through the floor for the future locating of cells and for system identification.

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

E 356.09 Junction boxes. Junction boxes shall be levelled to the floor grade and sealed against the entrance of water. Junction boxes used with these raceways shall be of metal and shall be electrically continuous with the raceway.

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

E 356.10 Inserts. Inserts shall be levelled to the floor grade and sealed against the entrance of water. Inserts shall be of metal and shall be electrically continuous with the raceway. In cutting through the cell wall and setting inserts, chips and other dirt shall not be allowed to fall into the raceway, and tools shall be used which are designed to prevent the tool from entering the cell and injuring the conductors.

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

E 356.11 Connection to cabinets and extensions from cells. Connections to cabinets and extensions from cells to outlets shall be made by means of rigid or flexible conduit or by means of fittings approved for the purpose.

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

B. CONSTRUCTION SPECIFICATIONS

E 356.12 General. Cellular metal floor raceways shall be so constructed that adequate electrical and mechanical continuity of the complete system will be secured. They shall provide a complete enclosure for the conductors. The interior surfaces shall be free from burrs and sharp edges, and surfaces over which conductors are drawn shall be smooth. Suitable bushings or fittings having smooth rounded edges shall be provided where conductors pass.

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

Chapter E 357

STRUCTURAL RACEWAYS

E 357.01 Definitions. Structural raceways are formed steel members approved for the installation of electrical wires or cables within them.

(1) Vertical members used for studs or columns shall be tubes or channels.

(2) Horizontal headers used as beams or top plates shall be provided with suitable covers, end closers, and fittings.

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

E 357.02 Use. Structural raceways used to enclose electrical conductors shall be used only in single-family dwellings.

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

E 357.03 Other articles. Installation of conductors in structural raceways shall comply with the applicable provisions of Wis. Adm. Code chapter E 300.

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

A. INSTALLATION

E 357.04 Openings in vertical members. Vertical members may have openings provided in them for the purpose of installing wiring devices. Vertical members may be concealed. Openings in vertical members shall provide access to wiring. The size of such openings shall comply with the provisions of section E 300.14 and chapter E 370. Wiring devices may be installed in openings in vertical members without the use of individual boxes, provided that the back and sides of each device are surrounded by terminal barriers.

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

E 357.05 Horizontal headers. Horizontal headers shall be securely fastened to vertical members.

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

E 357.06 Number of conductors in raceway. Structural raceways shall not contain more than 20 current-carrying conductors at any cross-section, and the total cross-sectional areas of all contained conductors shall not exceed 20% of the interior cross-section.

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

E 357.07 Splices and taps. Splices and taps shall be made only in horizontal headers, or junction boxes. The conductors including splices and taps shall not fill the structural raceway to more than 75% of its area at that point. All splices and taps shall be made and insulated by approved methods.

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

E 357.08 Size of conductors. No conductor larger than number 6 AWG shall be installed in vertical or horizontal members.

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

E 357.09 Accessibility. The covers of the horizontal members shall be accessible after installation and shall not be obstructed by the wall finish.

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

E 357.10 Fittings. Fittings shall be designed and installed to prevent physical damage to electrical conductors. Fittings shall be free from burrs and sharp edges.

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

E 357.11 Extensions from vertical structural members. Extensions from vertical structural members shall be made with rigid or flexible metal conduit, electrical metallic tubing, surface metal raceway or metal-clad cable.

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

E 357.12 Dead ends. Dead ends of structural raceways shall be closed.

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

E 357.13 Installation of electrical devices. The installation of switches, receptacles and outlets shall be in accordance with the requirements of Wis. Adm. Code chapters E 380 and E 310, except as otherwise permitted in this chapter.

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

E 357.14 Grounding. All elements of structural raceway systems shall be bonded and effectively grounded.

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

B. CONSTRUCTION SPECIFICATIONS

E 357.15 Marking. Structural raceways and fittings shall be marked with the manufacturer's name, trademark, or identification symbol.

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

E 357.16 General. All metal components shall be properly coated to prevent corrosion. The interior shall be free from sharp edges and burrs. The structural raceway systems shall be constructed to provide electrical and mechanical continuity of the complete system. They shall provide a complete enclosure for the conductors. Enclosures shall be approved for the purpose.

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

Chapter E 358

CELLULAR CONCRETE FLOOR RACEWAYS

E 358.01 Scope. Approved precast cellular concrete floor raceways shall comply with the applicable requirements of chapter E 300, and shall also comply with the provisions of sections E 358.02 to E 358.11 inclusive. For the purpose of this chapter, "precast cellular concrete floor raecways" shall be defined as the hollow spaces in floors constructed of precast cellular concrete slabs, together with suitable metal fittings designed to provide access to the floor cells in an approved manner. A "cell" shall be defined as a single, enclosed tubular space in a floor made of precast cellular concrete slabs, the direction of the cell being parallel to the direction of the floor member. "Header ducts" shall be defined as transverse metal raceways for electrical conductors, furnishing access to predetermined cells of a precast cellular concrete floor, thus providing for the installation of electrical conductors from a distribution center to the floor cells.

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

E 358.02 Use. Conductors shall not be installed in precast cellular concrete floor raceways (1) where subject to corrosive vapor; (2) in hazardous locations; nor (3) in commercial garages, except for supplying ceiling outlets or extensions to the area below the floor but not above. No electrical conductor shall be installed in any cell or header which contains a pipe for steam, water, air, gas, drainage, or any service other than electrical.

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

E 358.03 Header duct. The header duct shall be installed in a straight line, at right angles to the cells. The header duct shall be mechanically secured to the top of the precast cellular concrete floor. The end joints shall be closed by metallic closure fittings and sealed against the penetration of water. The header duct shall be electrically continuous throughout its entire length and shall be electrically bonded to the enclosure of the distribution center.

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

E 358.04 Connection to cabinets and other enclosures. Connection from header duct to cabinets and other enclosures shall be made by means of metallic duct and fittings approved for the purpose.

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

E 358.05 Junction boxes. Junction boxes shall be levelled to the floor grade and sealed against the entrance of water. Junction boxes shall be of metal and shall be mechanically and electrically continuous with the header ducts.

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

E 358.06 Markers. Each hidden access point between a header and a cell intended for future use shall be provided with a marker extending through the floor covering. A suitable number of markers shall be installed, extending through the floor covering, to locate the cells and to provide system identification.

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

E 358.07 Inserts. Inserts shall be levelled to the floor grade and sealed against the entrance of water. Inserts shall be of metal and shall be fitted with receptacles of the grounded type. A ground conductor shall connect the insert receptacles to a positive ground connection provided on the header duct. In cutting through the cell wall for setting inserts or other purposes (such as providing access openings between header duct and cells) chips and other dirt shall not be allowed to fall into the raceway, and the tool used shall be so designed as to prevent the tool from entering the cell and injuring the conductors.

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

E 358.08 Size of conductors. No conductor larger than No. 0 shall be installed, except by special permission.

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

E 358.09 Number of conductors in raceway. The total cross-sectional area of all conductors in a header or in an individual cell shall not exceed 40% of the cross-sectional area of the header or cell in which they are located; except that where the raceway contains only type AC metal-clad cable or nonmetallic sheathed cable, these requirements shall not apply.

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

E 358.10 Splices and taps. Splices and taps shall be made only in header duct access units or junction boxes.

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

E 358.11 Discontinued outlets. When an outlet is discontinued, the conductors supplying the outlet shall be removed from the header and cell.

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

Chapter E 362

WIREWAYS

E 362.01 Definition. Wireways are sheet-metal troughs with hinged or removable covers for housing and protecting electrical wires and cable and in which conductors are laid in place after the wireway has been installed as a complete system.

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

E 362.02 Use. Wireways may be installed only for exposed work. Wireways may be installed above false ceilings with panels which are designed to be removed and which provide openings of at least 2 feet by 4 feet. Wireways intended for outdoor use shall be of approved raintight construction. Wireways shall not be installed: (1) where subject to severe physical damage or corrosive vapor; nor (2) in any hazardous location.

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

E 362.03 Other chapters. Installations of wireways shall comply with the applicable provisions of Wis. Adm. Code chapter E 300.

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

E 362.04 Size of conductors. No conductor larger than 500,000 c.m. shall be installed in any wireway.

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

E 362.05 Number of conductors. (1) Wireways shall not contain more than 30 conductors at any cross-section, unless the additional conductors are for signal or control circuits. The sum of the cross-sectional areas of all contained conductors at any cross-section of a wireway shall not exceed 20% of the interior cross-sectional area of the wireway.

(2) The correction factors specified in Note 8 to tables E 310.12 through E 310.15 are not applicable to the foregoing.

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

E 362.06 Splices and taps. Splices or taps, made and insulated by approved methods, may be located within the wireway provided they are accessible. The conductors, including splices and taps, shall not fill the wireway to more than 75% of its area at that point.

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

E 362.07 Supports. Wireways shall be securely supported at intervals not exceeding 5 feet, unless specially approved for supports at greater intervals, but in no case shall the distance between supports exceed 10 feet.

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

E 362.08 Extension through walls. Wireways may extend transversely through walls if in unbroken lengths where passing through.

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

E 362.09 Dead-ends. Dead-ends of wireways shall be closed.

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

E 362.10 Extensions from wireways. Extensions from wireways shall be made with rigid or flexible metal conduit, electrical metallic tubing, surface metal raceway or metal-clad cable.

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

E 362.11 Marking. Wireways shall be marked so that their manufacturer's name or trademark will be visible after installation.

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

Chapter E 364

BUSWAYS

E 364.01 Other chapters. Installations of busways shall comply with the applicable provisions of Wis. Adm. Code chapter E 300.

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

E 364.02 Use. Busways may be installed only for exposed work. Busways may be installed above false ceilings with panels which are designed to be removed and which provide openings of at least 2 feet by 4 feet. Busways shall not be installed (1) where subject to severe physical damage or corrosive vapors; (2) in hoistways; (3) in any hazardous location; nor (4) outdoors or in wet or damp locations unless specially approved for the purpose.

Note 1. Busways may be used for service-entrance conductors. See section E 230.044.

Note 2. It is recommended that where secondary systems are operated ungrounded, a combination ground detector and potentializer plug be used as an auxiliary fitting for busway systems to establish a definite potential difference between the bus-bars and the grounded casing of the busways. This will serve to drain off any static or other charge from the entire busway system including its connected apparatus, supply and branch circuit conductors.

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

E 364.03 Support. Busways shall be securely supported at intervals not exceeding 5 feet, unless specially approved for supports at greater intervals, but in no case shall the distance between supports exceed 10 feet. Where a busway is installed in a vertical position, the supports for the bus-bars shall be designed for vertical installation.

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

E 364.04 Extension through walls. Busways may extend transversely through dry walls if in unbroken lengths where passing through. Busways may extend vertically through dry floors when totally enclosed (unventilated) where passing through and for a minimum distance of 6 feet above the floor to provide adequate protection from physical damage.

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

E 364.05 Dead-ends. A dead-end of a busway shall be closed.

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

E 364.07 Branches from busways. Branches from busways shall be made with busways or with rigid or flexible metal conduit, electrical metallic tubing, surface metal raceway, metal-clad cable or with suitable cord assemblies approved for hard usage for portable equipment or for the connection of stationary equipment to facilitate their interchange.

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

E 364.08 Overcurrent protection. Overcurrent protection shall be provided in accordance with sections E 364.09 to E 364.13 inclusive.

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

E 364.09 Rating of overcurrent protection; feeders and sub-feeders. Where the allowable current rating of the busway does not correspond to a standard rating of the overcurrent device, the next higher rating may be used.

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

E 364.10 Reduction in size of busway. Overcurrent protection may be omitted at points where busways are reduced in size, provided that the smaller busway does not extend more than 50 feet and has a current rating at least equal to one-third the rating or setting of the overcurrent device next back on the line, and provided further that such busway is free from contact with combustible material.

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

E 364.11 Branch circuits. Where a busway is used as a feeder, devices or plug-in connections for tapping off branch-circuits from the busway shall contain the overcurrent devices required for the protection of the branch circuits.

(1) EXCEPTION NO. 1. For overcurrent protection of taps, see section E 240.15.

(2) EXCEPTION NO. 2. For fixed or semi-fixed lighting fixtures, the branch circuit overcurrent device may be part of the fixture cord plug on cord-connected fixtures.

(3) EXCEPTION NO. 3. Where fixtures without cords are plugged directly into the busway, the overcurrent device may be mounted on the fixture.

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

E 364.12 Rating of overcurrent protection; branch circuits. A busway may be used as a branch circuit of any one of the types described in chapter E 210. When so used, the rating or setting of the overcurrent device protecting the busway shall determine the ampere rating of the branch circuit, and the circuit shall in all respects conform with the requirements of chapter E 210 that apply to branch circuits of that rating.

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

E 364.13 Length of busways used as branch circuits. Busways which are used as branch circuits and which are so designed that loads can be connected at any point shall be limited to such lengths as will provide that in normal use the circuits will not be overloaded.

Note: In general, the length of such run in feet should not exceed 3 times the ampere rating of the branch circuit.

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

E 364.14 Marking. Busways shall be marked with the voltage and current rating for which they are designed, and with the manufacturer's name or trademark in such manner as to be visible after installation.

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

Chapter E 370

OUTLET, SWITCH AND JUNCTION BOXES, AND FITTINGS

A. SCOPE AND GENERAL

E 370.01 Scope. The provisions of this chapter shall apply to the installation of outlet, switch and junction boxes, and fittings as required by section E 300.15. Installations in hazardous locations shall conform to chapters E 500 to E 517 inclusive.

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

E 370.02 Round boxes. Round boxes shall not be used where conduits or connectors requiring the use of locknuts or bushings are to be connected to the side of the box.

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

E 370.03 Non-metallic boxes. Non-metallic boxes approved for the purpose may be used only with open wiring on insulators, concealed knob-and-tube work, non-metallic sheathed cable, and with approved non-metallic conduit.

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

E 370.04 Metallic boxes. Where used with knob-and-tube work or non-metallic sheathed cable, and mounted on metal or metal lath ceilings or walls, such boxes shall be insulated from their supports and from the metal or metal lath, or shall be grounded.

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

B. INSTALLATION

E 370.05 Damp or wet locations. In damp or wet locations, boxes and fittings shall be so placed or equipped as to prevent moisture or water from entering and accumulating within the box or fitting. Boxes and fittings installed in wet locations shall be weatherproof. For boxes in floors, see section E 410.53.

Note: It is recommended that approved boxes of non-conductive material be used with non-metallic sheathed cable or approved non-metallic conduit when such cable or conduit is used in locations where there is likely to be occasional moisture present such as in dairy barns.

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

E 370.06 Number of conductors in a box. Boxes shall be of sufficient size to provide free space for all conductors enclosed in the box. The limitations in subsections E 370.06 (1) and (2) shall not apply to terminal housings supplied with motors, nor to types of boxes or fittings without knockouts and having hubs or recessed parts for terminal bushings and locknuts.

Note: Sections E 370.06 (1) and (2) do not apply to conductors used for rewiring existing raceways as referred to in table 3, chapter E 900.

(1) The maximum number of conductors, not counting fixture wires, permitted in outlet and junction boxes shall be as in tables E 370.06 (1) (a) and (b) with the exceptions noted.

TABLE E 370.06 (1) (a)
DEEP BOXES

Box Dimensions, Inches Trade Size	Maximum Number of Conductors				
	No. 14	No. 12	No. 10	No. 8	No. 6
1½ x 3¼ octagonal	5	5	4	0	0
1½ x 4 octagonal	8	7	6	5	0
1½ x 4 square	11	9	7	5	0
1½ x 4-11/16 square	16	12	10	8	0
2⅛ x 4-11/16 square	20	16	12	10	6
2 x 1¾ x 2¾	5	4	4	----	----
2½ x 1¾ x 2¾	6	6	5	----	----
3 x 1¾ x 2¾	7	7	6	----	----

Note: Where there is not sufficient space for a deeper box, four No. 14 AWG conductors may enter a box provided with cable clamps and containing one or more devices on a single mounting strap.

TABLE E 370.06 (1) (b)
SHALLOW BOXES

Box Dimensions, Inches Trade Size	Maximum Number of Conductors		
	No. 14	No. 12	No. 10
3¼	4	4	3
4	6	6	4
1¼ x 4 square	9	7	6
4-11/16	8	6	6

Note: **Any box less than 1½ inch deep is considered to be a shallow box.**

(a) Tables E 370.06 (1) (a) and (b) apply where no fittings or devices, such as fixture studs, cable clamps, hickeys, switches or receptacles are contained in the box. Where one or more fixture studs, cable clamps, or hickeys are contained in the box, the number of conductors shall be one less than shown in the tables, with a further deduction of one conductor for one or several flush devices mounted on the same strap. A conductor running through the box is counted as one conductor and each conductor originating outside the box and terminating inside the box is counted as one conductor. Conductors of which no part leaves the box are not to be counted in the above computation. If single flush boxes are ganged, and each section is occupied by a flush device or combination of flush devices on the same strap, the limitations will apply to each section individually.

(2) For combinations not shown in the above tables the following table shall apply.

TABLE E 370.06 (2)

Size of Conductor	Free Space Within Box for Each Conductor
No. 14	2. cubic inches
No. 12	2.25 cubic inches
No. 10	2.5 cubic inches
No. 8	3. cubic inches
No. 6	5. cubic inches

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

E 370.07 Conductors entering boxes or fittings. Conductors entering boxes or fittings shall be protected from abrasion and shall conform to the following:

(1) OPENINGS TO BE CLOSED. Openings through which conductors enter shall be adequately closed.

(2) METAL BOXES AND FITTINGS. Where metal outlet boxes or fittings are installed with open wiring or concealed knob-and-tube work, conductors shall enter through insulating bushings or, in dry places, through flexible tubing extending from the last insulating support and firmly secured to the box or fitting. Where raceway or cable is installed with metal outlet boxes or fittings, the raceway or cable shall be secured to such boxes and fittings.

(3) NON-METALLIC BOXES. Where non-metallic boxes are used with open wiring or concealed knob-and-tube work, the conductors shall enter through individual holes. Where flexible tubing is used to encase the conductor, the tubing shall extend from the last insulating support and may be run into the box or terminate at the wall of the box. If non-metallic sheathed cable is used, the cable assembly shall enter the box through a knockout opening. Clamping of individual conductors or cables to the box is not required where supported within 8 inches of the box. Where non-metallic conduit is installed with non-metallic boxes or fittings, the conduit shall be secured to such boxes and fittings in an approved manner.

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

E 370.08 Unused openings. Unused openings in boxes and fittings shall be effectively closed to afford protection substantially equivalent to that of the wall of the box or fitting. Metal plugs or plates used with non-metallic boxes or fittings shall be recessed at least ¼ inch from the outer surface.

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

E 370.09 Boxes enclosing flush devices. Boxes used to enclose flush devices shall be of such design that the devices will be completely enclosed on back and sides, and that substantial support for the devices will be provided. Screws for supporting the box shall not be used in attachment of the device contained therein.

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

E 370.10 In wall or ceiling. In walls or ceilings of concrete, tile or other noncombustible material, boxes and fittings shall be so installed that the front edge of the box or fitting will not set back of the finished surface more than ¼ inch. In walls and ceilings constructed of wood or other combustible material, outlet boxes and fittings shall be flush with the finished surface or project therefrom.

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

E 370.11 Repairing plaster. Except on walls or ceilings of concrete, tile or other noncombustible material, a plaster surface which is broken or incomplete shall be repaired so that there will be no gaps or open spaces at the edge of the box or fitting.

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

E 370.12 Exposed extensions. In making an exposed extension from an existing outlet of concealed wiring, a box, extension ring or blank cover shall be mounted over the original box and electrically and mechanically secured to it. The extension shall then be connected to this box in the manner prescribed for the method of wiring employed in making the extension.

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

E 370.13 Supports. (1) GENERAL. Boxes, fittings and cabinets shall be securely fastened in place. Boxes and fittings, not over 100 cubic inches in size, which are attached to firmly secured exposed raceway by threading or other connection designed for the purpose, are considered as so fastened.

(2) CONCEALED WORK. In concealed work, except as prescribed in subsection (3), boxes and fittings, unless securely held in place by concrete, masonry or other building material in which they are embedded, shall be secured to a stud, joist or similar fixed structural unit, or to a metal or wooden support which is secured to such a structural unit. Wooden supports shall be not less than 7/8 inch in thickness. Lath of wood, metal or composition shall not be considered a structural unit. See sections E 410.15 and E 410.16 for support of fixtures.

(3) EXPOSED WORK. In exposed work, and in concealed work in existing buildings where conductors or cables are fished and boxes cannot be secured as provided in subsection (2) without disturbing the building finish, the boxes may be mounted directly upon the plaster surface when securely fastened in place.

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

E 370.14 Depth of outlet boxes for concealed work. Outlet boxes for concealed work shall have an internal depth of at least 1½ inches, except that where the installation of such a box will result in injury to the building structure or is impracticable, a box not less than ½ inch internal depth may be installed.

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

E 370.15 Covers and canopies. In completed installations each outlet box shall be provided with a cover unless a fixture canopy is used.

(1) Non-metallic covers and plates or metallic covers and plates may be used with non-metallic outlet boxes. When metallic covers or

plates are used, they shall comply with the grounding requirements of section E 250.042. See section E 410.95.

(2) Where a fixture canopy or pan is used, any combustible wall or ceiling finish exposed between the edge of the canopy or pan and the outlet box shall be covered with non-combustible material.

(3) Covers of outlet boxes having holes through which flexible cord pendants pass, shall be provided with bushings designed for the purpose or shall have smooth, well-rounded surfaces on which the cords may bear. So-called hard-rubber or composition bushings shall not be used.

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

E 370.16 Fastened to gas pipes. Outlet boxes used where gas outlets are present shall be so fastened to the gas pipes as to be mechanically secure.

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

E 370.17 Boxes at lighting fixture outlets. Boxes used at outlets for lighting fixtures shall be designed for the purpose. At every outlet used exclusively for lighting, the box shall be so designed or installed that a lighting fixture may be attached.

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

E 370.18 Pull and junction boxes. Pull and junction boxes shall conform to the following:

(1) MINIMUM SIZE. For raceways of 1¼ inch trade size or larger, containing conductors of No. 4 or larger, and for cable containing conductors of No. 4 or larger, the minimum dimensions of a pull or junction box installed in a raceway or cable run shall conform to the following:

(a) *Straight pulls.* In straight pulls the length of the box shall be not less than 8 times the trade diameter of the largest raceway.

(b) *Angle or U pulls.* Where angle or U pulls are made, the distance between each raceway entry inside the box and the opposite wall of the box shall not be less than 6 times the trade diameter of the raceway. This distance shall be increased for additional entries by the amount of the sum of the diameters of all other raceway entries on the same wall of the box. The distance between raceway entries enclosing the same conductor shall not be less than 6 times the trade diameter of the larger raceway.

Exception. The limitations of subsections (1) (a) and (1) (b) are not intended to apply to terminal housings supplied with motors, nor to types of boxes or fittings without knockouts and having hubs or recessed parts for terminal bushings and locknuts.

Note: When transposing cable size into raceway size in subsections (1) and (2), the minimum trade size raceway required for the number and size of conductors in the cable shall be used.

(2) CONDUCTORS IN PULL OR JUNCTION BOXES. In pull boxes or junction boxes having any dimension over 6 feet, all conductors shall be cabled or racked up in an approved manner.

Note: See section E 373.06 (2) for insulation of conductors at bushings.

(3) COVERS. All pull boxes, junction boxes and fittings shall be provided with covers approved for the purpose. Where metallic covers

are used, they shall comply with the grounding requirements of section E 250.042.

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

E 370.19 Junction, pull and outlet boxes be accessible. Junction, pull and outlet boxes shall be so installed that the wiring contained in them may be rendered accessible without removing any part of the building, sidewalks or paving. In finished rooms, wiring and splices in a junction or outlet box having a blank cover, and not more than 6 inches back of the finished wall or ceiling surface, shall be considered accessible when one or more suitable markers extend through the plaster, paint or other finish for future location and identification of the box. Boxes may be installed above false ceilings with panels which are designed to be removed.

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

C. CONSTRUCTION SPECIFICATIONS

E 370.20 Metallic outlet, switch and junction boxes and fittings. Outlet, switch and junction boxes and fittings, when of metal, shall conform to the following:

(1) CORROSION-RESISTANT. Metallic boxes and fittings, unless of corrosion-resistant metal, shall be well galvanized, enameled, or otherwise properly coated, inside and out, to prevent corrosion.

Note 1. See section E 300.05 for limitation in the use of boxes and fittings protected from corrosion solely by enamel.

Note 2. It is recommended that the protective coating be of conductive material, such as cadmium, tin or zinc, in order to secure better electrical contact.

(2) THICKNESS OF METAL. (a) For sheet steel boxes and fittings not over 100 cubic inches in size, the metal shall not be less than No. 14 MS gauge (0.067 inch in thickness). Cast metal boxes shall have a wall thickness of not less than 1/8 inch, except that boxes of malleable iron shall have a wall thickness of not less than 3/32 inch.

(b) An outlet box made of a sheet-aluminum alloy shall not be less than 0.091 inch in thickness at any point except that a sharply bent section having a radius of curvature of not more than 1/4 inch may be less than 0.091 but not less than 0.087 inch in thickness; and no minus tolerance is applicable to either of these dimensions. The aluminum alloy shall have a tensile strength of not less than 17,000 pounds per square inch.

(3) BOXES OVER 100 CUBIC INCHES. Boxes of over 100 cubic inches in size shall be composed of metal and shall conform to the requirements for cabinets and cutout boxes, except that the covers may consist of single flat sheets secured to the box proper by screws, or bolts instead of hinges. Boxes having covers of this form are for use only for enclosing joints in conductors or to facilitate the drawing in of wires and cables. They are not intended to enclose switches, cutouts or other control devices.

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

E 370.21 Covers. Metal covers shall be of a thickness not less than that specified for the walls of the box or fitting of the same material and with which they are designed to be used, or shall be lined with firmly attached insulating material not less than 1/32 inch in thickness. Covers of porcelain or other approved insulating material may be used when of such form and thickness as to afford the requisite protection and strength.

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

E 370.22 Bushings. Covers of outlet boxes and outlet fittings having holes through which flexible cord pendants may pass, shall be provided with approved bushings or shall have smooth, well-rounded surfaces, upon which the cord may bear. Where conductors other than flexible cord may pass through a metal cover, there shall be provided a separate hole for each wire, said hole being equipped with a bushing of suitable insulating material.

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

E 370.23 Non-metallic boxes. Provisions for supports, or other mounting means, for non-metallic boxes, shall be outside of the box, or the box shall be so constructed as to prevent contact between the conductors in the box and the supporting screws.

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

Chapter E 373

CABINETS AND CUTOUT BOXES

E 373.01 Scope. The provisions of this chapter shall apply to the installation of cabinets and cutout boxes. Installations in hazardous locations shall conform to the provisions of Wis. Adm. Code chapters E 500 to E 517 inclusive.

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

A. INSTALLATION

E 373.02 Damp or wet locations. In damp or wet locations, cabinets and cutout boxes of the surface type shall be so placed or equipped as to prevent moisture or water from entering and accumulating within the cabinet or cutout box, and shall be mounted so there is at least ¼ inch air space between the enclosure and the wall or other supporting surface. Cabinets or cutout boxes installed in wet locations shall be weatherproof.

Note: It is recommended that boxes of non-conductive material be used with non-metallic sheathed cable when such cable is used in locations where there is likely to be moisture present.

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

E 373.03 Position in wall. In walls of concrete, tile, or other noncombustible material, cabinets shall be so installed that the front edge of the cabinet will not set back of the finished surface more than ¼ inch. In walls constructed of wood or other combustible material, cabinets shall be flush with the finished surface or project therefrom.

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

E 373.04 Unused Openings. Unused openings in cabinets or cutout boxes shall be effectively closed to afford protection substantially equivalent to that of the wall of the cabinet or cutout box. Where metal plugs or plates are used with non-metallic cabinets or cutout boxes, they shall be recessed at least ¼ inch from the outer surface.

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

E 373.05 Conductors entering cabinets or cutout boxes. Conductors entering cabinets or cutout boxes shall be protected from abrasion and shall conform to the following:

(1) OPENINGS TO BE CLOSED. Openings through which conductors enter shall be adequately closed.

(2) METAL CABINETS AND CUTOUT BOXES. Where metal cabinets or cutout boxes are installed with open wiring or concealed knob-and-tube work, conductors shall enter through insulating bushings or, in dry places, through flexible tubing extending from the last insulating support and firmly secured to the cabinet or cutout box.

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

E 373.06 Deflection of conductors. Conductors entering or leaving cabinets or cutout boxes and the like shall conform to the following:

(1) WIDTH OF GUTTERS. Conductors shall not be deflected within a cabinet unless a gutter having a width in accordance with table E 373.06 (1) is provided.

TABLE E 373.06 (1)

MINIMUM BENDING SPACE IN INCHES

AWG or Circular—Mil Size of Wire	Wires per Terminal				
	1	2	3	4	5
14-8	Not Specified				
6	1½				
4-3	2				
2	2½				
1	3				
0-00	3½				
000-0000	4	6	8		
250 MCM	4½	6	8	10	
300-350 MCM	5	8	10	12	
400-500 MCM	6	8	10	12	14
600-700 MCM	8	10	12	14	16
750-900 MCM	8				
1,000-1,250 MCM	10				
1,500-2,000 MCM	12				

(2) INSULATION AT BUSHINGS. Where ungrounded conductors of No. 4 or larger enter a raceway in a cabinet, pull box, junction box, or auxiliary gutter, the conductors shall be protected by a substantial bushing providing a smoothly rounded insulating surface, unless the conductors are separated from the raceway fitting by substantial insulating material securely fastened in place. Where conduit bushings are constructed wholly of insulating material, a locknut shall be installed both inside and outside the enclosure to which the conduit is attached.

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

E 373.07 Space in enclosures. Cabinets and cutout boxes shall be selected which have sufficient space to accommodate all conductors installed in them without crowding.

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

E 373.08 Single switch enclosures. Single switch enclosures shall not be used as junction boxes, troughs or raceways for conductors feeding through or tapping off to other switches, unless designs suitable for the purpose are employed to provide adequate space for this purpose.

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

E 373.09 Side or back wiring spaces or gutters. Cabinets and cutout boxes shall be provided with back wiring spaces, gutters, or wiring compartments as required by subsections E 373.11 (3) and (4).

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

B. CONSTRUCTION SPECIFICATIONS

E 373.10 Material. Cabinets and cutout boxes shall conform to the following:

(1) METAL CABINETS AND BOXES. Metal cabinets and cutout boxes shall be well galvanized, plated with cadmium or other approved metallic finish, enameled, or otherwise properly coated, inside and out, to prevent corrosion.

Note: It is recommended that the protective coating be of conductive material, such as cadmium, tin or zinc, in order to secure better electrical contact.

(2) STRENGTH. The design and construction of cabinets and cutout boxes shall be such as to secure ample strength and rigidity. If constructed of sheet steel, the metal shall be of not less than No. 16 MS (USS revised) gauge in thickness.

(3) COMPOSITION CABINETS. Composition cabinets shall be submitted for approval prior to installation.

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

E 373.11 Spacing. The spacing within cabinets and cutout boxes shall conform to the following:

(1) GENERAL. The spacing within cabinets and cutout boxes shall be sufficient to provide ample room for the distribution of wires and cables placed in them, and for a separation between metal parts of devices and apparatus mounted within them as follows:

(a) *Base.* There shall be an air space of at least 1/16 inch, except at points of support, between the base of the device and the wall of any metal cabinet or cutout box in which the device is mounted.

(b) *Doors.* There shall be an air space of at least 1 inch between any live metal part (including live metal parts of enclosed fuses) and the door, unless the door is lined with an approved insulating material or is of a thickness of metal not less than No. 12 MS (USS revised) gauge in thickness, when the air space shall be not less than ½ inch.

(c) *Doors and walls; link fuses.* There shall be a space of at least 2 inches between open link fuses and metal-lined walls or metal, metal-lined or glass-paneled doors.

(d) *Live parts.* Except as noted above, there shall be an air space of at least ½ inch between the walls, back, gutter partition, if of metal, or door of any cabinet or cutout box and the nearest exposed current-carrying part of devices mounted within the cabinet where the potentials do not exceed 250 volts. This spacing shall be increased to at least one inch where the potentials exceed 250 volts.

(2) SWITCH CLEARANCE. Cabinets and cutout boxes shall be deep enough to allow the closing of the doors when 30-ampere branch-circuit panelboard switches are in any position, or when combination cutout switches are in any position, or when other single-throw switches are opened as far as their construction will permit.

(3) WIRING SPACE. Cabinets and cutout boxes which contain devices or apparatus connected within the cabinet or box to more than 8 conductors, including those of branch circuits, meter loops, subfeeder circuits, power circuits and similar circuits, but not including the supply circuit or a continuation thereof, shall have back wiring spaces or one or more side wiring spaces, side gutters or wiring compartments.

(4) WIRING SPACE; ENCLOSURE. Side wiring spaces, side gutters or side wiring compartments of cabinets and cutout boxes shall be rendered tight enclosures by means of covers, barriers or partitions extending from the bases of the devices, contained in the cabinet, to the door, frame, or sides of the cabinet; provided, however, that where the enclosure contains only those conductors which are led from the cabinet at points directly opposite their terminal connections to devices within the cabinet, such covers, barriers or partitions may be omitted. Partially enclosed back wiring spaces shall be provided with covers to complete enclosure. Wiring spaces that are required by subsection (3) and which are exposed when doors are open, shall be provided with covers to complete the enclosure.

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

Chapter E 374

AUXILIARY GUTTERS

E 374.01 Purpose. Auxiliary gutters, used to supplement wiring spaces at meter centers, distribution centers, switchboards and similar points of wiring systems may enclose conductors or bus-bars, but shall not be used to enclose switches, overcurrent devices, appliances or similar equipment.

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

E 374.02 Extension beyond equipment. An auxiliary gutter shall not extend a greater distance than 30 feet beyond the equipment which it supplements except in elevator work. Any extension beyond this distance shall comply with the provisions for wireways in chapter E 362 or with the provisions for busways in chapter E 364.

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

E 374.03 Supports. Gutters shall be supported throughout their entire length at intervals not exceeding 5 feet.

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

E 374.04 Covers. Covers shall be securely fastened to the gutter.

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

E 374.05 Number of conductors. Auxiliary gutters shall not contain more than 30 conductors at any cross-section, unless the additional conductors are for signal or control circuits. The sum of the cross-sectional areas of all contained conductors at any cross-section of an auxiliary gutter shall not exceed 20% of the interior cross-sectional area of the gutter.

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

E 374.06 Ampacity of conductors. The ampacities of insulated copper and aluminum conductors are given in tables E 310.12 and E 310.14 respectively. The correction factors specified in note 8 of these tables shall not apply to conductors in auxiliary gutters. The current carried continuously in bare copper bars in auxiliary gutters shall not exceed 1000 amperes per square inch of cross section of the conductor. For aluminum bars the current carried continuously shall not exceed 700 amperes per square inch of cross-section of the conductor.

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

E 374.07 Clearance of bare live parts. Bare conductors shall be securely and rigidly supported so that the minimum clearance between bare current-carrying metal parts of opposite polarities mounted on the same surface shall be not less than 2 inches, nor less than 1 inch for parts that are held free in the air. A clearance not less than 1 inch shall be secured between bare current-carrying metal parts and any metal surface. Adequate provisions shall be made for the expansion and contraction of bus-bars.

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

E 374.08 Splices and taps. Splices and taps shall conform to the following:

(1) Splices or taps, made and insulated by approved methods, may be located within gutters when they are accessible by means of removable covers or doors. The conductors, including splices and taps, shall not fill the gutter to more than 75% of its area.

(2) Taps from bare conductors shall leave the gutter opposite their terminal connections and conductors shall not be brought in contact with uninsulated current-carrying parts of opposite polarity.

(3) All taps shall be suitably identified at the gutter as to the circuit or equipment which they supply.

(4) Tap connections from conductors in auxiliary gutters shall be provided with overcurrent protection in conformity with the provisions of section E 240.15.

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

E 374.09 Construction and installation. Auxiliary gutters shall be constructed in accordance with the following:

(1) Gutters shall be so constructed and installed that adequate electrical and mechanical continuity of the complete system will be secured.

(2) Gutters shall be of substantial construction and shall provide a complete enclosure for the contained conductors. All surfaces, both interior and exterior, shall be suitably protected from corrosion. Corner joints shall be made tight and where the assembly is held together by rivets or bolts, these shall be spaced not more than 12 inches apart.

(3) Suitable bushings, shields or fittings having smooth rounded edges shall be provided where conductors pass between gutters, through partitions, around bends, between gutters and cabinets or junction boxes and at other locations where necessary to prevent abrasion of the insulation of the conductors.

(4) Gutters shall be constructed of sheet metal of thicknessses not less than in the following table:

TABLE E 374.09 (4)

MAXIMUM WIDTH OF THE WIDEST SURFACE OF GUTTERS THICKESS (MANUFACTURERS STANDARD GAUGE)

Up to and including 6 inches	No. 16; 0.0598 inch
Over 6 in. and not over 18 in.	No. 14; 0.0747 inch
Over 18 in. and not over 30 in.	No. 12; 0.1046 inch
Over 30 inches	No. 10; 0.1345 inch

(5) Where insulated conductors are deflected within the auxiliary gutter, either at the ends or where conduits, fittings or other raceways

enter or leave the gutter, or where the direction of the gutter is deflected greater than 30 degrees, dimensions corresponding to section E 373.06 shall apply.

(6) Auxiliary gutters intended for outdoor use shall be of approved raintight construction.

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

Chapter E 380

SWITCHES

A. INSTALLATION

E 380.01 Grounded conductors. No switch or circuit-breaker shall disconnect the grounded conductor of a circuit unless the switch or circuit-breaker simultaneously disconnects the ungrounded conductor or conductors, or unless the switch or circuit-breaker is so arranged that the grounded conductor cannot be disconnected until the ungrounded conductor or conductors have first been disconnected.

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

E 380.02 Three-way and four-way switches. Three-way and four-way switches shall be so wired that all switching is done only in the ungrounded circuit conductor. Wiring between switches and outlets shall, where in metal enclosures, be run with both polarities in the same enclosure.

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

E 380.03 Enclosures. Switches and circuit-breakers shall be of the externally-operable type enclosed in metal boxes or cabinets, except pendent and surface type snap switches and knife switches mounted on an open face switchboard or panelboard.

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

E 380.04 Wet locations. A switch or circuit-breaker in a wet location or outside of a building shall be enclosed in a weatherproof enclosure or cabinet installed to conform to section E 373.02.

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

E 380.05 Time switches, flashers, and similar devices. Time switches, flashers, and similar devices need not be of the externally-operable type. They shall be enclosed in metal boxes or cabinets except:

(1) EXCEPTION No. 1. Where mounted on switchboards or control panels.

(2) EXCEPTION No. 2. Where enclosed in approved individual housings.

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

E 380.06 Position of knife switches. Single-throw knife switches shall be so placed that gravity will not tend to close them. Double-throw knife switches may be mounted so that the throw will be either vertical or horizontal as preferred, but where the throw be vertical a locking device shall be provided which will insure the blades remaining in the open position when so set.

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

E 380.07 Connection of knife switches. Knife switches, unless of the double-throw type, shall be so connected that the blades are dead when the switch is in the open position.

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

E 380.08 Accessibility and grouping. (1) Switches and circuit breakers, so far as practicable, shall be readily accessible and shall be grouped. See Wis. Adm. Code section E 195.23.

(2) Snap switches shall not be grouped or ganged in outlet boxes unless they can be so arranged that the voltage between exposed live metal parts of adjacent switches does not exceed 300 volts.

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

E 380.09 Covers of flush snap switches. Flush snap switches, that are mounted in ungrounded metal boxes and located within reach of conducting floors or other conducting surfaces, shall be provided with covers of non-conducting, non-combustible material. Metallic faceplates shall be of ferrous metal not less than 0.030 inch in thickness or of non-ferrous metal not less than 0.040 inch in thickness. Faceplates of insulating material shall be non-combustible and not less than 0.10 inch in thickness but may be less than 0.10 inch in thickness if formed or reinforced to provide adequate mechanical strength.

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

E 380.10 Mounting of surface-type snap switches. Snap switches used with open wiring on insulators shall be mounted on sub-bases of insulating material which will separate the conductors at least ½ inch from the surface wired over.

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

E 380.11 Circuit-breakers as switches. A circuit-breaker operable directly by applying the hand to a lever or handle may serve as a switch provided it has the number of poles required for such switch.

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

E 380.12 Grounding of enclosures. Enclosures for switches or circuit-breakers on circuits of over 150 volts to ground shall be grounded in the manner specified in chapter E 250, except where accessible to qualified operators only.

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

E 380.13 Knife switches. (1) Knife switches rated for more than 1200 amperes at 250 volts or less, and for more than 600 amperes at 251 to 600 volts, shall be used only as isolating switches and shall not be opened under load.

(2) To interrupt currents greater than 1200 amperes at 250 volts or less, or 600 amperes at 251 to 600 volts, a circuit-breaker or a switch of special design approved for such purpose shall be used.

(3) Knife switches of lower rating may be used as general-use switches and may be opened under load.

(4) Motor-circuit switches (see definition) may be of the knife-switch type.

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

E 380.14 Rating of snap switches. Snap switches installed for the following types of loads shall be rated as follows:

(1) NON-INDUCTIVE LOADS. For non-inductive loads other than tungsten-filament lamps, switches shall have an ampere rating not less than the ampere rating of the load.

(2) TUNGSTEN FILAMENT LOADS. For tungsten filament lamp loads and for combined tungsten filament and non-inductive loads, switches shall be "T" rated or, where on alternating-current circuits, may be a general use alternating-current snap switch.

(a) Exception. A switch that is not "T" rated may be installed to control such loads provided all 3 of the following qualifications are satisfied:

1. Where switches are used in branch circuit wiring systems in private homes; in rooms in multiple-occupancy dwellings used only as living quarters by tenants; in private hospital or hotel rooms; or in similar locations but not in public rooms or places of assembly; and

2. Only where such a switch controls permanently connected fixtures or lighting outlets in one room only, or in one continuous hallway where the lighting fixtures may be located at different levels, or on porches or in attics or basements not used for assembly purposes; and

3. The switch is rated at not less than 10A, 125V; 5A, 250V; or for the 4-way types, 5A, 125V; 2A, 250V.

(3) INDUCTIVE LOADS. Switches controlling inductive loads shall have an ampere rating twice the ampere rating of the load unless they are of a type approved as part of an assembly or for the purpose employed. On alternating-current circuits, general use alternating-current snap switches may be used to control inductive loads other than motors not exceeding the ampere rating of the switch.

Note 1. For switches on signs and outline lighting, see section E 600.02.

Note 2. For switches controlling motors, see sections E 430.083 and E 430.110.

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

B. CONSTRUCTION SPECIFICATIONS

E 380.15 Marking. Switches shall be marked with the current and voltage and, if horsepower rated, the maximum rating for which they are designed.

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

E 380.16 600-Volt knife switches. Auxiliary contacts of a renewable or quick-break type or the equivalent, shall be provided on all 600-volt knife switches designed for use in breaking currents over 200 amperes.

Note: It is recommended that such auxiliary contacts be provided on all direct-current switches rated at over 250 volts.

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

E 380.17 Multiple fuses. Switches rated above 600 amperes may be arranged for fuses in multiple provided as few fuses as possible are used and the fuses are of the same type and rating and are so mounted as to eliminate a potential difference between the terminals of the fuses.

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

Chapter E 384

SWITCHBOARDS AND PANELBOARDS

E 384.01 Scope. (1) The requirements of this chapter shall apply to all switchboards, panelboards, and distribution boards installed for the control of light and power circuits.

(a) *Exception No. 1.* Switchboards in utility company operated central stations or substations, which directly control energy derived from generators or transforming devices.

(b) *Exception No. 2.* Switchboards or portions thereof used exclusively to control signal circuits operated by batteries.

(2) The requirements of this chapter shall apply to battery-charging panels where current is taken from light or power circuits.

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

E 384.02 Application of other chapters. Switches, circuit-breakers and overcurrent devices used on switchboards, panelboards and distribution boards, the boards and their enclosures, shall conform to the requirements of Wis. Adm. Code chapters E 240, E 250, E 370, E 380 and other chapters which apply. Switchboards and panelboards in hazardous locations shall conform to the requirements of chapters E 500 to E 517 inclusive.

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

E 384.03 Support and arrangement of bus-bars and conductors. (1) Conductors and bus-bars on a switchboard, panelboard or control board shall be so located as to be free from physical damage and shall be held firmly in place.

(2) The arrangement of bus-bars and conductors shall be such as to avoid overheating due to inductive effects.

(3) Each switchboard, switchboard section or panelboard, if used as service equipment, shall be provided with an equipment grounding

means placed within the service disconnect section for connecting the neutral on its supply side to the switchboard or panelboard frame. The equipment grounding means for switchboards or panelboards rated more than 225 amperes shall have a cross sectional area of at least 25% of the cross sectional area of the service entrance conductors, but need not exceed the cross sectional area of the grounding conductors specified in table E 250.094 (1).

Note: It is recommended that the switchboard, if consisting of more than one section, be provided with a copper ground bus, and equipment ground strap be connected to the switchboard ground bus.

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

A. SWITCHBOARDS

E 384.04 Location of switchboards. Switchboards which have any exposed live parts shall be located in permanently dry locations and then only where under competent supervision and accessible only to qualified persons.

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

E 384.05 Wet locations. Where a switchboard is in a wet location or outside of a building, it shall be enclosed in a weather-proof enclosure or cabinet installed to conform to section E 373.02.

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

E 384.06 Location relative to easily ignitible material. Switchboards shall be so placed as to reduce to a minimum the probability of communicating fire to adjacent easily ignitible material.

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

E 384.07 Clearance from ceiling. Switchboards shall not be built up to a non-fireproof ceiling, a space of 3 feet being left between the ceiling and the board, unless an adequate fireproof shield is provided between the board and the ceiling.

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

E 384.08 Clearance back of switchboard. Clearances around switchboards shall conform to the provisions for working space about electrical equipment as specified in Wis. Adm. Code section E 195.16.

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

E 384.09 Conductor covering. Insulated conductors where closely grouped, as on the rear of switchboards, shall each have a flame-retardant outer covering. The conductor covering shall be stripped back a sufficient distance from the terminals so as not to make contact with them. Insulated conductors used for instrument and control wiring on the back of switchboards shall be flame-retardant, either inherently or by means of an outer covering, such as one of the following types: R, RH, RW, RHH, RHW, V, ALS, AVA, AVB, SIS, T, TA, TBS, TW, THW, MI, or other types specifically approved for the purpose.

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

E 384.11 Grounding switchboard frames. Switchboard frames and structures supporting switching equipment shall be grounded, except that frames of direct-current single-polarity switchboards need not be grounded if effectively insulated.

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

E 384.12 Grounding of instruments, relays, meters and instrument transformers on switchboards. Instruments, relays, meters and instrument transformers located on switchboards shall be grounded as specified in sections E 250.121 to E 250.125.

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

B. PANELBOARDS

E 384.13 General. All panelboards shall have a rating not less than the minimum feeder capacity required for the load as computed from chapter E 220. Panelboards shall be durably marked by the manufacturer with the voltage and the current rating and the number of phases for which they are designed and with the manufacturer's name, or trademark in such a manner as to be visible after installation, without disturbing the interior parts or wiring.

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

E 384.14 Lighting and appliance branch circuit panelboard. (1) For the purposes of this rule, a lighting and appliance branch circuit panelboard is one having more than 10% of its overcurrent devices rated 30 amperes or less, for which neutral connections are provided.

(2) A lighting and appliance branch circuit panelboard shall not contain the "wild" or high phase of 3-phase, 4-wire delta-connected system having the midpoint of one phase grounded.

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

E 384.15 Number of overcurrent devices on one panelboard. (1) Not more than 42 overcurrent devices, (other than those provided for in the mains) of a lighting and appliance branch circuit panelboard shall be installed in any one cabinet or cutout box.

(2) A lighting and appliance branch circuit panelboard shall be provided with physical means to prevent the installation of more overcurrent devices than the number for which the panelboard was designed, rated and approved.

(3) For the purposes of this chapter a two-pole circuit breaker shall be considered 2 overcurrent devices; a three-pole breaker shall be considered 3 overcurrent devices.

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

E 384.16 Overcurrent protection. (1) Each lighting and appliance branch circuit panelboard shall be individually protected on the supply side by not more than 2 main circuit breakers or 2 sets of fuses having a combined rating not greater than that of the panelboard.

(a) *Exception No. 1.* Individual protection for a lighting and appliance panelboard is not required when the panelboard feeder has overcurrent protection not greater than that of the panelboard.

(2) Panelboards equipped with snap switches rated at 30 amperes or less, shall have overcurrent protection not in excess of 200 amperes.

(3) The total load on any overcurrent device located in a panelboard shall not exceed 80% of its rating where in normal operation the load will continue for 3 hours or more.

(a) *Exception.* Except where the assembly including the overcurrent device is approved for continuous duty at 100% of its rating.

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

E 384.17 Panelboards in damp or wet locations. Panelboards in damp or wet locations shall be installed in conformity to section E 373.02.

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

E 384.18 Enclosure. Panelboards shall be mounted in cabinets or cutout boxes.

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

E 384.19 Relative arrangement of switches and fuses. Panelboards having switches on the load side of any type of fuses shall not be installed except for use as service equipment as provided in section E 230.094.

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

C. CONSTRUCTION SPECIFICATIONS

E 384.20 Panels. The panels of switchboards shall be made of moisture-resistant, noncombustible material.

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

E 384.21 Bus-bars. Bus-bars may be of bare metal provided they are rigidly mounted.

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

E 384.22 Protection of instrument circuits. Instruments, pilot lights, potential transformers, and other switchboard devices with potential coils, except where the operation of the overcurrent device might introduce a hazard in the operation of devices, shall be supplied by a circuit that is protected by standard overcurrent devices of a rating not greater than 15 amperes, except that for ratings of 2 amperes or less special types of enclosed fuses may be used.

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

E 384.23 Component parts. Switches, fuses, and fuseholders used on panelboards shall conform to the requirements of Wis. Adm. Code chapters E 240 and E 380 so far as they apply.

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

E 384.24 Knife switches. Knife switches shall be so arranged that the blades, when exposed during operation, will be dead when the switches are open.

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

E 384.25 Color-coding. On switchboards or panelboards that are provided with color markings to indicate the main bus-bars to which branch circuit bus-bars are connected, the colors shall conform to the color coding of section E 210.05.

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

E 384.26 Spacings. (1) Except at switches and circuit-breakers, the distance between bare metal parts, bus-bars, etc., shall be not less than specified in the following table:

TABLE E 384.26

SPACINGS BETWEEN BARE METAL PARTS

	Opposite Polarity When Mounted on the Same Surface	Opposite Polarity When Held Free in Air	*Live Parts to Ground
Not over 125 volts	¾ inch	½ inch	½ inch
Not over 250 volts	1¼ inch	¾ inch	½ inch
Not over 600 volts	2 inches	1 inch	1 inch

*For spacing between live parts and doors of cabinets, see section E 373.11(1).

Note: It should be noted that the above distances are the minimum allowable, and it is recommended that greater distances be provided wherever the conditions will permit.

(2) At switches, enclosed fuses, etc., parts of the same polarity may be placed as close together as convenience in handling will allow, unless close proximity causes excessive heating.

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

Chapter E 390

PREFABRICATED BUILDINGS

E 390.01 Scope. The intent and purpose of the following rules is to define approved methods for the wiring of prefabricated building sections, panels, or units designed for later erection or assembly as integral parts of buildings whether wired in the process of manufacture or at the site of erection or assembly.

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

E 390.02 Wiring methods. Only wiring methods recognized in this code shall be used.

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

E 390.03 Code provisions to apply. The provisions of this code shall apply for the type of wiring method used and the type of construction employed.

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

EQUIPMENT FOR GENERAL USE

Chapter E 400

FLEXIBLE CORDS

A. GENERAL AND TYPES

E 400.01 General. Flexible cords shall be suitable for the conditions of use and location.

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

E 400.02 Types. Cords of the several types shall conform to the descriptions of table E 400.11. Types of flexible cords other than those listed in table E 400.11 and other uses for types listed in the table, shall be the subject of special investigations and shall not be used before being approved.

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

B. USE AND INSTALLATION

E 400.03 Use. Flexible cord may be used only for (1) pendants; (2) wiring of fixtures; (3) connection of portable lamps or appliances; (4) wiring of cranes and hoists; (5) for the connection of stationary equipment to facilitate their interchange; or (6) to prevent the transmission of noise or vibration.

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

E 400.04 Prohibited uses. Flexible cord shall not be used (1) as a substitute for the fixed wiring of a structure; (2) where run through holes in walls, ceilings, or floors; (3) where run through doorways, windows, or similar openings; (4) where attached to building surfaces; (5) where concealed behind building walls, ceilings, or floors; or (6) above false ceilings.

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

E 400.05 Splices. Flexible cord shall be used only in continuous lengths without splice or tap.

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

E 400.06 Cords in show-windows and show-cases. Flexible cord used in show-windows and show-cases shall be of types S, SO, SJ, SJO, ST, SJT, or AFS, except for the wiring of chain supported fixtures, and for supplying current to portable lamps and other merchandise for exhibition purposes.

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

E 400.07 Minimum size. Flexible cord shall not be smaller than No. 18, except that tinsel cords, or cords having equivalent characteristics, of smaller size may be approved for use with specific appliances.

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

E 400.08 Insulation; over 300 volts. Where the voltage between any 2 conductors exceeds 300, but does not exceed 600, flexible cord of No. 10 and smaller shall have rubber or thermoplastic insulation on the individual conductors at least 3/64 inch in thickness, unless type S, SO or ST cord is used.

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

E 400.09 Overcurrent protection and ampacities of flexible cords. (1) OVERCURRENT PROTECTION. Flexible cords not smaller than No. 18, and tinsel cords, or cords having equivalent characteristics, of smaller size approved for use with specific appliances, shall be considered as protected against overcurrent by the overcurrent devices described in Wis. Adm. Code section E 240.05. Cords shall be not smaller than required in table E 400.09 (2) for the rated current of the connected equipment.

(2) Table E 400.09 (2) gives the allowable ampacity for not more than three current carrying conductors in a cord. If the number of current carrying conductors in a cord is from 4 to 6, the allowable ampacity of each conductor shall be reduced to 80% of the values in the table. The ampacities for the sizes and types of three conductor cords connected to utilization equipment, where the third conductor is used for equipment grounding only and does not carry any load current, are given in notes 1 and 2 following the table.

TABLE E 400.09 (2)
AMPACITY OF FLEXIBLE CORD IN AMPERES
(Based on Room Temperature of 30°C., 86°F.)
(See section E 400.09 and table E 400.11)

Size AWG	Rubber Types TP, TS / Thermoplastic Types TPT, TSP	Rubber PO, C, PD, P, K, E, EO / Thermoplastic Type ET	Rubber Types S, SO, SRD, SJ, SJO, SV, SVO, SP, / Thermoplastic Types ST, STO, SRDT, SJT, SJTO, SVT, SVTO, SPT	Types AFS, AFSJ, HC, HPD, HSJ, HSJO, HS, HSO, HPN	Types AVPO, AVPD	Cotton Types CFC* CFPO* CFPD* / Asbestos Types AFC* AFPO* AFPD*
27**	0.5					
18		5	7	10	17	6
17				12		
16		7	10	15	22	8
15				17		
14		15	15	20	28	17
12		20	20	30	36	23
10		25	25	35	47	28
8		35	35			
6		45	45			
4		60	60			
2		80				

*These types are used almost exclusively in fixtures where they are exposed to high temperatures and ampere ratings are assigned accordingly.
**Tinsel cord.

Note 1. For Nos. 18, 16 and 14 AWG sizes of types S, SO, and ST Cords, the allowable ampacities are 10, 13 and 18 amperes respectively.

Note 2. For Nos. 18 and 16 AWG sizes of SJ, SJO and SJT Cords, the allowable ampacities are 10 and 13 amperes respectively.

Note 3. Ultimate insulation temperature. In no case shall conductors be associated together in such a way with respect to the kind of circuit, the wiring method employed, or the number of conductors, that the limiting temperature of the conductors will be exceeded.

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

E 400.10 Pull at joints and terminals. Flexible cords shall be so connected to devices and to fittings that tension will not be transmitted to joints or terminal screws. This shall be accomplished by a knot in the cord, winding with tape, by a special fitting designed for that purpose, or by other approved means which will prevent a pull on the cord from being directly transmitted to joints or terminal screws.

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

Notes to table E 400.11

1. Except for types AFPO, CFPO, PO-1, PO-2, PO, SP-1, SP-2, SPT-1, SPT-2, TP, TPT, and AVPO, individual conductors are twisted together.

2. Type PO-1 is for use only with portable lamps, portable radio receiving appliances, portable clocks and similar appliances which are not liable to be moved frequently and where appearance is a consideration.

3. Types TP, TPT, TS, and TST are suitable for use in lengths not exceeding 8 feet when attached directly, or by means of a special type of plug, to a portable appliance rated at 50 watts or less and of such nature that extreme flexibility of the cord is essential.

4. Type K is suitable for use on theatre stages.

5. Rubber-filled or varnished cambric tapes may be substituted for the inner braids.

6. Types S, SO, and ST are suitable for use on theatre stages, in garages and elsewhere, where flexible cords are permitted by this code.

7. Traveling cables for operating, control and signal circuits may have one or more nonmetallic fillers or may have a supporting filler of stranded steel wires having its own protective braid or cover. Cables exceeding 100 feet in length shall have steel supporting fillers, except in locations subject to excessive moisture or corrosive vapors or gases. Where steel supporting fillers are used, they shall run straight through the center of the cable assembly and shall not be cabled with the copper strands of any conductor. Type E and EO cables may incorporate in the construction #20 gauge conductors formed as a pair, and covered with suitable metallic braided shielding for telephone circuits. The insulation of the conductors may be rubber or thermoplastic of thickness specified for type E and EO cables. The shield shall have its own protective covering. This component may be incorporated in any layer of the cable assembly, and shall not run straight through the center.

8. A third conductor in these cables is for grounding purposes only.

9. The individual conductors of all cords except those of heat-resistant cords (types AFC, AFPO, AFPD, AFS, AFSJ, AVPO, AVPD, CFC, CFPO and CFPD) shall have a rubber or thermoplastic insulation except that the grounding conductor where used, shall be in accordance with section E 400.14 (2). A rubber compound shall be vulcanized except for header cords (types HC, HPD and HSJ) and for belt fillers in types P-1, P-2, and P.

TABLE E 400.11
FLEXIBLE CORD
(See section E 400.02)

Trade Name	Type Letter	Size AWG	No. of Conductors	Insulation	Braid on Each Conductor	Outer Covering	Use		
Parallel Tinsel Cord	TP See Note 3	27	2	Rubber	None	Rubber	Attached to an Appliance	Damp Places	Not Hard Usage
	TPT See Note 3	27	2	Thermoplastic	None	Thermoplastic	Attached to an Appliance	Damp Places	Not Hard Usage
Jacketed Tinsel Cord	TS See Note 3	27	2 or 3	Rubber	None	Rubber	Attached to an Appliance	Damp Places	Not Hard Usage
	TST See Note 3	27	2 or 3	Thermoplastic	None	Thermoplastic	Attached to an Appliance	Damp Places	Not Hard Usage
Asbestos-Covered Heat-Resistant Cord	AFC	18–10	2 or 3	Impregnated Asbestos	Cotton or Rayon	None	Pendant	Dry Places	Not Hard Usage
	AFPO		2		None	Cotton, Rayon or Saturated Asbestos			
	AFPD		2 or 3						
Cotton-Covered Heat-Resistant Cord	CFC	18–10	2 or 3	Impregnated Cotton	Cotton or Rayon	None	Pendant	Dry Places	Not Hard Usage
	CFPO		2		None	Cotton or Rayon			
	CFPD		2 or 3						
Parallel Cord	PO-1	18	2	Rubber	Cotton	Cotton or Rayon	See Note 2	Dry Place	Not Hard Usage
	PO-2	18–16					Pendant or Port.		
	PO	18–10							

See Notes to Table E 400.11

TABLE E 400.11—Continued

Trade Name	Type Letter	Size AWG	No. of Conductors	Insulation	Braid on Each Conductor	Outer Covering	Use		
All Rubber Parallel Cord	SP-1	18	2	Rubber	None	Rubber	Pendant or Portable	Damp Places	Not Hard Usage
	SP-2 See Note 8	18–16							
	SP-3 See Note 8	18–12		Rubber	None	Rubber	Refrigerators or Room Air Conditioners	Damp Places	Not Hard Usage
All Plastic Parallel Cord	SPT-1	18	2	Thermoplastic	None	Thermoplastic	Pendant or Portable	Damp Places	Not Hard Usage
	SPT-2 See Note 8	18–16							
All Plastic Parallel Cord	SPT-3 Note 8	18–10	2	Thermoplastic	None	Thermoplastic	Refrigeraators or Room Air Conditioners	Damp Places	Not Hard Usage
Lamp Cord	C	18–10	2 or more	Rubber	Cotton	None	Pendant or Portable	Dry Places	Not Hard Usage
Twisted Portable Cord	PD	18–10	2 or more	Rubber	Cotton	Cotton or Rayon	Pendant or Portable	Dry Places	Not Hard Usage
Reinforced Cord	P-1	18	2 or more	Rubber	Cotton	Cotton over Rubber Filler	Pendant or Portable	Dry Places	Not Hard Usage
	P-2	18–16							
	P	18–10							Hard Usage
Braided Heavy Duty Cord	K See Note 4	18–10	2 or more	Rubber	Cotton	Two Cotton, Moisture-Resistant Finish See Note 5	Pendant or Portable	Damp Places	Hard Usage

See Notes to Table E 400.11

TABLE E 400.11—Continued

Trade Name	Type Letter	Size AWG	No. of Conductors	Insulation	Braid on Each Conductor	Outer Covering	Use		
Vacuum Cleaner Cord	SV, SVO	18	2	Rubber	None	Rubber	Pendant or Portable	Damp Places	Not Hard Usage
	SVT, SVTO See Note 8			Thermoplastic		Thermoplastic			
Junior Hard Service Cord	SJ	18–16	2, 3, or 4	Rubber	None	Rubber	Pendant or Portable	Damp Places	Hard Usage
	SJO					Oil Resistant Compound			
	SJT SJTO			Thermoplastic or Rubber		Thermoplastic			
Hard Service Cord	S See Note 6	18–2	2 or More	Rubber	None	Rubber	Pendant or Portable	Damp Places	Extra Hard Usage
	SO					Oil Resistant Compound			
	ST			Thermoplastic or Rubber		Thermoplastic			
	STO					Oil Resistant Thermoplastic			
Rubber-Jacketed Heat-Resistant Cord	AFSJ	18–16	2 or 3	Impregnated Asbestos	None	Rubber	Portable	Damp Places	Portable Heaters
	AFS	18–16–14							
Heater Cord	HC	18–12	2, 3, or 4	Rubber and Asbestos	Cotton	None	Portable	Dry Places	Portable Heaters
	HPD	18–12	2, 3, or 4	Rubber with Asbestos or All Neoprene	None	Cotton or Rayon			
Rubber Jacketed Heater Cord	HSJ	18–16	2, 3, or 4	Rubber with Asbestos or All Neopreme	None	Cotton and Rubber	Portable	Damp Places	Portable Heaters

See Notes to Table E 400.11

TABLE E 400.11—Continued

Trade Name	Type Letter	Size AWG	No. of Conductors	Insulation	Braid on Each Conductor	Outer Covering	Use		
Jacketed Heater Cord	HSJO	18–16	2, 3, or 4	Rubber with Asbestos or All Neoprene	None	Cotton and Oil Resistant Compound	Portable	Damp Places	Portable Heaters
	HS	14–12				Cotton and Rubber or Neoprene			
	HSO	14–12				Cotton and Oil Resistant Compound			
Parallel Heater Cord	HPN	18–16	2	Thermoset-ting	None	Thermosettling	Portable	Damp Places	Portable Heaters
Heat and Moisture Resistant Cord	AVPO	18–10	2	Asbestos and Var. Camb.	None	Asbestos, Flame-ret. Moisture Resist.	Pendant or Portable	Damp Places	Not Hard Usage
	AVPD		2 or 3						
Range Dryer Cable	SRD	10–4	3 or 4	Rubber	None	Rubber or Neoprene	Portable	Damp Places	Ranges Dryers
	SRDT	10–4	3 or 4	Thermoplastic	None	Thermoplastic	Portable	Damp Places	Ranges Dryers
Elevator Cable	E See Note 7	18–14	2 or more	Rubber	Cotton	Three Cotton, Outer One Flame-Retardant and Moisture Resist. See Note 5	Elevator Lighting and Control	Non-Hazardous Locations	
	EO See Note 7					One Cotton and a Neoprene Jacket See Note 5		Hazardous Locations	
	ET See Note 7	18–14		Thermoplastic	Rayon	Three Cotton, Outer One Flame-Retardant and Moisture Resistant. See Note 5		Non-Hazardous Locations	

See Notes to Table E 400.11

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

C. CONSTRUCTION SPECIFICATIONS

E 400.12 Labels. Flexible cords shall be examined and tested at the factory and shall be labeled before shipment.

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

E 400.13 Grounded conductor identification. One conductor of flexible cords shall have a continuous marker readily distinguishing it from the other conductor or conductors. The identification shall consist of one of the following:

(1) COLORED BRAID. A braid finished to show a white or natural gray color and the braid on the other conductor or conductors finished to show a readily distinguishable solid color or colors.

(2) TRACER IN BRAID. A tracer in a braid of any color contrasting with that of the braid and no tracer in the braid of the other conductor or conductors. No tracer shall be used in the braid of any conductor of a flexible cord which contains a conductor having a braid finished to show white or natural gray, except, in the case of types C, PD and PO cords having the braids on the individual conductors finished to show white or natural gray. In such C, PD and PO cords the identifying marker may consist of the solid white or natural gray finish on one conductor provided there is a colored tracer in the braid of each other conductor.

(3) COLORED INSULATION. A white or natural gray insulation on one conductor and insulation of a readily distinguishable color or colors on the other conductor or conductors for cords having no braids on the individual conductors (except cords which have insulation on the individual conductors integral with the jacket). The insulation may be covered with an outer finish to provide the desired color.

(4) COLORED SEPARATOR. A white or natural gray separator on one conductor and a separator of a readily distinguishable solid color on the other conductor or conductors of cords having insulation on the individual conductors integral with the jacket.

(5) TINNED CONDUCTORS. One conductor having the individual strands tinned and the other conductor or conductors having the individual strands untinned for cords having insulation on the individual conductors integral with the jacket.

(6) SURFACE MARKING. A stripe, ridge or groove so located on the exterior of the cord as to identify one conductor for cords having insulation on the individual conductors integral with the jacket.

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

E 400.14 Grounding conductor identification. A conductor intended to be used as a grounding conductor shall have a continuous identifying marker readily distinguishing it from the other conductor or conductors. Conductors having a green covering shall not be used for other than grounding purposes. The identifying marker shall consist of one of the following:

(1) COLORED BRAID. A braid finished to show a continuous green color or a continuous green color with a yellow stripe.

(2) COLORED INSULATION OR COVERING. For cords having no braids on the individual conductors a continuous green color insulation or a continuous green color with a yellow stripe covering on one conductor.

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

E 400.15 Insulation thickness. The nominal thickness of rubber or thermoplastic conductor insulation in types TS, TST, PO-1, P-1, SV, and SVT shall be not less than 1/64 inch. The nominal thickness of rubber insulation in types HC, HPD, HSJ, and HS shall be not less than 1/64 inch for the Nos. 18–16 AWG sizes, and not less than 2/64 inch for the Nos. 14–12 AWG sizes. For heater cord other than types HS and HPS, the all neoprene insulation shall be 2/64 inch for No. 18 and No. 16 AWG sizes and 3/64 inch for No. 14 and No. 12 AWG sizes. The nominal thickness of the thermoplastic insulation in type ET elevator cable shall be not less than 20 mils for the No. 18 and No. 16 AWG size and not less than 1/32 inch for the No. 14 AWG size. The nominal thickness of the rubber insulation in types E and EO elevator cables shall be not less than 20 mils for the No. 18 and 16 AWG sizes and not less than 2/64 inch for the No. 14 AWG size for ratings not exceeding 300 volts. The nominal thickness of latex-rubber insulation, when employed, in types SJ, SJO, S and SO shall be not less than 15 mils for the Nos. 18–16 AWG sizes and not less than 18 mils for the No. 14 AWG and larger sizes. The nominal thickness of conductor insulation in types PO, P, SP-2, SPT-2, HPN, SRD, and SRDT shall be not less than 3/64 inch. The nominal thickness of thermoplastic insulation in type SPT-3 shall be not less than 4/64 inch for sizes 18–16 and 5/64 inch for No. 14, 6/64 inch for No. 12 and 7/64 inch for No. 10 AWG. For other types, the minimum nominal thickness of rubber or thermoplastic conductor insulation shall be as follows: Size AWG 27, and 18 to 16—2/64 inch; 14 to 10—3/64 inch; 8 to 2—4/64 inch.

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

E 400.16 Attached to receptacle plugs. Where a flexible cord is provided with a grounding conductor and equipped with an attachment plug, the plug shall comply with sections E 250.059 (1) and (2).

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

Chapter E 402

FIXTURE WIRES

E 402.01 Use. Fixture wires are designed for installation in lighting fixtures and in similar equipment where enclosed or protected and not subject to bending or twisting in use. Also, they are used for connecting lighting fixtures to the conductors of the circuit that supplies the fixtures.

Note 1: For application in lighting fixtures, see Wis. Adm. Code chapter E 410.

Note 2: Fixture wires are not intended for the connection of portable or stationary appliances, nor for installation as branch circuit conductors, except as permitted in chapter E 725.

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

E 402.02 Minimum size. Fixture wires shall not be smaller than No. 18.

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

E 402.03 Insulation. (1) The rubber insulations include those made from natural and synthetic rubber, neoprene and other vulcanized materials.

Note: Thermoplastic insulation may stiffen at temperatures below minus 10° C. (14° F.) and care should be used in its installation at such temperatures. It may be deformed when subject to pressure; care should be taken in its installation, as for example, at bushings, or points of support. See subsection E 373.06 (2).

(2) No conductor shall be used under such conditions that its temperature, even when carrying current, will exceed the temperature specified in table E 310.02 (1) for the type of insulation involved.

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

TABLE E 402.04
ALLOWABLE AMPACITY OF FIXTURE WIRE
(Based on Room Temperature of 30°C., 86°F.)

Size AWG	Fixture Wire	
	Rubber Types RF-1, RF-2, FF-1, FF-2, RFH-1, RFH-2, FFH-1, FFH-2	Thermoplastic Types TF, TFF Cotton Type CF* Asbestos Type AF* Silicone Rubber Types SF-1*, SF-2*, SFF-1*, SFF-2* Fluorinated Ethylene Propylene Types PF*, PGF*, PFF*, PGFF*
18	5	6
16	7	8
14	----------	17

*These types are used almost exclusively in fixtures where they are exposed to high temperatures and ampere ratings are assigned accordingly.

Note: Ultimate insulation temperature. In no case shall conductors be associated together in such a way with respect to the kind of circuit, the wiring method employed, or the number of conductors, that the limiting temperature of the conductors will be exceeded.

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

E 402.05 Overcurrent protection. See section E 240.05 (3).

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

TABLE E 402.06
FIXTURE WIRE

Trade Name	Type Letter	Insulation	Thickness of Insulation	Outer Covering
Rubber-Covered Fixture Wire Solid or 7-Strand	RF-1	Code Rubber	18 ... 1/64 Inch	Non-metallic covering
	RF-2	Code Rubber	18–16 ... 2/64 Inch	Non-metallic covering
		Latex Rubber	18–16 ... 18 Mils	
Rubber-Covered Fixture Wire Flexible Stranding	FF-1	Code Rubber	18 ... 1/64 Inch	Non-metallic covering
	FF-2	Code Rubber	18–16 ... 2/64 Inch	Non-metallic covering
		Latex Rubber	18–16 ... 18 Mils	
Heat-Resistant Rubber-Covered Fixture Wire Solid or 7-Strand	RFH-1	Heat-Resistant Rubber	18 ... 1/64 Inch	Non-metallic covering
	RFH-2	Heat-Resistant Rubber	18–16 ... 2/64 Inch	Non-metallic covering
		Heat-Resistant Latex Rubber	18–16 ... 18 Mils	
Heat-Resistant Rubber-Covered Fixture Wire Flexible Stranding	FFH-1	Heat-Resistant Rubber	18 ... 1/64 Inch	Non-metallic covering
	FFH-2	Heat-Resistant Rubber	18–16 ... 2/64 Inch	Non-metallic covering
		Heat-Resistant Latex Rubber	18–16 ... 18 Mils	
Thermoplastic-Covered Fixture Wire Solid or Stranded	TF	Thermoplastic	18–16 ... 2/64 Inch	None
Thermoplastic-Covered Fixture Wire Flexible Stranding	TFF	Thermoplastic	18–16 ... 2/64 Inch	None
Fluorinated Ethylene Propylene Fixture Wire Solid or 7 Strand	PF	Fluorinated Ethylene Propylene	18–14 ... 20 Mils	None
	PGF	Fluorinated Ethylene Propylene	18–14 ... 14 Mils	Non-metallic covering
Fluorinated Ethylene Propylene Fixture Wire Solid or 7 Strand	PFF	Fluorinated Ethylene Propylene	18–14 ... 20 Mils	None
	PGFF	Fluorinated Ethylene Propylene	18–14 ... 14 Mils	Non-metallic covering
Cotton-Covered, Heat-Resistant, Fixture Wire	CF	Impregnated Cotton	18–14 ... 2/64 Inch	None
Asbestos-Covered, Heat-Resistant, Fixture Wire	AF	Impregnated Asbestos	18–14 ... 2/64 Inch	None
Silicone Insulated Fixture Wire Solid or 7-Strand	SF-1	Silicone Rubber	18 ... 1/64 Inch	Non-metallic covering
	SF-2	Silicone Rubber	18–14 ... 1/32 Inch	Non-metallic covering
Silicone Insulated Fixture Wire Flexible Stranding	SFF-1	Silicone Rubber	18 ... 1/64 Inch	Non-metallic covering
	SFF-2	Silicone Rubber	18–14 ... 1/32 Inch	Non-metallic covering

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

Chapter E 410

LIGHTING FIXTURES, LAMPHOLDERS, LAMPS, RECEPTACLES AND ROSETTES

A. GENERAL

E 410.01 Scope. Lighting fixtures, lampholders, pendants, receptacles, rosettes, incandescent filament lamps, arc lamps, electric discharge lamps, the wiring and equipment forming part of such lamps, fixtures and lighting installations shall conform to the provisions of this chapter, except as otherwise provided in this code.

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

E 410.02 Application to other chapters. Equipment for use in hazardous locations shall conform to Wis. Adm. Code chapters E 500 to E 517.

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

E 410.03 Live parts. Fixtures, lampholders, lamps, rosettes and receptacles shall have no live parts normally exposed to contact, except in the case of cleat-type lampholders, receptacles and rosettes which are located at least 8 feet above the floor. Lampholders, receptacles and switches which have exposed accessible terminals shall not be installed in metal fixture canopies or in open bases of portable table or floor lamps.

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

B. PROVISIONS FOR FIXTURE LOCATIONS

E 410.04 Fixtures in damp, wet or corrosive locations. (1) Fixtures installed in damp or wet locations shall be approved for such locations and shall be so constructed or installed that water cannot enter or accumulate in wireways, lampholders or other electrical parts. All fixtures installed outdoors, in damp or wet locations shall be marked "Suitable for Wet Locations."

(2) Fixtures installed in corrosive locations shall be of a type approved for such locations.

Note: See section E 210.21 (2) for receptacles in fixtures.

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

E 410.05 Fixtures near combustible material. Fixtures shall be so constructed, or installed, or equipped with shades or guards that combustible material will not be subjected to temperatures in excess of 90°C. (194°F.).

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

E 410.06 Fixtures over combustible material. Lampholders installed over highly combustible material shall be of the unswitched type and unless an individual switch is provided for each fixture, shall be located at least 8 feet above the floor, or shall be otherwise so located or guarded that the lamps cannot be readily removed or damaged.

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

E 410.07 Fixtures in show-windows. Externally wired fixtures shall not be used in a show-window.

(1) Exception: Fixtures of the chain-supported type may be externally wired.

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

E 410.08 Fixtures in clothes closets. (1) A fixture in a clothes closet shall be installed:

(a) On the wall above the closet door, or

(b) On the ceiling over an area which is unobstructed to the floor, and

(c) So that the clearance from the fixture to any combustible material within the closet is not less than 18".

Note: A flush recessed fixture equipped with a solid lens is considered to be outside the closet area.

(2) Pendants shall not be installed in clothes closets.

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

E 410.09 Space for cove lighting. Coves shall have adequate space and shall be so located that lamps and equipment can be properly installed and maintained.

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

C. PROVISIONS AT FIXTURE OUTLET BOXES, CANOPIES AND PANS

E 410.10 Space for conductors. Canopies and outlet boxes taken together shall provide adequate space so that fixture conductors and their connecting devices may be properly installed.

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

E 410.11 Temperature limit of conductors in outlet boxes. Fixtures shall be of such construction or so installed that the conductors in outlet boxes shall not be subjected to temperatures greater than that for which the conductors are approved.

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

E 410.12 Outlet boxes to be covered. In a completed installation, each outlet box shall be provided with a cover unless covered by means of a fixture canopy, lampholder, receptacle, rosette, or similar device.

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

E 410.13 Covering of combustible material at outlet boxes. Any combustible wall or ceiling finish exposed between the edge of a fixture canopy or pan and an outlet box shall be covered with noncombustible material.

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

E 410.14 Connection of fixtures. Fluorescent fixtures supported independently of the outlet box shall be connected through metal raceways, metal-clad cable or flexible cord when the cord-equipped fixture is suspended directly below the outlet box and the exposed cord is not subject to strain or physical damage.

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

D. FIXTURE SUPPORTS

E 410.15 **Supports; general.** Fixtures, lampholders, rosettes and receptacles shall be securely supported. A fixture which weighs more than 6 lbs. or exceeds 16 inches in any dimension shall not be supported by the screw shell of a lampholder.

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

E 410.16 Means of support. Where the outlet box or fitting will provide adequate support, a fixture shall be attached thereto; otherwise a fixture shall be supported as required by section E 370.13. A fixture which weighs more than 50 lbs. shall be supported independently of the outlet box.

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

E. WIRING OF FIXTURES

E 410.17 Fixture wiring; general. Wiring on or within fixtures shall be neatly arranged and shall not be exposed to physical damage. Excess wiring shall be avoided. Conductors shall be so arranged that they shall not be subjected to temperatures above those for which they are approved.

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

E 410.18 Conductor size. Fixture conductors shall not be smaller than No. 18.

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

E 410.19 Conductor insulation. (1) Fixtures shall be wired with conductors having insulation suitable for the current, voltage, and temperature to which the conductors will be subjected.

(2) Where fixtures are installed in damp, wet, or corrosive locations, conductors shall be of a type approved for such locations.

(3) For ampacity of fixture wire, see table E 402.04.

(4) For maximum operating temperature and voltage limitation of fixture wires, see section E 310.02.

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

E 410.20 Conductors for certain conditions. (1) Fixtures provided with Mogul base screw-shell lampholders and operating at not more than 300 volts between conductors shall be wired with type AF, SF-1, SF-2, SFF-1, SFF-2, PF, PGF, PFF or PGFF fixture wire.

(2) Fixtures provided with other than Mogul base screw-shell lampholders and operating at not more than 300 volts between conductors shall be wired with type AF, SF-1, SF-2, PF, PGF, PFF, PGFF fixture wire or type AFC, AFPO, or AFPD flexible cord.

(a) *Exception No. 1.* Where temperatures do not exceed 90°C. (194°F.), type CF fixture wire or type CFC, CFPD, or CFPO flexible cord may be used.

(b) *Exception No. 2.* Where temperatures exceed 60°C. (140°F.) but are not higher than 75°C. (167°F.), type RH rubber-covered wire, type RFH-1, RFH-2, FFH-1, and FFH-2 fixture wires may be used.

(c) *Exception No. 3.* Where temperatures do not exceed 60°C. (140°F.), type T thermoplastic wire, types TF and TFF fixture wire, type R rubber-covered wire, and types RF-1, RF-2, FF-1, FF-2 fixture wire may be used, including use in fixtures of decorative type on which lamps of not over 60-watt rating are used in connection with imitation candles.

Note: See sections E 402.06 and E 310.02 for fixture wires and conductors; also, table E 400.09 (2) for flexible cords.

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

E 410.21 Conductors for movable parts. (1) Stranded conductor shall be used for wiring on fixture chains and on other movable or flexible parts.

(2) Conductors shall be so arranged that the weight of the fixture or movable parts will not put a tension on the conductors.

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

E 410.22 Pendent conductors for incandescent filament lamps. (1) Pendent lampholders with permanently attached leads, where used in other than festoon wiring, shall be hung from separate stranded rubber-covered conductors which are soldered directly to the circuit conductors but supported independently thereof.

(2) Such pendent conductors shall be not smaller than No. 14 for heavy-duty or medium-base screw-shell lampholders, nor, except for approved Christmas tree and decorative lighting outfits, smaller than No. 18 for intermediate or candelabra-base lampholders.

(3) Pendent conductors longer than 3 feet shall be twisted together where not cabled in an approved assembly.

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

E 410.23 Protection of conductors and insulation. (1) Conductors shall be secured in a manner that will not tend to cut or abrade the insulation.

(2) Conductor insulation shall be protected from abrasion where it passes through metal.

(3) Fixtures in permanently installed (fixed) showcases or wall cases shall be supplied through a permanent connection to a recognized wiring system. Stationary equipment may be cord-connected as provided in section E 400.03 (5).

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

E 410.24 Conductor protection at lampholders. Where a metal lampholder is attached to a flexible cord, the inlet shall be equipped with an insulating bushing which, if threaded, shall not be smaller than nominal ⅜ inch pipe size. The cord hole shall be of a size appropriate for the cord and all burrs and fins removed in order to provide a smooth bearing surface for the cord.

Note: Bushings having holes 9/32 inch in diameter are suitable for use with plain pendant cord and holes 13/32 inch in diameter with reinforced cord.

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

E 410.25 Connections, splices and taps. (1) Fixtures shall be so installed that the connections between the fixture conductors and the circuit conductors may be inspected without requiring the disconnection of any part of the wiring, unless the fixture is connected by means of a plug and receptacle.

(2) Splices and taps shall not be located within fixture arms or stems.

(3) No unnecessary splices or taps shall be made within or on a fixture.

(4) For approved means of making connections, see sections E 195.13 and E 195.14.

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

E 410.26 Fixture raceways. (1) Fixtures shall not be used as a raceway for circuit conductors unless the fixtures meet the requirements for approved raceways, except that the conductors of the single branch circuit supplying the fixtures may be carried through as follows:

(a) *Exception No. 1.* An installation of fixtures approved for end to end assembly to form a continuous raceway, or

(b) *Exception No. 2.* Fixtures which are connected together by approved wiring methods.

(2) Branch circuit conductors within 3 inches of a ballast within the ballast compartment shall be recognized for use at temperatures not lower than 90°C. (194°F.).

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

E 410.27 Polarization of fixtures. Fixtures shall be so wired that the screw-shells of lampholders will be connected to the same fixture or circuit conductor or terminal. For polarity identification of conductors to screw-shells of lampholders, see Wis. Adm. Code section E 200.08.

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

F. CONSTRUCTION OF FIXTURES

E 410.28 Combustible shades and enclosures. Adequate air space shall be provided between lamps and shades or other enclosures of combustible material.

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

E 410.29 Fixture rating. (1) All fixtures requiring ballasts or transformers shall be plainly marked with their electrical rating and the manufacturer's name, trade-mark or other suitable means of identification.

(2) The electrical rating shall include the voltage and frequency, and shall indicate the current rating of the unit including the ballast, transformer or auto-transformer.

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

E 410.30 Design and material. Fixtures shall be constructed of metal, wood, or other approved material and shall be so designed and assembled as to secure requisite mechanical strength and rigidity. Wireways, including the entrances thereto, shall be such that conductors may be drawn in and withdrawn without injury.

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

E 410.31 Non-metallic fixtures. In all fixtures not made entirely of metal, wireways shall be lined with metal unless approved armored or lead covered conductors with suitable fittings are used.

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

E 410.32 Mechanical strength. (1) Tubing used for arms and stems where provided with cut threads shall be not less than 0.040 inch in thickness and when provided with rolled (pressed) threads shall be not less than 0.025 inch in thickness. Arms and other parts shall be fastened to prevent turning.

(2) Metal canopies supporting lampholders, shades, etc., exceeding 8 lbs., or incorporating attachment plug receptacles, shall be not less than 0.020 inch in thickness. Other canopies shall be not less than 0.016 inch when made of steel and not less than 0.020 inch when of other metals.

(3) Pull type canopy switches shall not be inserted in the rims of metal canopies which are less than 0.025 inch in thickness unless the rims are reinforced by the turning of a bead or the equivalent. Pull type canopy switches, whether mounted in the rims or elsewhere in sheet metal canopies, shall be located not more than 3½ inches from the center of the canopy. Double set screws, double canopy rings, a screw ring, or equal method shall be used where the canopy supports a pull type switch or pendent receptacle.

Note: The above thickness requirements apply to measurements made on finished (formed) canopies.

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

E 410.33 Wiring space. Bodies of fixtures, including portable lamps, shall provide ample space for splices and taps and for the installation of devices, if any. Splice compartments shall be of non-absorptive, non-combustible material.

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

E 410.34 Fixture studs. Fixture studs which are not parts of outlet boxes, hickeys, tripods, and crowfeet shall be made of steel, malleable iron, or other approved material.

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

E 410.35 Insulating joints. Insulating joints shall be composed of materials especially approved for the purpose. Those which are not designed to be mounted with screws or bolts shall have a substantial exterior metal casing, insulated from both screw connections.

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

E 410.36 Portable lamps. Portable table and floor lamps and fan motors on ceiling fixtures may be wired with approved rubber-covered conductors, provided the wiring is not located so as to be subject to undue heating from lamps.

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

E 410.37 Portable handlamps. Handlamps of the portable type supplied through flexible cords shall be of the molded composition or other type approved for the purpose. Metal-shell paper-lined lampholders shall not be used. Handlamps shall be equipped with a handle. Where subject to physical damage or where lamps may come in contact with combustible material, handlamps shall be equipped with a substantial guard attached to the lampholder or the handle.

Note: For garages, see Wis. Adm. Code section E 511.06.

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

E 410.38 Cord bushings. Bushing or the equivalent shall be provided where flexible cord enters the base or stem of a portable lamp. The bushing shall be of insulating material unless a jacketed type of cord is used.

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

E 410.39 Tests. All wiring shall be free from short-circuits and grounds, and shall be tested for these defects prior to being connected to the circuit.

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

E 410.40 Live parts. Exposed live parts within porcelain fixtures shall be suitably recessed and so located as to make it improbable that wires will come in contact with them. There shall be a spacing of at least ½ inch between live parts and the mounting plane of the fixture.

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

G. INSTALLATION OF LAMPHOLDERS

E 410.41 Screw-shell type. Lampholders of the screw-shell type shall be installed for use as lampholders only.

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

E 410.42 Double-pole switched lampholders. Where used on unidentified 2-wire circuits tapped from the ungrounded conductors of multi-wire circuits, the switching device of lampholders of the switched type shall simultaneously disconnect both conductors of the circuit. See Wis. Adm. Code section E 200.05.

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

E 410.43 Lampholders in damp or wet locations. Lampholders installed in damp or wet locations shall be of the weatherproof type.

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

H. CONSTRUCTION OF LAMPHOLDERS

E 410.44 Insulation. The outer metal shell and the cap shall be lined with insulating material which shall prevent the shell and cap from becoming a part of the circuit. The lining shall not extend beyond the metal shell more than ⅛ inch, but shall prevent any current-carrying part of the lamp base from being exposed when a lamp is in the lampholding device.

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

E 410.45 Lead wires. Lead wires, furnished as a part of weatherproof lampholders and intended to be exposed after installation, shall be of approved, stranded, rubber-covered conductors, not less than No. 14 gauge (No. 18 gauge for candelabra sockets), and shall be sealed in place or otherwise made raintight.

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

E 410.46 Switched lampholders. Switched lampholders shall be of such construction that the switching mechanism interrupts the electrical connection to the center contact. The switching mechanism may also interrupt the electrical connection to the screw shell when connection to the center contact is simultaneously interrupted.

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

J. LAMPS

E 410.49 Bases, incandescent lamps. An incandescent lamp for general use on lighting branch circuits shall not be equipped with a medium base when rated over 300 watts, nor with a Mogul base when rated over 1,500 watts. Above 1,500 watts, special approved bases or other devices shall be used.

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

E 410.50 Enclosures, mercury-vapor lamp auxiliary equipment. Resistors or regulators for mercury-vapor lamps shall be enclosed in noncombustible cases and treated as sources of heat.

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

E 410.51 Arc lamps. Arc lamps used in theatres shall conform to section E 520.61, and arc lamps used in projection machines shall conform to section E 540.20. Arc lamps used on constant-current systems shall conform to the general requirements of chapter E 710.

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

K. RECEPTACLES, CORD CONNECTORS AND ATTACHMENT PLUGS (CAPS)

E 410.52 Rating and type. (1) Receptacles installed for the attachment of portable cords shall be rated at not less than 15 amperes, 125 volts, or 10 amperes, 250 volts, and shall be of a type not suitable for use as lampholders.

(2) METALLIC FACEPLATES. Metallic faceplates shall be of ferrous metal not less than 0.030 inch in thickness or of non-ferrous metal not less than 0.040 inch in thickness. Faceplates of insulating material shall be non-combustible and not less than 0.10 inch in thickness but may be less than 0.10 inch in thickness if formed or reinforced to provide adequate mechanical strength.

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

E 410.53 Receptacles in floors. Receptacles located in floors shall be enclosed in floor boxes especially approved for the purpose.

(1) EXCEPTION. Where such receptacles are located in elevated floors of show-windows or other locations and when the administrative authority judges them to be free from physical damage, moisture and dirt, the standard approved type of flush receptacle box may be used.

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

E 410.54 Receptacles in damp or wet locations. Receptacles installed in damp or wet locations shall be of the weatherproof type.

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

E 410.55 Receptacles and cord connectors—grounding type. Receptacles and cord connectors which are installed to provide for an equipment grounding connection for cord-connected equipment for a 2-wire power supply from a receptacle rated 15 or 20 amperes at a potential under 300 volts shall have one separate fixed grounding member. The terminal for connection to the grounding member shall be designated by a green-colored finish. The design of receptacles and cord connectors shall be such that the grounding connection shall be made before the current carrying connection.

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

E 410.56 Attachment plugs (caps)—grounding type. An attachment plug (cap) for use wih a grounding-type receptacle shall, when for use with a grounding type receptacle as described in section E 410.55, have one separate fixed grounding member which shall be so designed as to prevent it from being capable of touching any current-carrying contact of the receptacle. The terminal connection for this grounding member shall be designated by a green-colored finish. The design of attachment plugs (caps) shall be such that the grounding connection shall be made before the current carrying connection.

(1) EXCEPTION: The grounding contacting member of grounding type attachment plugs on the power suply cord of a hand-held tool or hand-held appliance may be of the movable self-restoring type.

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

L. ROSETTES

E 410.57 Approved types. (1) Fusible rosettes shall not be installed.

(2) Separable rosettes which make possible a change in polarity shall not be used.

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

E 410.58 Rosettes in damp and wet locations. Rosettes installed in damp or wet locations shall be of the weatherproof type.

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

E 410.59 Rating. Rosettes shall be rated at 660 watts, 250 volts, with a maximum current rating of 6 amperes.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 410.60 Rosettes for exposed wiring. When designed for use with exposed wiring, rosettes shall be provided with bases which shall have at least 2 holes for supporting screws, shall be high enough to keep the wires and terminals at least ½ inch from the surface wired over, and shall have a porcelain lug under each terminal to prevent the rosette being placed over projections which would reduce the separation to less than ½ inch.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 410.61 Rosettes for use with boxes or raceways. When designed for use with conduit boxes or wire raceways, rosette bases shall be high enough to keep wires and terminals at least ⅜ inch from the surface wired over.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

M. SPECIAL PROVISIONS FOR FLUSH AND RECESSED FIXTURES

E 410.62 Approved type. Fixtures which are installed in recessed cavities in walls or ceilings shall be of an approved type and shall conform to sections E 410.63 to E 410.70 inclusive.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 410.63 Temperature. (1) Fixtures shall be so constructed or installed that adjacent combustible material will not be subjected to temperatures in excess of 90°C. (194°F.).

(2) Where a fixture is recessed in fire-resistant material in a building of fire-resistant construction, a temperature higher than 90° C. (194° F.), but not higher than 150° C. (320° F.) is acceptable if the fixture is plainly marked that it is approved for that service.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 410.64 Clearance. Recessed portions of enclosures, other than at points of support, shall be spaced at least ½ inch from combustible material.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 410.65 Wiring. (1) Conductors having insulation suitable for the temperature encountered shall be used.

(2) Fixtures having branch circuit terminal connections which operate at temperatures higher than 60°C. (140°F.) shall have circuit conductors as described in subsections E 410.65 (2) (a) and (2) (b):

(a) Branch circuit conductors having an insulation suitable for the temperature encountered may be run directly to the fixture.

(b) Tap connection conductors having an insulation suitable for the temperature encountered shall be run from the fixture terminal connection to an outlet box placed at least one foot from the fixture. Such a tap shall extend for at least 4 feet but not more than 6 feet and shall be in a suitable metal raceway.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

N. CONSTRUCTION; FLUSH AND RECESSED FIXTURES

E 410.66 Temperature. Fixtures shall be so constructed that adjacent combustible material will not be subject to temperatures in excess of 90°C. (194°F.).

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 410.67 Enclosure. Sheet metal enclosures shall be protected against corrosion by galvanizing, plating, or other equivalent heat-resisting coating, and shall not be less than No. 22 MS (USS revised) gauge in thickness.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 410.68 Lamp wattage marking. Incandescent lamp fixtures shall be marked to indicate the maximum allowable wattage of lamps. The markings shall be permanently installed, in letters at least ¼ inch high, and located where visible during relamping.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 410.69 Solder prohibited. No solder shall be used in the construction of the fixture box.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 410.70 Lampholders. Lampholders of the screw-shell type shall be of porcelain unless especially approved for the purpose. Cements, where used, shall be of the high-heat type.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

P. SPECIAL PROVISIONS FOR ELECTRIC DISCHARGE LIGHTING SYSTEMS OF 1,000 VOLTS OR LESS

E 410.71 General. (1) Equipment for use with electric discharge lighting systems and designed for an open-circuit voltage of 1,000 volts or less shall be of a type approved for such service.

(2) The terminals of an electric discharge lamp shall be considered as alive where any lamp terminal is connected to a potential of more than 300 volts.

(3) Transformers of the oil-filled type shall not be used.

(4) In addition to complying with the general requirements for lighting fixtures, such equipment shall conform to part P of this chapter.

(5) Fluorescent fixtures for indoor installations shall incorporate ballast protection.

(a) *Exception:* Fluorescent fixtures for indoor installations need not incorporate ballast protection when they employ simple reactance type ballasts.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 410.72 Direct-current equipment. Fixtures installed on direct-current circuits shall be equipped with auxiliary equipment and resistors especially designed and approved for direct current operation and the fixtures shall be so marked.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 410.73 Voltages; dwelling occupancies. (1) Equipment having an open-circuit voltage of more than 1,000 volts shall not be installed in dwelling occupancies.

(2) Equipment having an open-circuit voltage of more than 300 volts shall not be installed in dwelling occupancies unless such equipment is so designed that there shall be no exposed live parts when lamps are being inserted, are in place, or are being removed.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 410.74 Fixture mounting. (1) EXPOSED BALLASTS. Fixtures having exposed ballasts or transformers shall be so installed that such ballasts or transformers shall not be in contact with combustible material.

(2) COMBUSTIBLE LOW-DENSITY CELLULOSE FIBERBOARD. Where a fixture containing a ballast is to be installed on combustible low-density cellulose fiberboard it shall, where surface mounted:

(a) Be approved for this condition, or

(b) Be spaced not less than 1½ inches from the surface of the fiberboard.

(c) Where such fixtures are partially or wholly recessed, the provisions of sections E 410.62 to E 410.70 shall apply.

Note: Combustible low-density cellulose fiberboard is considered to include sheets, panels and tiles which have a density of 20 pounds per cubic foot or less, and which are formed of bonded plant fiber material; but does not include solid or laminated wood, nor fiberboard which has a density in excess of 20 pounds per cubic foot or is an approved material which has been integrally treated with fire retarding chemicals to the degree that the flame spread in any plane of the material will not exceed twenty-five as determined by the method of NFPA No. 225, ASTM Designation E-84 or U.L. No. 723.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 410.75 Auxiliary equipment not integral with fixture. (1) Auxiliary equipment, including reactors, capacitors, resistors, and similar equipment, where not installed as part of a lighting fixture assembly shall be enclosed in accessible, permanently-installed metal cabinets.

(2) Where display cases are not permanently installed, no portion of a secondary circuit may be included in more than a single case.

(3) Ballasts approved for separate mounting and for direct connection to an approved wiring system need not be separately enclosed.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 410.76 Auto-transformers. An auto-transformer which is used as part of a ballast for supplying lighting units and which raises the voltage to more than 300 volts shall be supplied only by a grounded system.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 410.77 Switches. Snap switches shall conform to section E 380.14.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

Q. SPECIAL PROVISIONS FOR ELECTRIC DISCHARGE LIGHTING SYSTEMS OF MORE THAN 1,000 VOLTS

E 410.78 General. (1) Equipment for use with electric discharge lighting systems and designed for an open-circuit voltage of more than 1,000 volts shall be of a type approved for such service.

(2) The terminal of an electric discharge lamp shall be considered as alive when any lamp terminal is connected to a potential of more than 300 volts.

(3) In addition to complying with the general requirements for lighting fixtures, such equipment shall conform to sections E 410.78 to E 410.90 inclusive.

Note: For signs and outline lighting, see chapter E 600.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 410.79 Control. (1) Fixtures or lamp installations shall be controlled either singly or in groups by an externally-operable switch or circuit-breaker which shall open all ungrounded primary conductors.

(2) The switch or circuit-breaker shall be located within sight of the fixtures or lamps, or it may be located elsewhere if it is provided with means for locking in the open position.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 410.80 Lamp terminals and lampholders. Parts which must be removed for lamp replacement shall be hinged or fastened by an approved means. Lamps or lampholders or both shall be so designed that there shall be no exposed live parts when lamps are being inserted or are being removed.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 410.81 Transformer ratings. Transformers and ballasts shall have a secondary open-circuit voltage of not more than 15,000 volts with an allowance on test of 1,000 volts additional. The secondary current rating shall be not more than 120 milliamperes when the open circuit voltage is more than 7,500 volts, and not more than 240 milliamperes when the open circuit voltage is 7,500 volts or less.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 410.82 Transformer type. Transformers shall be of an approved enclosed type. Transformers of other than the askarel insulated or dry type shall not be used.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 410.83 Transformer secondary connections. (1) The high-voltage windings of transformers shall not be connected in series or in parallel, except that for two transformers, each having one end of its high-voltage winding grounded and connected to the enclosure, the high-voltage windings may be connected in series to form the equivalent of a mid-point grounded transformer.

(2) The grounded ends shall be connected by an insulated conductor not smaller than No. 14 AWG.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 410.84 Transformer locations. (1) Transformers shall be accessible after installation.

(2) The transformers shall be installed as near to the lamps as practicable to keep the secondary conductors as short as possible.

(3) Transformers shall be so located that adjacent combustible materials will not be subjected to temperatures in excess of 90°C. (194°F.).

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 410.85 Transformer loading. The lamps connected to any transformer shall be of such length and characteristics as not to cause a condition of continuous over-voltage on the transformer.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 410.86 Wiring method: secondary conductors. Approved gas-tube sign cable suitable for the voltage of the circuit shall be used. For installation of conductors, see Wis. Adm. Code section E 600.31.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 410.87 Lamp supports. Lamps shall be adequately supported as required in section E 600.33.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 410.88 Exposure to damage. Lamps shall not be located where normally exposed to physical damage.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 410.89 Marking. Each fixture or each secondary circuit of tubing having an open-circuit voltage of more than 1,000 volts shall have a clearly legible marking in letters not less than ¼ inch high reading "Caution ________ volts". The voltage indicated shall be the rated open-circuit voltage.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 410.90 Switches. Snap switches shall conform to section E 380.14.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

R. GROUNDING

E 410.91 General. Fixtures and lighting equipment shall be grounded as provided in sections E 410.92 to E 410.96 inclusive.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 410.92 Metallic wiring systems. Metal fixtures installed on outlets wired with grounded metal raceway or grounded type AC metal-clad cable shall be grounded.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 410.93 Non-metallic wiring systems. Metal fixtures installed on outlets wired with knob-and-tube work, or non-metallic sheathed cable, on circuits operating at 150 volts or less to ground, shall be grounded.

(1) *Exception No. 1.* Fixtures mounted on metal or metal lath ceilings or walls may be insulated from their supports and from the metal lath by the use of insulating joints or fixture supports and canopy insulators. See section E 410.95.

(2) *Exception No. 2.* Fixtures not mounted on metal or metal-lath ceilings or walls need not be insulated or grounded. See section E 410.95.

Note: Fixtures made of insulating materials, and lampholders with shells of insulating material, are recommened for use with wiring systems that do not afford a ready means for grounding the exposed non-current-carrying parts of fixtures and lampholders.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 410.94 Equipment of more than 150 volts to ground. (1) Metal fixtures, transformers and transformer enclosures on circuits operating at more than 150 volts to ground shall be grounded.

(2) Other exposed metal parts shall be grounded unless they are insulated from ground and other conducting surfaces and are inaccessible to unqualified persons, except that lamp tie wires, mounting screws, clips and decorative bands on glass lamps spaced not less than 1½ inches from lamp terminals need not be grounded.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 410.95 Equipment near grounded surfaces. (1) Ungrounded metal lighting fixtures, lampholders and face plates shall not be installed in contact with conducting surfaces nor within 8 feet vertically or 5 feet horizontally of laundry tubs, bath tubs, shower baths, plumbing fixtures, steam pipes or other grounded metal work or grounded surfaces.

(2) Metal pull chains used at these locations shall be provided with insulating links.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 410.96 Methods of grounding. Equipment shall be considered as grounded where mechanically connected in a permanent and effective manner to metal raceway, the armor of type AC metal-clad cable, the grounding conductor in non-metallic sheathed cable, or to a separate grounding conductor not smaller than No. 14, provided that the raceway, armor, or grounding conductor is grounded in a manner specified in Wis. Adm. Code chapter E 250.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

Chapter E 422

APPLIANCES

A. GENERAL

E 422.01 Scope. This chapter shall apply to electric appliances used in any occupancy.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 422.02 Branch circuit requirements. Every appliance shall be supplied by a branch circuit of one of the types specified in Wis. Adm. Code chapter E 210. Motor-operated appliances shall also conform to the requirements of chapter E 430.

Note: See table E 220.05 for the conductors of a household range branch circuit.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

B. INSTALLATION OF APPLIANCES

E 422.03 Flexible cords. Flexible cords used to connect heating appliances shall comply with the following:

(1) Heater cords required. All smoothing irons and portable electrically-heated appliances rated at more than 50 watts and which produce temperatures in excess of 121°C. (250°F.) on surfaces with which the cord is liable to be in contact shall be provided with one of the types of approved heater cords listed in table E 400.11.

(2) Other heating appliances. All other portable electrically-heated appliances shall be connected with one of the approved types of cord listed in table E 400.11, selected in accordance with the usage specified in that table.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 422.04 Insulation of appliances. Portable appliances shall be provided with an adequate dielectric interposed between current-carrying parts and those external surfaces which persons can touch, except for toasters, grills or other heating appliances in which the current-carrying parts at high temperature are necessarily exposed. In locations where the dielectric is exposed to physical damage, it shall be suitably protected.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 422.05 Portable immersion heaters. Electric heaters of the portable immersion type shall be so constructed and installed that current-carrying parts are effectively insulated from electrical contact with the substance in which immersed. The administrative authority may make exception of special applications of apparatus where suitable precautionary measures are followed.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 422.06 Protection of combustible material. Each electrically-heated appliance that is obviously intended by size, weight and service to be located in a fixed position shall be so placed as to provide ample protection between the appliance and adjacent combustible material.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 422.07 Stands for portable appliances. Each smoothing iron and other portable electrically-heated appliance which is intended to be applied to combustible material shall be equipped with an approved stand, which may be a separate piece of equipment or may be a part of the appliance.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 422.08 Signals for heated appliances. In other than residence occupancies, each electrically-heated appliance, or group of electrically-heated appliances, intended to be applied to combustible material, shall be installed in connection with a signal unless the appliance is provided with an integral temperature-limiting device.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 422.09 Flatirons. Electrically-heated smoothing irons intended for use in residences shall be equipped with approved temperature-limiting means.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E **422.10 Water heaters.** Each water heater shall be equipped with temperature limiting means in addition to the control thermostats to disconnect all ungrounded conductors and such means shall be:

(1) installed to sense maximum water temperature.

(2) trip-free manually reset or it shall use a replacement element.

(3) in addition to any other devices protecting the tank against excessive temperature or pressure or both.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 422.11 Infra-red lamp industrial heating appliances. (1) Infra-red heating lamps rated at 300 watts or less may be used with lampholders of the medium-base unswitched porcelain type, or other types approved for the purpose.

(2) Screw-shell lampholders shall not be used with infra-red lamps over 300 watts rating unless the lampholders are especially approved for the purpose.

(3) Lampholders may be connected to any of the branch circuits of Wis. Adm. Code chapter E 210 and, in industrial occupancies, may be operated in series on circuits of more than 150 volts to ground provided the voltage rating of the lampholders is not less than the circuit voltage.

Note: Each section, panel or strip carrying a number of infra-red lampholders (including the internal wiring of such section, panel or strip) is considered an appliance. The terminal connection block of each such assembly is deemed an individual outlet.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 422.12 Grounding. Metal frames of portable and stationary electrically-heated appliances, operating on circuits above 150 volts to ground, shall be grounded in the manner specified in chapter E 250; provided, however, that where this is impracticable, grounding may be omitted by special permission, in which case the frames shall be permanently and effectively insulated from the ground.

Note: It is recommended that the frames be grounded in all cases. For methods of grounding frames of electric ranges and clothes dryers, see sections E 250.057 and E 250.060.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 422.13 Wall-mounted ovens and counter-mounted cooking units. (1) Wall-mounted ovens and counter-mounted cooking units complete with provisions for mounting and for making electrical connections shall be considered as fixed appliances.

(2) A separable connector or a plug and receptacle combination in the supply line to an oven or cooking unit used only for ease in servicing or for installation shall:

(a) Not be installed as the disconnecting means required by section E 422.20.

(b) Be approved for the temperature of the space in which it is located.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

C. CONTROL AND PROTECTION OF APPLIANCES

E 422.20 Disconnecting means. Each appliance shall be provided with a means for disconnection from all ungrounded conductors.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 422.21 Disconnection of fixed appliances. (1) For fixed appliances rated at not over 300 volt amperes or ⅛ hp the branch circuit overcurrent device may serve as the disconnection means.

(2) For fixed appliances of greater rating the branch circuit switch or circuit breaker may, where readily accessible to the user of the appliance, serve as the disconnecting means.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 422.22 Disconnection of portable appliances. (1) For portable appliances a separable connector or an attachment plug and receptacle may serve as the disconnecting means.

(2) The rating of a receptacle or of a separable connector shall not be less than the rating of any appliance connected thereto, except that demand factors authorized elsewhere in this code may be applied.

(3) Attachment plugs and connectors shall conform to the following:

(a) *Live parts.* They shall be so constructed and installed as to guard against inadvertent contact with live parts.

(b) *Interrupting capacity.* They shall be capable of interrupting their rated current without hazard to the operator.

(c) *Interchangeability.* They shall be so designed that they will not fit into receptacles of lesser rating.

Note: For household electric ranges, a plug and receptacle connection at the rear base of a range, if it is accessible from the front by removal of a drawer, is considered as meeting the intent of this rule.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 422.23 Disconnection of stationary appliances. (1) For stationary appliances rated at not over 300 volt amperes or ⅛ horsepower, the branch-circuit overcurrent device may serve as the disconnecting means.

(2) For stationary appliances of greater rating the branch-circuit switch or circuit-breaker may, where readily accessible to the user of the appliance, serve as the disconnecting means.

(3) For cord-connected appliances, such as household ranges and clothes dryers, a separable connector or an attachment plug and receptacle may serve as the disconnecting means.

Note: For household electric ranges, a plug and receptacle connection at the rear base of a range, if it is accessible from the front by removal of a drawer, is considered as meeting the intent of this rule.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 422.24 Unit switches as disconnecting means. Unit switches which are a part of an appliance shall not be considered as taking the place of the single disconnecting means required by part C of this chapter unless there are other means for disconnection as follows:

(1) MULTI-FAMILY DWELLINGS. In multi-family (more than 2) dwellings, the disconnecting means shall be within the apartment, or on the

same floor as the apartment in which the appliance is installed, and may control lamps and other appliances.

(2) TWO-FAMILY DWELLINGS. In 2-family dwellings, the disconnecting means may be outside of the apartment in which the appliance is installed. This will permit an individual switch for the apartment to be used.

(3) SINGLE-FAMILY DWELLINGS. In single-family dwellings, the service disconnecting means may be used.

(4) OTHER OCCUPANCIES. In other occupancies, the branch-circuit switch or circuit-breaker, where readily accessible to the user of the appliance, may be used for this purpose.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 422.25 Switch and circuit-breaker to be indicating. Switches and circuit-breakers used as disconnecting means shall be of the indicating type.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 422.26 Motor-driven appliances. A switch or circuit-breaker which serves as the disconnecting means for a stationary motor-driven appliance of more than ⅛ horsepower shall be located within sight of the motor controller or shall be capable of being locked in the open position.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 422.27 Overcurrent protection. (1) Appliances, other than such motor-operated appliances as are required by Wis. Adm. Code chapter E 430 to have additional overcurrent protection, shall be considered as protected against overcurrent when supplied by one of the circuits of chapter E 210 and in accordance with the requirements therein specified.

(2) A household type appliance with surface heating elements and which have a maximum demand of more than 60 amperes as calculated in accordance with table E 220.05 shall have its power supply subdivided into two or more circuits each of which is provided with overcurrent protection rated at not more than 50 amperes.

(3) Infra-red lamp heating appliances shall have overcurrent protection not exceeding 50 amperes.

(4) Open coil or exposed sheathed-coil types of surface heating elements in commercial type heating appliances shall be protected by overcurrent protection devices which are rated at not more than 50 amperes.

(5) A duct heater exceeding a 40 ampere rating shall have the heating elements subdivided and each such subdivision shall be protected by overcurrent protection devices which are rated at not more than 50 amperes.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

D. MARKING OF APPLIANCES

E 422.30 Nameplate. Each electric appliance shall be provided with a nameplate, giving the maker's name and the normal rating in volts and amperes, or in volts and watts.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 422.31 Marking of heating elements. Individual heating elements which are a part of an electric appliance containing more than one heating element shall each be legibly marked with normal rating in volts and amperes, or in volts and watts.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 422.32 Appliance consisting of motors and other loads. The marking on an appliance shall specify the rating of the motor in volts and amperes, and the additional load (heaters, lights, etc.) in volts and watts or amperes.

(1) EXCEPTION No. 1—Portable appliances.

(2) EXCEPTION No. 2—Fixed or stationary appliances employing a motor 1/20 hp. or less.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E. SPECIAL PROVISIONS FOR FIXED INDOOR ELECTRICAL SPACE HEATING

E 422.40 General. (1) Equipment for use with electrical space heating systems shall be of a type approved for such service.

(2) In addition to complying with the general requirements for appliances, such equipment shall comply with part E of this chapter.

(3) The special provisions of this chapter shall apply to electrically energized units, panels and cables for space heating. They shall also include central heating systems employing electrical heating units.

(4) Electrical space heating systems employing methods of installation other than covered by part E of this chapter may be used only by special permission.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 422.41 Use. Space heating systems shall not be used:

(1) Where exposed to severe physical damage unless adequately protected.

(2) In wet or damp locations unless specially approved for the purpose.

Note: See also rules on corrosive conditions, section E 310.07.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 422.42 Temperature limitations. The operating temperature of room surfaces where embedded elements and panels are used shall not exceed 66°C. (150°F.). (Based on room temperature of 30°C., 86°F.).

Note: It is recommended that a temperature limiting control device be incorporated in each baseboard electric heater unit in a residential occupancy.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 422.43 Appliances to be complete units. (1) Panels and cables shall be installed in their complete sizes or lengths as supplied by the manufacturer.

(2) Units which are shortened or from which the marking labels or nameplates are missing shall not be installed.

(3) Units shall be suitable for use with approved wiring systems.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 422.44 Heating cable construction. Heating cables shall be furnished complete with factory-assembled non-heating leads at least 7 feet in length, and the leads shall consist of conductors and wiring approved for general use or other wiring approved for the purpose.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 422.45 Marking of heating cables. (1) Each unit length of heating cable shall have a permanent marking located within 3 inches of the terminal end of the non-heating leads, and shall be legibly marked with the manufacturer's name or identification symbol, catalog number, and rating in volts and watts or amperes.

(2) The lead wires shall have the following color identifications: 230 volts nominal—red, 115 volts nominal—yellow.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 422.46 Controllers and disconnecting means. (1) Thermostats and thermostatically controlled switching devices which indicate an "off" position and which interrupt line current shall open all ungrounded conductors in the "off" position.

(2) Thermostats and thermostatically controlled switching devices which do not have "on" or "off" positions are not required to open all ungrounded conductors.

Note: See sections E 422.20, E 422.23 and E 422.24 for disconnecting means for stationary appliances.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

(3) Switching devices consisting of combined thermostats and manually controlled switches which serve both as controllers and disconnecting means shall:

(a) Open regardless of temperature all ungrounded conductors when manually placed in the "off" position;

(b) Be so designed that the circuit cannot be energized automatically after the device has been manually placed in the "off" position.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 422.47 Clearances of wiring in ceilings. (1) Wiring located above heated ceilings and within thermal insulation shall be spaced not less than 2 inches above the heated ceiling and shall be considered as operating at the ambient of 50°C. The ampacities of conductors shall be computed on the basis of the correction factors given in tables E 310.12 and E 310.14.

(2) Wiring located above heated ceilings and over thermal insulation having a minimum thickness of 2 inches requires no correction for temperature.

(3) Wiring located above heated ceilings and within a joist space having no thermal insulation shall be spaced not less than 2 inches above the ceiling and shall be considered as operating at an ambient of 50°C. The ampacities of conductors shall be computed on the basis of the correction factors given in tables E 310.12 and E 310.14.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 422.48 Clearances of wiring in walls. (1) Where located in exterior walls, wiring shall be located outside the thermal insulation.

(2) Where located in interior walls or partitions, wiring shall be located away from the heated surfaces, and the wiring shall be con-

sidered as operating at an ambient of 40°C. (104°F.); and the ampacities of conductors shall be computed on the basis of the correction factors given in tables E 310.12 and E 310.14.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 422.49 Area restrictions. (1) Heating panels shall not extend beyond the room in which they originate.

(2) Cables shall not be installed in closets, over cabinets which extend to the ceiling, under walls or partitions or over walls or partitions which extend to the ceiling.

(a) *Exception:* Single runs of cable may pass over partitions where they are embedded.

(3) This requirement shall not prohibit low-temperature heat sources in closets to control relative humidity.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 422.50 Clearance from other objects and openings. Panels and cables shall be separated at least 8 inches from lighting fixtures, outlet and junction boxes, and 2 inches from ventilating openings and other such openings in room surfaces, or sufficient area shall be provided to assure that no heating cables or panels will be covered by surface mounted lighting units.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 422.51 Splices. Embedded cables may be spliced only where necessary and only by approved means, and in no case shall the length of the heating cable be altered.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 422.52 Installation of heating cables in dry board and plaster. (1) Cables shall not be installed in walls.

(2) Adjacent runs of cable not exceeding 2¾ watts per foot shall be installed not less than 1½ inches on centers.

(3) Heating cables may be applied only to gypsum board, plaster lath and similar fire-resistant materials. With metal lath or other conducting surfaces, a coat of plaster (brown or scratch coat) shall be applied to completely cover the metal lath or conducting surface before the cable is attached.

(4) The entire ceiling surface shall have a finish of thermally non-insulating sand plaster or other approved non-insulating material having a nominal thickness of ½ inch.

(5) Cables shall be secured at intervals not exceeding 16 inches by means of approved stapling, tape, plaster or other approved means. Staples or metal fasteners which straddle the cable shall not be used with metal lath or other conducting surface.

(6) In dry board installations, after the heating cable is installed, the entire ceiling below it shall be covered with gypsum board not exceeding ½ inch thickness. The void between the upper layer of gypsum board and the surface layer of gypsum board shall be filled with thermally conducting plaster or other approved material.

(7) Cables shall be kept free from contact with metal or conducting surfaces.

(8) Caution should be used in attaching a surface layer of gypsum so that the nails or other fastenings do not pierce the heating cable.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 422.53 Installation of non-heating leads. (1) Non-heating leads of cables shall be installed in accordance with approved wiring methods from the junction box to a location on the underside of the ceiling.

(2) Excess leads shall not be cut but shall be secured to the underside of the ceiling and embedded in plaster or other approved material, leaving only a length sufficient to reach the junction box with not less than 6 inches of free lead within the box.

(3) The marking of the leads shall be visible in the junction box.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 422.54 Installation of cables in concrete or poured masonry floors. (1) Adjacent runs of cable not exceeding 2¾ watts per foot shall be installed not less than 1 inch on centers.

(2) Cables shall be secured in place by non-metallic frames or spreaders or other approved means while the concrete or other finish is applied.

(3) A spacing of at least 1 inch shall be maintained between the heating cable and other metallic bodies embedded in the floor.

(4) Leads shall be protected where they leave the floor by rigid metal conduit, electrical metallic tubing, or by other approved raceways extending to the junction box.

(5) Bushings shall be used where the leads emerge in the floor slab.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 422.55 Tests during and after installation. (1) Embedded cable installations shall be made with due care to prevent damage to the cable assembly and shall be inspected and approved before cables are covered or concealed.

(2) Cable shall be tested for insulation resistance after plastering or the pouring of floors. See Wis. Adm. Code section E 195.20, insulation resistance.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 422.56 Installation of resistance heaters in air ducts. A heater which is to be installed in an air duct or plenum shall be approved for the purpose and shall be installed in the manner approved for the equipment. Each such heater shall be provided with approved controls which disconnect the power supply to the heaters in the case of failure of a normal air flow across the heaters for any reason, such as blocked filters, motor failure, broken belts, shafts or other driving equipment, etc., and shall be provided with an approved temperature-limiting control.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

F. PROVISIONS FOR ROOM AIR-CONDITIONING UNITS

E 422.60 General. The provisions of sections E 422.61 to E 422.63 inclusive shall apply to electrically energized units and equipment which control temperature and humidity.

Note: See section E 422.56.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 422.61 Grounding. Exposed non-current-carrying metal parts which are liable to become energized shall be grounded under one or more of the following conditions:

(1) Where permanently connected to metal-enclosed wiring;

(2) When in a wet location and not isolated;

(3) When within reach of a person standing on the ground outside of a building;

(4) When in a hazardous location, see chapter E 500;

(5) Where in electrical contact with metal or metal lath;

(6) Where more than 150 volts to ground.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 422.62 Branch circuit requirements. (1) The total load of motor operated air-conditioning equipment shall not exceed 80% of the rating of a branch circuit which does not supply lighting units or other appliances.

(2) The total load of air-conditioning equipment shall not exceed 50% of the rating of a branch circuit where lighting units or other appliances are also supplied.

(3) For air-conditioning units employing 2 or more motors, see subsection E 430.053 (3).

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 422.63 Disconnecting means. A separable connector or an attachment plug and receptacle may serve as the disconnecting means.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

G. SPECIAL PROVISIONS FOR FIXED OUTDOOR ELECTRIC DEICING AND SNOW MELTING INSTALLATIONS

422.70 General. (1) Equipment for use with electric deicing and snow melting systems shall be of a type approved for such service.

(2) In addition to complying with the general requirements for appliances, such equipment shall comply with part G of this chapter.

(3) The special provisions of this chapter shall apply to electrically energized heating units, panels, and cables, embedded in poured masonry or asphalt driveways, walks, steps, and other areas.

(4) Electrical heating systems employing methods of construction or installation other than covered by part G of this chapter may be used only by special permission.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 422.71 Use. (1) Deicing and snow melting equipment may be installed only in the specific materials for which they are approved.

(2) Deicing and snow melting units shall not be used where exposed to severe physical damage, unless adequately protected.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 422.72 Appliances to be complete units. (1) Units, panels, and cables shall be installed in their complete sizes or lengths as supplied by the manufacturer.

(a) *Exception:* By special permission of the authority enforcing the code.

(2) Units which are shortened, or from which the marking nameplates are missing shall not be installed except that the nonheating lead may be shortened if the marking specified in section E 422.76 is retained.

(3) Units shall be suitable for use with approved wiring systems.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 422.73 Nonheating leads. Nonheating leads on the cables, panels, or units shall be furnished as part of the factory assembly. The leads shall consist of conductors and wiring approved for general use, or other wiring approved for the purpose.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 422.74 Installation of heating cables, units or panels. (1) The operating characteristics of embedded assemblies of heating equipment depend upon the specific materials involved and therefore embedded equipment should be installed as designed for use in such materials.

(2) Panels or heating units shall not exceed 120 watts per square foot of heated area.

(3) The spacing between adjacent cable runs is dependent upon the rating of the cable, but may in no case be less than 1 inch on centers.

(4) Units, panels and cables shall be installed either:

(a) On a substantial asphalt or masonry base at least 2 inches thick and have at least 1½ inches of asphalt or masonry applied over the units, panels or cables, or

(b) They may be installed over other approved bases and embedded within 3½ inches of masonry or asphalt but not less than one inch from the top surface.

(5) Cables shall be secured in place by frames or spreaders, or other approved means, while the masonry or asphalt finish is applied.

(6) Cables, units and panels shall not be installed where they bridge expansion joints unless adequately protected from expansion and contraction.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 422.75 Installation of non-heating leads. (1) Non-heating leads having a grounding sheath or braid may be embedded in masonry or asphalt similar to the heating cable without additional protection.

(2) Non-heating leads of type TW and other approved types not having a grounding sheath shall be enclosed in conduit, electrical metallic tubing or other raceways within the asphalt or masonry and the distance from the factory splice to the raceway shall be not less than 1 inch or more than 6 inches.

(3) Bushings shall be used in the asphalt or masonry where leads enter conduit, tubing or raceway.

(4) Leads shall be protected in expansion joints and where they emerge from masonry or asphalt by conduit, electrical metallic tubing or other raceways.

(5) Not less than 6 inches of non-heating lead shall be within the junction box.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 422.76 Marking. Each heating unit, panel and cable shall be legibly marked within 3 inches of the termination of the non-heating lead with the identification symbol, catalog number, and rating in volts and watts or amperes.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 422.77 Junction boxes. All splices other than factory splices shall be made in properly installed boxes approved for the location.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 422.78 Grounding. (1) Grounding means such as copper braid, lead or copper sheath, or other approved means shall be provided as part of the heating section of the approved cable, panel or unit.

(2) All non-current-carrying parts which are liable to become energized shall be bonded together and positively connected to a continuous (unbroken) No. 14 AWG or larger covered copper wire extending to the distribution panelboard. Where the bonding conductor is subject to physical damage it shall be at least No. 10 AWG copper.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 422.79 Tests. Embedded heating installation shall be inspected and approved before being covered.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

Chapter E 430

MOTORS, MOTOR CIRCUITS AND CONTROLLERS

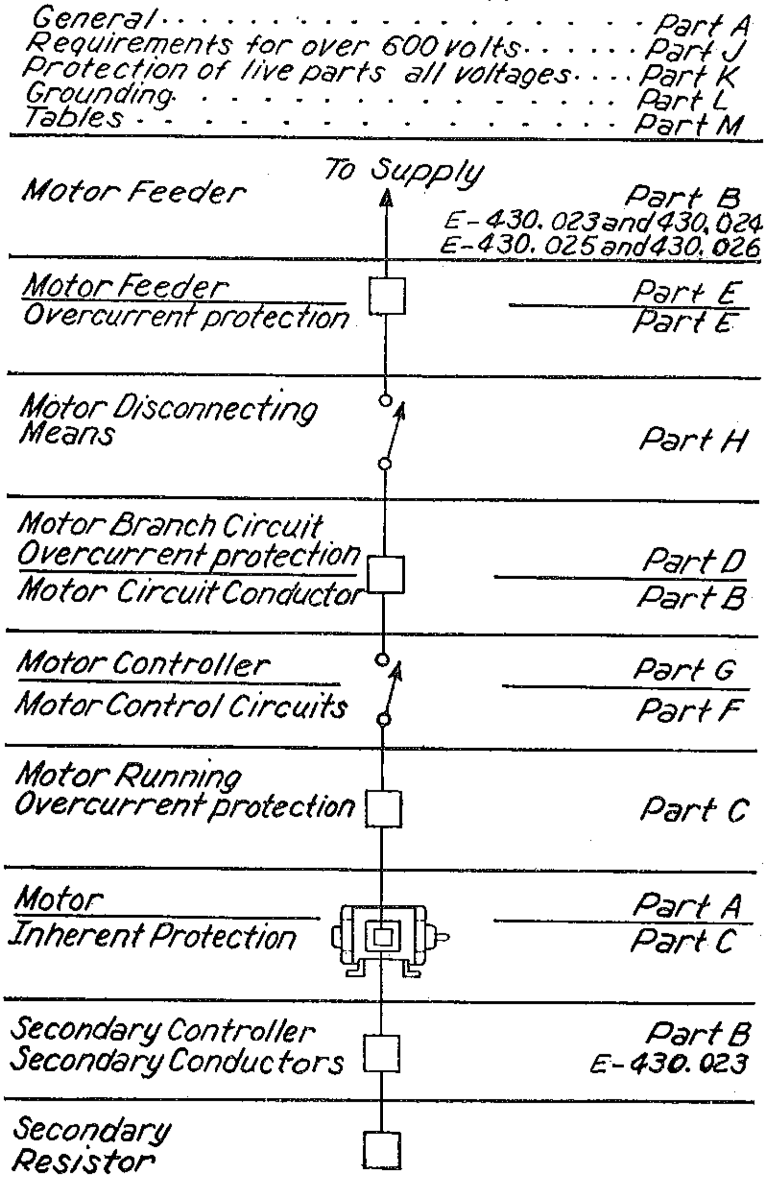
Note: See diagram next page for E 430.001

A. GENERAL

E 430.001 Motor feeder and branch circuits. (1) See diagram E 430.001 (1).

(2) GENERAL. The following general requirements cover provisions for motors, motor circuits and controllers which do not properly fall into other parts of this chapter.

DIAGRAM E 430.001 (1)



History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 430.002 Sealed (hermetic-type) refrigeration compressor. For the purposes of this chapter, a sealed (hermetic-type) refrigeration compressor is a mechanical compressor consisting of a compressor and a motor, both of which are enclosed in the same housing, with no external shaft nor shaft seals, the motor operating in the refrigerant atmosphere.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 430.003 Part winding motors. (1) A part-winding-start induction or synchronous motor is one arranged for starting by first energizing part of its primary (armature) winding and, subsequently, energizing the remainder of this winding in one or more steps. The purpose is to reduce the initial values of the starting current drawn on the starting torque developed by the motor. A standard part-winding-start induction motor is arranged so that one-half of its primary winding can be energized initially and, subsequently, the remaining half can be energized, both halves then carrying the same current. A sealed "hermetic-type" refrigeration compressor motor is not to be considered a standard part-winding-start induction motor.

(2) When separate overcurrent devices are used with a standard part-winding-start induction motor, each half of the motor winding shall be individually protected in accordance with sections E 430.032 and E 430.037 except that the trip current shall be one-half that specified.

(3) Each motor winding connection shall have short circuit and ground fault protection rated at not more than one-half that specified by section E 430.052 except that a single device having this half rating may be used for both windings if this will allow the motor to start.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 430.004 In sight from. Where in this chapter it is specified that some equipment shall be "in sight from" another equipment, it means that the equipment must be visible and not more than 50 feet distant.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 430.005 Other chapters. Motors and controllers shall also comply with the applicable provisions of the following:

Capacitors	Section E 460.09
Cranes and Hoists	Chapter E 610
Elevators, Dumbwaiters, Escalators, and Moving Walks	Chapter E 620
Garages, Aircraft Hangars, Gasoline Dispensing and Service Stations, Bulk Storage Plants, Finishing Processes and Flammable Anesthetics	Chapters E 511, E 513, E 514, E 515, E 516 and E 517
Hazardous Locations	Chapters E 500–E 503
Metal Working Machine Tools	Chapter E 670
Motion-picture Projectors	Sections E 540.12, E 540.17

History: Cr. Register, January, 1968, No. 145, eff. 2–1–68.

E 430.006 Ampacity determination. Ampacities shall be determined as follows:

(1) GENERAL MOTOR APPLICATIONS. Except as noted in subsection (2), whenever the current rating of a motor is used to determine the ampacity of conductors, switches, branch-circuit overcurrent devices, etc., the values given in tables E 430.147, E 430.148, E 430.149, and E 430.150, including notes, shall be used instead of actual current rating marked on the motor nameplate. Motor running overcurrent protection shall be based on the motor nameplate current rating. When a motor is marked in amperes, but not horsepower, the horsepower rating shall be assumed to be that corresponding to the value given in tables E 430.147, E 430.148, E 430.149, and E 430.150 interpolated if necessary

(a) *Exception:* For multispeed motors, see subsection E 430.022 (1) and section E 430.052.

(2) SEALED (HERMETIC-TYPE) REFRIGERATION COMPRESSOR MOTORS. For sealed (hermetic-type) refrigeration compressor motors the full-load current marked on the nameplate for the compressor shall be used to determine the ampacity of the branch-circuit conductors (see sections E 430.022 and E 430.024), branch-circuit overcurrent protection, and motor-running overcurrent protection. For motor controllers and disconnecting means, see section E 430.083, exception No. 3, and section E 430.110.

History: Cr. Register, January, 1968, No. 145, eff. 2–1–68.

E 430.007 Marking on motors. (1) USUAL MOTOR APPLICATIONS. A motor shall be provided with a nameplate showing the maker's name, the rating in volts and amperes, including those of a secondary if a wound-rotor type of motor, the normal full-load speed and the interval during which it can operate at full load starting cold, before reaching its rated temperature. The time interval shall be 5, 15, 30, or 60 minutes, or continuous. A motor rated at 1/8 horsepower or larger shall have the horsepower rating marked on the nameplate except that the motors of arc welders may be marked in amperes. A multispeed motor, except a shaded pole or permanent split-capacitor motor, shall have the amperes and horsepower at each speed marked on the nameplate. A motor provided with a protective device integral with the motor, that complies with section E 430.032 (1) (b) or E 430.032 (3) (b) shall be permanently marked "Thermally Protected." An alternating-current motor rated at 1/2 horsepower or larger, unless it is a polyphase wound-rotor motor, shall have the nameplate marked with a code letter to show its input in kilovolt-amperes with locked rotor, selected from table E 430.007 (2). Motors complying with section E 430.032 (3) (d) shall be marked "Impedance-Protected."

(2) LOCKED ROTOR INDICATING CODE LETTERS. Code letters marked on motor nameplates to show motor input with locked rotor shall be in accordance with table E 430.007 (2).

TABLE E 430.007 (2)

LOCKED ROTOR INDICATING CODE LETTERS

Code Letter	Kilovolt-Amperes per Horsepower with Locked Rotor
A	0- 3.14
B	3.15- 3.54
C	3.55- 3.99
D	4.0 - 4.49
E	4.5 - 4.99
F	5.0 - 5.59
G	5.6 - 6.29
H	6.3 - 7.09
J	7.1 - 7.99
K	8.0 - 8.99
L	9.0 - 9.99
M	10.0 -11.19
N	11.2 -12.49
P	12.5 -13.99
R	14.0 -15.99
S	16.0 -17.99
T	18.0 -19.99
U	20.0 -22.39
V	22.4 -and up

Note 1. The above table is an adopted standard of the National Electrical Manufacturers Association.

Note 2. The code letter indicating motor input with locked rotor must be in an individual block on the nameplate, properly designated. This code letter is to be used for determining branch-circuit overcurrent protection by reference to table E 430.152, as provided in section E 430.052.

(a) Multi-speed motors shall be marked with the code letter designating the locked-rotor KVA per horsepower for the highest speed, except constant horsepower motors which shall be marked with the code letter giving the highest locked-rotor KVA per horsepower.

(b) Single-speed motors starting on Y connection and running on delta connections shall be marked with a code letter corresponding to the locked-rotor KVA per horsepower for the Y connection.

(c) Dual-voltage motors which have a different locked-rotor KVA per horsepower on the two voltages shall be marked with the code letter for the voltage giving the highest locked-rotor KVA per horsepower.

(d) Motors with 60 and 50-cycle ratings shall be marked with a code letter designating the locked-rotor KVA per horsepower on 60 cycles.

(e) Part-winding-start motors shall be marked with a code letter designating the locked-rotor KVA per horsepower that is based upon the locked-rotor current for the full winding of the motor.

(3) SEALED (HERMETIC-TYPE) REFRIGERATION COMPRESSOR MOTORS. Sealed (hermetic-type) refrigeration compressors shall be provided with a nameplate which shall give the manufacturer's name; the phase, voltage, frequency, and the full load current in amperes of the motor (operating current when the compressor is delivering rated output). The locked-rotor current of single-phase motors having full load cur-

rents in amperes of more than 9 amperes at 115 volts and more than 4.5 amperes at 230 volts and all polyphase motors shall also be marked on the nameplate. When a protective device integral with a motor is used (see section E 430.032), the nameplate shall be marked with the words "Thermal Protection".

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 430.008 Marking on controllers. A controller shall be marked with the maker's name or identification, the voltage, the current or horsepower rating, and such other data as may be needed to properly indicate the motors for which it is suitable.

Note: Where a controller is built in as an integral part of a motor or of a motor-generator set, the controller need not be individually marked when the necessary data is on the motor nameplate.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 430.009 Marking at terminals. Terminals of motors and controllers shall be suitably marked or colored where necessary to indicate the proper connections.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 430.010 Wiring space in enclosures. Enclosures for controllers and disconnecting means for motors shall not be used as junction boxes, auxiliary gutters, or raceways for conductors feeding through or tapping off to other apparatus unless designs are employed which provide adequate space for this purpose.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 430.011 Protection against liquids. Suitable guards or enclosures shall be provided to protect exposed current-carrying parts of motors and the insulation of motor leads where installed directly under equipment, or in other locations where dripping or spraying oil, water, or other injurious liquid may occur, unless the motor is designed for the existing conditions.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 430.012 Motor terminal housings. Motor terminal housings shall be of ample size to properly make connections and shall be of substantial metal construction.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 430.013 Bushing. Where wires pass through an opening in an enclosure, conduit box or barrier, a bushing shall be used to protect the conductors from the edges of the openings having sharp edges. The bushing shall have smooth, well-rounded surfaces where it may be in contact with the conductors. If used where there may be a presence of oils, greases, or other contaminants, the bushing shall be made of material not deleteriously affected.

Note: For conductors, see Wis. Adm. Code section E 310.07.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 430.014 Location of motors. (1) VENTILATION AND MAINTENANCE. Motors shall be located so that adequate ventilation is provided and so that maintenance such as lubrication of bearings and replacing of brushes can be readily accomplished.

(2) OPEN MOTORS. Open motors having commutators or collector rings shall be located or protected so that sparks cannot reach adjacent combustible material. This does not prohibit the installation of these motors on wooden floors or supports.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 430.016 Overheating from dust accumulations. In locations where dust or flying material will collect on or in motors in such quantities as to seriously interfere with the ventilation or cooling of motors, and thereby cause dangerous temperatures, suitable types of enclosed motors which will not overheat under the prevailing conditions, shall be used. Especially severe conditions may require the use of enclosed pipe ventilated motors, or enclosure in separate dust-tight rooms, properly ventilated from a source of clean air.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

B. MOTOR CIRCUIT CONDUCTORS

E 430.021 General. The provisions of part B specify sizes of conductors capable of carrying the motor current without overheating under the conditions specified.

(1) The provisions of chapters E 250 and E 310 are not intended to apply to conductors which form an integral part of equipment, such as motors, motor controllers, and the like. See subsections E 300.01 (4) and E 310.01 (3).

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 430.022 Single motor. (1) Branch-circuit conductors supplying a single motor shall have an ampacity not less than 125% of the motor full-load current rating. In case of a multispeed motor, the selection of branch circuit conductors on the line side of the controller shall be based on the highest of the full load current ratings shown on the motor nameplate; selection of branch circuit conductors between the controller and the motor, which are energized for that particular speed, shall be based on the current rating for that speed.

(a) *Exception:* Conductors for a motor used for short-time, intermittent, periodic, or varying duty may have an ampacity not less than the percentage of the motor nameplate current rating as shown in table E 430.022 (1) Exception: Unless the administrative authority grants special permission for conductors of smaller size.

Note 1: Any motor application is considered to be for continuous duty unless the nature of the apparatus which it drives is such that the motor will not operate continuously with load under any condition of use.

Note 2: For long runs, it may be necessary in order to avoid excessive voltage drop, to use conductors of sizes larger than the minimum sizes selected from tables E 310.12 to E 310.15 inclusive.

Note 3: See diagram E 430.001, and example No. 8, chapter E 900.

(2) The conductors between a stationary motor rated one horsepower or less, and the separate terminal enclosures permitted in section E 430.145 (2) may be smaller than No. 14 but not smaller than No. 18, provided they have ampacity as specified above.

TABLE E 430.022 (1)
EXCEPTION

Classification of Service	Percentages of Nameplate Current Rating			
	5-Minute Rated Motor	15-Minute Rated Motor	30 & 60 Minute Rated Motor	Continuous Rated Motor
Short-Time Duty				
Operating valves, raising or lowering rolls, etc.	110	120	150	----------
Intermittent Duty				
Freight and passenger elevators, tool heads, pumps, drawbridges, turntables, single-operator arc welders for manual welding, etc.	85	85	90*	140
Periodic Duty				
Rolls, ore and coal-handling machines, etc.	85	90	95	140
Varying Duty	110	120	150	200

*This figure also applies for conductors which supply a motor-generator single-operator arc welder which has a 60% duty cycle rating.

History: Cr. Register, January, 1968, No. 145, eff. 2–1–68.

E 430.023 Wound-rotor secondary. (1) For continuous duty the conductors connecting the secondary of a wound-rotor alternating-current motor to its controller shall have an ampacity which is not less than 125% of the full-load secondary current of the motor.

(2) For other than continuous duty, these conductors shall have an ampacity, in per cent of full load secondary current, not less than that specified in table E 430.022.

(3) Where the secondary resistor is separate from the controller, the ampacity of the conductors between controller and resistor shall be not less than that given in table E 430.023 (Exception).

TABLE E 430.023
EXCEPTION

Resistor Duty Classification	Carrying Capacity of Wire in Per Cent of Full-Load Secondary Current
Light starting duty	35
Heavy starting duty	45
Extra heavy starting duty	55
Light intermittent duty	65
Medium intermittent duty	75
Heavy intermittent duty	85
Continuous duty	110

History: Cr. Register, January, 1968, No. 145, eff. 2–1–68.

E 430.024 Conductors supplying several motors. Conductors supplying two or more motors shall have an ampacity of not less than 125% of the full-load current rating of the highest rated motor in the group plus the sum of the full-load current ratings of the remainder of the motors in the group. Where one or more motors of a group are used on short time, intermittent, periodic, or varying duty, the conductors shall have an ampacity of not less than 125% of the name plate full load current of the highest rated continuous duty motor or the highest current obtained by multiplying the applicable percentage of table E 430.022 (1) Exception, by the name plate full load current of any non-continuous duty motor, whichever is the larger, plus the name plate full load current of any non-continuous duty motor, whichever is the larger, plus the name plate full load currents of the other motors, each multiplied by 100% or the applicable percentage of the table, whichever is smaller.

(1) EXCEPTION: When the circuitry is so interlocked as to prevent the starting and running of a second motor or group of motors, the conductor size shall be determined from the larger motor or group of motors that are to be operated at a given time.

Note: See Example No. 8, Wis. Adm. Code chapter E 900.
History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 430.025 Combination load. Conductors supplying a motor load, and in addition a lighting or appliance load as computed from chapter E 220 and other applicable sections, shall have an ampacity sufficient for the lighting or appliance load plus the required capacity for the motor load determined in accordance with section E 430.024 or, for a single motor, in accordance with section E 430.022.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 430.026 Feeder demand-factor. Where a reduced heating of the conductors results from motors operating on duty-cycle, intermittently, or from all motors not operating at one time the administrative authority may grant permission for feeder conductors to be of a capacity less than specified in sections E 430.024 and E 430.025, provided the conductor is of sufficient ampacity for the maximum load determined by the sizes and number of motors supplied and the character of their loads and duties.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 430.027 Capacitors with motors. For provisions covering conductors where capacitors are installed on motor circuits, see sections E 460.07, E 460.08 and E 460.09.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

C. MOTOR RUNNING OVERCURRENT (OVERLOAD) PROTECTION

E 430.031 General. The provisions of part C specify overcurrent devices intended to protect the motors, the motor-control apparatus, and the branch-circuit conductors against excessive heating due to motor overloads.

(1) Overload in electrical apparatus is an operating overcurrent which, when it persists for a sufficient length of time, would cause damage or dangerous overheating of the apparatus. It does not include short-circuits or ground faults.

(2) These provisions shall not be interpreted as requiring overcurrent protection where it might introduce additional or increased hazards as in the case of fire pumps.

Note: See NFPA standard for centrifugal fire pumps (No. 20).
History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 430.032 Continuous duty motors. (1) MORE THAN ONE HORSEPOWER. Each continuous duty motor rated more than one horsepower shall be protected against running overcurrent by one of the following means:

(a) A separate overcurrent device which is responsive to motor current. This device shall be rated or selected to trip at not more than 125% of the motor full-load current rating for sealed (hermetic-type) refrigeration compressor motors and motors marked to have a temperature rise not over 40°C., and at not more than 115% for all other types of motors. This value may be modified as permitted by section E 430.034. For a multispeed motor, each winding connection shall be considered separately.

(b) A thermal protector integral with the motor, approved for use with the motor which it protects on the basis that it will prevent dangerous overheating of the motor due to overload or failure to start. If the motor current interrupting device is separate from the motor and its control circuit is operated by a protective device integral with the motor, it shall be so arranged that the opening of the control circuit will result in interruption of current to the motor.

(c) For motors larger than 1500 horsepower, a protective device employing embedded temperature detectors which cause current to the motor to be interrupted when the motor attains a temperature rise greater than marked on the nameplate in an ambient of 40° C.

Note: Standards for the application of embedded temperature detectors are given in the American Standards for Rotating Electrical Machinery, ASA C50-1 and C50-2.

(2) ONE HORSEPOWER OR LESS, MANUALLY STARTED. Each continuous duty motor rated at one horsepower or less which is not permanently installed, is manually started and is within sight from the controller location, shall be considered as protected against overcurrent by the overcurrent device protecting the conductors of the branch circuit. This branch circuit overcurrent device shall not be larger than that specified in table E 430.146, except that any such motor may be used at 125 volts or less on a branch circuit protected at 20 amperes. Any such motor which is not in sight from the controller location shall be protected as specified in subsection (3). Any motor rated at one horsepower or less which is permanently installed, shall be protected in accordance with subsection (3).

(3) ONE HORSEPOWER OR LESS, AUTOMATICALLY STARTED. Any motor of one horsepower or less which is started automatically shall be protected against overcurrent by the use of one of the following means:

(a) A separate overcurrent device which is responsive to motor current. This device shall be rated or selected to trip at not more than 125% of the motor full-load current rating for sealed (hermetic-type) refrigeration compressor motors and motors marked to have a temperature rise not over 40°C., and at not more than 115% for all other types of motors. This value may be modified as permitted by section E 430.034. For a multispeed motor each winding connection shall be considered separately.

(b) A thermal protector integral with the motor, approved for use with the motor which it protects on the basis that it will prevent dangerous overheating of the motor due to overload or failure to start. Where the motor current interrupting device is separate from the motor and its control circuit is operated by a protective device integral with the motor, it shall be so arranged that the opening of the control circuit will result in interruption of current to the motor.

(c) The motor shall be considered as being properly protected where it is part of an approved assembly which does not normally subject the motor to overloads and which is also equipped with other safety controls (such as the safety combustion controls of a domestic oil burner) which protect the motor against damage due to stalled rotor current. Where such protective equipment is used it shall be indicated on the nameplate of the assembly where it will be visible after installation.

(d) 1. In case the impedance of the motor windings is sufficient to prevent overheating due to failure to start, the motor may be protected as specified in subsection (2) for manually started motors.

2. Many alternating-current motors of less than 1/20 horsepower, such as clock motors, series motors, etc., and also some larger motors such as torque motors, come within this classification. It does not include split-phase motors having automatic switches to disconnect the starting windings.

(4) WOUND-ROTOR SECONDARIES. The secondary circuits of wound-rotor alternating-current motors, including conductors, controllers, resistors, etc., shall be considered as protected against overcurrent by the motor-running over-current device.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 430.033 Intermittent and similar duty. A motor used for a condition of service which is inherently short time, intermitent, periodic, or varying duty, as illustrated by table E 430.022 (1). Exception: Shall be considered as protected against overcurrent by the branch-circuit overcurrent device, provided the overcurrent protection does not exceed that specified in table E 430.152 and E 430.153.

Note: Any motor application shall be considered to be for continuous duty unless the nature of the apparatus which it drives shall be such that the motor cannot operate continuously with load under any condition of use.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 430.034 Selection or setting of protective device. (1) Where the values specified for motor-running overcurrent protection do not correspond to the standard sizes or ratings of fuses, non-adjustable circuit-breakers, thermal cut-outs, thermal relays, the heating elements of thermal trip motor switches, or possible settings of adjustable circuit-breakers adequate to carry the load, the next higher size, rating, or setting may be used, but not higher than 140% of the full-load current rating of sealed (hermetic-type) refrigeration compressor motors and motors marked to have a temperature rise not over 40° C., and not higher than 130% of the full-load current rating for all other motors.

(2) In case it is not shunted during the starting period of the motor (see section E 430.035), the protective device shall have sufficient time delay to permit the motor to start and accelerate its load.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 430.035 Shunting during starting period. (1) In the case of a motor that is manually started (including starting with a magnetic starter having push-button control), the running overcurrent protection may be shunted or cut out of circuit during the starting period of the motor, provided the device by which the overcurrent protection is shunted or cut out cannot be left in the starting position, and fuses or time-delay circuit-breakers rated or set at not over 400% of the full-load current of the motor, are so located in the circuit as to be operative during the starting period of the motor.

(2) The motor-running overcurrent protection shall not be shunted or cut out during the starting period if the motor is automatically started.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 430.036 Fuses; in which conductor. Where fuses are used for motor-running protection, a fuse shall be inserted in each ungrounded conductor.

(1) EXCEPTION: A fuse shall also be inserted in a grounded conductor under the circumstances set forth in the note following table E 430.037.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 430.037 Devices other than fuses; in which conductor. Where devices other than fuses are used for motor-running overload protection, table E 430.037 shall govern the minimum allowable number and location of overcurrent units such as trip coils, relays, or thermal cutouts.

TABLE E 430.037

Kind of Motor	Supply System	Number and location of over-current units, such as trip coils, relays or thermal cutouts
1-phase A.C. or D.C.	2-wire, 1-phase A.C. or D.C. ungrounded	1 in either conductor
1-phase A.C. or D.C.	2-wire, 1-phase A.C. or D.C., one conductor grounded	1 in ungrounded conductor
1-phase A.C. or D.C.	3-wire, 1-phase A.C. or D.C., grounded-neutral	1 in either ungrounded conductor
2-phase A.C.	3-wire, 2-phase A.C., ungrounded	2, one in each phase
2-phase A.C.	3-wire, 2-phase A.C., one conductor grounded	2 in ungrounded conductors
2-phase A.C.	4-wire, 2-phase A.C. grounded or ungrounded	2, one per phase in ungrounded conductors
2-phase A.C.	5-wire, 2-phase A.C., grounded-neutral or ungrounded	2, one per phase in any ungrounded phase wire
3-phase A.C.	3-wire, 3-phase A.C., ungrounded	*2 in any 2 conductors
3-phase A.C.	3-wire, 3-phase A.C., one conductor grounded	*2 in ungrounded conductors
3-phase A.C.	3-wire, 3-phase A.C. grounded-neutral	*2 in any 2 conductors
3-phase A.C.	4-wire, 3-phase A.C. grounded-neutral or ungrounded	*2 in any 2 conductors except the neutral

Note 1: Three running overcurrent units shall be used where 3-phase motors are installed in isolated, inaccessible, or unattended locations unless the motor is protected by other approved means.

Note: Unattended (definition): Lacking the presence of a person capable of exercising responsible control of the motor under consideration.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 430.038 Number of conductors opened by overcurrent device. Motor-running protective devices, other than fuses, thermal cutouts, or thermal protectors, shall simultaneously open a sufficient number of ungrounded conductors to interrupt current flow to the motor.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 430.039 Motor controller as running overcurrent protection. A motor controller may also serve as the running overcurrent device where the number of overcurrent units complies with section E 430.037 and where these overcurrent units are operative in both the starting and running position in the case of a direct-current motor, and in the running position in the case of an alternating-current motor. When a non-automatic motor controller serves as the running over-current device, it is recommended that all ungrounded conductors be opened.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 430.040 Thermal cutouts and relays. Thermal cutouts, thermal relays, and other devices for motor-running protection which are not capable of opening short-circuits, shall be protected by fuses or circuit-breakers with ratings or settings of not over 4 times the rating of the motor for which they are designed, unless approved for group installation, and marked to indicate the maximum size of fuse by which they must be protected.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 430.042 Motors on general purpose branch circuits. Overcurrent protection for motors used on general purpose branch circuits as permitted in Wis. Adm. Code chapter E 210, shall be provided as follows:

(1) One or more motors without individual running overcurrent protection may be connected to general purpose branch-circuits only where the limiting conditions specified for each of 2 or more motors in section E 430.053 (1) are complied with.

(2) Motors of larger ratings than specified in subsection E 430.053(1) may be connected to general purpose branch-circuits only in case each motor is protected by running overcurrent protection selected to protect the motor as specified in section E 430.032. Both the controller and the motor-running overcurrent device shall be approved for group installation with the protective device of the branch circuit to which the motor is connected. See section E 430.053.

(3) Where a motor is connected to a branch circuit by means of a plug and receptacle, and individual running overcurrent protection is omitted as provided in subsection (1), the rating of the plug and receptacle shall not exceed 15 amperes at 125 volts or 10 amperes at 250 volts. Where individual overcurrent protection is required as provided in subsection (2) for a motor or motor-operated appliance provided with an attachment plug for attaching to the branch circuit through a receptacle, the running overcurrent device shall be an integral part of the motor or of the appliance. The rating of the plug and receptacle shall be assumed to determine the rating of the circuit to which the motor may be connected, as provided in chapter E 210.

(4) The overcurrent device protecting a branch circuit to which a motor or motor-operated appliance is connected shall have sufficient time delay to permit the motor to start and accelerate its load.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 430.043 Automatic restarting. A motor-running protective device which can restart a motor automatically after overcurrent tripping shall not be installed unless approved for use with the motor which it protects. A motor which can restart automatically after shutdown shall not be installed so that its automatic restarting can result in injury to persons.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

D. MOTOR-BRANCH-CIRCUIT SHORT CIRCUIT AND GROUND FAULT PROTECTION

E 430.051 General. The provisions of part D specify overcurrent devices intended to protect the motor-branch-circuit conductors, the motor control apparatus, and the motors against overcurrent due to short-circuits or grounds. They are in addition to or amendatory of the provisions of chapter E 240.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 430.052 Rating or setting for individual motor circuit. (1) The motor-branch-circuit overcurrent device shall be capable of carrying the starting current of the motor. Overcurrent protection shall be considered as being obtained when this overcurrent device has a rating or setting not exceeding the values given in table E 430.152 or E 430.153; provided that where the overcurrent protection specified in the table is not sufficient for the starting current of the motor, it may be increased, but shall in no case exceed 225% of the motor full load current for sealed (hermetic-type) refrigeration compressor motors of 400 KVA locked rotor or less, nor more than 400% for other motors.

(2) For a multispeed motor, a single short-circuit and ground fault protective device may be used for one or more windings of the motor provided the rating of the protective device does not exceed the above applicable percentage of the nameplate rating of the smallest winding protected.

(3) Where maximum protective device ratings shown on manufacturer's heater table for use with a motor controller are less than 15 amperes, the protective device rating shall not exceed the manufacturer's values marked on the equipment.

Note 1: Branch circuit protective device ratings calculated on this basis are given in columns 4, 5, 6, and 7, table E 430.146.

Note 2: See example No. 8, chapter E 900, and diagram in section E 430.001.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 430.053 Several motors on one branch circuit. Two or more motors may be connected to the same branch circuit under the following conditions:

(1) Two or more motors each not exceeding one horsepower in rating and each having a full-load rated capacity not exceeding 6 amperes, may be used on a branch circuit protected at not more than 20 amperes at 125 volts or less, or 15 amperes at 600 volts or less. Individual running overcurrent protection is unnecessary for such motors unless required by the provisions of section E 430.032.

(2) If the branch circuit protective device is selected not to exceed that allowed by section E 430.052 for the motor of the smallest rating, 2 or more motors each having individual running overcurrent protection may be connected to a branch circuit when it can be determined that branch circuit protective device will not open under the most severe normal conditions of service which might be encountered.

(3) Except as provided for in subsection (4), 2 or more motors of any rating, each having individual running overcurrent protection, may be connected to one branch circuit provided all of the following conditions are complied with:

(a) Each motor-running overcurrent device must be approved for group installation.

(b) Each motor controller must be approved for group installation.

(c) The branch circuit shall be protected by fuses having a rating not exceeding that specified in section E 430.052 for the largest motor connected to the branch circuit plus an amount equal to the sum of the full load current ratings of all other motors connected to the circuit.

(d) The branch circuit fuses must not be larger than allowed by section E 430.040 for the thermal cutout or relay protecting the smallest motor of the group.

(e) The conductors of any tap supplying a single motor need not have individual branch circuit protection, provided they comply with either of the following: 1. No conductor to the motor shall have an ampacity less than that of the branch circuit conductors, or 2. No conductor to the motor shall have an ampacity less than one-third that of the branch circuit conductors, with a minimum in accordance with section E 430.022; the conductors to the motor-running protective device being not more than 25 feet long and being protected from physical damage.

(4) The nameplate marking of a room air conditioner unit shall be used in determining the branch circuit requirements, and each unit shall be considered as a single-motor unit unless the nameplate is otherwise marked. For the purpose of this paragraph a room air conditioner is an alternating-current hermetic type air cooled window, console, or in-wall room air conditioner which is installed in the conditioned room. It covers equipment rated not greater than 250 volts, single phase. It also applies to such a room air conditioner, if it has provisions for heating.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 430.054 Combined overcurrent protection. Motor-branch-circuit overcurrent protection and motor-running overcurrent protection may be combined in a single overcurrent device when the rating or setting of the device provides the running overcurrent protection specified in section E 430.032.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 430.055 Overcurrent devices; in which conductor. Overcurrent devices shall comply with the provisions of section E 240.11.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 430.056 Size of fuseholder. Where fuses are used for motor-branch-circuit protection, the fuseholders shall not be of a smaller size than required to accommodate the fuses specified by table E 430.146.

(1) Exception. Where fuses having time delay appropriate for the starting characteristics of the motor are used, fuseholders of smaller size than specified in table E 430.146 may be used.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 430.057 Rating of circuit-breaker. A circuit-breaker for motor-branch circuit protection shall have a continuous current rating of not less than 115% of the full load current rating of the motor.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 430.058 Feeder taps in inaccessible location. If the location of the connection of a tap to the feeder conductors is not accessible, the motor-branch-circuit overcurrent device may be placed where it will be accessible, provided the conductors between the tap and the overcurrent device have the same ampacity as the feeder; or provided they have an ampacity of at least ⅓ that of the feeder and are not more than 25 feet long and are protected from physical damage. Where feeders are at a greater elevation than 25 feet, this distance may be increased to 50 feet.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 430.059 Selection or setting of protective device. In case the values for branch circuit protective devices determined by table E 430.152 or E 430.153 do not correspond to the standard sizes or ratings of fuses, non-adjustable circuit-breakers, or thermal devices, or possible settings of adjustable circuit-breakers adequate to carry the load, the next higher size, rating or setting may be used. (See sections E 240.06 and E 240.07 for standard ratings.)

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E. MOTOR-FEEDER SHORT-CIRCUIT AND GROUND FAULT PROTECTION

E 430.061 General. The provisions of part E specify overcurrent devices intended to protect feeder conductors supplying motors against overcurrents due to short-circuits or grounds.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 430.062 Rating or setting; motor load. (1) A feeder which supplies a specific fixed motor load and consisting of conductor sizes based on section E 430.024 shall be provided with overcurrent protection which shall not be greater than the largest rating or setting of the branch-circuit protective device, for any motor of the group (based on tables E 430.152 and E 430.153), plus the sum of the full-load currents of the other motors of the group.

Note 1. Where 2 or more motors of equal horsepower rating are the largest in the group, one of these motors should be considered as the largest for the above calculations.

Note 2. Where 2 or more motors of a group must be started simultaneously, it may be necessary to install larger feeder conductors and correspondingly larger ratings or settings of feeder overcurrent protection.

Note 3. See example 8, chapter E 900.

(2) For large capacity installations, where heavy capacity feeders are installed to provide for future additions or changes, the feeder overcurrent protection may be based on the rated current-carrying capacity of the feeder conductors.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 430.063 Rating or setting; power and light loads. Where a feeder supplies a motor load, and in addition a lighting or a lighting and appliance load, the feeder overcurrent protective device may have a rating or setting sufficient to carry the lighting or the lighting and appliance load as determined in accordance with chapters E 210 and

E 220 plus, for a single motor, the rating permitted by section E 430.052, and for 2 or more motors, the rating permitted by section E 430.062.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

F. MOTOR-CONTROL CIRCUITS

E 430.071 General. Part F contains modifications of the general requirements and applies to the particular conditions of motor control circuits.

Note: Control circuit (definition): The control circuit of a control apparatus or system is the circuit which carries the electric signals directing the performance of the controller, but does not carry the main power circuit.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 430.072 Overcurrent protection. Conductors of control circuits shall be protected against overcurrent in accordance with section E 240.05, Exception No. 5. Exception: Such conductors shall be considered as being properly protected by the branch-circuit overcurrent devices under any one of the following conditions:

(1) Where the rating or setting of the branch-circuit overcurrent device is not more than 500% of the ampacity of the control-circuit conductors.

(2) Where the controlled device and the point of control (start and stop buttons, pressure switch, thermostatic switch, etc.) are both located on the same machine and the control circuit does not extend beyond the machine.

(3) Where the opening of the control circuit would create a hazard; as for example, the control circuit of fire-pump motors, and the like.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 430.073 Mechanical protection of conductor. (1) Where damage to a control circuit would constitute a hazard, all conductors of such remote-control circuit shall be installed in a raceway or be otherwise suitably protected from physical damage outside the control device itself.

(2) Control circuits shall be so arranged that an accidental ground in the remote control devices will not start the motor.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 430.074 Disconnection. (1) Control circuits shall be so arranged that they will be disconnected from all sources of supply when the disconnecting means is in the open position. The disconnecting means may consist of 2 separate devices, one of which disconnects the motor and the controller from the source of power supply for the motor, and the other, the control circuit from its power supply. Where the 2 separate devices are used, they shall be located immediately adjacent one to the other.

(2) Where a transformer or other device is used to obtain a reduced voltage for the control circuit and is located in the controller, such transformer or other device shall be connected to the load side of the disconnecting means for the control circuit.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

G. MOTOR CONTROLLERS

E 430.081 General. The provisions of part G are intended to require suitable controllers for all motors.

(1) DEFINITION. For definition of "controller", see chapter E 100. For the purpose of this chapter, the term "controller" includes any switch or device normally used to start and stop the motor.

(2) STATIONARY MOTOR OF ⅛ HORSEPOWER OR LESS. For a stationary motor rated at ⅛ horsepower or less, that is normally left running and is so constructed that it cannot be damaged by overload or failure to start, such as clock motors and the like, the branch circuit overcurrent device may serve as the controller.

(3) PORTABLE MOTOR OF ⅓ HORSEPOWER OR LESS. For a portable motor rated at ⅓ horsepower or less, the controller may be an attachment plug and receptacle.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 430.082 Controller design. (1) CONTROLLER. Each controller shall be capable of starting and stopping the motor which it controls, and for an alternating-current motor shall be capable of interrupting the stalled-rotor current of the motor.

(2) AUTO-TRANSFORMER. An auto-transformer starter shall provide an off position, a running position, and at least one starting position. It shall be so designed that it cannot rest in the starting position, or in any position which will render inoperative the overcurrent protective device in the circuit.

(3) RHEOSTATS. Rheostats shall conform to the following: (a) *Internal connections.* Motor-starting rheostats shall be so designed that the contact arm cannot be left on intermediate segments. The point or plate on which the arm rests when in the starting position shall have no electrical connection with the resistor.

(b) *Under-voltage release, direct-current motors.* Motor-starting rheostats for direct-current motors operated from a constant voltage supply shall be equipped with automatic devices which will interrupt the supply before the speed of the motor has fallen to less than one-third its normal value.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 430.083 Rating. The controller shall have a horsepower rating, which shall not be lower than the horsepower rating of the motor, except as follows:

(1) EXCEPTION NO. 1. STATIONARY MOTOR OF 2 HORSEPOWER OR LESS. For a stationary motor rated at 2 horsepower or less, and 300 volts or less, the controller may be a general-use switch having an ampere rating at least twice the full-load current rating of the motor. On AC circuits, general use snap switches suitable only for use on AC (not general use AC–DC snap switches) may be used to control a motor rated at 2 horsepower or less and 300 volts or less having a full-load current rating not exceeding 80% of the ampere rating of the switch.

(2) EXCEPTION NO. 2. CIRCUIT-BREAKER AS CONTROLLER. A branch-circuit circuit-breaker, rated in amperes only, may be used as a con-

troller. Where this circuit-breaker is also used for overcurrent protection, it shall conform to the appropriate provisions of this chapter governing overcurrent protection.

(3) EXCEPTION NO. 3. SEALED (HERMETIC-TYPE) REFRIGERATION COMPRESSOR MOTORS. The motor controller shall have both a continuous duty full-load current rating, and a locked-rotor current rating, not less than the nameplate full-load current and locked-rotor current, respectively, of the compressor. In case the motor controller is rated in horsepower, but is without one or both of the foregoing current ratings, equivalent currents shall be determined from the rating as follows: Use table E 430.148, E 430.149, or E 430.150 to determine the equivalent full-load current rating. Use table E 430.151 to determine the equivalent locked-rotor current rating.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 430.084 Need not open all conductors. Except when it serves also as a disconnecting means (see section E 430.111), the controller need not open all conductors to the motor.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 430.085 In grounded conductors. One pole of the controller may be placed in a permanently grounded conductor provided the controller is so designed that the pole in the grounded conductor cannot be opened without simultaneously opening all conductors of the circuit.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 430.086 Motor not in sight from controller. Where a motor and the driven machinery are not in sight from the controller location, the installation shall comply with one of the following conditions:

(1) The controller disconnecting means is capable of being locked in the open position.

(2) A manually-operable switch which will disconnect the motor from its source of supply is placed within sight from the motor location.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 430.087 Number of motors served by each controller. Each motor shall be provided with an individual controller. Exception: For motors of 600 volts or less a single controller may serve a group of motors under any one of the following conditions:

(1) Where a number of motors drive several parts of a single machine or piece of apparatus such as metal and wood-working machines, cranes, hoists, and similar apparatus.

(2) Where a group of motors is under the protection of one overcurrent device as permitted in subsection E 430.053 (1).

(3) Where a group of motors is located in a single room within sight from the controller location.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 430.088 Adjustable-speed motors. Adjustable-speed motors that are controlled by means of field regulation shall be so equipped and connected that they cannot be started under weakened field, unless the motor is designed for such starting.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 430.089 Speed limitation. Machines of the following types shall be provided with speed limiting devices.

(1) Separately-excited direct-current motors.

(2) Series motors.

(3) 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.

(a) *Exception No. 1.* Unless the inherent characteristics of the machines, the system, or the load and the mechanical connection thereto, are such as to safely limit the speed.

(b) *Exception No. 2.* Unless the machine is always under the manual control of a qualified operator.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 430.090 Combination fuseholder and switch as controller. The rating of a combination fuseholder and switch used as a motor-controller shall be such that the fuseholder will accommodate the size of fuse specified in table E 430.146, for motor-running overcurrent protection.

(1) EXCEPTION. Where fuses having time delay appropriate for the starting characteristics of the motor are used, fuseholders of smaller size than specified in table E 430.146 may be used.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

H. DISCONNECTING MEANS

E 430.101 General. The provisions of part H are intended to require disconnecting means capable of disconnecting motors and controllers from the circuit.

Note: See diagram E 430.001.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 430.102 In sight from controller location. A disconnecting means shall be located in sight from the controller location, except as recognized in section E 422.26.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 430.103 To disconnect both motor and controller. The disconnecting means shall disconnect both the motor and the controller from all ungrounded supply conductors. The disconnecting means may be in the same enclosure with the controller. See section E 430.113.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 430.104 To be indicating. The disconnecting means shall plainly indicate whether it is in the open or closed position.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 430.105 Grounded conductors. One pole of the disconnecting means may disconnect a permanently grounded conductor, provided the disconnecting means is so designed that the pole in the grounded conductor cannot be opened without simultaneously disconnecting all conductors of the circuit.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 430.106 Service switch as disconnecting means. Where an installation consists of a single motor, the service switch may serve as the disconnecting means, provided it conforms to the requirements of this chapter, and is within sight from the controller location, except as recognized in section E 422.26.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 430.107 Readily accessible. One of the disconnecting means shall be readily accessible.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 430.108 Every switch. Every switch in the motor branch circuit within sight from the controller location shall comply with the requirements of part H.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 430.109 Type. The disconnecting means shall be a motor-circuit switch, rated in horsepower, or a circuit-breaker, except as permitted in section E 430.109 (1), (2), (3), (4), or (5).

(1) ONE-EIGHTH HORSEPOWER OR LESS. For stationary motors of ⅛ horsepower or less, the branch-circuit overcurrent device may serve as the disconnecting means.

(2) TWO HORSEPOWER OR LESS. For stationary motors rated at 2 horsepower or less and 300 volts or less, the disconnecting means may be a general-use switch having an ampere rating not less than twice the full-load current rating of the motor. On AC circuits, general use snap switches suitable only for use on AC (not general use AC–DC snap switches) may be used to disconnect a motor having a full-load current rating not exceeding 80% of the ampere rating of the switch.

(3) OVER 2 HORSEPOWER TO AND INCLUDING 50 HORSEPOWER. The separate disconnecting means required for a motor with an autotransformer type of controller may be a general-use switch where all of the following provisions are complied with:

(a) The motor drives a generator which is provided with overcurrent protection.

(b) The controller 1. is capable of interrupting the stalled-rotor current of the motor, 2. is provided with a no-voltage release, and 3. is provided with running-overcurrent protection not exceeding 125% of the motor full-load current rating.

(c) Separate fuses or a circuit-breaker, rated or set at not more than 150% of the motor full-load current, are provided in the motor branch circuit.

(4) EXCEEDING 50 HORSEPOWER. (a) For stationary motors rated at more than 50 horsepower, the disconnecting means may be a motor-circuit switch also rated in amperes, a general-use switch, or an isolating switch.

(b) Isolation switches for motors exceeding 50 horsepower, not capable of interrupting stalled-rotor currents, shall be plainly marked "Do not open under load."

(5) PORTABLE MOTORS. For portable motors an attachment plug and receptacle may serve as the disconnecting means.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 430.110 Ampacity and interrupting capacity. (1) The disconnecting means shall have an ampacity of at least 115% of the full-load current rating of the motor.

(2) The disconnecting means for sealed (hermetic-type) refrigeration compressors shall be selected on the basis of the nameplate full-load current and locked-rotor current respectively of the compressor motor as follows:

(a) The ampacity shall be at least 115% of the nameplate full-load current.

(b) To determine the equivalent horsepower in complying with the requirements of section E 430.109, select the horsepower rating from tables E 430.148, E 430.149, and E 430.150 corresponding to the full-load current, and also the horsepower rating from table E 430.151 corresponding to the locked-rotor current. In case the nameplate full-load current and locked-rotor current do not correspond to the currents shown in tables E 430.148, E 430.149, and E 430.150, respectively, the horsepower rating corresponding to the next higher value shall be selected. In case 2 different horsepower ratings are obtained when applying tables E 430.148, E 430.149, E 430.150 and E 430.151, a horsepower rating at least equal to the larger of the 2 values obtained shall be selected.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 430.111 Switch or circuit-breaker as both controller and disconnecting means. (1) A switch or circuit-breaker complying with the provisions of section E 430.083 may serve as both controller and disconnecting means provided it opens all ungrounded conductors to the motor, is protected by an overcurrent device (which may be the branch circuit fuses) which opens all ungrounded conductors to the switch or circuit-breaker, and is of one of the following types:

(a) An air-break switch, operable directly by applying the hand to a lever or handle.

(b) A circuit-breaker operable directly by applying the hand to a lever or handle.

(c) An oil switch used on a circuit whose rating does not exceed 600 volts or 100 amperes, or by special permission on a circuit exceeding this capacity where under expert supervision.

(2) The oil switch or circuit-breaker specified above may be both power and manually operable. If power operable, provision should be made to lock it in the open position.

(3) The overcurrent device protecting the controller may be part of the controller assembly or may be separate.

(4) An auto-transformer type of controller is not included above and will require a separate disconnecting means.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 430.112 Motors served by a single disconnecting means. (1) Each motor shall be provided with individual disconnecting means. Exception: For motors of 600 volts or less a single disconnecting means may serve a group of motors under any one of the following conditions:

(a) Where a number of motors drive several parts of a single machine or piece of apparatus such as metal and woodworking machines, cranes, and hoists.

(b) Where a group of motors is under the protection of one set of overcurrent devices as permitted by subsection E 430.053 (1).

(c) Where a group of motors is in a single room within sight from the location of the disconnecting means.

(2) The disconnecting means shall have a rating not less than is required by section E 430.109 for a single motor, the rating of which equals the sum of the horsepowers or currents of all the motors of the group.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 430.113 Energy from more than one source. Equipment receiving electrical energy from more than one source shall be provided with disconnecting means from each source of electrical energy adjacent to the equipment served.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

J. REQUIREMENTS FOR OVER 600 VOLTS

E 430.121 General. The provisions of part J recognize the additional hazard due to the use of high voltage. They are in addition to or amendatory of the other provisions of this chapter. Other requirements for circuits and equipment operating at more than 600 volts are in Wis. Adm. Code chapter E 710.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 430.122 More than 7500 volts. Motors operating at more than 7500 volts between conductors shall be installed in fire-resistant motor rooms.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 430.123 Motor running overcurrent (overload) protection. Running overcurrent protection for a motor of over 600 volts shall consist either of a circuit-breaker, or of overcurrent units integral with the controller which shall simultaneously open all ungrounded conductors to the motor. The overcurrent device shall have a setting as specified elsewhere in this chapter for motor-running overcurrent (overload) protection.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 430.124 Short-circuit and ground fault protection. Each motor branch circuit and feeder of more than 600 volts shall be protected against overcurrent by one of the following means:

(1) A circuit-breaker of suitable rating so arranged that it can be serviced without hazard.

(2) Fuses of the oil-filled or other suitable type. Fuses shall be used with suitable disconnecting means or they shall be of a type which can also serve as the disconnecting means. They shall be so arranged that they cannot be re-fused or replaced while they are energized.

(3) Differential protection may be employed to protect an alternating-current motor, the motor control apparatus, and the branch-circuit conductors against over-current due to short circuits or grounds. When all these elements are included within the protected zone of a differential protective system, the ratings or settings specified in section E 430.052 do not apply.

Note 1. A differential protective system is a combination of 2 or more sets of current transformers and a relay or relays energized from their interconnected secondaries. The primaries of the current transformers are connected on both sides of the equipment to be protected; both ends of the motor phase windings being brought out for this purpose. All of the apparatus and circuits included between the sets of current transformer primaries constitute the protected zone. The current transformer secondaries and the relay elements are so interconnected that the relay elements respond only to a predetermined difference between the currents entering and leaving the protected zone. When actuated, the relay or relays serve to trip the branch-circuit circuit-breaker, thus disconnecting the motor, control apparatus in the motor circuit and the branch-circuit conductors from the source of power and, in the case of a synchronous motor, de-energizing its field circuit.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 430.126 Disconnecting means. The circuit-breaker or the fuses specified in section E 430.124 may constitute the disconnecting means if they conform to the other applicable requirements of this chapter.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

K. PROTECTION OF LIVE PARTS—ALL VOLTAGES

E 430.131 General. The provisions of part K specify that live parts shall be protected in a manner judged adequate to the hazard involved.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 430.132 Where required. Exposed live parts of motors and controllers operating at 50 volts or more between terminals, shall be guarded against accidental contact by enclosure, or by location as follows:

(1) By installation in a room or enclosure which is accessible only to qualified persons;

(2) By installation on a suitable balcony, gallery or platform, so elevated and arranged as to exclude unqualified persons;

(3) By elevation 8 feet or more above the floor;

(4) So that it will be protected by a guard rail when the motor operates at 600 volts or less.

Exception. Stationary motors having commutators, collectors and brush rigging located inside of motor end brackets and not conductively connected to supply circuits operating at more than 150 volts to ground.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 430.133 Guards for attendants. Where the live parts of motors or controllers operating at more than 150 volts to ground are guarded against accidental contact only by location as specified in section E 430.132, and where adjustment or other attendance may be necessary during the operation of the apparatus, suitable insulating mats or platforms shall be provided so that the attendant cannot readily touch live parts unless standing on the mats or platforms. Where necessary, steps and handrails should be installed on or about large machines to afford safe access to parts which must be examined or adjusted during operation.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

L. GROUNDING

E 430.141 General. The provisions of part L specify the grounding of motor and controller frames to prevent a potential above ground in the event of accidental contact between live parts and frames. Insulation, isolation, or guarding are suitable alternatives to grounding of motors under certain conditions.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 430.142 Stationary motors. (1) The frames of stationary motors shall be grounded where any of the following conditions exist:

(a) Supplied by means of metal-enclosed wiring.

(b) Located in a wet place and not isolated nor guarded.

(c) In a hazardous location. (See Wis. Adm. Code chapters E 500 to E 517 inclusive.)

(d) The motor operates with any terminal at more than 150 volts to ground.

(2) Grounding of the motor frame is preferable, but where the frame of the motor is not grounded, it shall be permanently and effectively insulated from the ground.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 430.143 Portable motors. The frames of portable motors which operate at more than 150 volts to ground shall be guarded or grounded. See section E 250.045 (4) on grounding of portable appliances in other than residential occupancies.

Note 1. It is recommended that the frames of motors which operate at less than 150 volts to ground be grounded where this can be readily accomplished.

Note 2: See section E 250.059 (2) for color of grounding conductor.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 430.144 Controllers. Controller cases, except those attached to ungrounded portable equipment and except the lined covers of snap switches, shall be grounded regardless of voltage.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 430.145 Method of grounding. Grounding where required shall be done in the manner specified in Wis. Adm. Code chapter E 250.

(1) GROUNDING THROUGH TERMINAL HOUSINGS. Where the wiring to fixed motors is in type AC metal-clad cable or metal raceways, junction boxes to house motor terminals shall be provided, and the armor of the cable or the metal raceways shall be connected to them in the manner specified in chapter E 250.

(2) SEPARATION OF JUNCTION BOX FROM MOTOR. The junction box required by subsection (1) may be separated from the motor not more than 6 feet provided the leads to the motor are type AC metal-clad cable or armored cord or are stranded leads enclosed in flexible or rigid conduit or electrical metallic tubing not smaller than ⅜ inch electrical trade size, the armor or raceway being connected both to the motor and to the box. Where stranded leads are used, protected as specified above, they shall not be larger than No. 10, and shall comply with other requirements of the code for conductors to be used in raceways.

(3) GROUNDING OF CONTROLLER MOUNTED DEVICES. Instrument transformer secondaries, and exposed noncurrent-carrying metal or other conductive parts or cases of instrument transformers, motors, instruments, and relays shall be grounded as specified in Wis. Adm. Code sections E 250.121 through E 250.125.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

TABLE E 430.146
OVERCURRENT PROTECTION FOR MOTORS
(See tables E 430.152 and E 430.153)

These values are in accordance with sections E 430.006, E 430.022, E 430.032, E 430.034, E 430.062, E 430.059, except as follows: The current values in column 1 are to be taken from tables E 430.147 through E 430.150, including footnotes, but the values shown for running protection in columns 2 and 3 must be modified if nameplate full load current values are different, as provided in section E 430.006. The current values shown in columns 2 and 3 must be reduced by 8% for all motors other than open type motors marked to have a temperature rise of not over 40° C. as required by section E 430.032. For certain exceptions to the values in columns 4, 5, 6, and 7, see sections E 430.052 and E 430.059. See section E 430.053 for values to be used for several motors on one branch circuit. For running protection of motors, see section E 430.032. For setting of motor-branch-circuit protective devices, see tables in sections E 430.152 and E 430.153. For grouping of small motors under the protection of a single set of fuses, see section E 430.053.

Col. No. 1	2	3	4		5		6		7	
			Maximum Allowable Rating or Setting of Branch Circuit Protective Devices							
	For Running Protection of Motors		WITH CODE LETTERS Single phase, squirrel cage and synchronous. Full voltage, resistor or reactor starting, Code letters F to V inclusive.		WITH CODE LETTERS Single phase, squirrel cage and synchronous. Full voltage, resistor or reactor start, Code letters B to E inclusive. Auto-transformer start, Code letters F to V inclusive.		WITH CODE LETTERS Squirrel cage and synchronous auto-transformer start, Code letters B to E inclusive.		WITH CODE LETTERS All motors Code letter A.	
Full load current rating of motor amperes	Maximum rating of nonadjustable protective devices.	Maximum setting of adjustable protective devices.	WITHOUT CODE LETTERS Same as above.		WITHOUT CODE LETTERS (Not more than 30 Amperes) squirrel cage and synchronous, auto-transformer start, high reactance squirrel cage.*		WITHOUT CODE LETTERS (More than 30 amperes) squirrel cage and synchronous auto-transformer start, high reactance squirrel cage.*		WITHOUT CODE LETTERS DC and wound rotor motors.	
	Amperes	Amperes	Fuses	Circuit Breakers (Non-adjustable Over-load Trip)	Fuses	Circuit Breakers (Non-adjustable Over-load Trip)	Fuses	Circuit Breakers (Non-adjustable Over-load Trip)	Fuses	Circuit Breakers (Non-adjustable Over-load Trip)
1	2	1.25	15	15	15	15	15	15	15	15
2	3	2.50	15	15	15	15	15	15	15	15
3	4	3.75	15	15	15	15	15	15	15	15
4	6	5.0	15	15	15	15	15	15	15	15
5	8	6.25	15	15	15	15	15	15	15	15
6	8	7.50	20	15	15	15	15	15	15	15
7	10	8.75	25	20	20	15	15	15	15	15
8	10	10.0	25	20	20	20	20	20	15	15
*See note at end of table.										
9	12	11.25	30	30	25	20	20	20	15	15
10	15	12.50	30	30	25	20	20	20	15	15
11	15	13.75	35	30	30	30	25	30	20	20
12	15	15.00	40	30	30	30	25	30	20	20
13	20	16.25	40	40	35	30	30	30	20	20
14	20	17.50	45	40	35	30	30	30	25	30
15	20	18.75	45	40	40	30	30	30	25	30
16	20	20.00	50	40	40	40	35	40	25	30

Col. No. 1	2	3	4		5		6		7	
	For Running Protection of Motors		Maximum Allowable Rating or Setting of Branch Circuit Protective Devices							
Full load current rating of motor amperes	Maximum rating of nonadjustable protective devices.	Maximum setting of adjustable protective devices.	WITH CODE LETTERS Single phase, squirrel cage and synchronous. Full voltage, resistor or reactor starting, Code letters F to V inclusive. WITHOUT CODE LETTERS Same as above.		WITH CODE LETTERS Single phase, squirrel cage and synchronous. Full voltage, resistor or reactor start, Code letters B to E inclusive. Auto-transformer start, Code letters F to V inclusive. WITHOUT CODE LETTERS (Not more than 30 Amperes) squirrel cage and synchronous, auto-transformer start, high reactance squirrel cage.*		WITH CODE LETTERS Squirrel cage and synchronous auto-transformer start, Code letters B to E inclusive. WITHOUT CODE LETTERS (More than 30 amperes) squirrel cage and synchronous auto-transformer start, high reactance squirrel cage.*		WITH CODE LETTERS All motors Code letter A. WITHOUT CODE LETTERS DC and wound rotor motors.	
	Amperes	Amperes	Fuses	Circuit Breakers (Non-adjustable Over-load Trip)	Fuses	Circuit Breakers (Non-adjustable Over-load Trip)	Fuses	Circuit Breakers (Non-adjustable Over-load Trip)	Fuses	Circuit Breakers (Non-adjustable Over load Trip)
17	25	21.25	60	50	45	40	35	40	30	30
18	25	22.50	60	50	45	40	40	40	30	30
19	25	23.75	60	50	50	40	40	40	30	30
20	25	25.00	60	50	50	40	40	40	30	30
22	30	27.50	70	70	60	50	45	50	35	40
24	30	30.00	80	70	60	50	50	50	40	40
26	35	32.50	80	70	70	70	60	70	40	40
28	35	35.00	90	70	70	70	60	70	45	50
30	40	37.50	90	100	80	70	60	70	45	50
32	40	40.00	100	100	80	70	70	70	50	50
34	45	42.50	110	100	90	70	70	70	60	70
36	45	45.00	110	100	90	100	80	100	60	70
38	50	47.50	125	100	100	100	80	100	60	70
40	50	50.00	125	100	100	100	80	100	60	70
42	50	52.50	125	125	110	100	90	100	70	70
44	60	55.00	125	125	110	100	90	100	70	70
46	60	57.50	150	125	125	100	100	100	70	70
48	60	60.00	150	125	125	100	100	100	80	100
50	60	62.50	150	125	125	100	100	100	80	100
52	70	65.00	175	150	150	125	110	125	80	100
54	70	67.50	175	150	150	125	110	125	90	100
56	70	70.00	175	150	150	125	125	125	90	100
58	70	72.50	175	150	150	125	125	125	90	100
60	80	75.00	200	150	150	125	125	125	90	100
62	80	77.50	200	175	175	125	125	125	100	100
64	80	80.00	200	175	175	150	150	150	100	100
66	80	82.50	200	175	175	150	150	150	100	100
68	90	85.00	225	175	175	150	150	150	110	125
70	90	87.50	225	175	175	150	150	150	110	125
72	90	90.00	225	200	200	150	150	150	110	125
74	90	92.50	225	200	200	150	150	150	125	125
76	100	95.00	250	200	200	175	175	175	125	125
78	100	97.50	250	200	200	175	175	175	125	125
80	100	100.00	250	200	200	175	175	175	125	125
82	110	102.50	250	225	225	175	175	175	125	125
84	110	105.00	250	225	225	175	175	175	150	150

Col. No. 1	2	3	4		5		6		7	
			Maximum Allowable Rating or Setting of Branch Circuit Protective Devices							
	For Running Protection of Motors		WITH CODE LETTERS Single phase, squirrel cage and synchronous. Full voltage, resistor or reactor starting, Code letters F to V inclusive.		WITH CODE LETTERS Single phase, squirrel cage and synchronous. Full voltage, resistor or reactor start, Code letters B to E inclusive. Auto-transformer start, Code letters F to V inclusive.		WITH CODE LETTERS Squirrel cage and synchronous auto-transformer start, Code letters B to E inclusive.		WITH CODE LETTERS All motors Code letter A.	
Full load current rating of motor amperes	Maximum rating of nonadjustable protective devices.	Maximum setting of adjustable protective devices.	WITHOUT CODE LETTERS Same as above.		WITHOUT CODE LETTERS (Not more than 30 Amperes) squirrel cage and synchronous, auto-transformer start, high reactance squirrel cage.*		WITHOUT CODE LETTERS (More than 30 amperes) squirrel cage and synchronous auto-transformer start, high reactance squirrel cage.*		WITHOUT CODE LETTERS DC and wound rotor motors.	
	Amperes	Amperes	Fuses	Circuit Breakers (Non-adjustable Overload Trip)	Fuses	Circuit Breakers (Non-adjustable Overload Trip)	Fuses	Circuit Breakers (Non-adjustable Overload Trip)	Fuses	Circuit Breakers (Non-adjustable Overload Trip)
86	110	107.50	300	225	225	175	175	175	150	150
88	110	110.00	300	225	225	200	200	200	150	150
90	110	112.50	300	225	225	200	200	200	150	150
92	125	115.00	300	250	250	200	200	200	150	150
94	125	117.50	300	250	250	200	200	200	150	150
96	125	120.00	300	250	250	200	200	200	150	150
98	125	122.50	300	250	250	200	200	200	150	150
100	125	125.00	300	250	250	200	200	200	150	150
105	150	131.50	350	300	300	225	225	225	175	175
110	150	137.50	350	300	300	225	225	225	175	175
115	150	144.00	350	300	300	250	250	250	175	175
120	150	150.00	400	300	300	250	250	250	200	200
125	175	156.50	400	350	350	250	250	250	200	200
130	175	162.50	400	350	350	300	300	300	200	200
135	175	169.00	450	350	350	300	300	300	225	225
140	175	175.00	450	350	350	300	300	300	225	225
145	200	181.50	450	400	400	300	300	300	225	225
150	200	187.50	450	400	400	300	300	300	225	225
155	200	194.00	500	400	400	350	350	350	250	250
160	200	200.00	500	400	400	350	350	350	250	250
165	225	206.00	500	500	450	350	350	350	250	250
170	225	213.00	500	500	450	350	350	350	300	300
175	225	219.00	600	500	450	350	350	350	300	300
180	225	225.00	600	500	450	400	400	400	300	300
185	250	231.00	600	500	500	400	400	400	300	300
190	250	238.00	600	500	500	400	400	400	300	300
195	250	244.00	600	500	500	400	400	400	300	300
200	250	250.00	600	500	500	400	400	400	300	300
210	250	263.00	800	600	600	500	450	500	350	350
220	300	275.00	800	600	600	500	450	500	350	350
230	300	288.00	800	600	600	500	500	500	350	350
240	300	300.00	800	600	600	500	500	500	400	400

Col. No. 1	2	3	4		5		6		7	
			Maximum Allowable Rating or Setting of Branch Circuit Protective Devices							
Full load current rating of motor amperes	For Running Protection of Motors		WITH CODE LETTERS Single phase, squirrel cage and synchronous. Full voltage, resistor or reactor starting, Code letters F to V inclusive.		WITH CODE LETTERS Single phase, squirrel cage and synchronous. Full voltage, resistor or reactor start, Code letters B to E inclusive. Auto-transformer start, Code letters F to V inclusive.		WITH CODE LETTERS Squirrel cage and synchronous auto-transformer start, Code letters B to E inclusive.		WITH CODE LETTERS All motors Code letter A.	
	Maximum rating of nonadjustable protective devices.	Maximum setting of adjustable protective devices.	WITHOUT CODE LETTERS Same as above.		WITHOUT CODE LETTERS (Not more than 30 Amperes) squirrel cage and synchronous, auto-transformer start, high reactance squirrel cage.*		WITHOUT CODE LETTERS (More than 30 amperes) squirrel cage and synchronous auto-transformer start, high reactance squirrel cage.*		WITHOUT CODE LETTERS DC and wound rotor motors.	
	Amperes	Amperes	Fuses	Circuit Breakers (Non-adjustable Overload Trip)	Fuses	Circuit Breakers (Non-adjustable Overload Trip)	Fuses	Circuit Breakers (Non-adjustable Overload Trip)	Fuses	Circuit Breakers (Non-adjustable Overload Trip)
250	300	313.00	800	700	800	500	500	500	400	400
260	350	325.00	800	700	800	600	600	600	400	400
270	350	338.00	1000	700	800	600	600	600	450	500
280	350	350.00	1000	700	800	600	600	600	450	500
290	350	363.00	1000	800	800	600	600	600	450	500
300	400	375.00	1000	800	800	600	600	600	450	500
320	400	400.00	1000	800	800	700	800	700	500	500
340	450	425.00	1200	---	1000	700	800	700	600	600
360	450	450.00	1200	---	1000	800	800	800	600	600
380	500	475.00	1200	---	1000	800	800	800	600	600
400	500	500.00	1200	---	1000	800	800	800	600	600
420	600	525.00	1600	---	1200	---	1000	---	800	700
440	600	550.00	1600	---	1200	---	1000	---	800	700
460	600	575.00	1600	---	1200	---	1000	---	800	700
480	600	600.00	1600	---	1200	---	1000	---	800	800
500	---	625.00	1600	---	1600	---	1000	---	800	800

*High-reactance squirrel-cage motors are those designed to limit the starting current by means of deep slot secondaries or double-wound secondaries and are generally started on full voltage.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

TABLE E 430.147
FULL LOAD CURRENTS IN AMPERES
Direct Current Motors

The following values of full-load currents are for motors running at base speed.

HP	120 V	240 V
¼	2.9	1.5
⅓	3.6	1.8
½	5.2	2.6
¾	7.4	3.7
1	9.4	4.7
1½	13.2	6.6
2	17	8.5
3	25	12.2
5	40	20
7½	58	29
10	76	38
15		55
20		72
25		89
30		106
40		140
50		173
60		206
75		255
100		341
125		425
150		506
200		675

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

TABLE E 430.148
FULL LOAD CURRENTS IN AMPERES
Single Phase Alternating Current Motors

The following values of full-load currents are for motors running at usual speeds and motors with normal torque characteristics. Motors built for especially low speeds or high torques may have higher full-load currents, and multispeed motors will have full load current varying with speed, in which the nameplate current ratings shall be used.

To obtain full-load currents of 208 and 200-volt motors, increase corresponding 230-volt motor full-load currents by 10 and 15%, respectively.

The voltages listed are rated motor voltages. Corresponding nominal system voltages are 110 to 120, 220 to 240, 440 to 480.

HP	115 V	230 V	440 V
1/6	4.4	2.2	
¼	5.8	2.9	
⅓	7.2	3.6	
½	9.8	4.9	
¾	13.8	6.9	
1	16	8	
1½	20	10	
2	24	12	
3	34	17	
5	56	28	
7½	80	40	21
10	100	50	26

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

TABLE E 430.149

FULL-LOAD CURRENT

Two-Phase A. C. Motors (4-wire)

The following values of full-load current are for motors running at speeds usual for belted motors and motors with normal torque characteristics. Motors built for especially low speeds or high torques may require more running current, and multispeed motors will have full load current varying with speed, in which case the nameplate current rating shall be used. Current in common conductor of 2-phase, 3-wire system will be 1.41 times value given.

The voltages listed are rated motor voltages. Corresponding nominal system voltages are 110 to 120, 220 to 240, 440 to 480 and 550 to 600 volts.

	Induction Type Squirrel-Cage and Wound Rotor Amperes					Synchronous Type *Unity Power Factor Amperes			
HP	110V	220V	440V	550V	2300V	220V	440V	550V	2300V
½	4	2	1	.8					
¾	4.8	2.4	1.2	1.0					
1	6.4	3.2	1.6	1.3					
1½	8.8	4.4	2.2	1.8					
2	11.2	5.6	2.8	2.2					
3		8	4	3.2					
5		13	7	6					
7½		19	9	8					
10		24	12	10					
15		34	17	14					
20		45	23	18					
25		55	28	22	6	47	24	19	4.7
30		67	34	27	7.5	56	29	23	5.7
40		88	44	35	9	75	37	31	7
50		108	54	43	11	94	47	38	9
60		129	65	52	13	111	56	44	11
75		158	79	63	16	140	70	57	13
100		212	106	85	21	182	93	74	17
125		268	134	108	26	228	114	93	22
150		311	155	124	31		137	110	26
200		415	208	166	41		182	145	35

*For 90 and 80% P.F. the above figures should be multiplied by 1.1 and 1.25 respectively

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

TABLE E 430.150

FULL-LOAD CURRENT*

Three-Phase A. C. Motors

	Induction Type Squirrel-Cage and Wound Rotor Amperes					Synchronous Type **Unity Power Factor Amperes			
HP	110V	220V	440V	550V	2300V	220V	440V	550V	2300V
½	4	2	1	.8					
¾	5.6	2.8	1.4	1.1					
1	7	3.5	1.8	1.4					
1½	10	5	2.5	2.0					
2	13	6.5	3.3	2.6					
3		9	4.5	4					
5		15	7.5	6					
7½		22	11	9					
10		27	14	11					
15		40	20	16					
20		52	26	21					
25		64	32	26	7	54	27	22	5.4
30		78	39	31	8.5	65	33	26	6.5
40		104	52	41	10.5	86	43	35	8
50		125	63	50	13	108	54	44	10
60		150	75	60	16	128	64	51	12
75		185	93	74	19	161	81	65	15
100		246	123	98	25	211	106	85	20
125		310	155	124	31	264	132	106	25
150		360	180	144	37		158	127	30
200		480	240	192	48		210	168	40

For full-load currents of 208 and 200 volt motors, increase the corresponding 220-volt motor full-load current by 6 and 10%, respectively.

*These values of full-load current are for motors running at speeds usual for belted motors and motors with normal torque characteristics. Motors built for especially low speeds or high torques may require more running current, and multispeed motors will have full load current varying with speed, in which case the nameplate current rating shall be used.

**For 90 and 80% P.F. the above figures should be multiplied by 1.1 and 1.25 respectively.

The voltages listed are rated motor voltages. Corresponding nominal system voltages are 110 to 120, 220 to 240, 440 to 480 and 550 to 600 volts.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

TABLE E 430.151

LOCKED-ROTOR CURRENT CONVERSION TABLE

As Determined from Horsepower and Voltage Rating
For Use Only with section E 430.083, exception No. 3, and section E 430.110 (2)
Conversion Table

Max. HP Rating	Maximum Motor Locked-Rotor Amperes					
	Single Phase		Two or Three Phase			
	115 V	230 V	110 V	220 V	440 V	550 V
½	58.8	29.4	24	12	6	4.8
¾	82.8	41.4	33.6	16.8	8.4	6.6
1	96	48	42	21	10.8	8.4
1½	120	60	60	30	15	12
2	144	72	78	39	19.8	15.6
3	204	102	----------	54	27	24
5	336	168	----------	90	45	36
7½	480	240	----------	132	66	54
10	600	300	----------	162	84	66
15	----------	----------	----------	240	120	96
20	----------	----------	----------	312	156	126
25	----------	----------	----------	384	192	156
30	----------	----------	----------	468	234	186
40	----------	----------	----------	624	312	246
50	----------	----------	----------	750	378	300
60	----------	----------	----------	900	450	360
75	----------	----------	----------	1110	558	444
100	----------	----------	----------	1476	738	588
125	----------	----------	----------	1860	930	744
150	----------	----------	----------	2160	1080	864
200	----------	----------	----------	2880	1440	1152

History: Cr. Register, January, 1968, No. 145, eff. 2–1–68.

TABLE E 430.152

MAXIMUM RATING OR SETTING OF MOTOR-BRANCH-CIRCUIT PROTECTIVE DEVICES FOR MOTORS MARKED WITH A CODE LETTER INDICATING LOCKED ROTOR KVA

Type of Motor	Per Cent of Full-Load Current		
	Fuse Rating See also Table E 430.146, Columns 4, 5, 6, 7	Circuit Breaker Setting	
		Instantaneous Type	Time Limit Type
All AC single-phase and polyphase squirrel cage and synchronous motors with full-voltage, resistor or reactor starting:			
Code Letter A	150	----------	150
Code Letter B to E	250	----------	200
Code Letter F to V	300	----------	250
All AC squirrel cage and synchronous motors with auto-transformer starting:			
Code Letter A	150	----------	150
Code Letter B to E	200	----------	200
Code Letter F to V	250	----------	200

Note 1. For certain exceptions to the values specified see sections E 430.052 and E 430.054. The values given in the last column also cover the ratings of non-adjustable, time-limit types of circuit-breakers which may also be modified as in section E 430.052.

Note 2. Synchronous motors of the low-torque, low-speed type (usually 450 RPM or lower), such as are used to drive reciprocating compressors, pumps, etc., which start up unloaded, do not require a fuse rating or circuit-breaker setting in excess of 200% of full-load current.

Note 3. For motors not marked with a code letter, see table E 430.153.

History: Cr. Register, January, 1968, No. 145, eff. 2–1–68.

TABLE E 430.153

MAXIMUM RATING OR SETTING OF MOTOR-BRANCH-CIRCUIT PROTECTIVE DEVICES FOR MOTORS NOT MARKED WITH A CODE LETTER INDICATING LOCKED ROTOR KVA

Type of Motor	Per Cent of Full-Load Current		
	Fuse Rating See also Table E 430.146, Columns 4, 5, 6, 7	Circuit-Breaker Setting	
		Instantaneous Type	Time Limit Type
Single-phase, all types	300	----------	250
Squirrel-cage and synchronous (full-voltage, resistor and reactor starting)	300	----------	250
Squirrel-cage and synchronous (auto-transformer starting)			
Not more than 30 amperes	250	----------	200
More than 30 amperes	200	----------	200
High-reactance squirrel-cage			
Not more than 30 amperes	250	----------	250
More than 30 amperes	200	----------	200
Wound-rotor	150	----------	150
Direct-current			
Not more than 50 H.P.	150	250	150
More than 50 H.P.	150	175	150
Sealed (Hermetic Type) Refrigeration Compressor* 400 KVA locked-rotor or less	**175	----------	**175

*The locked rotor KVA is the product of the motor voltage and the motor-locked rotor current (LRA) given on the motor nameplate divided by 1,000 for single-phase motors or divided by 580 for 3-phase motors.

**This value may be increased to 225% if necessary to permit starting.

Note 1. For certain exceptions to the values specified see sections E 430.052 and E 430.059. The values given in the last column also cover the ratings of non-adjustable, time-limit types of circuit-breakers which may also be modified as in section E 430.052.

Note 2. Synchronous motors of the low-torque, low-speed type (usually 450 RPM or lower), such as are used to drive reciprocating compressors, pumps, etc., which start up unloaded, do not require a fuse rating or circuit-breaker setting in excess of 200% of full-load current.

Note 3. For motors marked with a code letter, see table E 430.152.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

Chapter E 445

GENERATORS

E 445.01 Location. Generators shall be located in dry places, and also so as to meet the requirements for motors in Wis. Adm. Code section E 430.014. Generators installed in hazardous locations as described in chapters E 500–E 503, or in other locations as described in chapters E 510–E 517, E 520, E 530, and E 665, shall also comply with the provisions of those chapters.

Note: It is recommended that waterproof covers be provided for use in emergency.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 445.02 Marking. Each generator shall be provided with a nameplate giving the maker's name, the rating in kilowatts or kilovolt-amperes, the normal volts and amperes corresponding to the rating, and the revolutions per minute.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 445.03 Drip pans. Generators shall be provided with suitable drip pans if required by the administrative authority.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 445.04 Overcurrent protection. (1) CONSTANT-POTENTIAL GENERATORS. Constant-potential generators, except alternating-current generators and their exciters, shall be protected from excessive current by circuit-breakers or fuses.

(2) TWO-WIRE GENERATORS. Two-wire, direct-current generators may have overcurrent protection in one conductor only if the overcurrent device is actuated by the entire current generated, except that in the shunt field. The overcurrent device shall not open the shunt field.

(3) 65 VOLTS OR LESS. Generators operating at 65 volts or less and driven by individual motors shall be considered as protected by the overcurrent device protecting the motor if these devices will operate when the generators are delivering not more than 150% of their full-load rated current.

(4) BALANCER SETS. Two-wire, direct-current generators used in conjunction with balancer sets to obtain neutrals for 3-wire systems shall be equipped with overcurrent devices which will disconnect the 3-wire system in the case of excessive unbalancing of voltages or currents.

(5) 3-WIRE, DIRECT-CURRENT GENERATORS. Three-wire, direct-current generators, whether compound or shunt wound, shall be equipped with

overcurrent devices, one in each armature lead, and so connected as to be actuated by the entire current from the armature. Such overcurrent devices shall consist either of a double-pole, double-coil circuit-breaker, or of a 4-pole circuit-breaker connected in the main and equalizer leads and tripped by 2 overcurrent devices, one in each armature lead. Such protective devices shall be so interlocked that no one pole can be opened without simultaneously disconnecting both leads of the armature from the system.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 445.05 Size of conductors. The conductors from the generator terminals to supplied equipment shall have an ampacity not less than 115% of the nameplate current rating of the generator. Neutral conductors shall be the same size as the conductors of the outside legs.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 445.06 Protection of live parts. Live parts of generators of more than 150 volts to ground shall not be exposed to accidental contact where accessible to unqualified persons.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 445.07 Guards for attendants. Where necessary for the safety of attendants the provisions of section E 430.133 shall be complied with.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 445.08 Grounding. If a generator operates at a terminal voltage in excess of 150 volts to ground, the frame shall be grounded in the manner specified in chapter E 250. If the frame is not grounded, it shall be permanently and effectively insulated from the ground.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 445.09 Bushings. Where wires pass through an opening in an enclosure, conduit box, or barrier, a bushing shall be used to protect the conductors from the edges of the opening having sharp edges. The bushing shall have smooth, well rounded surfaces where it may be in contact with the conductors. If used where there may be a presence of oils, grease, or other contaminants, the bushing shall be made of a material not deleteriously affected.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

Chapter E 450

TRANSFORMERS AND TRANSFORMER VAULTS
(Including Secondary Ties)

E 450.01 Application. (1) This chapter applies to the installation of all transformers except: (a) current transformers; (b) dry-type transformers which constitute a component part of other apparatus and which conform to the requirements for such apparatus; (c) transformers for use with X-ray and high-frequency; (d) transformers used with class 1 low-voltage power circuits or class 2 remote control low-energy power and signal circuits which shall conform to Wis. Admin. Code chapter E 725; (e) transformers for sign and outline lighting which shall conform to chapter E 600; and (f) transformers for electric discharge lighting which shall conform to chapter E 410.

(2) This chapter applies to the installation of transformers in hazardous locations except as modified by chapter E 500.

Note: Supplementary rules are found also in chapter E 710, Circuits and Equipment Operating at More than 600 Volts Between Conductors; and Service Installations Over 600 Volts as referred to in chapter E 230.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

A. GENERAL PROVISIONS

E 450.02 Location. The location of oil insulated transformers and transformer vaults is covered in sections E 450.24, E 450.25 and E 450.41; dry type transformers in E 450.21 and askarel insulated in E 450.23.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 450.03 Overcurrent protection. (1) Overcurrent protection shall conform to the following. As used in this section, the word "transformer" means a transformer or polyphase bank of 2 or 3 single phase transformers operating as a unit.

(a) *Primary side.* Each transformer shall be protected by an individual overcurrent device in the primary connection, rated or set at not more than 250% of the rated primary current of the transformer, except that an individual overcurrent device is not required when the primary circuit overcurrent device provides the protection specified in this paragraph, and except as provided in section E 450.03 (1) (b).

(b) *Primary and secondary side.* A transformer having an overcurrent device in the secondary connection, rated or set at not more than 250% of the rated secondary current of the transformer, or a transformer equipped with a coordinated thermal overload protection by the manufacturer, is not required to have an individual overcurrent device in the primary connection provided the primary feeder overcurrent device is rated or set to open at a current value not more than 6 times the rated current of the transformer for transformers having not more than 6% impedance, and not more than 4 times rated current of the transformer for transformers having more than 6 but not more than 10% impedance.

(c) *Potential (voltage) transformers.* Potential transformers should be protected with primary fuses. The fuse rating should not exceed 10 amperes for circuits of 600 volts or less, and 3 amperes for circuits of more than 600 volts. A resistor should be connected in series with high tension fuses when necessary to limit the possible short-circuit current to a value within the interrupting capacity of the fuse.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 450.05 Secondary ties. (1) As used in this chapter, the word "transformer" means a transformer or a bank of transformers operating as a unit. A secondary tie is a circuit operating at 600 volts or less between phases which connects 2 power sources or power supply points, such as the secondaries of 2 transformers. The tie may consist of one or more conductors per phase.

(a) *Tie circuits.* Tie circuits shall be provided at each end with overcurrent protection as required in chapter E 240 of this code, except under the conditions described in subsections (1) (a) 1. and E 450.05 (1) (a) 2., in which cases the overcurrent protection may be in accordance with subsection (1) (a) 3.

1. Loads at transformer supply points only. Where all loads are connected at the transformer supply points at each end of the tie and overcurrent protection is not provided in accordance with chapter E 240, the rated ampacity of the tie shall be not less than 67% of the rated secondary current of the largest transformer connected to the secondary tie system.

2. Loads connected between transformer supply points. Where load is connected to the tie at any point between transformer supply points and overcurrent protection is not provided in accordance with chapter E 240, the rated ampacity of the tie shall be not less than 100% of the rated secondary current of the largest transformer connected to the secondary tie system except as otherwise provided in subsection (1) (a) 4.

3. Tie circuit protection. Under the conditions described in subsections (1) (a) 1. and (1) (a) 2., both ends of each tie conductor shall be equipped with a protective device which will open at a predetermined temperature of the tie conductor under short circuit conditions. This protection shall consist of one of the following: a. A fusible link cable connector, terminal or lug, commonly known as a limiter, each being of a size corresponding with that of the conductor and of approved construction and characteristics according to the operating voltage and the type of insulation on the tie conductors, or b. Automatic circuit-breakers actuated by devices having comparable current-time characteristics.

4. Interconnection of phase conductors between transformer supply points. Where the tie consists of more than one conductor per phase, the conductors of each phase shall be interconnected in order to establish a load supply point, and the protection specified in subsection (1) (a) 3. shall be provided in each tie conductor at this point, except as follows:

a. Exception. Loads may be connected to the individual conductors of a mulitple-conductor tie without interconnecting the conductors of each phase and without the protection specified in subsection (1) (a) 3. at load connection points provided; the tie conductors of each phase have a combined capacity not less than 133% of the rated secondary current of the largest transformer connected to the secondary tie system; the total load of such taps does not exceed the rated secondary current of the largest transformer; the loads are equally divided on each phase and on the individual conductors of each phase as far as practicable.

5. Tie circuit control. Where the operating voltage exceeds 150 volts to ground, secondary ties provided with limiters shall have a switch at each end which when open will de-energize the associated tie conductors and limiters. The current rating of the switch shall be not less than the rated current of the conductors connected to the switch. It shall be capable of opening its rated current, and it shall be constructed so that it will not open under the magnetic forces resulting from short-circuit current.

(b) *Overcurrent protection for secondary connections.* When secondary ties are used an overcurrent device rated or set at not more than 250% of the rated secondary current of the transformers shall be provided in the secondary connections of each transformer, and in addition an automatic circuit-breaker actuated by a reverse-current relay set to open the circuit at not more than the rated secondary current of the transformer shall be provided in the secondary connection of each transformer.

History: Cr. Register, January, 1968, No. 145, eff. 2–1–68.

E 450.06 Parallel operation. Transformers may be operated in parallel and switched as a unit provided that the overcurrent protection for each transformer meets the requirements of section E 450.03.

Note: To obtain balanced division of load current, both transformers should have the same rated percent impedance and be operated on the same voltage-ratio tap.

History: Cr. Register, January, 1968, No. 145, eff. 2–1–68.

E 450.07 Guarding. Transformers shall be guarded as follows:

(1) MECHANICAL PROTECTION. Appropriate provisions shall be made to minimize the possibility of damage to transformers from external causes where the transformers are located where they are exposed to physical damage.

(2) CASE OR ENCLOSURE. Dry-type transformers shall be provided with a non-combustible moisture-resistant case or enclosure which will provide reasonable protection against the accidental insertion of foreign objects.

(3) EXPOSED LIVE PARTS. The transformer installation shall conform with the provisions for guarding of live parts in section E 195.17.

(4) VOLTAGE WARNING. The operating voltage of exposed live parts of transformer installations shall be indicated by signs or visible markings on the equipment or structures.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 450.08 Grounding. Exposed non-current carrying metal parts of transformer installations including fences, guards, etc., shall be grounded where required under the conditions and in the manner prescribed for electrical equipment and other exposed metal parts in chapter E 250.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 450.09 Marking. Each transformer shall be provided with a nameplate giving the name of the manufacturer; rated kilovolt-amperes, frequency, primary and secondary voltage; and the amount and kind of insulating liquid where used and the transformer rating exceeds 25 kva. Where class B insulation is used in the construction of dry-type transformers rated more than 100 kva, the nameplate shall indicate the temperature rise for this insulation system.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

B. SPECIFIC PROVISIONS APPLICABLE TO DIFFERENT TYPES OF TRANSFORMERS

E 450.21 Dry-type transformers installed indoors. (1) Transformers rated 112½ kva or less shall have a separation of at least 12 inches from combustible material unless separated therefrom by a fire-resistant heat insulating barrier, or unless of a rating not exceeding 600 volts and completely enclosed except for ventilating openings.

(2) Transformers of more than 112½ kva rating shall be installed in a transformer room for fire-resistant construction unless they are constructed with class B (80° C. rise), class F (115° C. rise) or class H (150° C. rise) insulation, and are separated from combustible material not less than 6 feet horiontally and 12 feet vertically or are separated therefrom by a fire-resistant heat-insulating barrier.

(3) Transformers rated more than 35,000 volts shall be installed in a vault. See Part C of this chapter.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 450.23 Askarel-insulated transformers installed indoors. Askarel-insulated transformers rated in excess of 25 kva shall be furnished with a pressure-relief vent. Where installed in a poorly ventilated place they shall be furnished with a means for absorbing any gases generated by arcing inside the case, or the pressure relief vent shall be connected to a chimney or flue which will carry such gases outside the building. Askarel-insulated transformers rated more than 35,000 volts shall be installed in a vault.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 450.24 Oil-insulated transformers installed indoors. Oil-insulated transformers shall be installed in a vault constructed as specified in this chapter except as follows:

(1) NOT OVER 112½ KVA TOTAL CAPACITY. The provisions for transformer vaults specified in part C of this chapter apply except that the

vault may be constructed of reinforced concrete not less than 4 inches thick.

(2) NOT OVER 600 VOLTS. A vault is not required provided suitable arrangements are made where necessary to prevent a transformer oil fire igniting other materials, and the total transformer capacity in one location does not exceed 10 kva in a section of the building classified as combustible, or 75 kva where the surrounding structure is classified as fire-resistant construction.

(3) FURNACE TRANSFORMERS. Electric furnace transformers of a total rating not exceeding 75 kva may be installed without a vault in a building or room of fire-resistant construction provided suitable arrangements are made to prevent a transformer oil fire spreading to other combustible material.

(4) DETACHED BUILDINGS. Transformers may be installed in a building which does not conform with the provisions specified in this code for transformer vaults, provided neither the building nor its contents present a fire hazard to any other building or property, and provided the building is used only in supplying electric service and the interior is accessible only to qualified persons.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 450.25 Oil-insulated transformers installed outdoors. Combustible material, combustible buildings and parts of buildings, fire escapes, door and window openings shall be safeguarded from fires originating in oil-insulated transformers installed on, attached to, or adjacent to a building or combustible material. Space separations, fire-resistant barriers, automatic water spray systems and enclosures which confine the oil of a ruptured transformer tank are recognized safeguards. One or more of these safeguards shall be applied according to the degree of hazard involved in cases where the transformer installation presents a fire hazard. Oil enclosures may consist of fire-resistant dikes, curbed areas or basins, or trenches filled with coarse crushed stone. Oil enclosure shall be provided with trapped drains in cases where the exposure and the quantity of oil involved are such that removal of oil is important.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 450.26 Oil-insulated transformers installed on roofs. Oil-insulated transformers installed on the roof of a building shall comply with the following conditions:

(1) The structure of the building shall be of sufficient strength to carry the weight of the transformers and their enclosures and the equipment used in connection therewith. There shall be a path from the edge of the roof to the transformer location, of sufficient strength to support the transformer.

(2) Where the roof is of 2-hour or greater fire-resistive construction, the transformers shall be installed in a fenced enclosure, vault or other enclosure where the live parts are guarded against accidental contact. Where a fence is used it shall be of a type that cannot be readily climbed and shall not be less than 6 feet in height excluding any barbed wire. A locked gate shall be provided. Where the transformers are installed in other than a vault, a curb or basin shall be

provided. The curb shall be high enough to contain the oil from the largest of the transformers, but in no case less than 6 inches high. A drain shall be provided to carry any oil away from the building.

(3) Where the roof is less than 2-hour fire-resistive construction, the transformers shall be enclosed in a vault complying with chapter E 450, part C—Provisions for Transformer Vaults.

Note: See Wis. Adm. Code sections Ind 51.04 and 51.07 for fire-resistive standards.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

C. PROVISIONS FOR TRANSFORMER VAULTS

E 450.41 Location. Vaults containing oil-insulated transformers shall be located where they can be ventilated to the outside air without using flues or ducts.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 450.42 Walls, roof and floor. The walls and roofs of vaults shall be constructed of reinforced concrete, brick, load-bearing tile, concrete block, or other fire-resistive constructions which have adequate structural strength for the conditions, and a minimum fire resistance of 3 hours. The floors of vaults in contact with the earth shall be of concrete not less than 4 inches thick, but when the vault is constructed with a vacant space or other stories below it, the floor shall have adequate structural strength for the load imposed thereon and a minimum fire resistance of 3 hours. The administrative authority shall determine the type of construction required to comply with this section.

Note: See Wis. Adm. Code sections Ind 51.05 and Ind 51.06.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 450.43 Doorways. Any doorway leading from the vault into the building shall be protected as follows:

(1) TYPE OF DOOR. Each doorway shall be provided with a tight-fitting class A fire door. The administrative authority may require such a door on each side of the wall where conditions warrant.

(2) SILLS. A door sill or curb of sufficient height to confine within the vault the oil from the largest transformer shall be provided and in no case shall the height be less than 6 inches.

(3) LOCKS. Entrance doors shall be equipped with locks, and doors shall be kept locked, access being allowed only to qualified persons. Locks and latches shall be so arranged that the door may be readily and quickly opened from the inside.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 450.44 Ventilation. The ventilation shall be adequate to prevent excessive transformer temperature. See ASA C57.12-58. Vaults containing oil-filled equipment shall be vented to the outside.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 450.45 Ventilation openings. When required by section E 450.44, openings for ventilation shall be provided in accordance with the following:

(1) LOCATION. Ventilation openings shall be located as far away as possible from doors, windows, fire escapes, and combustible material.

(2) ARRANGEMENT. Vaults ventilated by natural circulation of air may have roughly half of the total area of openings required for ventilation in one or more openings near the floor and the remainder in one or more openings in the roof or in the sidewalls near the roof; or all of the area required for ventilation may be provided in one or more openings in or near the roof.

(3) SIZE. In the case of vaults ventilated to an outdoor area without using ducts or flues the combined net area of all ventilating openings after deducting the area occupied by screens, gratings, or louvers, shall be not less than 3 square inches per kva of transformer capacity in service, except that the net area shall be not less than 1 square foot for any capacity under 50 kva.

(4) COVERING. Ventilation openings shall be covered with durable gratings, screens, or louvers, according to the treatment required in order to avoid unsafe conditions.

(5) DAMPERS. Where automatic dampers are used in the ventilation openings of vaults containing oil-insulated transformers, the actuating device should be made to function at a temperature resulting from fire and not at a temperature which might prevail as a result of an overheated transformer or bank of transformers. Automatic dampers should be so designed and constructed to minimize the possibility of accidental closing.

(6) DUCTS. Ventilating ducts shall be constructed of fire-resistant material.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 450.46 Drainage. Where practicable, vaults containing more than 100 kva transformer capacity shall be provided with a drain or other means which will carry off any accumulation of oil or water in the vault unless local conditions make this impracticable. The floor shall be pitched to the drain when provided.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 450.47 Water pipes and accessories. Any pipe or duct systems foreign to the electrical installation should not enter or pass through a transformer vault. Where the presence of such foreign systems cannot be avoided, appurtenances thereto which require maintenance at regular intervals shall not be located inside the vault. Arrangement shall be made where necessary to avoid possible trouble from condensation, leaks and breaks in such foreign systems. Piping or other facilities provided for fire protection or for water-cooled transformers are not deemed to be foreign to the electrical installation.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 450.48 Storage in vaults. Materials shall not be stored in transformer vaults.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

Chapter E 460

CAPACITORS

E 460.01 Application. This chapter applies to installation of capacitors on electric circuits in or on buildings.

(1) EXCEPTION NO. 1. Capacitors that are components of other apparatus shall conform to the requirements for such apparatus.

(2) EXCEPTION NO. 2. Capacitors in hazardous locations shall comply with additional requirements in Wis. Adm. Code chapters E 500–E 517.

History: Cr. Register, January, 1968, No. 145, eff. 2–1–68.

E 460.02 Location. An installation of capacitors in which any single unit contains more than 3 gallons of combustible liquid shall be in a vault conforming to part C of chapter E 450.

History: Cr. Register, January, 1968, No. 145, eff. 2–1–68.

E 460.03 Mechanical protection. Capacitors shall be protected from physical damage by location or by suitable fences, barriers or other enclosures.

History: Cr. Register, January, 1968, No. 145, eff. 2–1–68.

E 460.04 Cases and supports. Capacitors shall be provided with noncombustible cases and supports.

History: Cr. Register, January, 1968, No. 145, eff. 2–1–68.

E 460.05 Transformers used with capacitors. Transformers that are components of capacitor installations and are used for the purpose of connecting the capacitor to a power circuit shall be installed in accordance with chapter E 450. The kva rating shall not be less than 135% of the capacitor rating in kvar.

History: Cr. Register, January, 1968, No. 145, eff. 2–1–68.

E 460.06 Drainage of stored charge. Capacitors shall be provided with a means of draining the stored charge.

(1) TIME OF DISCHARGE. The residual voltage of a capacitor shall be reduced to 50 volts or less within one minute after the capacitor is disconnected from the source of supply in the case of capacitors rated 600 volts or less and in 5 minutes in the case of capacitors rated more than 600 volts.

(2) MEANS OF DISCHARGE. The discharge circuit shall be either permanently connected to the terminals of the capacitor or capacitor bank, or provided with automatic means of connecting it to the terminals of the capacitor bank on removal of voltage from the line. Manual means of switching or connecting the discharge circuit shall not be used. The windings of motors, of transformers, or of other equipment directly connected to capacitors without a switch or overcurrent device interposed, constitutes a suitable discharge means.

History: Cr. Register, January, 1968, No. 145, eff. 2–1–68.

E 460.07 Power factor correction; motor circuit. The total kvar rating of capacitors which are connected on the load side of a motor controller shall not exceed the value required to raise the no-load power factor of the motor to unity.

History: Cr. Register, January, 1968, No. 145, eff. 2–1–68.

E 460.08 Conductor rating. (1) AMPACITY OF CAPACITOR CIRCUIT CONDUCTORS. The ampacity of capacitor circuit conductors shall be not less than 135% of the rated current of the capacitor. The ampacity of conductors which connect a capacitor to the terminals of a motor or to motor circuit conductors, shall be not less than one-third the ampacity of the motor circuit conductors but not less than 135% of the rated current of the capacitor.

(2) OVERCURRENT PROTECTION. (a) An overcurrent device shall be provided in each ungrounded conductor.

Exception: A separate overcurrent device is not required on the load-side of a motor running overcurrent device.

(b) The rating or setting of the overcurrent device shall be as low as practicable.

(3) DISCONNECTING MEANS. (a) A disconnecting means shall be provided in each ungrounded conductor.

Exception: A separate disconnecting means is not required for a capacitor connected on the load side of a motor overcurrent device.

(b) The disconnecting device need not open all ungrounded conductors simultaneously.

(c) The disconnecting device may be used for disconnecting the capacitor from the line as a regular operating procedure.

(d) The continuous ampacity of the disconnecting device shall be not less than 135% of the rated current of the capacitor.

History: Cr. Register, January, 1968, No. 145, eff. 2–1–68.

E 460.09 Rating or setting of the motor-running overcurrent device. Where a motor installation includes a capacitor connected on the load side of the motor-running overcurrent device, and the overcurrent device used can be adjusted, the rating or setting of the motor overcurrent device shall be determined as provided in section E 430.032, except that instead of using the full-load rated current of the motor as provided in that rule a lower value corresponding with the improved power-factor of the motor circuit shall be used. Section E 430.022 applies with respect to the rating of the motor circuit conductors.

History: Cr. Register, January, 1968, No. 145, eff. 2–1–68.

E 460.10 Grounding. Capacitor cases shall be grounded in accordance with Wis. Adm. Code chapter E 250.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 460.11 Guarding. All live parts of capacitors which are connected to circuits of more than 600 volts between conductors and are accessible to unqualified persons, shall be enclosed or isolated. For isolation by elevation, see Wis. Adm. Code section E 710.34 (6).

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 460.12 Marking. Each capacitor shall be provided with a nameplate giving the maker's name, rated voltage, frequency, kvar, or amperes, number of phases, and if filled with a combustible liquid, the amount of liquid in gallons. When filled with a non-flammable liquid, the nameplate shall so state. The nameplate shall also indicate if a capacitor has a discharge device inside the case.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

Chapter E 470

RESISTORS AND REACTORS

(For Rheostats see section E 430.082)

E 470.01 Location. Resistors and reactors shall not be placed where exposed to physical damage. Where in the immediate vicinity of easily ignitible material they shall be of the oil-immersed type or shall be enclosed in metal boxes or cabinets. See Wis. Adm. Code chapter E 500 for Hazardous Locations.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 470.02 Space separation. Unless attached to a switchboard or other non-combustible material, or unless mounted as provided in section E 470.03, resistors and reactors shall be separated from combustible material by a distance of not less than 1 foot.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 470.03 On or in a proximity to combustible material. Where placed within a distance of 1 foot from combustible material, resistors and reactors shall be installed as follows:

(1) SLAB OR PANEL. They shall be attached to a slab or panel of noncombustible, nonabsorptive material such as slate, soapstone, or marble.

(2) SIZE OF SLAB. The slab shall extend beyond the edges of the device and shall have a thickness proportioned to the size and weight of the device but shall not be less than ½ inch thick.

(3) SUPPORTS. The slab shall be secured in position by supports independent of those fastening the device to the slab. Bolts which support the device shall be countersunk at least ⅛ inch below the rear surface of the slab and shall be covered with insulating material.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 470.04 Contacts. Fixed and movable contacts shall be so designed that arcing will be kept at a minimum.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 470.05 Reactor materials. Reactors shall be composed of noncombustible materials, and shall be mounted on noncombustible bases.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 470.06 Mounting. Enclosures when mounted on plain surfaces shall make contact with such surfaces only at the point of support, an air space of at least ¼ inch being maintained between the enclosures and surfaces.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 470.07 Conductor insulation. Insulated conductors used for connection between resistance elements and controllers shall be suitable for an operating temperature of not less than 90° C. (194° F.). Exception: For motor starting service other conductor insulations may be used.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 470.08 Incandescent lamps as resistors. Incandescent lamps may be used as protective resistors for automatic controllers, or may by special permission be used as resistors in series with other devices and shall conform to the following:

(1) MOUNTING. They shall be mounted in porcelain receptacles on noncombustible supports.

(2) VOLTAGE. They shall be so arranged that they cannot have impressed upon them a voltage greater than that for which they are rated.

(3) NAMEPLATE. They shall be provided with a nameplate, permanently attached, giving the wattage and voltage of the lamp to be used in each receptacle.

(4) NOT CARRY MAIN CURRENT. They shall not carry or control the main current nor constitute the regulating resistance of the device.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

Chapter E 480

STORAGE BATTERIES

E 480.01 Scope. The provisions of this chapter shall apply to all stationary installations of storage batteries using acid or alkali as the electrolyte and consisting of a number of cells connected in series with a nominal voltage in excess of 16 volts.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 480.02 Definition of nominal battery voltage. The nominal battery voltage shall be calculated on the basis of 2.0 volts per cell for the lead-acid type, and 1.2 volts per cell for the alkali type.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 480.03 Wiring and apparatus supplied from batteries. Wiring, appliances, and apparatus supplied from storage batteries shall be subject to the requirements of this code applying to wiring, appliances, and apparatus operating at the same voltage, except as otherwise provided for communication systems in Wis. Adm. Code chapter E 800.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 480.04 Insulation of batteries of not over 250 volts. The provisions of this rule shall apply to storage batteries having the cells so connected as to operate at a nominal battery voltage not exceeding 250 volts.

(1) LEAD-ACID BATTERIES. Cells in lead-lined wood tanks, where the number of cells in series does not exceed 25, shall be supported individually on glass or glazed porcelain insulators. Where the number of the cells in series exceeds 25, the cells shall be supported individually on oil insulators.

(2) ALKALI-TYPE BATTERIES. Cells of the alkali type in jars made of conducting material shall be installed in trays of nonconducting material, with not over 20 cells in a series circuit in any one such tray, or the cells may be supported singly or in groups on porcelain or other suitable insulators.

(3) UNSEALED JARS. Cells in unsealed jars made of nonconductive material shall be assembled in trays of glass or supported on glass or glazed porcelain insulators; or, where installed on a rack, shall be supported singly or in groups on glass or other suitable insulators.

(4) SEALED RUBBER JARS. Cells in sealed rubber or composition containers shall require no additional insulating support where the total

nominal voltage of all cells in series does not exceed 150 volts. Where the total voltage exceeds 150 volts, batteries shall be sectionalized into groups of 150 volts or less and each group shall have the individual cells installed in trays or on racks. Where trays or racks are required for this type of cell, such trays or racks shall be supported on glass or glazed porcelain insulators or oil-type insulators.

(5) SEALED GLASS OR PLASTIC JARS. Cells in sealed glass jars or in sealed jars of approved heat-resistant plastic, with or without wood trays, require no additional insulation.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 480.05 Insulation of batteries of over 250 volts. The provisions of E 480.04 shall apply to storage batteries having the cells so connected as to operate at a nominal voltage exceeding 250 volts and, in addition, the provisions of this chapter shall also apply to such batteries. Cells shall be installed in groups having a total nominal voltage of not over 250 volts, in trays or on racks supported on oil insulators.

(1) EXCEPTION NO. 1. Where each individual cell, or sub-group in the tray or rack, is supported on oil insulators, no additional insulation for the group need be provided.

(2) EXCEPTION NO. 2. Cells of not over 10 ampere-hour capacity in sealed glass jars may be grouped in trays, the total nominal voltage of all cells in such group not to exceed 250 volts, and each such tray to be supported on glass or glazed porcelain insulators, the trays being mounted on racks supported on oil insulators with a total nominal voltage of not over 500 volts for all cells in series on each such insulated rack.

Note: Maximum protection is secured by sectionalizing high-voltage batteries into cell groups insulated from each other.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 480.06 Racks and trays. Racks and trays shall conform to the following:

(1) RACKS. Racks, as required in this chapter, 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 the 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 480.07 Battery rooms. Battery rooms shall conform to the following:

(1) USE. Separate battery rooms or enclosures shall be required only for batteries in unsealed jars and tanks where the aggregate capacity at the 8-hour discharge rate exceeds 5 kilowatt hours.

(2) VENTILATION. Provision shall be made for sufficient diffusion and ventilation of the gases from the battery to prevent the accumulation of an explosive mixture in the battery room.

(3) WIRING METHOD. In storage battery rooms, bare conductors, open wiring, type MI cable, type ALS cable, or conductors in rigid conduit or electrical metallic tubing shall be used as the wiring method. Rigid metal conduit, or electrical metallic tubing, where used, shall be of corrosion-resistant material or shall be suitably protected from corrosion.

(4) VARNISHED-CAMBRIC CONDUCTORS. Varnished-cambric-covered conductors, type V, shall not be used.

(5) BARE CONDUCTORS. Bare conductors shall not be taped.

(6) TERMINALS. Where metal raceway or other metallic covering is used in the battery room, at least 12 inches of the conductor at the end connected to a cell terminal shall be free from the raceway or metallic covering and shall be bushed by a substantial glazed insulating bushing. The end of the raceway shall be sealed tightly to resist the entrance of electrolyte by spray or by creepage. Sealing compound, rubber insulating tape or other suitable material shall be used for this purpose.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

SPECIAL OCCUPANCIES

Chapter E 500

HAZARDOUS LOCATIONS

E 500.01 Scope. (1) The provisions of Wis. Adm. Code chapters E 500–E 503 apply to locations in which the administrative authority judges the apparatus and wiring to be subject to the conditions indicated by the following classifications. It is intended that each room, section or area (including motor and generator rooms, and rooms for the enclosure of control equipment) shall be considered individually in determining its classification. Except as modified in chapters E 500–E503, all other applicable rules contained in this code shall apply to electrical apparatus and wiring installed in hazardous locations. For definitions of "approved" and "explosion-proof" as used in these chapters, refer to chapter E 100; "dust-ignition-proof" is defined in section E 502.01.

(2) Equipment and associated wiring approved as intrinsically safe may be installed in any hazardous location for which it is approved, and the provisions of chapters E 500—E 517 need not apply to such installation. Intrinsically safe equipment and wiring is incapable of releasing sufficient electrical energy under normal or abnormal conditions to cause ignition of a specific hazardous atmospheric mixture. Abnormal conditions will include accidental damage to any part of the equipment or wiring, insulation or other failure of electrical components, application of over-voltage, adjustment and maintenance operations, and other similar conditions.

(3) All conduit referred to herein shall be threaded with standard conduit cutting die which provides ¾" taper per foot. Such conduit shall be made up wrench tight to minimize sparking when fault current flows through the conduit system. Where it is impractical to make a threaded joint tight, a bonding jumper shall be utilized.

Note 1: Through the exercise of ingenuity in the layout of electrical installations for hazardous locations, it is frequently possible to locate much of the equipment in less hazardous or in nonhazardous areas and thus to reduce the amount of special equipment required. In some cases, hazards may be reduced or hazardous areas limited or eliminated by adequate positive-pressure ventilation from a source of clean air in conjunction with effective safeguards against ventilation failure. It is recommended that the authority enforcing this code be consulted before such layouts are prepared. It is recommended also that the code enforcing authority be familiar with such recorded industrial experience as well as with such standards of the National Fire Protection Association as may be of use in the classification of various areas with respect to hazard. For further information see NFPA No. 30, Flammable and Combustible Liquids Code; No. 32, Standard for Dry Cleaning Plants; No. 35M, Organic Coatings Manufacture; and No. 36, Standard for Solvent Extraction Plants.

Note 2. For recommendations for protection against static electricity hazards, refer to the standards of the National Fire Protection Association on this subject.

Note 3. Where rigid conduit is used in hazardous locations, it is necessary to have all threaded joints made up wrench tight to minimize sparking when fault current flows through the conduit system. Where it is impractical to make a threaded joint tight, a bonding jumper should be utilized.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 500.02 Special precaution. (1) The intent of chapters E 500—E 503 is to require a form of construction of equipment, and of installation that will insure safe performance under conditions of proper use and maintenance. It, therefore, is assumed that inspection authorities and users will exercise more than ordinary care with regard to installation and maintenance.

(2) The characteristics of various atmospheric mixtures of hazardous gases, vapors and dusts depend on the specific hazardous material involved. It is necessary therefore that equipment be approved not only for the class of location but also for the specific gas, vapor or dust that will be present.

Note: For purposes of testing and approval, various atmospheric mixtures have been grouped on the basis of their hazardous characteristics and facilities have been made available for testing and approval of equipment for use in the following atmospheric groups:

Group A, Atmospheres containing acetylene;

Group B, Atmospheres containing hydrogen, or gases or vapors of equivalent hazard such as manufactured gas;

Group C, Atmospheres containing ethyl-ether vapors, ethylene, or cyclo-propane;

Group D, Atmospheres containing gasoline, hexane, naphtha, benzine, butane, propane, alcohol, acetone, benzol, lacquer solvent vapors or natural gas;

Group E, Atmospheres containing metal dust, including aluminum, magnesium, and their commercial alloys, and other metals of similarly hazardous characteristics;

Group F, Atmospheres containing carbon black, coal or coke dust;

Group G, Atmospheres containing flour, starch, or grain dusts.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 500.03 Specific occupancies. See chapters E 510 to E 517 inclusive for rules applying to garages, aircraft hangars, gasoline dispensing and service stations, bulk storage plants, finishing processes, and flammable anesthetics.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 500.04 Class I locations. Class I locations are those in which flammable gases or vapors are or may be present in the air in quantities sufficient to produce explosive or ignitible mixtures. Class I locations shall include the following:

(1) CLASS I, DIVISION 1. Locations (a) in which hazardous concentrations of flammable gases or vapors exist continuously, intermittently, or periodically under normal operating conditions, (b) in which hazardous concentrations of such gases or vapors may exist frequently because of repair or maintenance operations or because of leakage, or (c) in which breakdown or faulty operation of equipment or processes which might release hazardous concentrations of flammable gases or vapors, might also cause simultaneous failure of electrical equipment.

Note: This classification usually includes locations where volatile flammable liquids or liquefied flammable gases are transferred from one container to another; interiors of spray booths and areas in the vicinity of spraying and painting operations where volatile flammable solvents are used; locations containing open tanks or vats of volatile flammable liquids; drying rooms or compartments for the evaporation of flammable solvents; locations containing fat and oil extraction apparatus using volatile flammable solvents; portions of cleaning and dyeing plants where hazardous liquids are used; gas generator rooms and other portions of gas manufacturing plants where flammable gas may escape; inadequately ventilated pump rooms for flammable gas or for volatile flammable liquids; the interiors of refrigerators and freezers in which volatile, flammable materials are stored in open, lightly stoppered, or easily ruptured containers, and all other locations where hazardous concentrations of flammable vapors or gases are likely to occur in the course of normal operations.

(2) CLASS I, DIVISION 2. Locations (a) in which flammable volatile liquids or flammable gases are handled, processed or used, but in which the hazardous liquids, vapors or gases will normally be confined within closed containers or closed systems from which they can escape only in case of accidental rupture or breakdown of such containers or systems, or in case of abnormal operation of equipment, (b) in which hazardous concentrations of gases or vapors are normally prevented by positive mechanical ventilation, but which might become hazardous through failure or abnormal operation of the ventilating equipment, or (c) which are adjacent to class I, division 1 locations, and to which hazardous concentrations of gases or vapors might occasionally be communicated unless such communication is prevented by adequate positive-pressure ventilation from a source of clear air, and effective safeguards against ventilation failure are provided.

Note 1. This classification usually includes locations where flammable volatile liquids or flammable gases or vapors are used, but which, in the judgment of the code administrative authority, would become hazardous only in case of an accident or of some unusual operating condition. The quantity of hazardous material that might escape in case of accident, the adequacy of ventilating equipment, the total area involved, and the record of the industry or business with respect to explosions or fires are all factors that should receive consideration in determining the classification and extent of each hazardous area.

Note 2. Piping without valves, checks, meters and similar devices would not ordinarily be deemed to introduce a hazardous condition even though used for hazardous liquids or gases. Locations used for the storage of hazardous liquids or of liquefied or compressed gases in sealed containers would not normally be considered hazardous unless subject to other hazardous conditions also.

(3) Electrical conduits and their associated enclosures separated from process fluids by a single seal or barrier shall be classed as division 2 locations if the outside of conduit and enclosures is a nonhazardous area.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 500.05 Class II locations. Class II locations are those which are hazardous because of the presence of combustible dust. Class II locations shall include the following:

(1) CLASS II, DIVISION 1. Locations (a) in which combustible dust is or may be in suspension in the air continuously, intermittently or periodically under normal operating conditions, in quantities sufficient to produce explosive or ignitible mixtures, (b) where mechanical failure or abnormal operation of machinery or equipment might cause such mixtures to be produced, and might also provide a source of ignition through simultaneous failure of electrical equipment, operation of protection devices, or from other causes, or (c) in which dusts of an electrically conducting nature may be present.

Note 1. This classification usually includes the working areas of grain handling and storage plants; rooms containing grinders or pulverizers, cleaners, graders, scalpers, open conveyors or spouts, open bins or hoppers, mixers or blenders, automatic or hopper scales, packing machinery, elevator heads and boots, stock distributors, dust and stock collectors (except all-metal collectors vented to the outside), and all similar dust producing machinery and equipment in grain processing plants, starch plants, sugar pulverizing plants; malting plants, hay grinding plants, and other occupancies of similar nature; coal pulverizing plants (except where the pulverizing equipment is essentially dust-tight); all working areas where metal dusts and powders are produced, processed, handled, packed or stored (except in tight containers); and all other similar locations where combustible dust may, under normal operating conditions, be present in the air in quantities sufficient to produce explosive or ignitible mixtures.

Note 2: Combustible dusts which are electrically nonconducting include dusts produced in the handling and processing of grain and grain products, pulverized sugar and cocoa, dried egg and milk powders, pulverized spices, starch and pastes, potato and woodflour, oil meal from beans and seed, dried hay, and other organic materials which may produce combustible dusts when processed or handled. Electrically conducting nonmetallic dusts include dusts from pulverized coal, coke and charcoal. Dusts containing magnesium or aluminum are particularly hazardous and every precaution must be taken to avoid ignition and explosion.

(2) CLASS II, DIVISION 2. Locations in which combustible dust will not normally be in suspension in the air, or will not be likely to be thrown into suspension by the normal operation of equipment or apparatus, in quantities sufficient to produce explosive or ignitible mixtures, but (a) where deposits or accumulations of such dust may be sufficient to interfere with the safe dissipation of heat from electrical equipment or apparatus, or (b) where such deposits or accumulations of dust on, in, or in the vicinity of electrical equipment might be ignited by arcs, sparks or burning material from such equipment.

Note: Locations where dangerous concentrations of suspended dust would not be likely, but where dust accumulations might form on, or in the vicinity of electrical equipment, would include rooms and areas containing only closed spouting and conveyors, closed bins or hoppers, or machines and equipment from which appreciable quantities of dust would escape only under abnormal operating conditions; rooms or areas adjacent to locations described in section E 500.05 (1), and into which explosive or ignitible concentrations of suspended dust might be communicated only under abnormal operating conditions; rooms or areas where the formation of explosive or ignitible concentrations of suspended dust is prevented by the operation of effective dust control equipment; warehouses and shipping rooms where dust producing materials are stored or handled only in bags or containers; and other similar locations.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 500.06. Class III locations. Class III locations are those which are hazardous because of the presence of easily ignitible fibers or flyings, but in which such fibers or flyings are not likely to be in suspension in air in quantities sufficient to produce ignitible mixtures. Class III locations shall include the following:

(1) CLASS III, DIVISION 1. Locations in which easily ignitible fibers or materials producing combustible flyings are handled, manufactured or used.

Note 1. Such locations usually include some parts of rayon, cotton and other textile mills; combustible fiber manufacturing and processing plants; cotton gins and cotton-seed mills; flax processing plants; clothing manufacturing plants; woodworking plants; and establishments and industries involving similar hazardous processes or conditions.

Note 2. Easily ignitible fibers and flyings include rayon, cotton (including cotton linters and cotton waste), sisal or henequen, istle, jute, hemp, tow, cocoa fiber, oakum, baled waste kapok, Spanish moss, excelsior and other materials of similar nature.

(2) CLASS III, DIVISION 2. Locations in which easily ignitible fibers are stored or handled (except in process of manufacture).

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

Chapter E 501

CLASS I INSTALLATIONS; HAZARDOUS LOCATIONS

Note: Where conduit is threaded in the field, it is assumed that a standard conduit cutting die providing ¾ inch taper per foot will be employed.

E 501.01 General. The general rules of this code shall apply to the installation of electrical wiring and equipment in locations classified as class I under section E 500.04 except as modified by this chapter.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 501.02 Transformers and capacitors. The installation of transformers and capacitors shall conform to the following:

(1) CLASS I, DIVISION 1. In class I, division 1 locations, transformers and capacitors shall conform to the following:

(a) *Containing a liquid that will burn.* Transformers and capacitors containing a liquid that will burn shall be installed only in approved vaults, which shall conform to sections E 450.41 to E 450.48 inclusive, and in addition, 1. there shall be no door or other communicating opening between the vault and the hazardous area, 2. ample ventilation shall be provided for the continuous removal of hazardous gases or vapor, 3. vent openings or ducts shall lead to a safe location outside of buildings, and 4. vent ducts and openings shall be of sufficient area to relieve explosion pressures within the vault, and all portions of vent ducts within the buildings shall be of reinforced concrete construction.

(b) *Not containing a liquid that will burn.* Transformers and capacitors which do not contain a liquid that will burn shall 1. be installed in vaults conforming to the requirements of subsection E 501.02 (1) (a), or 2. be approved for class I locations (explosion-proof).

(2) CLASS I, DIVISION 2. In class I, division 2 locations, transformers and capacitors shall conform to sections E 450.21 to E 450.25 inclusive.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 501.03 Meters, instruments and relays. The installation of meters, instruments and relays shall conform to the following:

(1) CLASS I, DIVISION 1. In class I, division 1 locations, meters, instruments and relays, including kilowatt-hour meters, instrument transformers and resistors, rectifiers and thermionic tubes, shall be provided with enclosures approved for class I locations.

(2) CLASS I, DIVISION 2. In class I, division 2 locations, meters, instruments and relays shall conform to the following:

(a) *Contacts.* Switches and circuit-breakers, and make and break contacts of push buttons, relays, and alarm bells or horns, shall have enclosures approved for class I locations, unless general purpose enclosures are provided, and current interrupting contacts are 1. immersed in oil, 2. enclosed within a chamber hermetically sealed against the entrance of gases or vapors, or 3. in circuits which under normal conditions do not release sufficient energy to ignite a specific hazardous atmospheric mixture.

(b) *Resistors and similar equipment.* Resistors, resistance devices, thermionic tubes, and rectifiers, which are used in or in connection with meters, instruments and relays, shall conform to section E 501.03 (1), except that enclosures may be of general purpose type when such equipment is without make and break or sliding contacts other than as provided in subsection (2) (a) above) and when the maximum operating temperature of any exposed surface will not exceed 80% of the ignition temperature in degrees Centigrade of the gas or vapor involved as determined by approved test procedures.

(c) *Without make or break contacts.* Transformer windings, impedance coils, solenoids, and other windings which do not incorporate sliding or make or break contacts shall be provided with enclosures which may be of general purpose type where vents adequate to permit prompt escape of any gases or vapors are provided.

(d) *General purpose assemblies.* Where an assembly is made up of components for which general purpose enclosures are acceptable under sections E 501.03 (2) (a) (b) (c), a single general purpose enclosure is acceptable for the assembly. Where such an assembly includes any of the equipment described in section E 501.03 (2) (b) the maximum obtainable surface temperature of any component of the assembly shall be clearly and permanently indicated on the outside of the enclosure.

(e) *Fuses.* Where general purpose enclosures are permitted under subsections (2) (a), (b), (c), (d), fuses for overcurrent protection of the instrument circuits may be mounted in general purpose enclosures provided such fuses do not exceed 3 ampere rating in 120 volts and provided each such fuse is preceded by a switch conforming to subsection (2) (a).

History: Cr. Register, January, 1968, No. 145, eff. 2–1–68.

E 501.04 Wiring methods. Wiring methods shall conform to the following:

(1) CLASS I, DIVISION 1. In class I, division 1 locations, threaded rigid metal conduit or type MI cable with termination fittings approved for the location shall be the wiring method employed. All boxes, fittings, and joints shall be threaded for connection to conduit

or cable terminations, and shall be explosion-proof. Threaded joints shall be made up with at least 5 threads fully engaged. Type MI cable shall be installed and supported in a manner to avoid tensile stress at the termination fittings. Where necessary to employ flexible connections, as at motor terminals, flexible fittings approved for class I locations (explosion-proof) shall be used.

(2) CLASS I, DIVISION 2. In class 1 division 2 locations, threaded rigid metal conduit or type MI cable with termination fittings approved for class I locations, or approved type MC or ALS cable with termination fittings approved for class I locations shall be the wiring method employed. Type MI, MC or ALS cable shall be installed in a manner to avoid tensile stress at the termination fittings. Boxes, fittings and joints need not be explosion proof except as required by sections E 501.05 (2) (a) and (b). Where provision must be made for limited flexibility, as at motor terminals, flexible metal fittings, flexible metal conduit with approved fittings, or flexible cord approved for extra hard usage and provided with approved bushed fittings shall be used. An additional conductor for grounding shall be included in the flexible cord unless other acceptable means of grounding are provided.

History: Cr. Register, January, 1968, No. 145, eff. 2–1–68.

E 501.05 Sealing and drainage. Seals are provided in conduit and cable systems to prevent the passage of gases, vapors or flames from one portion of the electrical installation to another through the conduit. Such communication through type MI cable is inherently prevented by construction of the cable, but sealing compound is used in cable termination fittings to exclude moisture and other fluids from the cable insulation, and shall be of a type approved for the conditions of use. Seals in conduit and cable systems shall conform to the following:

(1) CLASS I, DIVISION 1. In class I, division 1 locations, seals shall be located as follows:

(a) In each conduit run entering an enclosure for switches, circuit-breakers, fuses, relays, resistors or other apparatus which may produce arcs, sparks or high temperatures. Seals shall be placed as close as practicable and in no case more than 18 inches from such enclosures.

(b) In each conduit run of 2-inch size or larger entering the enclosure or fitting housing terminals, splices or taps, and within 18 inches of such enclosure or fitting.

Note: Where 2 or more enclosures for which seals are required under sections E 501.05 (1) (a) (b) are connected by nipples or by runs of conduit not more than 36 inches long, a single seal in each such nipple connection or run of conduit would be sufficient if located not more than 18 inches from either enclosure. Ordinary conduit fittings of the "L", "T" or "Cross" type would not usually be classed as enclosures when not larger than the trade size of the conduit.

(c) In each conduit run leaving the class I, division 1 hazardous area. The sealing fitting may be located on either side of the boundary of such hazardous area, but shall be so designed and installed that any gases or vapors which may enter the conduit system, within the division 1 hazardous area, will not enter or be communicated to the conduit beyond the seal. There shall be no union, coupling, box or fitting in the conduit between the sealing fitting and the point at which the conduit leaves the division 1 hazardous area.

(2) CLASS I, DIVISION 2. In class I, division 2 locations, seals shall be located as follows:

(a) For conduit connections to enclosures which are required to be approved for class I locations, seals shall be provided in conformance to subsections (1) (a) (b). All portions of the conduit run or nipple between the seal and such enclosure shall conform to section E 501.04 (1).

(b) In each conduit run passing from the class I, division 2 hazardous area into a non-hazardous area. The sealing fitting may be located on either side of the boundary of such hazardous area, but shall be so designed and installed that any gases or vapors which may enter the conduit system, within the division 2 hazardous area, will not enter or be communicated to the conduit beyond the seal. Rigid conduit shall be used between the sealing fitting and the point at which the conduit leaves the hazardous area, and a threaded connection shall be used at the sealing fitting. There shall be no union, coupling, box or fitting in the conduit between the sealing fitting and the point at which the conduit leaves the hazardous area.

(3) CLASS I, DIVISIONS 1 AND 2. Where seals are required, they shall conform to the following:

(a) *Fittings.* Enclosures for connections or for equipment shall be provided with approved integral means for sealing, or sealing fittings approved for class I locations shall be used. Sealing fittings shall be accessible.

(b) *Compound.* Sealing compound shall be approved for the purpose, shall not be affected by the surrounding atmosphere or liquids, and shall not have a melting point of less than 93°C. (200°F.).

(c) *Thickness of compound.* In the completed seal, the minimum thickness of the sealing compound shall be not less than the trade size of the conduit, and in no case less than ⅝ inch.

(d) *Splices and taps.* Splices and taps shall not be made in fittings intended only for sealing with compound, nor shall other fittings in which splices or taps are made be filled with compound.

(e) *Assemblies.* In an assembly where equipment which may produce arcs, sparks or high temperatures is located in a compartment separate from the compartment containing splices or taps, and an integral seal is provided where conductors pass from one compartment to the other, the entire assembly shall be approved for class I locations. Seals in conduit connections to the compartment containing splices or taps shall be provided in class I, division 1, locations where required by subsection (1) (b).

(4) DRAINAGE. (a) *Control equipment.* Where there is probability that liquid or other condensed vapor may be trapped within enclosures for control equipment or at any point in the raceway system, approved means shall be provided to prevent accumulation or to permit periodic draining of such liquid or condensed vapor.

(b) *Motors and generators.* Where the authority enforcing this code judges that there is probability that liquid or condensed vapor may accumulate within motors or generators, joints and conduit systems shall be arranged to minimize entrance of liquid. If means to prevent accumulation or to permit periodic draining are judged necessary, such means shall be provided at the time of manufacture, and shall be deemed an integral part of the machine.

(c) *Canned pumps, etc.* Canned pumps, process connections for flow, pressure or analysis measurement, etc., frequently depend upon a single seal diaphragm or tube to prevent process fluids from entering the electrical conduit system. An additional approved seal or barrier shall be provided with an adequate drain between the seals in such a manner that leaks would be obvious.

Note: See section E 500.04 (3).

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 501.06 Switches, circuit-breakers, motor controllers and fuses. Switches, circuit-breakers, motor controllers and fuses shall conform to the following:

(1) CLASS I, DIVISION 1. In class I, division 1 locations, switches, circuit-breakers, motor controllers and fuses, including push buttons, relays and similar devices, shall be provided with enclosures, and the enclosure in each case together with the enclosed apparatus shall be approved as a complete assembly for use in class I locations.

(2) CLASS I, DIVISION 2. Switches, circuit-breakers, motor controllers and fuses in class I, division 2 locations shall conform to the following:

(a) *Type required.* Circuit-breakers, motor controllers and switches intended to interrupt current in the normal performance of the function for which they are installed shall be provided with enclosures approved for class I locations, unless general purpose enclosures are provided and 1. the interruption of current occurs within a chamber hermetically sealed against the entrance of gases and vapors, or 2. the current interrupting contacts are oil-immersed and the device is approved for locations of this class and division.

Note: This includes service and branch circuit switches and circuit-breakers; motor controllers, including push-buttons, pilot switches, relays and motor-overload protective devices; and switches and circuit-breakers for the control of lighting and appliance circuits. Oil-immersed circuit-breakers and controllers of ordinary general use type may not confine completely the arc produced in the interruption of heavy overloads, and specific approval for locations of this class and division is therefore necessary.

(b) *Isolating switches.* Enclosures for disconnecting and isolating switches without fuses and which are not intended to interrupt current may be of general purpose type.

(c) *Fuses.* For the protection of motors, appliances and lamps, except as provided in subsection (2) (d), 1. standard plug or cartridge fuse may be used provided they are placed within enclosures approved for the purpose and for the location, or 2. fuses of a type in which the operating element is immersed in oil or other approved liquid, or is enclosed within a chamber hermetically sealed against the entrance of gases and vapors may be used provided they are approved for the purpose and are placed within general purpose enclosures.

(d) *Fuses or circuit-breakers for overcurrent protection.* When not more than 10 sets of approved enclosed fuses, or not more than 10 circuit-breakers which are not intended to be used as switches for the interruption of current, are installed for branch or feeder circuit protection in any one room, area or section of this class and division, the enclosures for such fuses or circuit-breakers may be of general purpose type, provided the fuses or circuit-breakers are for the protection of circuits or feeders supplying lamps in fixed positions only.

Note: A set of fuses is construed to mean a group containing as many fuses as are required to perform a single protective function in a circuit. For example, a group of 3 fuses protecting an ungrounded 3-phase circuit, and a single fuse protecting the ungrounded conductor of an identified 2-wire single-phase circuit, would each be considered as a set of fuses. Fuses conforming to section E 501.06 (2) (c) need not be included in counting the 10 sets of fuses permitted in general purpose enclosures.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 501.07 Control transformers and resistors. Transformers, impedance coils and resistors used as or in conjunction with control equipment for motors, generators and appliances shall conform to the following:

(1) CLASS I, DIVISION 1. In class I, division 1 locations, transformers, impedance coils and resistors, together with any switching mechanism associated with them, shall be provided with enclosures approved for class I locations (explosion-proof).

(2) CLASS I, DIVISION 2. In class I, division 2 locations control transformers and resistors shall conform to the following:

(a) *Switching mechanisms.* Switching mechanisms used in conjunction with transformers, impedance coils and resistors shall conform to section E 501.06 (2).

(b) *Coils and windings.* Enclosures for windings of transformers, solenoids or impedance coils may be of general purpose type, but shall be provided with vents adequate to permit prompt escape of gases or vapors that may enter the enclosure.

(c) *Resistors.* Resistors shall be provided with enclosures and the assembly shall be approved for class I locations, unless resistance is non-variable and maximum operating temperature, in degrees Centigrade, will not exceed 80% of the ignition temperature of the gas or vapor involved as determined by approved test procedures.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 501.08 Motors and generators. Motors and generators shall conform to the following:

(1) CLASS I, DIVISION 1. In class I, division 1 locations, motors, generators and other rotating electrical machinery shall be (a) approved for class I locations (explosion-proof), or (b) of the totally-enclosed type supplied with positive-pressure ventilation from a source of clean air with discharge to a safe area, so arranged to prevent energizing of the machine until ventilation has been established and the enclosure has been purged with at least 10 volumes of air, and also arranged to automatically de-energize the equipment when the air supply fails, or (c) of the totally-enclosed inert-gas -filled type supplied with a suitable reliable source of inert gas for pressuring the enclosure, with devices provided to insure a positive pressure in the enclosure, and arranged to automatically de-energize the equipment when the gas supply fails. Totally-enclosed motors of types (b) or (c) shall have no external surface with an operating tem-

perature in degrees centigrade in excess of eighty per cent (80%) of the ignition temperature of the gas or vapor involved, as determined by ASTM test procedure (Designation: D-286-30). Appropriate devices shall also be provided to detect ay increase in temperature of the motor beyond design limits and automatically de-energize the equipment. Auxiliary equipment shall be of a type approved for the location in which it is installed.

(2) CLASS I, DIVISION 2. In class I, division 2 locations, motors, generators and other rotating electrical machinery in which are employed sliding contacts, centrifugal or other types of switching mechanism (including motor overcurrent devices), or integral resistance devices, either while starting or while running, shall be approved for class I locations (explosion-proof), unless such sliding contacts, switching mechanisms and resistance devices are provided with enclosures approved for such locations.

Note: This rule does not prohibit installation of open or non-explosion-proof enclosed motors, such as squirrel-cage induction motors, without brushes, switching mechanism, etc., in class I, division 2 locations.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 501.09 Lighting fixtures. Lamps shall be installed in fixtures which shall conform to the following:

(1) CLASS I, DIVISION 1. In class I, division 1 locations, lighting fixtures shall conform to the following:

(a) *Approved fixtures.* Each fixture shall be approved as a complete assembly for locations of this class, and shall be clearly marked to indicate the maximum wattage of lamps for which it is approved. Fixtures intended for portable use shall be specifically approved as a complete assembly for that use.

(b) *Physical damage.* Each fixture shall be protected against physical damage by a suitable guard or by location.

(c) *Pendent fixtures.* Pendent fixtures shall be suspended by and supplied through threaded rigid conduit stems and threaded joints shall be provided with set-screws or other effective means to prevent loosening. For stems longer than 12 inches, permanent and effective bracing against lateral displacement shall be provided at a level not more than 12 inches above the lower end of the stem, or flexibility in the form of a fitting or flexible connector approved for the purpose and for the location shall be provided not more than 12 inches from the point of attachment to the supporting box or fitting.

(d) *Supports.* Boxes, box assemblies or fittings used for the support of lighting fixtures shall be approved for the purpose and for class I locations.

(2) CLASS I, DIVISION 2. In class I, division 2 locations lighting fixtures shall conform to the following:

(a) *Portable lamps.* Portable lamps shall conform to section E 501.09 (1) (a).

(b) *Fixed lighting.* Lighting fixtures for fixed lighting shall be protected from physical damage by suitable guards or by location. Where there is danger that falling sparks or hot metal from lamps or fixtures might ignite localized concentrations of flammable vapors or gases, suitable enclosures or other effective protective means shall be provided. Where lamps are of a size or type which may, under normal operating conditions, reach surface temperatures exceeding 80% of the ignition temperature in degrees Centigrade of the gas or vapor involved, as determined by approved test procedures fixtures shall conform to subsection (1) (a).

(c) *Pendent fixtures.* Pendent fixtures shall be suspended by threaded rigid conduit stems or by other approved means. For rigid stems longer than 12 inches, permanent and effective bracing against lateral displacement shall be provided at a level not more than 12 inches above the lower end of the stem, or flexibility in the form of a fitting or flexible connector approved for the purpose shall be provided not more than 12 inches from the point of attachment to the supporting box or fitting.

(d) *Supports.* Boxes, box assemblies, or fittings used for the support of lighting fixtures shall be approved for the purpose.

(e) *Switches.* Switches which are a part of an assembled fixture or of an individual lampholder shall conform to the requirements of section E 501.06 (2) (a).

(f) *Starting equipment.* Starting and control equipment for mercury-vapor and fluorescent lamps shall conform to the requirements of subsection E 501.07 (2).

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 501.10 Utilization equipment, fixed and portable. Utilization equipment, fixed and portable, shall conform to the following:

(1) CLASS I, DIVISION 1. In class I, division 1 locations, utilization equipment, including electrically-heated and motor-driven equipment shall be approved for class I locations.

(2) CLASS I, DIVISION 2. In class I, division 2 locations, utilization equipment, fixed and portable, shall conform to the following:

(a) *Heaters.* Electrically-heated utilization equipment shall be approved for class I locations.

(b) *Motors.* Motors of motor-driven utilization equipment shall conform to section E 501.08 (2).

(c) *Switches, circuit-breakers, and fuses.* Switches, circuit-breakers and fuses shall conform to section E 501.06 (2).

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 501.11 Flexible cords, class I, divisions 1 and 2. A flexible cord may be used only for connection between a portable lamp or other portable utilization equipment and the fixed portion of its supply circuit and where used shall (1) be of a type approved for extra hard usage, (2) contain, in addition to the conductors of the circuit, a grounding conductor conforming to section E 400.13, (3) be connected to terminals or to supply conductors in an approved manner, (4) be supported by clamps or by other suitable means in such a manner that there will be no tension on the terminal connections, and (5) suitable seals shall be provided where the flexible cord enters boxes, fittings or enclosures of explosion-proof type.

Note: Refer to section E 501.13 when flexible cords are exposed to liquids having a deleterious effect on the conductor insulation.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 501.12 Receptacles and attachment plugs, class I, divisions 1 and 2. Receptacles and attachment plugs shall be of the type providing for connection to the grounding conductor of the flexible cord, and shall be approved for class I locations.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 501.13 Conductor insulation class I, divisions 1 and 2. Where condensed vapors or liquids may collect on or come in contact with the insulation on conductors, such insulation shall be of a type approved for use under such conditions or the insulation shall be protected by a sheath of lead or by other approved means.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 501.14 Signal, alarm, remote-control and communication systems. Signal, alarm, remote-control and communication systems shall conform to the following:

(1) CLASS I, DIVISION 1. In class I, division 1 locations, all apparatus and equipment of signalling, alarm, remote-control and communication systems, irrespective of voltage, shall be approved for class I locations, and all wiring shall conform to sections E 501.04 (1) and E 501.05 (1) and (3).

(2) CLASS I, DIVISION 2. In class I, division 2 locations, signal, alarm, remote-control and communication systems shall conform to the following:

(a) *Contacts.* Switches and circuit breakers, and make and break contacts of push buttons, relays, and alarm bells or horns, shall have enclosures approved for class I locations, unless general purpose enclosures are provided and current interrupting contacts are 1. immersed in oil, or 2. enclosed within a chamber hermetically sealed against the entrance of gases or vapors, or 3. in circuits which under normal conditions do not release sufficient energy to ignite a specific hazardous atmospheric mixture.

(b) *Resistors and similar equipment.* Resistors, resistance devices, thermionic tubes and rectifiers shall conform to section E 501.03 (2) (b).

(c) *Protectors.* Enclosures which may be of general purpose type shall be provided for lightning protective devices and for fuses.

(d) All wiring shall conform to sections E 501.04 (2) and E 501.05 (2) and (3).

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 501.15 Live parts, class I, divisions 1 and 2. There shall be no exposed live parts.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 501.16 Grounding, class I, divisions 1 and 2. Wiring and equipment shall be grounded in conformity with the following:

(1) EXPOSED PARTS. The exposed non-current-carrying metal parts of equipment such as the frames or metal exteriors of motors, fixed or portable lamps or other utilization equipment, lighting fixtures, cabinets, cases, and conduit, shall be grounded as specified in Wis. Adm. Code chapter E 250.

(2) BONDING. The locknut-bushing and double-locknut types of contacts shall not be depended upon for bonding purposes, but bonding jumpers with proper fittings or other approved means shall be used. Such means of bonding shall apply to all intervening raceways, fittings, boxes, enclosures, etc. between hazardous areas and the point of grounding for service equipment. Where flexible conduit is used as permitted in section E 501.04 (2), bonding jumpers with proper fittings shall be provided around such conduit.

(3) LIGHTNING PROTECTION. Each ungrounded service conductor of a wiring system in a class I location, when supplied from an overhead line in an area where lightning disturbances are prevalent, shall be protected by a lightning protective device of proper type. Lightning protective devices shall be connected to the service conductors on the supply side of the service disconnecting means, and shall be bonded to the raceway system at the service entrance.

Note: Also refer to section E 502.03.

(4) GROUNDED SERVICE CONDUCTOR BONDED TO RACEWAY. Wiring in a class I location, when supplied from a grounded alternating current supply system in which a grounded conductor is a part of the service, shall have the grounded service conductor bonded to the raceway system and to the grounding conductor for the raceway system. The bonding connection to the grounded service conductor shall be made on the supply side of the service disconnecting means.

(5) TRANSFORMER GROUND BONDED TO RACEWAY. Wiring in a class I location, when supplied from a grounded alternating current supply system in which no grounded conductor is a part of the service, shall be provided with a metallic connection between the supply system ground and the raceway system at the service entrance. The metallic connection shall have ampacity not less than 1/5 that of the service conductors, and shall in no case be smaller than No. 10 when of soft copper, or No. 12 when of medium or hard-drawn copper.

(6) MULTIPLE GROUNDS. Where, in the application of section E 250.021, it is necessary to abandon one or more grounding connections to avoid objectionable passage of current over the grounding conductors, the connection required in subsections (4) and (5) shall not be abandoned while any other grounding connection remains connected to the supply system.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

Chapter E 502

CLASS II INSTALLATIONS; HAZARDOUS LOCATIONS

E 502.01 General. (1) The general rules of this code shall apply to the installation of electrical wiring and apparatus in locations classified as class II under section E 500.05 except as modified by this chapter.

(2) "Dust-ignition-proof", as used in this chapter, shall mean enclosed in a manner which will exclude ignitible amounts of dust or amounts which might affect performance or rating and which, when installation and protection are in conformance with this code, will not permit arcs, sparks or heat otherwise generated or liberated inside of the enclosure, to cause ignition of exterior accumulations or atmospheric suspensions of a specified dust on or in the vicinity of the enclosure.

(3) Equipment installed in class II locations shall be able to function at full rating without developing surface temperatures high enough to cause excessive dehydration or gradual carbonization of any organic dust deposits that may occur. Dust which is carbonized or is excessively dry is highly susceptible to spontaneous ignition. In general, maximum surface temperatures under actual operating conditions shall not exceed 165° C. (329° F.) for equipment which is not subject to overloading, and 120° C (248° F.) for equipment such as motors, power transformers, etc., which may be overloaded.

Note: Equipment and wiring of the type defined in chapter E 100 as explosion-proof is not required in class II locations, and may not be acceptable unless approved for such locations.

History: Cr. Register, January, 1968, No. 145, eff. 2–1–68.

E 502.02 Transformers and capacitors. The installation of transformers and capacitors shall conform to the following:

(1) CLASS II, DIVISION 1. In class II, division 1 locations, transformers and capacitors shall conform to the following:

(a) *Containing a liquid that will burn.* Transformers and capacitors containing a liquid that will burn shall be installed only in approved vaults conforming to sections E 450.41 to E 450.48 inclusive, and in addition 1. doors or other openings communicating with the hazardous area shall have self-closing fire doors on both sides of the wall, and the doors shall be carefully fitted and provided with suitable seals (such as weather stripping) to minimize the entrance of dust into the vault, 2. vent openings and ducts shall communicate only with the outside air, and 3. suitable pressure-relief openings communicating with the outside air shall be provided.

(b) *Not containing a liquid that will burn.* Transformers and capacitors which do not contain a liquid that will burn shall 1. be installed in vaults conforming to sections E 450.41 to E 450.48 inclusive, or 2. be approved as a complete assembly including terminal connections for class II locations.

(c) *Metal dusts.* No transformer or capacitor shall be installed in a location where dust from magnesium, aluminum, aluminum bronze powders, or other metals of similarly hazardous characteristics may be present.

(2) CLASS II, DIVISION 2. In class II, division 2 locations, transformers and capacitors shall conform to the following:

(a) *Containing a liquid that will burn.* Transformers and capacitors containing a liquid that will burn shall be installed in vaults conforming to sections E 450.41 to E 450.48 inclusive.

(b) *Containing askarel.* Transformers containing askarel and rated in excess of 25 kva shall 1. be provided with pressure-relief vents, 2. be provided with means for absorbing any gases generated by arcing inside the case, or the pressure-relief vents shall be connected to a chimney or flue which will carry such gases outside the building and 3. have an air space of not less than 6 inches between the transformer cases and any adjacent combustible material.

(c) *Dry-type transformers.* Dry-type transformers shall be installed in vaults or shall 1. have their windings and terminal connections enclosed in tight metal housings without ventilating or other openings, and 2. operate at voltages not exceeding 600 volts.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 502.03 Surge protection, class II, divisions 1 and 2. In geographical locations where lightning disturbances are prevalent, wiring systems in class II locations shall, when supplied from overhead lines, be suitably protected against high-voltage surges. This protection shall include suitable lightning protective devices, interconnection of all grounds, and surge-protective capacitors.

(1) Interconnection of all grounds shall include grounds for primary and secondary lightning protective devices, secondary system grounds if any, and grounds of conduit and equipment of the interior wiring system. For ungrounded secondary systems, secondary lightning protective devices may be provided both at the service and at the point where the secondary system receives its supply, and the intervening secondary conductors may be accepted as the metallic connection between the secondary protective devices, provided grounds for the primary and secondary devices are metallically interconnected at the supply end of the secondary system and the secondary devices are grounded to the raceway system at the load end of the secondary system.

(2) Surge protective capacitors shall be of a type especially designed for the duty, shall be connected to each ungrounded service

conductor, and shall be grounded to the interior conduit system. Capacitors shall be protected by 30-ampere fuses of suitable type and voltage rating, or by automatic circuit-breakers of suitable type and rating and shall be connected to the supply conductors on the supply side of the service disconnecting means.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 502.04 Wiring methods. Wiring methods shall conform to the following:

(1) CLASS II, DIVISION 1. In class II, division 1 locations, threaded rigid metal conduit or type MI cable with termination fittings approved for the location shall be the wiring method employed. Type MI cable shall be installed and supported in a manner to avoid tensile stress at the termination fittings.

(a) *Fittings and boxes.* Fittings and boxes shall be provided with threaded bosses for connection to conduit or cable terminations, shall have close fitting covers, and shall have no openings (such as holes for attachment screws) through which dust might enter, or through which sparks or burning material might escape. Fittings and boxes in which taps, joints or terminal connections are made, or which are used in locations where dusts are of an electrically-conducting nature shall be dust-ignition-proof and approved for class II locations.

(b) *Flexible connections.* Where necessary to employ flexible connections, dust-tight flexible connectors, liquid-tight flexible metal conduit with approved fittings, or flexible cord approved for extra hard usage and provided with bushed fittings shall be used, except that where dusts are of an electrically-conducting nature, flexible cords shall be provided with dust-tight seals at both ends. An additional conductor for grounding shall be provided in the flexible cord unless other acceptable means of grounding is provided. Where flexible connections are subject to oil or other corrosive conditions, the insulation of the conductors shall be of a type approved for the condition or shall be protected by means of a suitable sheath.

(2) CLASS II, DIVISION 2. In class II, division 2 locations, rigid metal conduit, electrical metallic tubing, type MI cable with approved termination fittings, or approved type MC or ALS cable with approved termination fittings for class II locations shall be the wiring method employed.

(a) *Fittings and boxes.* Fittings and boxes in which taps, joints or terminal connections are made shall be designed to minimize the entrance of dust, and 1. shall be provided with telescoping or close fitting covers, or other effective means to prevent the escape of sparks or burning material, and 2. shall have no openings (such as holes for attachment screws) through which, after installation, sparks or burning material might escape, or through which adjacent combustible material might be ignited.

(b) *Flexible connections.* Where flexible connections are necessary the provisions of subsection (1) (b) shall apply.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 502.05 Sealing. class II, divisions 1 and 2. Where a raceway provides communication between an enclosure which is required to be dust-ignition-proof and one which is not, suitable means shall be provided to prevent the entrance of dust into the dust-ignition-proof enclosure through the raceway. This means may be (1) a permanent and effective seal, (2) a horizontal section not less than 10 feet long in the raceway, or (3) a vertical section of raceway not less than 5 feet long and extending downward from the dust-ignition-proof enclosure. Sealing fittings shall be accessible.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 502.06 Switches, circuit-breakers, motor controllers, and fuses. Switches, circuit-breakers, motor controllers and fuses shall conform to the following:

(1) CLASS II, DIVISION 1. In class II, division 1 locations, switches, circuit-breakers, motor controllers and fuses shall conform to the following:

(a) *Type required.* Switches, circuit-breakers, motor controllers and fuses, including push buttons, relays and similar devices, which are intended to interrupt current in the normal performance of the function for which they are installed, or which are installed where dusts of an electrically-conducting nature may be present, shall be provided with dust-ignition-proof enclosures which, together with the enclosed apparatus in each case, shall be approved as a complete assembly for class II locations.

Note: This includes service and branch circuit fuses, switches and circuit-breakers, motor controllers (including push buttons, pilot switches, relays, and motor overload protective devices), and switches, fuses and circuit-breakers for the control and protection of lighting and appliance circuits.

(b) *Isolating switches.* Disconnecting and isolating switches containing no fuses and not intended to interrupt current, and which are not installed where dusts may be of an electrically-conducting nature, shall be provided with tight metal enclosures which shall be designed to minimize the entrance of dust, and which shall 1. be equipped with telescoping or close fitting covers, or with other effective means to prevent the escape of sparks or burning material, and 2. have no openings (such as holes for attachment screws) through which, after installation, sparks or burning material might escape, or through which exterior accumulations of dust or adjacent combustible material might be ignited.

(c) *Metal dusts.* In locations where dust from magnesium, aluminum, aluminum bronze powders, or other metals of similarly hazardous characteristics may be present, fuses, switches, motor controllers and circuit-breakers shall have enclosures specifically approved for such locations.

(2) CLASS II, DIVISION 2. In class II, division 2 locations, enclosures for fuses, switches, circuit-breakers and motor controllers including push buttons, relays and similar devices, shall conform to the requirements of subsection (1) (b).

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 502.07 Control transformers and resistors. Transformers, solenoids, impedance coils and resistors used as or in conjunction with control equipment for motors, generators and appliances shall conform to the following:

(1) CLASS II, DIVISION 1. In class II, division 1 locations, control transformers, solenoids, impedance coils and resistors, and any overcurrent devices or switching mechanisms associated with them shall have dust-ignition-proof enclosures approved for class II locations. No control transformer, impedance coil or resistor shall be installed in a location where dust from magnesium, aluminum, aluminum bronze powders, or other metals of similarly hazardous characteristics may be present unless provided with an enclosure specifically approved for such locations.

(2) CLASS II, DIVISION 2. In class II, division 2 locations, transformers and resistors shall conform to the following:

(a) *Switching mechanisms.* Switching mechanisms (including overcurrent devices) associated with control transformers, solenoids, impedance coils and resistors, shall be provided with enclosures conforming to section E 502.06 (1) (b).

(b) *Coils and winding.* Where not located in the same enclosure with switching mechanisms, control transformers, solenoids and impedance coils shall be provided with tight metal housings without ventilating openings.

(c) *Resistors.* Resistors and resistance devices shall have dust-ignition-proof enclosures approved for class II locations, except that where the maximum normal operating temperature of the resistor will not exceed 120° C. (248° F.) non-adjustable resistors and resistors which are part of an automatically timed starting sequence may have enclosures conforming to section E 502.07 (2) (b).

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 502.08 Motors and generators. Motors and generators shall conform to the following:

(1) CLASS II, DIVISION 1. In class II, division 1 locations, motors, generators, and other rotating electrical machinery shall be totally-enclosed not ventilated, totally-enclosed pipe ventilated, or totally-enclosed fan-cooled, and shall be approved as dust-ignition-proof for class II locations. Motors, generators or other rotating electrical machinery shall not be installed in locations where dust from magnesium, aluminum, aluminum bronze powders, or other metals of similarly hazardous characteristics may be present unless such machines are totally-enclosed, or totally-enclosed fan-cooled, and specially approved for such locations.

(2) CLASS II, DIVISION 2. In class II, division 2 locations, motors, generators and other rotating electrical machinery shall be totally-enclosed not ventilated, totally-enclosed pipe ventilated, or totally-enclosed fan-cooled, except that in locations where, in the judgment of the administrative authority, only moderate accumulations of non-conducting, non-abrasive dust are likely to occur, and where the equipment is readily accessible for routine cleaning and maintenance self-cleaning textile motors of the squirrel-cage type, standard open type machines without sliding contacts, centrifugal or other types of switching mechanism (including motor overcurrent devices), or integral resistance devices, or standard open type machines having such contacts, switching mechanisms or resistance devices enclosed within tight metal housings without ventilating or other openings, may be

installed. Motors, generators or other rotating electrical machinery of partially-enclosed or splashproof type shall not be installed in such locations.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 502.09 Ventilating piping. Vent pipes for motors, generators or other rotating electrical machinery, or for enclosures for electrical apparatus or equipment, shall be of metal not lighter than No. 24 MS (USS Revised) gauge, or of equally substantial noncombustible material, and shall: lead directly to a source of clean air outside of buildings, be screened at the outer ends to prevent the entrance of small animals or birds, be protected against physical damage and against rusting or other corrosive influences. In addition, vent pipes shall conform to the following:

(1) CLASS II, DIVISION 1. In class II, division 1 locations, vent pipes, including their connections to motors or to the dust-ignition-proof enclosures for other equipment or apparatus, shall be dust-tight throughout their length. For metal pipes, seams and joints shall be (a) riveted (or bolted) and soldered, (b) welded, or (c) rendered dust-tight by some other equally effective means.

(2) CLASS II, DIVISION 2. In class II, division 2 locations, vent pipes and their connections shall be sufficiently tight to prevent the entrance of appreciable quantities of dust into the ventilated equipment or enclosure, and to prevent the escape of sparks, flame or burning material which might ignite dust accumulations or combustible material in the vicinity. For metal pipes, lock seams and riveted or welded joints may be used, and tight-fitting slip joints may be used where some flexibility is necessary as at connections to motors.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 502.10 Utilization equipment, fixed and portable. Utilization equipment, fixed and portable, shall conform to the following:

(1) CLASS II, DIVISION 1. In class *II*, division 1 locations, utilization equipment, including electrically-heated and motor-driven equipment, shall be dust-ignition-proof approved for class II locations. Where dust from magnesium, aluminum, aluminum bronze powders, or other metals of similarly hazardous characteristics may be present, such equipment shall be specifically approved for such locations.

(2) CLASS II, DIVISION 2. In class II, division 2, locations, utilization equipment, fixed and portable, shall conform to the following:

(a) *Heaters.* Electrically-heated utilization equipment shall be dust-ignition-proof approved for class II locations.

(b) *Motors.* Motors of motor-driven utilization equipment shall conform to section E 502.08 (2).

(c) *Switches, circuit-breakers and fuses.* Enclosures for switches, circuit-breakers, and fuses shall conform to section E 502.06 (1) (b).

(d) *Transformers, impedance coils and resistors.* Transformers, solenoids, impedance coils and resistors shall conform to section E 502.07 (2).

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 502.11 Lighting fixtures. Lamps shall be installed in fixtures which shall conform to the following:

(1) CLASS II, DIVISION 1. In class II, division 1 locations, lighting fixtures for fixed and portable lighting shall conform to the following:

(a) *Approved fixtures.* Each fixture shall be dust-ignition-proof and approved for class II locations, and shall be clearly marked to indicate the maximum wattage of the lamp for which it is approved. In locations where dust from magnesium, aluminum, aluminum bronze powders, or other metals of similarly hazardous characteristics may be present, fixtures for fixed or portable lighting, and all auxiliary equipment, shall be specifically approved for such locations.

(b) *Physical damage.* Each fixture shall be protected against physical damage by a suitable guard or by location.

(c) *Pendent fixtures.* Pendent fixtures shall be suspended by threaded rigid conduit stems or chains with approved fittings, or by other approved means. For rigid stems longer than 12 inches permanent and effective bracing against lateral displacement shall be provided at a level not more than 12 inches above the lower end of the stem, or flexibility in the form of a fitting or a flexible connector approved for the purpose and for the location shall be provided not more than 12 inches from the point of attachment to the supporting box or fitting. Threaded joints shall be provided with set-screws or other effective means to prevent loosening. Where wiring between an outlet box or fitting and a pendent fixture is not enclosed in conduit, flexible cord approved for hard usage shall be used, and suitable seals shall be provided where the cord enters the fixture and the outlet box or fitting. Flexible cord shall not serve as the supporting means for a fixture.

(d) *Supports.* Boxes, box assemblies or fittings used for the support of lighting fixtures shall be approved for the purpose and for class II locations.

(2) CLASS II, DIVISION 2. In class II, division 2 locations, lighting fixtures shall conform to the following:

(a) *Portable lamps.* Portable lamps shall be dust-ignition-proof and approved for class II locations. They shall be clearly marked to indicate the maximum wattage of lamps for which they are approved.

(b) *Fixed lighting.* Lighting fixtures for fixed lighting, when not of a type approved for class II locations, shall provide enclosures for lamps and lampholders which shall be designed to minimize the deposit of dust on lamps and to prevent the escape of sparks, burning material or hot metal. Each fixture shall be clearly marked to indicate the maximum wattage of lamp which may be used without exceeding a maximum exposed surface temperature of 165°C. (329°F.) under normal conditions of use.

(c) *Physical damage.* Lighting fixtures for fixed lighting shall be protected from physical damage by suitable guards or by location.

(d) *Pendent fixtures.* Pendent fixtures shall be suspended by threaded rigid conduit stems or chains with approved fittings, or by other approved means. For rigid stems longer than 12 inches permanent and effective bracing against lateral displacement shall be provided at a level not more than 12 inches above the lower end of the stem, or flexibility in the form of a fitting or a flexible connector approved for the purpose shall be provided not more than 12 inches from the point of attachment to the supporting box or fitting. When wiring between an outlet box or fitting and a pendent fixture is not enclosed in conduit, flexible cord approved for hard usage shall be used. Flexible cord shall not serve as the supporting means for a fixture.

(e) *Supports.* Boxes, box assemblies and fittings used for the support of lighting fixtures shall be approved for that purpose.

(f) *Electric discharge lamps.* Starting and control equipment for mercury vapor and fluorescent lamps shall conform to the requirements of section E 502.07 (2).

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 502.12 Flexible cords, class II, divisions 1 and 2. Flexible cords used in class II locations shall (1) be of a type approved for extra hard usage, (2) contain, in addition to the conductors of the circuit, a grounding conductor conforming to section E 400.13 (3) be connected to terminals or to supply conductors in an approved manner, (4) be supported by clamps or by other suitable means in such a manner that there will be no tension on the terminal connections, and (5) be provided with suitable seals to prevent the entrance of dust where the flexible cord enters boxes or fittings which are required to be dust-ignition-proof.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 502.13 Receptacles and attachment plugs. (1) CLASS II, DIVISION 1. In class II, division 1 locations, receptacles and attachment plugs shall be of the type providing for connection to the grounding conductor of the flexible cord, and shall be dust-ignition-proof approved for class II locations.

(2) CLASS II, DIVISION 2. In class II, division 2 locations, receptacles and attachment plugs shall be of the type providing for connection to the grounding conductor of the flexible cord and shall be so designed that connection to the supply circuit cannot be made or broken while live parts are exposed.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 502.14 Signal, alarm, remote-control, and local loud-speaker intercommunication systems. Signal, alarm, remote-control and local loud-speaker intercommunication systems shall conform to the following:

Note: Refer to chapter E 800 for rules governing the installation of communication circuits as defined in chapter E 100.

(1) CLASS II, DIVISION 1. In class II, division 1 locations, signal, alarm, remote-control and local loud-speaker intercommunication systems shall conform to the following:

(a) *Wiring method.* Where accidental damage or breakdown of insulation might cause arcs, sparks or high temperatures, rigid metal conduit, electrical metallic tubing, or type MI cable with approved termination fittings shall be the wiring method employed. For conduit or electrical metallic tubing, the number of conductors shall be limited only by the requirement that the cross-sectional area of all conductors shall not exceed 40% of the area of the raceway. Where limited flexibility is desirable or where exposure to physical damage is not severe, flexible cord approved for extra-hard usage may be used.

(b) *Contacts.* Switches, circuit-breakers, relays, contactors and fuses which may interrupt other than voice currents, and current-breaking contacts for bells, horns, howlers, sirens and other devices in which sparks or arcs may be produced, shall be provided with enclosures approved for the location, unless current-breaking contacts are immersed in oil, or unless the interruption of current occurs within a chamber sealed against the entrance of dust, in which case enclosures may be of general purpose type.

(c) *Resistors and similar equipment.* Resistors, transformers and choke coils which may carry other than voice currents, and rectifiers, thermionic tubes, and other heat generating equipment or apparatus shall be provided with dust-ignition-proof enclosures approved for class II locations.

(d) *Rotating machinery.* Motors, generators and other rotating electrical machinery shall conform to section E 502.08 (1).

(e) *Electrical conducting dusts.* Where dusts are of an electrically-conducting nature, all wiring and equipment shall be approved for class II locations.

(f) *Metal dusts.* Where dust from magnesium, aluminum, aluminum bronze powders, or other metals of similarly hazardous characteristics may be present, all apparatus and equipment shall be specifically approved for such conditions.

(2) CLASS II, DIVISION 2. In class II, division 2 locations, signal, alarm, remote-control and local loud-speaker intercommunication systems shall conform to the following:

(a) *Contacts.* Enclosures shall conform to subsection (1) (b) or contacts shall have tight metal enclosures designed to minimize the entrance of dust, and shall have telescoping or tight fitting covers and no openings through which, after installation, sparks or burning material might escape.

(b) *Transformers and similar equipment.* The windings and terminal connections of transformers and choke coils shall be provided with tight metal enclosures without ventilating openings.

(c) *Resistors and similar equipment.* Resistors, resistance devices, thermionic tubes and rectifiers shall conform to subsection (1) (c) except that enclosures for thermionic tubes, non-adjustable resistors or rectifiers for which maximum operating temperature will not exceed 120°C. (248°F.) may be of general purpose type.

(d) *Rotating machinery.* Motors, generators and other rotating electrical machinery shall conform to section E 502.08 (b).

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 502.15 Live parts, class II, divisions 1 and 2. There shall be no exposed live parts.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 502.16 Grounding, class II, divisions 1 and 2. Wiring and equipment shall be grounded in conformity with the following:

(1) EXPOSED PARTS. The exposed non-current-carrying metal parts

of equipment such as the frames or metal exteriors of motors, fixed or portable lamps or other utilization equipment, lighting fixtures, cabinets, cases, and conduit, shall be grounded as specified in Wis. Adm. Code chapter E 250.

(2) BONDING. The locknut-bushing and double-locknut types of contact shall not be depended upon for bonding purposes, but bonding jumpers with proper fittings, or other approved means shall be used. Such means of bonding shall apply to all intervening raceways, fittings, boxes, enclosures, etc., between hazardous areas and the point of grounding for service equipment. Where flexible conduit is used as permitted in secton E 502.04, bonding jumpers with proper fittings shall be provided around such conduit.

(3) LIGHTNING PROTECTION. Each ungrounded service conductor of a wiring system in a class II location, when supplied from an ungrounded overhead electrical supply system in an area where lightning disturbances are prevalent, shall be protected by a lightning protective device of proper type. Lightning protective devices shall be connected to the service conductors on the supply side of the service disconnecting means, and shall be bonded to the raceway system at the service entrance.

(4) GROUNDED SERVICE CONDUCTOR BONDED TO RACEWAY. Wiring in a class II location, when supplied from a grounded alternating-current supply system in which a grounded conductor is a part of the service, shall have the grounded service conductor bonded to the raceway system and to the grounding conductor for the raceway system. The bonding connection to the grounded service conductor shall be made on the supply side of the service disconnecting means.

(5) TRANSFORMER GROUND BONDED TO RACEWAY. Wiring in a class II location, where supplied from a grounded alternating-current supply system in which no grounded conductor is a part of the service, shall be provided with a metallic connection between the supply system ground and the raceway system at the service entrance. The metallic connection shall have an ampacity not less than 1/5 that of the service conductors, and shall in no case be smaller than No. 10 when of soft copper. or No. 12 when of medium or hard-drawn copper.

(6) MULTIPLE GROUNDS. Where, in the application of section E 250.021, it is necessary to abandon one or more grounding connections to avoid objectionable passage of current over the grounding conductors, the connection required in subsection (4) or (5) shall not be abandoned while any other grounding connection remains connected to the supply system.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

Chapter E 503

CLASS III INSTALLATIONS; HAZARDOUS LOCATIONS

E 503.01 General. The general rules of this code shall apply to the installation of electrical wiring and apparatus in locations classified as class III under section E 500.06 except as modified by this chapter.

(1) Equipment installed in class III locations shall be able to function at full rating without developing surface temperatures high enough to cause excessive dehydration or gradual carbonization of accumulated fibers or flyings. Organic material which is carbonized or is excessively dry is highly susceptible to spontaneous ignition. In general, maximum surface temperatures under operating conditions shall not exceed 165°C. (329°F.) for equipment which is not subject to overloading, and 120°C. (248°F.) for equipment such as motors, power transformers, etc., which may be overloaded.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 503.02 Transformers and capacitors, class III, divisions 1 and 2. Transformers and capacitors shall conform to section E 502.02 (2).

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 503.03 Wiring methods. Wiring methods shall conform to the following:

(1) CLASS III, DIVISION 1. In class III, division 1 locations, rigid metal conduit or type MI cable shall be the wiring method employed.

(a) *Boxes and fittings.* Fittings and boxes in which taps, joints or terminal connections are made shall 1. be provided with telescoping or close fitting covers, or other effective means to prevent the escape of sparks or burning material, and 2. shall have no openings (such as holes for attachment screws) through which, after installation, sparks or burning material might escape, or through which adjacent combustible material might be ignited.

(b) *Flexible connections.* Where flexible connections are necessary the provisions of section E 502.04 (1) (b) shall apply.

(2) CLASS III, DIVISION 2. In class III, division 2 locations, the wiring method shall conform to subsection (1), except that in sections, compartments or areas used solely for storage and containing no machinery, open wiring on insulators may be employed when installed to conform to chapter E 320, but only on condition that protection as required by section E 320.12 be provided where conductors are not run in roof spaces, and well out of reach of sources of physical damage.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 503.04 Switches, circuit-breakers, motor controllers and fuses, class III, divisions 1 and 2. Switches, circuit-breakers, motor controllers and fuses, including pushbuttons, relays and similar devices, shall be provided with tight metal enclosures designed to minimize entrance of fibers and flyings, and which shall (1) be equipped with telescoping or close fitting covers, or with other effective means to prevent escape of sparks or burning material, and (2) have no openings (such as holes for attachment screws) through which, after installation, sparks or burning material might escape, or through which exterior accumulations of fibers or flyings or adjacent combustible material might be ignited.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 503.05 Control transformers and resistors, class III, divisions 1 and 2. Transformers, impedance coils and resistors used as or in conjunction with control equipment for motors, generators and appliances, shall conform to section E 502.07 (2), with the exception that, in class III, division 1 locations, when these devices are in the same enclosure with switching devices of such control equipment, and are used only for starting or short time duty, the enclosure shall conform to the requirements of section E 503.04.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 503.06 Motors and generators. Motors and generators shall conform to the following:

(1) CLASS III, DIVISION 1. In class III, division 1 locations, motors, generators, and other rotating electrical machinery shall be totally-enclosed not ventilated, totally-enclosed pipe ventilated, or totally-enclosed fan-cooled, except that in locations where, in the judgment of the administrative authority, only moderate accumulations of lint and flyings will be likely to collect on, in, or in the vicinity of a rotating electrical machine, and where such machine is readily accessible for routine cleaning and maintenance, self-cleaning textile motors of the squirrel-cage type, standard open type machines without sliding contacts, centrifugal or other types of switching mechanism (including motor overload devices), or standard open type machines having such contacts, switching mechanisms or resistance devices enclosed within tight metal housings without ventilating or other openings, may be installed.

(2) CLASS III, DIVISION 2. In class III, division 2 locations, motors, generators, and other rotating electrical machinery shall be totally-

enclosed not ventilated, totally-enclosed pipe ventilated, or totally-enclosed fan-cooled, except that in locations where, in the judgment of the administrative authority, only moderate accumulations of lint and flyings will be likely to collect on, in, or in the vicinity of a rotating electrical machine, and where such machine is readily accessible for routine cleaning and maintenance, self-cleaning textile motors of the squirrel-cage type, standard open type machines without sliding contacts, centrifugal or other types of switching mechanism (including motor overload devices), or standard open type machines having such contacts, switching mechanisms or resistance devices enclosed within tight metal housings without ventilating or other openings, may be installed.

(3) PARTIALLY ENCLOSED TYPE, CLASS III, DIVISIONS 1 AND 2. Motors, generators or other rotating electrical machinery of the partially enclosed or splash-proof type shall not be installed in class III locations.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 503.07 Ventilating piping, class III, divisions 1 and 2. Vent pipes for motors, generators or other rotating electrical machinery, or for enclosures for electrical apparatus or equipment, shall be of metal not lighter than No. 24 MS (USS Revised) gauge, or of equally substantial noncombustible material, and shall (1) lead directly to a source of clean air outside of buildings, (2) be screened at the outer ends to prevent the entrance of small animals or birds, (3) be protected against physical damage and against rusting or other corrosive influences, and (4) vent pipes and their connections shall be sufficiently tight to prevent the entrance of appreciable quantities of fibers or flyings into the ventilated equipment or enclosure, and to prevent the escape of sparks, flame or burning material which might ignite accumulations of fibers or flyings or combustible material in the vicinity. For metal pipes, lock seams and riveted or welded joints may be used, and tight fitting slip joints may be used where some flexibility is necessary as at connections to motors.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 503.08 Utilization equipment, fixed and portable, class III, divisions 1 and 2. Utilization equipment shall conform to the following:

(1) HEATERS. Electrically heated utilization equipment shall be approved for class III locations.

(2) MOTORS. Motors of motor-driven utilization equipment shall conform to section E 503.06 (2). Utilization equipment which may be readily moved from one location to another should conform to requirements for the most hazardous location.

(3) SWITCHES, CIRCUIT-BREAKERS, MOTOR CONTROLLERS AND FUSES. Switches, circuit-breakers, motor controllers and fuses shall conform to section E 503.04.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 503.09 Lighting fixtures, class III, divisions 1 and 2. Lamps shall be installed in fixtures which shall conform to the following:

(1) FIXED LIGHTING. Lighting fixtures for fixed lighting shall provide enclosures for lamps and lampholders which shall be designed

to minimize entrance of fibers and flyings, and to prevent the escape of sparks, burning material or hot metal. Each fixture shall be clearly marked to show wattage of lamp which may be used without exceeding a maximum exposed surface temperature of 165°C. (329°F.) under operating conditions of use.

(2) PHYSICAL DAMAGE. A fixture which may be exposed to physical damage shall be protected by a suitable guard.

(3) PENDENT FIXTURES. Pendent fixtures shall be suspended by stems of threaded rigid conduit or threaded metal tubing of equivalent thickness. For stems longer than 12 inches, permanent and effective bracing against lateral displacement shall be provided at a level not more than 12 inches above the lower end of the stem, or flexibility in the form of a fitting or a flexible connector approved for the purpose shall be provided not more than 12 inches from the point of attachment to the supporting box or fitting.

(4) SUPPORTS. Boxes, box assemblies or fittings used for the support of lighting fixtures shall be of a type approved for the purpose.

(5) PORTABLE LAMPS. Portable lamps shall be equipped with handles and protected with substantial guards, and lampholders shall be of unswitched type with no exposed metal parts and without provision for receiving attachment plugs. In all other respects, portable lamps shall conform to section E 503.09 (1).

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 503.10 Flexible cords, class III, divisions 1 and 2. Flexible cords shall conform to section E 502.12.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 503.11 Receptacles and attachment plugs, class III, divisions 1 and 2. Receptacles and attachment plugs shall conform to section E 502.13 (2).

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 503.12 Signal, alarm, remote-control and local loud-speaker intercommunication systems, class III, divisions 1 and 2. Signal, alarm, remote-control and local loud-speaker intercommunication systems shall conform to section E 502.14 (1).

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 503.13 Electric cranes and hoists, and similar equipment, class III, divisions 1 and 2. Where installed for operation over combustible fibers or accumulations of flyings, traveling cranes and hoists for material handling, traveling cleaners for textile machinery, and similar equipment shall conform to the following:

(1) Power supply to contact conductors shall be isolated from all other systems and shall be ungrounded, and shall be equipped with an acceptable recording ground detector which will give an alarm and will automatically de-energize the contact conductors in case of a fault to ground, or with an acceptable ground fault indicator which will give a visual and audible alarm, and maintain the alarm as long as power is supplied to the system and the ground fault remains.

(2) Contact conductors shall be so located or guarded as to be inaccessible to other than authorized persons, and shall be protected against accidental contact with foreign objects.

(3) Current collectors shall be arranged or guarded to confine normal sparking and to prevent escape of sparks or hot particles. To reduce sparking, 2 or more separate surfaces of contact shall be provided for each contact conductor. Reliable means shall be provided to keep contact conductors and current collectors free of accumulations of lint or flyings.

(4) Control equipment shall conform to sections E 503.04 and E 503.05.

Note: It is recommended that where the distance of travel permits, current to the crane be supplied through flexible cord approved for extra hard usage and equipped with approved type of reel or takeup device.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 503.14 Electric trucks. Electric trucks shall be used, maintained and operated in an approved manner.

Note: See NFPA standard No. 505.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 503.15 Storage-battery charging equipment, class III, divisions 1 and 2. Storage-battery charging equipment shall be located in separate rooms built or lined with substantial noncombustible materials so constructed as to adequately exclude flyings or lint, and shall be well ventilated.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 503.16 Live parts, class III, divisions 1 and 2. There shall be no exposed live parts except as provided in section E 503.13.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 503.17 Grounding, class III, divisions 1 and 2. Wiring and equipment shall be grounded in conformity with section E 502.16.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

Chapter E 510

HAZARDOUS LOCATIONS; SPECIFIC

E 510.01 Scope. The provisions of Wis. Adm. Code chapters E 511 to E 517 inclusive shall apply to occupancies or parts of occupancies which are or may be hazardous because of atmospheric concentrations of hazardous gases or vapors, or because of deposits or accumulations of materials which may be readily ignitible. It is the intent to assist the administrative authority in the classfication of areas with respect to hazardous conditions which may or may not require construction and equipment conforming to chapters E 501 to E 503 inclusive, and to set forth such additional special requirements as are applicable to the specific occupancy.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 510.02 General. The general rules of this code shall apply to the installation of electrical wiring and equipment in occupancies within the scope of chapters E 511 to E 517 inclusive, except as such rules are modified in those chapters. Where unusual conditions exist in a specific occupancy, the administrative authority shall judge with respect to the application of specific rules.

Note: It is recommended that the administrative authority be familiar with National Fire Protection Association standards applying to occupancies included within the scope of chapters E 511 to E 517 inclusive.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

Chapter E 511

COMMERCIAL GARAGES, REPAIR AND STORAGE

E 511.01 Scope. These occupancies shall include locations used for service and repair operations in connection with self-propelled vehicles (including passenger automobiles, busses, trucks, tractors, etc.) in which volatile flammable liquids or flammable gases are used for fuel or power, and locations in which more than 3 such vehicles are or may be stored at one time.

Note: For further information regarding classification of garages, refer to the NFPA Standard for Garages (No. 88).

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 511.02 Hazardous areas. Classification under chapter E 500. (1) For each floor at or above grade, the entire area up to a level 18 inches above the floor shall be considered to be a class I, division 2 location.

(2) For each floor below grade, the entire area up to a level 18 inches above the bottom of outside doors or other openings which are at or above grade level shall be considered to be a class I, division 2 location. Where adequate positive-pressure ventilation is provided, the administrative authority may judge that the hazardous location extends up to a level of only 18 inches above each such floor.

(3) Any pit or depression below floor level shall be considered to be a class I, division 2 location which shall extend up to said floor level, except that an individual unventilated pit or depression may be judged by the administrative authority to be a class I, division 1 location.

(4) Adjacent areas at the same or higher elevation and in which hazardous vapors are not likely to be released, such as offices, salesrooms, stock rooms, switchboard rooms and other similar locations, shall not be classed as hazardous.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 511.03 Wiring and equipment in hazardous areas. Within hazardous areas as defined in section E 511.02, wiring and equipment shall conform to applicable provisions of chapter E 501.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 511.04 Sealing. Approved seals conforming to the requirements of section E 501.05 shall be provided, and section E 501.05 (2) (b) shall apply to horizontal as well as to vertical boundaries of the defined hazardous areas. Raceways embedded in a masonry floor or buried beneath a floor shall be considered to be within the hazardous area above the floor if any connections or extensions lead into or through such area.

(1) EXCEPTION: Rigid raceways extending or running through a hazardous area without couplings, unions or fittings need not be sealed.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 511.05 Wiring in spaces above hazardous areas. (1) All fixed wiring shall be in metallic raceways or shall be type MI or type ALS cable. Cellular metal floor raceways may be used only for supplying ceiling outlets or extensions to the area below the floor, but such raceways shall have no connections leading into or through any hazardous area above the floor. No electrical conductor shall be installed in any cell, header or duct which contains a pipe for steam, water, air, gas, drainage, or other service except electrical.

(2) For pendants, flexible cord suitable for the type of service and approved for hard usage shall be used.

(3) For connection of portable lamps, motors or other utilization equipment, flexible cord suitable for the type of service and approved for extra hard usage shall be used.

(4) When a circuit which supplies portables or pendants includes an identified grounded conductor as provided in Wis. Adm. Code chapter E 200, receptacles, attachment plugs, connectors, and similar devices shall be of polarized type, and the identified conductor of the flexible cord shall be connected to the screw shell of any lampholder or to the identified terminal of any utilization equipment supplied.

(5) When a pendant is used to supply a portable lamp or utilization equipment, the female portion of a polarized pin-plug connector or equivalent shall be attached to the lower end of the pendant, and the male portion shall be attached to the cord for the portable. The connector shall be designed to break apart readily in any position, and shall be suspended at a level not less than that specified in section E 511.02. Attachment plug receptacles in fixed position shall be located above the level specified in section E 511.02.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 511.06 Equipment above hazardous areas. (1) Equipment which is less than 12 feet above floor level, and which may produce arcs, sparks or particles of hot metal, such as cutouts, switches, receptacles, charging panels, generators, motors, or other equipment (excluding lamps and lampholders) having make and break or sliding contacts, shall be of totally-enclosed type or shall be provided with suitable guards or screens to prevent escape of sparks or hot metal particles.

(2) Lamps, lampholders and fixtures for fixed lighting which are located over lanes through which vehicles are commonly driven or which may otherwise be exposed to physical damage, shall be located not less than 12 feet above floor level unless of totally-enclosed type or provided with suitable guards, screens or covers to prevent escape of sparks or hot metal particles.

(3) Portable lamps shall be equipped with handle, lampholder, hook and substantial guard attached to the lampholder or handle. All exterior surfaces which might come in contact with battery terminals, wiring terminals or other objects shall be of non-conducting material or shall be effectively protected with insulation. Lampholders shall be

of unswitched type, and shall not provide means for plug-in of attachment plugs. Outer shell shall be of moulded composition or other material approved for the purpose, and metal-shell, lined lampholders, either of switched or unswitched type, shall not be used. Unless the lamp and its cord are supported or arranged in such a manner that they cannot be used in the hazardous areas classified in section E 511.02, they shall be of a type approved for such hazardous locations.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 511.07 Battery-charging equipment. Battery chargers and their control equipment, and batteries being charged shall not be located within hazardous areas classified in section E 511.02. Tables, racks, trays, and wiring shall, in addition, conform to the provisions of Wis. Adm. Code chapter E 480.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 511.08 Electric vehicle charging. (1) Flexible cords used for charging shall be suitable for the type of service and approved for extra hard usage. Their ampacity shall be adequate for the charging current.

(2) Connectors shall have a rating not less than the ampacity of the cord, and in no case less than 50 amperes.

(3) Connectors shall be so designed and installed that they will break apart readily at any position of the charging cable, and live parts shall be guarded from accidental contact. No connector shall be located within a hazardous area defined in section E 511.02.

(4) Where plugs are provided for direct connection to vehicles, the point of connection shall not be within a hazardous area as defined in section E 511.02, and where the cord is suspended from overhead, it shall be so arranged that the lowest point of sag is at least 6 inches above the floor. Where the vehicle is equipped with an approved plug which will readily pull apart, and where an automatic arrangement is provided to pull both cord and plug beyond the range of physical damage, no additional connector is required in the cable or at the outlet.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

Chapter E 512

RESIDENTIAL STORAGE GARAGES

E 512.01 Definition. A residential storage garage is a building or room in which not more than 3 vehicles of the types described in section E 511.01 are or may be stored, but which will not normally be used for other than minor service or repair operations on such stored vehicles.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 512.02 At or above grade. Where the lowest floor is at or above adjacent ground or driveway level, and where there is at least one outside door at or below floor level, the garage area shall not be classed as a hazardous location.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 512.03 Below grade. Where the lowest floor is below adjacent ground or driveway level, the following shall apply:

(1) The entire area of the garage or of any enclosed space which includes the garage shall be classified as a class I, division 2 location up to a level 18 inches above the garage floor. All electrical equipment and wiring within such hazardous location shall conform to applicable provisions of chapter E 501.

(2) Wiring and equipment above the defined hazardous location shall conform to the requirements of this code for non-hazardous locations.

(3) Adjacent areas in which hazardous vapors or gases are not likely to be released, and having floors elevated at least 18 inches above the garage floor, or separated therefrom by tight curbs or partitions at least 18 inches high, shall not be classed as hazardous.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

Chapter E 513

AIRCRAFT HANGARS

E 513.01 Definition. This occupancy shall include locations used for storage or servicing of aircraft in which gasoline, jet fuels, or other volatile flammable liquids, or flammable gases, are used, but shall not include such locations when used exclusively for aircraft which have never contained such liquids or gases, or which have been drained and properly purged.

History: Cr. Register, January, 1968, No. 145, eff. 2–1–68.

E 513.02 Hazardous areas. Classification under chapter E 500. (1) Any pit or depression below the level of the hangar floor shall be considered to be a class I, division 1 location which shall extend up to said floor level.

(2) The entire area of the hangar including any adjacent and communicating areas not suitably cut off from the hangar shall be considered to be a class I, division 2 location up to a level 18 inches above the floor.

(3) The area within 5 feet horizontally from aircraft power plants, aircraft fuel tanks or aircraft structures containing fuel shall be considered to be a class I, division 2 hazardous location which shall extend upward from the floor to a level 5 feet above the upper surface of wings and of engine enclosures.

(4) Adjacent areas in which hazardous vapors are not likely to be released such as stock rooms, electrical control rooms, and other similar locations, shall not be classed as hazardous when adequately ventilated and when effectively cut off from the hangar itself by walls or partitions.

History: Cr. Register, January, 1968, No. 145, eff. 2–1–68.

E 513.03 Wiring and equipment in hazardous areas. All fixed and portable wiring and equipment which is or may be installed or operated within any of the hazardous locations defined in section E 513.02 shall conform to applicable provisions of chapter E 501. All wiring installed in or under the hangar floor shall conform to the requirements for class I, division 1. When such wiring is located in vaults, pits, or ducts, adequate drainage shall be provided, and the wiring shall not be placed within the same compartment with any other service except piped compressed air.

History: Cr. Register, January, 1968, No. 145, eff. 2–1–68.

E 513.04 Wiring not within hazardous areas. (1) All fixed wiring in a hangar, but not within a hazardous area as defined in section E 513.02, shall be installed in metallic raceways or shall be type MI or type ALS cable, except that wiring in non-hazardous locations as defined in section E 513.02 (4) may be of any type recognized in chapter E 300 of this code.

(2) For pendants, flexible cord suitable for the type of service and approved for hard usage shall be used. Each such cord shall include a separate grounding conductor.

(3) For portable utilization equipment and lamps, flexible cord suitable for the type of service and approved for extra hard usage shall be used. Each such cord shall include a separate grounding conductor.

(4) Where a circuit which supplies portables or pendants includes an identified grounded conductor as provided in chapter E 200, receptacles, attachment plugs, connectors, and similar devices shall be of polarized type, and the identified conductor of the flexible cord shall be connected to the screw shell of any lampholder or to the identified terminal of any utilization equipment supplied. Acceptable means shall be provided for maintaining continuity of the grounding conductor between the fixed raceway system and the non-current-carrying metallic portions of pendent fixtures, portable lamps, and portable utilization equipment.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 513.05 Equipment not within hazardous areas. (1) In locations other than those described in section E 513.02, equipment which is less than 10 feet above wings and engine enclosures of aircraft and which may produce arcs, sparks or particles of hot metal, such as lamps and lampholders for fixed lighting, cutouts, switches, receptacles, charging panels, generators, motors, or other equipment having make and break or sliding contacts, shall be of totally-enclosed type or shall be provided with suitable guards or screens to prevent escape of sparks or hot metal particles, except that equipment in areas described in section E 513.02 (4) may be of general purpose type.

(2) Lampholders of metal shell, fiber-lined types shall not be used for fixed incandescent lighting.

(3) Portable lamps which are or may be used within a hangar shall be approved for class I locations.

(4) Portable utilization equipment which is or may be used within a hangar shall be of a type suitable for use in class I, division 2 locations.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 513.06 Stanchions, rostrums and docks. (1) Electric wiring, outlets and equipment (including lamps) on or attached to stanchions, rostrums or docks which are located or likely to be located in a hazardous area as defined in section E 513.02 (3) shall conform to the requirements for class I, division 2 locations.

(2) Where stanchions, rostrums, or docks are not located or likely to be located in a hazardous area as defined in section E 513.02 (3), wiring and equipment shall conform to sections E 513.04 and E 513.05, except that such wiring and equipment not more than 18 inches above the floor in any position shall conform to section E 513.06 (1).

Receptacles and attachment plugs shall be of locking type which will not break apart readily.

(3) Mobile stanchions with electrical equipment conforming to section E 513.06 (2) shall carry at least one permanently affixed warning sign to read: "WARNING—KEEP 5 FEET CLEAR OF AIRCRAFT ENGINES AND FUEL TANK AREAS."

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 513.07 Sealing. Approved seals shall be provided in conformance with section E 501.05, and subsections E 501.05 (1) (c) and E 501.05 (2) (b) and shall apply to horizontal as well as vertical boundaries of the defined hazardous areas. Raceways embedded in a masonry floor or buried beneath a floor shall be considered to be within the hazardous area above the floor when any connections or extensions lead into or through such area.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 513.08 Aircraft electrical systems. Aircraft electrical systems should be de-energized when the aircraft is stored in a hangar, and, whenever possible, while the aircraft is undergoing maintenance.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 513.09 Aircraft battery; charging and equipment. (1) Aircraft batteries should not be charged when installed in an aircraft located inside or partially inside a hangar.

(2) Battery chargers and their control equipment shall not be located or operated within any of the hazardous areas defined in section E 513.02, and should preferably be located in a separate building or in an area such as described in section E 513.02 (4). Mobile chargers shall carry at least one permanently affixed warning sign to read: "WARNING—KEEP 5 FEET CLEAR OF AIRCRAFT ENGINES AND FUEL TANK AREAS." Tables, racks, trays, and wiring shall not be located within a hazardous area, and shall, in addition, conform to the provisions of chapter E 480.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 513.10 External power sources for energizing aircraft. (1) Aircraft energizers shall be so designed and mounted that all electrical equipment and fixed wiring will be at least 18 inches above floor level and shall not be operated in a hazardous area as defined in section E 513.02 (3).

(2) Mobile energizers shall carry at least one permanently affixed warning sign to read: "WARNING—KEEP 5 FEET CLEAR OF AIRCRAFT ENGINES AND FUEL TANK AREAS."

(3) Aircraft energizers shall be equipped with polarized external power plugs and shall have automatic controls to isolate the ground power unit electrically from the aircraft in case excessive voltage is generated by the ground power unit.

(4) Flexible cords for aircraft energizers and ground support equipment shall be approved for the type of service and extra hard usage and shall include a ground conductor.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 513.11 Mobile servicing equipment with electrical components. (1) Mobile servicing equipment (such as vacuum cleaners, air compressors, air movers, etc.) having electrical wiring and equipment not suitable for class I, division 2 locations shall be so designed and mounted that all such fixed wiring and equipment will be at least 18 inches above the floor. Such mobile equipment shall not be operated within the hazardous areas defined in section E 513.02 (3) and shall carry at least one permanently affixed warning sign to read: "WARNING—KEEP 5 FEET CLEAR OF AIRCRAFT ENGINES AND FUEL TANK AREAS."

(2) Flexible cords for mobile equipment shall be suitable for the type of service and approved for extra hard usage, and shall include a grounding conductor. Attachment plugs and receptacles shall be approved for the location in which they are installed, and shall provide for connection of the grounding conductor to the raceway system.

(3) Equipment not of a type suitable for class I, division 2 locations shall not be operated in areas where maintenance operations likely to release hazardous vapors are in progress.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 513.12 Grounding. All metallic raceways, and all non-current-carrying metallic portions of fixed or portable equipment, regardless of voltage, shall be grounded as provided in Wis. Adm. Code chapter E 250.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

Chapter E 514

GASOLINE DISPENSING AND SERVICE STATIONS

E 514.01 Definitions. (1) This classification shall include locations where gasoline or other volatile flammable liquids or liquefied flammable gases are transferred to the fuel tanks (including auxiliary fuel tanks) of self-propelled vehicles.

(2) Other areas used as lubritoriums, service rooms and repair rooms, and offices, salesrooms, compressor rooms and similar locations shall conform to chapters E 510 and E 511 with respect to electrical wiring and equipment.

Note 1: Where the authority enforcing the code can satisfactorily determine that flammable liquids having a flash point below 100° F such as gasoline will not be handled, he may classify such an area as non-hazardous.

Note 2: For further information regarding safeguards for gasoline dispensing and service stations see NFPA Flammable Liquids Code (No. 30).

History: Cr. Register, January, 1968, No. 145, eff. 2–1–68.

E 514.02 Hazardous areas. (1) The space within the dispenser up to 4 feet from its base and the space within 18 inches extending horizontally from the dispenser up to 4 feet from its base shall be considered a class I, division 1 location. This classification shall also apply to any space below the dispenser which may contain electrical wiring or equipment.

(2) In an outside location, any area (excluding class I, division 1, but including buildings not suitably cut off) within 20 feet horizontally from the exterior enclosure of any dispensing pump shall be considered class I, division 2 location which will extend to a level 18 inches above driveway or ground level.

(3) In an outside location, any area (excluding class I, division 1, but including buildings not suitably cut off) within 10 feet horizontally from any tank fill-pipe shall be considered class I, division 2 location which shall extend upward to a level 18 inches above driveway or ground level.

(4) Electrical wiring and equipment, any portion of which is below the surface of areas defined as class I, division 1 or division 2 in subsections (1), (2), (3) above shall be considered to be within a class I, division 1 location which shall extend at least to the point of emergence above grade.

(5) The spherical volume within a 3 foot radius from point of discharge of any tank vent-pipe shall be considered a class I, division 1 location and the volume between 3 foot to 5 foot radius from point of discharge of a vent shall be considered a class I, division 2 location. For any vent that does not discharge upward, the cylindrical volume below both the division 1 and 2 locations extending to the

ground shall be considered a class I, division 2 location. The hazardous area shall not extend beyond an unpierced wall.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 514.03 Wiring and equipment within hazardous areas. All electrical equipment and wiring within the hazardous areas defined in section E 514.02 shall conform to applicable provisions of chapter E 501.

Note: For special requirements for conductor insulation, see section E 501.13.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 514.04 Wiring and equipment above hazardous areas. Wiring and equipment above hazardous areas defined in section E 514.02 shall conform to sections E 511.05 and E 511.06.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 514.05 Circuit disconnects. Each circuit leading to or through a dispensing pump shall be provided with a switch or other acceptable means to disconnect simultaneously from the source of supply all conductors of the circuit including the grounded neutral, if any.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 514.06 Sealing. (1) An approved seal shall be provided in each conduit run entering or leaving a dispenser or any cavities or enclosures in direct communication therewith. The sealing fittng shall be the first fitting after the conduit emerges from the earth or concrete.

Note: This paragraph states that the first fitting after the conduit emerges from the slab or from the concrete must be the sealing fitting. Above the fitting, the remainder of the wiring and equipment is required to conform to the rules for the area classification involved.

(2) Additional seals shall be provided in conformance with section E 501.05 and sections E 501.05 (1) (c) and E 501.05 (2) (b) shall apply to horizontal as well as to vertical boundaries of the defined hazardous areas.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 514.07 Grounding. Metallic portions of dispensing pumps, metallic raceways, and all non-current-carrying portions of electrical equipment, regardless of voltage, shall be grounded as provided in chapter E 250.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 514.08 Underground wiring. Underground wiring shall be installed in rigid metal conduit, or, where buried under not less than 2 feet of earth, may be installed in non-metallic conduit conforming to the requirements of section E 347.02 (3). Where non-metallic conduit is used, an additional grounding conductor shall be included to provide for metallic continuity of the raceway system and for grounding of noncurrent carrying metallic parts of equipment.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

Chapter E 515

BULK-STORAGE PLANTS

E 515.01 Definition. This designation shall include locations where gasoline or other volatile flammable liquids are stored in tanks having an aggregate capacity of one carload or more, and from which such products are distributed (usually by tank truck).

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 515.02 Hazardous areas. (1) PUMPS, BLEEDERS, WITHDRAWAL FITTINGS, METERS AND SIMILAR DEVICES. (a) Adequately ventilated indoor areas containing pumps, bleeders, withdrawal fittings, meters and similar devices which are located in pipe lines handling flammable liquids under pressure shall be considered as class 1, division 2 locations within a 5 foot distance extending in all directions from the exterior surface of such devices. The class 1, division 2 location shall also extend 25 feet horizontally from any surface of these devices and extend upward to 3 feet above floor or grade level.

Note: See Flammable Liquids Code, NFPA No. 30, for discussion of factors influencing adequacy of ventilation required to prevent formation of hazardous vapor-air mixtures.

(b) Inadequately ventilated indoor areas containing pumps, bleeders, withdrawal fittings, meters and similar devices which are located in pipe lines handling flammable liquids under pressure shall be considered as class I, division 1 location within a 5 foot distance extending in all directions from the exterior surface of such devices. The class I, division 1 location shall also extend 25 feet horizontally from any surface of the devices and extend upward to 3 feet above floor or grade level.

(c) Outdoor areas containing pumps, bleeders, withdrawal fittings, meters and similar devices which are located in pipe lines handling flammable liquids under pressure shall be considered as class I, division 2 locations within a 3 foot distance extending in all directions from the exterior surface of such devices. The class I, division 2 location shall also extend up to 18 inches above grade level within 10 feet horizontally from any surface of the devices.

(2) TRANSFER OF FLAMMABLE LIQUIDS TO INDIVIDUAL CONTAINERS. (a) In outdoor areas or where positive and reliable mechanical ventilation is provided in indoor areas in which flammable liquids are transferred to individual containers, such areas shall be considered to be a class I, division 1 location within 3 feet of the vent or fill opening extending in all directions and a class I, division 2 location

within the area extending between a 3 foot and 5 foot radius from the vent or fill opening extending in all directions, and including the area within a horizontal radius of 10 feet from the vent or fill opening and extending to a height of 18 inches above floor or grade levels.

Note: See Flammable Liquids Code, NFPA No. 30, for discussion of factors influencing adequacy and reliability of mechanical ventilation required to prevent formation of hazardous vapor-air mixtures.

(b) When positive and reliable mechanical ventilation is not provided in indoor areas in which flammable liquds are transferred to individual containers, such areas shall be considered to be a class I, division 1 location.

(3) LOADING AND UNLOADING OF TANK VEHICLES AND TANK CARS IN OUTSIDE LOCATIONS. (a) The area extending 3 feet in all directions from the dome when loading through an open dome or from the vent when loading through a closed dome with atmospheric venting shall be considered a class I, division 1 location.

(b) The area extending between a 3 foot and 5 foot radius from the dome when loading through an open dome or from the vent when loading through a closed dome with atmospheric venting shall be considered a class I, division 2 location.

(c) The area extending within 3 feet in all directions from a fixed connection used in bottom loading or unloading, loading through a closed dome with atmospheric venting, or loading through a closed dome with a vapor recovery system, shall be considered a class I, division 2 location. In the case of bottom loading or unloading this classification shall also be applied to the area within a 10 foot radius from point of connection and extending 18 inches above grade.

Note: In deciding upon extent of hazardous area, consideration should be given to the total area within which loading and unloading operation may occur such as racks, platforms, driveways, etc.

(4) ABOVEGROUND TANKS. (a) The area above the roof and within the shell of a floating roof type tank shall be considered a class I, division 1 location.

(b) For all types of above ground tanks the area within 10 feet from the shell, ends and roof of other than a floating roof shall be considered a class I, division 2 location. Where dikes are provided the area inside the dike and extending upward to the top of the dike shall be considered to be a class I, division 2 location.

(c) The area within 5 feet of a vent opening and extending in all directions shall be considered a class I, division 1 location.

(d) The area between 5 and 10 feet of a vent opening and extending in all directions shall be considered a class I, division 2 location.

(e) Open conductors shall not pass over aboveground flammable liquids storage tanks. Such conductors operating at more than 300 volts to ground shall be kept at least 15 feet horizontally from such tanks. When the voltage is 300 or below a horizontal clearance of not less than 8 feet shall be maintained.

Note: For underground tanks see chapter E 514.

(5) PITS. (a) Any pit or depression, any part of which lies within a division 1 or division 2 location as defined herein, shall be considered a class I, division 1 location unless provided with positive and reliable mechanical ventilation.

(b) Any such areas when provided with positive and reliable mechanical ventilation shall be considered a class I, division 2 location.

Note: See Flammable Liquids Code, NFPA No. 30, for discussion of factors pertaining to positive and reliable mechanical ventilation required to prevent formulation of hazardous vapor-air mixtures.

(c) Any pit or depression not within a division 1 or division 2 location as defined herein, but which contains piping, valves or fittings shall be classified as a class I, division 2 location.

(6) STORAGE AND REPAIR GARAGES FOR TANK VEHICLES. Storage and repair garages for tank vehicles shall be considered to be a class I, division 2 location up to 18 inches above floor or grade level unless in the judgment of the authority enforcing this code conditions warrant more severe classification or a greater extent of the hazardous area.

(7) LOCATIONS OUTSIDE THE LIMITS OF HAZARDOUS AREAS. Office buildings, boiler rooms and other similar locations which are outside the limits of hazardous areas as defined herein, and which are not used for handling or storage of volatile flammable liquids or containers for such liquids, shall not be considered to be hazardous locations.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 515.03 Wiring and equipment within hazardous areas. All electrical wiring and equipment within the hazardous areas defined in section E 515.02 shall conform to applicable provisions of chapter E 501.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 515.04 Wiring and equipment above hazardous areas. All fixed wiring above hazardous areas shall be in metallic raceways or shall be type ALS cable. Fixed equipment which may produce arcs, sparks or particles of hot metal, such as lamps and lampholders for fixed lighting, cutouts, switches, receptacles, motors, or other equipment having make and break or sliding contacts, shall be of totally-enclosed type or shall be provided with suitable guards or screens to prevent escape of sparks or hot metal particles. Portable lamps or utilization equipment, and their flexible cords shall conform to the provisions of chapter E 501 for the class of location above which they are connected or used.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 515.05 Underground wiring. (1) Underground wiring shall be installed in rigid metal conduit, or, where buried under not less than 2 feet of earth, may be installed in non-metallic conduit or duct, or in the form of cable approved for the purpose. Where cable is used, it shall be enclosed in rigid metal conduit from the point of lowest buried cable level to the point of connection to the aboveground raceway.

(2) Conductor insulation shall conform to section E 501.13 of chapter E 501.

(3) Where cable with non-metallic sheath or non-metallic conduit is used, an additional grounding conductor shall be included to provide

for metallic continuity of the raceway system and for grounding of non-current-carrying metallic parts of equipment.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 515.06 Sealing. Approved seals shall be provided in conformance with section E 501.05 and subsections E 501.05 (1) (c) and E 501.05 (2) (b) shall apply to horizontal as well as to vertical boundaries of the defined hazardous areas. Buried raceways under defined hazardous areas shall be considered to be within such areas.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 515.07 Gasoline dispensing. Where gasoline dispensing is carried on in conjunction with bulk station operations, applicable provisions of chapter E 514 shall apply.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 515.08 Grounding. All metallic raceways, and all non-current-carrying metallic portions of electrical equipment shall be grounded as provided in Wis. Adm. Code chapter E 250.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

Chapter E 516

FINISHING PROCESSES

E 516.01 Definition. This chapter shall apply to locations where paints, lacquers or other flammable finishes are regularly or frequently applied by spraying, dipping, brushing or by other means, and where volatile flammable solvents or thinners are used or where readily ignitible deposits or residues from such paints, lacquers or finishes may occur.

Note: For information regarding safeguards for finishing processes, see the Wisconsin Administrative Code chapter Ind 21, NFPA Standard for Spray Finishing Using Flammable Materials (No. 33) and the NFPA Standard for Dip Tanks Containing Flammable or Combustible Liquids (No. 34).

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 516.02 Hazardous areas. Classification with respect to flammable vapors. For deposits and residues, see section E 516.03.

(1) The following areas shall be considered to be class I, division 1 locations:

(a) The interiors of spray booths and their exhaust ducts.

(b) 20 feet horizontally and up to an elevation of 12 feet above the floor or 7 feet above the work, whichever is higher where open-spraying operations more extensive than touch-up spraying are permitted. The dimensions may be reduced if the space is limited by a ceiling or permanent walls.

(c) 20 feet horizontally and 12 feet above the floor or 7 feet above the top of dip tanks and their drain boards, whichever is higher. The dimensions may be reduced if the space is limited by a ceiling or permanent walls.

(d) Spaces where hazardous concentrations of flammable vapors are likely to occur.

(2) The following shall be considered to be class I, division 2 locations:

(a) A rectangular base area 10 feet wide having a long side extending across any door, open face, material handling or conveyor opening and 10 feet beyond either face of these openings and extending to the ceiling or 5 feet above the top of the booth. The upper limit for any hazardous area through which material passes after leaving the booth shall be at least 7 feet above the work. The hazardous area shall not include any space directly above the booth.

1. EXCEPTION No. 1. Where a fully closing door is equipped with an additional electric interlock so installed and interconnected with the compressed air supply for spray painting as to prevent spraying

unless the door is fully closed, that door need not be considered an opening for the purpose of this subsection.

2. EXCEPTION NO. 2. Door openings equipped with suitable filter pads need not be considered for the purpose of this subsection.

(b) Thirty feet horizontally beyond the limits of class I, division 1 areas (see subsection (1)) surrounding open spraying dip tanks and drain boards and other hazardous operations. The vertical dimension of the class I, division 2 area shall be the same as the class I, division 1 area. The area need not extend above ceilings nor beyond permanent walls.

(3) Adjacent areas which are cut off from the defined hazardous areas by tight partitions without communicating openings, and within which hazardous vapors are not likely to be released, shall be classed as non-hazardous.

(4) Drying and baking areas provided with positive mechanical ventilation adequate to prevent formation of flammable concentrations of vapors, and provided with effective interlocks to de-energize all electrical equipment (other than equipment approved for class I locations) in case the ventilating equipment is inoperative, may be classed as non-hazardous.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 516.03 Wiring and equipment in hazardous areas. (1) All electrical wiring and equipment within the hazardous areas defined in section E 516.02 shall conform to applicable provisions of chapter E 501.

(2) Unless approved for both readily ignitible deposits and the flammable vapor location, no electrical equipment shall be installed or used where it may be subject to hazardous accumulations of readily ignitible deposits or residues, except that wiring in rigid conduit or in threaded boxes or fittings containing no taps, splices or terminal connections may be installed in such locations. Type MI cable without fittings or boxes may be used.

(3) Illumination of readily ignitible areas through panels of glass or other transparent or translucent material is permissible only where: (a) fixed lighting units are used as the source of illumination, (b) the panel effectively isolates the hazardous area from the area in which the lighting unit is located, (c) the lighting unit is approved for its specific location, (d) the panel is of a material or is so protected that breakage will be unlikely and (e) the arrangement is such that normal accumulations of hazardous residue on the surface of the panel will not be raised to a dangerous temperature by radiation or conduction from the source of illumination.

(4) Portable electric lamps or other utilization equipment shall not be used within a hazardous area during operation of the finishing process. When such lamps or utilization equipment are used during cleaning or repairing operations, they shall be of a type approved for class I locations, and all exposed metal parts shall be effectively grounded.

(5) Electrostatic spraying or detearing equipment shall be installed and used only as provided in section E 516.04.

Note: For more details, see NFPA No. 33.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 516.04 Fixed electrostatic equipment. Where electrostatic spraying and detearing equipment is installed, such equipment shall be of approved type, and shall conform to the following requirements:

(1) No transformers, power packs, control apparatus, or other electrical portion of the equipment (except high voltage grids and their connections) shall be installed in any of the hazardous areas defined in section E 516.02 unless of a type approved for the location.

(2) High voltage grids or electrodes shall be located in suitable noncombustible booths or enclosures provided with adequate mechanical ventilation, shall be rigidly supported and of substantial construction, and shall be effectively insulated from ground by means of non-porous noncombustible insulators.

(3) High voltage leads shall be effectively and permanently supported on suitable insulators, shall be effectively guarded against accidental contact or grounding, and shall be provided with automatic means for discharging any residual charge to ground when the supply voltage is interrupted.

(4) Goods being processed shall be supported on conveyors in such a manner that minimum clearance between goods and high voltage grids or conductors cannot be less than twice the sparking distance. A conspicuous sign indicating the sparking distance shall be permanently posted near the equipment.

(5) Approved automatic controls which will operate without time-delay shall be provided to disconnect the power supply and to signal the operator in case of (a) stoppage of ventilating fans or failure of ventilating equipment from any cause, (b) stoppage of the conveyor carrying goods through the high voltage field, (c) occurrence of a ground or of an imminent ground at any point on the high voltage system, or (d) reduction of clearance below that specified in subsection (4).

(6) Adequate fencing, railings or guards which are electrically conducting and effectively grounded shall be provided for safe isolation of the process, and signs shall be permanently posted designating the process zone as dangerous because of high voltage.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 516.05 Electrostatic hand spraying equipment. Electrostatic hand spray apparatus and devices used in connection with paint spraying operations shall be of approved types and shall conform to the following requirements:

(1) The equipment shall be so designed that the maximum surface temperature of the equipment in the spraying area cannot exceed 150°F. under any condition. The high voltage circuits shall be designed so as to be intrinsically safe and not produce a spark of sufficient intensity to ignite any vapor-air mixtures nor result in appreciable shock hazard upon coming on contact with a grounded object. The electrostatically charged exposed elements of the hand gun shall be capable of being energized only by a switch which also controls the paint supply.

(2) Transformers, power packs, control apparatus, and all other electrical portion of the equipment, with the exception of the hand gun itself and its connections othe power supply, shall be located outside of the hazardous area.

(3) The handle of the spraying gun shall be electrically connected to ground by a metallic connection and be so constructed that the operator in normal operating position is in intimate electrical contact with the grounded handle. This requirement is to prevent buildup of a static charge on the operator's body.

(4) All electrically conductive objects in the spraying area shall be adequately grounded. This requirement shall apply to paint containers, wash cans and any other objects or devices in the area. The equipment shall carry a prominent permanently installed warning regarding the necessity for this grounding feature.

(5) Objects being painted shall be maintained in metallic contact with the conveyor or other grounded support. Hooks shall be regularly cleaned to insure this contact and areas of contact shall be sharp points or knife edges where possible. Points of support of the object shall be concealed from random spray where feasible and where the objects being sprayed are supported from a conveyor, the point of attachment to tthe conveyor shall be so located as to not collect spray material during normal operation.

(6) The spraying operation shall take place within a spray area which is adequately ventilated to remove solvent vapors released from the operation. The electrical equipment shall be so interlocked with the ventilation of spraying area that the equipment cannot be operated unless the ventilation fans are in operation.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 516.06 Wiring and equipment above hazardous areas. (1) All fixed wiring above hazardous areas shall be in metallic raceways or shall be type MI cable or type ALS cable. Cellular metal floor raceways may be used only for supplying ceiling outlets or extensions to the area below the floor of a hazardous area, but such raceways shall have no connection leading into or through the hazardous area above the floor unless suitable seals are provided. No electrical conductor shall be installed in any cell, header or duct which contains a pipe for steam, water, air, gas, drainage, or for other service except electrical.

(2) Equipment which may produce arcs, sparks or particles of hot metal, such as lamps and lampholders for fixed lighting, cutouts, switches, receptacles, motors, or other equipment having make and break or sliding contacts, where installed above a hazardous area or above an area where freshly finished goods are handled, shall be of totally-enclosed type or shall be provided with suitable guards or screens to prevent escape of sparks or hot metal particles.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 516.07 Grounding. All metallic raceways, and all non-current-carrying metallic portions of fixed or portable equipment, regardless of voltage, shall be grounded as provided in chapter E 250.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

Chapter E 517

FLAMMABLE ANESTHETICS

E 517.01 Definitions. (1) Flammable anesthetics are gases or vapors such as cyclopropane, divinyl ether, ethyl chloride, ethyl ether, and ethylene, which may form flammable or explosive mixtures with air, oxygen, or nitrous oxide.

(2) For the purpose of this chapter, anesthetizing locations are areas in hospitals in which flammable anesthetics are or may be administered to patients. Such locations will include operating rooms, delivery rooms and anesthesia rooms, and will also include any corridors, utility rooms or other areas which are or may be used for administering flammable anesthetics to patients. Recovery rooms are not classed as anesthetizing locations unless used for administering flammable anesthetics.

Note: For further information regarding safeguards for hospital operating rooms, see the NFPA Code for the Use of Flammable Anesthetics (No. 56).

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 517.02 Hazardous areas. (1) Any room or space in which flammable anesthetics or volatile flammable disinfecting agents are stored shall be considered to be a class I, division 1 location throughout.

(2) In an anesthetizing location as defined in section E 517.01, the entire area shall be considered to be a class I, division 1 location which shall extend upward to a level 5 feet above the floor.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 517.03 Wiring and equipment within hazardous areas. (1) In hazardous areas as defined in section E 517.02, all fixed wiring and equipment, and all portable equipment, including lamps and other utilization equipment, operating at more than 8 volts between conductors, shall conform to the requirements of sections E 501.01 to E 501.15 inclusive and of sections E 501.16 (1) and (2) for class I, division 1 locations, and all such equipment shall be specifically approved for the hazardous atmospheres involved.

(2) Where a box fitting or enclosure is partially but not entirely within a hazardous area, the hazardous area shall be considered to be extended to include the entire box, fitting or enclosure.

(3) Flexible cords which are or may be used in hazardous areas for connection to portable utilization equipment, including lamps operating at more than 8 volts between conductors shall be of a type approved for extra hard usage, shall be of ample length, and shall

include an additional conductor for grounding. A storage device for the flexible cord shall be provided, and shall not subject the cord to bending at a radius of less than 3 inches.

(4) Receptacles and attachment plugs shall be of the type with provision for connection of the grounding conductor, and where located within a hazardous area, shall be approved for class 1 location. Single phase, 125 volt receptacles and attachment plugs shall be of the type recognized for use in anesthetizing locations.

Note: See section 2438 of NFPA Code for the Use of Flammable Anesthetics (No. 56).

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 517.04 Wiring and equipment above hazardous areas. (1) Wiring above a hazardous area as defined in section E 517.02 (2) shall be installed in metal raceways or shall be type MI cable or type ALS cable.

(2) Equipment which may produce arcs, sparks or particles of hot metal, such as lamps and lampholders for fixed lighting less than 8 feet above the floor, cutouts, switches, receptacles, generators, motors, or other equipment having make and break or sliding contacts, shall be of totally-enclosed type or shall be provided with suitable guards or screens to prevent escape of sparks or hot metal particles.

(3) Surgical and other lighting fixtures shall conform to section E 501.09 (2), except that surface temperature limitations set forth in section E 501.09 (2) (b) shall not apply, and except that integral or pendant switches which are located above and cannot be lowered into the hazardous area need not be explosion-proof.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 517.05 Sealing. Approved seals shall be provided in conformance with section E 501.05 and E 501.05 (1) (c) and shall apply to horizontal as well as to vertical boundaries of the defined hazardous areas.

(1) EXCEPTION. Seals may be located within 18 inches of the point at which a conduit emerges from a wall forming the boundary of an anesthetizing location if all of the following conditions are met.

(a) The junction box switch or receptacle contains a seal-off device between the arcing contacts and the conduit.

(b) The conduit is continuous (without coupling or fitting) between the junction box and the sealing fitting within 18 inches of the point where the conduit emerges from the wall.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 517.06 Circuits in anesthetizing locations. (1) Except as provided in subsection (5), each circuit within or partially within an anesthtizing location as defined in section E 517.01 (2) shall be controlled by a switch having a disconnecting pole in each circuit conductor, and shall be supplied from an ungrounded distribution system which shall be isolated from any distribution system supplying areas other than anesthetizing locations. Such isolation moy be obtained by means of one or more transformers having no electrical connection between primary and secondary windings, by means of motor generator sets, or by means of suitably isolated batteries.

(2) Circuits supplying primaries of isolating transformers shall operate at not more than 300 volts between conductors, and shall be

provided with proper overcurrent protection. Secondary voltage of such transformers shall not exceed 300 volts between conductors, and all circuits supplied from such secondaries shall be ungrounded and shall have an approved overcurrent device of proper rating in each conductor. Circuits supplied from batteries or from generators, or motor-generator sets shall be ungrounded, and shall be protected against overcurrent in the same manner as transformer secondary circuits.

(3) Transformers, motor-generator sets, batteries and battery chargers, together with their overcurrent devices shall be installed in non-hazardous locations, and shall conform to the requirements of this code for such locations.

(4) In addition to the usual control and protective devices, the ungrounded system shall be provided with an approved ground contact indicator so arranged that a green signal lamp conspicuously visible to persons in the anesthetizing location remains lighted while the system is isolated from ground. An adjacent red signal lamp and an audible warning signal shall be energized when any conductor of the system becomes grounded through a resistance or a capacitive reactance of any value up to at least 60,000 ohms. The current through the ground indicator to the ground shall not exceed 2 milliamperes. The indicator and associated signals shall not be installed within a hazardous area.

Note: For maintenance tests of the ground indicator, see section 3422 of the NFPA Code for the Use of Flammable Anesthetics (No. 56).

(5) Branch circuits supplying only fixed lighting fixtures above the hazardous location other than surgical lighting fixtures or supplying only approved permanently installed X-ray equipment which complies with section 2434 of the NFPA Code for the Use of Flammable Anesthetics (No. 56) may be supplied by a conventional grounded system, provided: (a) wiring for grounded and ungrounded circuits does not occupy the same raceways; (b) the lighting fixtures and the X-ray equipment (except the enclosed X-ray tube and the metal-enclosed high voltage leads to the tube) are located at least 8 feet above the floor or outside the anesthetizing location; and (c) switches for the grounded circuits are located outside of the anesthetizing location.

Note: Remote control stations for remote control switches may be installed in the anesthetizing location if the remote control circuit is energized from the ungrounded distribution system.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 517.07 Low voltage equipment and instruments. (1) Electrical apparatus and equipment used within a hazardous area, and which has exposed current-carrying elements or which is frequently in contact with the bodies of persons, shall be designed to operate at 8 volts or less unless it is entirely surrounded by a metallic casing or sheath. Power supply shall be ungrounded, and shall be electrically isolated from all circuits of higher voltage.

(2) Where a low voltage unit receives current from an individual transformer located within a hazardous area, the flexible cord shall conform to section E 517.03 (4), the core and case of the transformer shall be effectively grounded, and the transformer shall be approved for class I locations.

(3) Where low voltage units within a hazardous area are supplied with current from a common source, such as a transformer, motor-generator set, or storage battery, such common source shall be installed in a non-hazardous location. Where located or used within a hazardous area, receptacles and attachment plugs shall be approved for class I locations. Plugs shall be so designed that they cannot be inserted into receptacles for higher voltage. Flexible cords shall be of adequate length and ampacity, and shall be approved for extra hard usage. An extra conductor for grounding is not required.

(4) Low voltage equipment and wiring (including flexible cords) shall be protected from dangerous overcurrents by suitable overcurrent devices or by inherent current limiting characteristics of the source of supply. Overcurrent devices shall not be installed in a hazardous area.

(5) Resistance or impedance devices may be used to control low voltage units but shall not be used to limit maximum input voltage. Where a low voltage unit includes a switch or other make and break or sliding contact, or where it includes a resistor or resistance device which may under any operating condition reach a surface temperature exceeding 80% of the lowest ignition temperature in degrees Centigrade (as determined by approved test procedure) of the gases or vapors that may be present, the unit shall be of a type approved for class I locations.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 517.08 Other equipment. (1) Suction, pressure, or insufflation equipment involving electrical elements, and located or used within a hazardous area shall be approved for class I locations.

(2) X-ray equipment installed or operated in an anesthetizing location as defined in section E 517.01 (2) shall be provided with approved means for preventing accumulation of electrostatic charges. All control devices, switches, relays, meters, and transformers shall be totally enclosed, and where installed or operated within a hazardous area, shall be approved for class I locations. High voltage wiring shall be effectively insulated from ground and adequately guarded against accidental contact.

(3) Equipment for generating high frequency currents or voltages used in electrocautery, diathermy, television, etc., where installed or used in an anesthetizing location, shall conform to sections E 517.03 and E 517.04.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 517.09 Grounding. In any hazardous area, all metallic raceways, and all non-current-carrying metallic portions of fixed or portable equipment (except equipment operating at not more than 8 volts between conductors) shall be grounded as provided in sections E 501.16 (1) and (2).

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

Chapter E 520

THEATERS AND ASSEMBLY HALLS

A. GENERAL

E 520.01 Scope. The requirements of this chapter shall apply to all buildings, or part of a building, designed, intended, or used for dramatic, operatic, motion-picture or other shows, and night clubs, dance halls, armories, sporting arenas, bowling alleys, public auditoriums, television studios and like buildings used for public assembly.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 520.02 Motion-picture projectors. Motion-picture equipment and its installation and use shall comply with chapter E 540.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 520.03 Sound reproduction. Sound-reproducing equipment and its installation shall comply with Wis. Adm. Code chapter E 640.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 520.04 Wiring method. The wiring method shall be metal raceways, type ALS cable or type MI cable except as follows:

(1) EXCEPTION No. 1. As provided in Wis. Adm. Code chapter E 640, Sound Reproduction, in chapter E 800, Communication Circuits, and in chapter E 725 for Class 2 Remote Control and Signal Circuits.

(2) EXCEPTION No. 2. Where the area intended for public assembly has a capacity of less than 200 persons, type AC metal-clad cable as provided in chapter E 334 may be used, or for concealed work, concealed knob-and-tube work or non-metallic sheathed cable as provided in chapters E 324 and E 336 may also be used.

Note: For recommendations for determination of population capacity, refer to the table in the note under Wis. Adm. Code section E 700.06.

(3) EXCEPTION NO. 3. The wiring for stage set lighting and stage effects and other wiring which is not fixed as to location shall be done with approved portable cables and approved flexible cords.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 520.05 Number of conductors in raceway. The number of conductors permitted in any metal conduit or electrical metallic tubing for border or stage pocket circuits or for remote control conductors shall not exceed that shown in table 1 of chapter E 900. In the case of auxiliary gutters or wireways, the sum of the cross-sectional areas of all contained conductors at any cross-section shall not exceed 20% of the interior cross-sectional area of the gutter or wireway.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 520.06 Enclosing and guarding live parts. Live parts shall be enclosed or guarded to prevent accidental contact by persons and objects. All switches shall be of the externally operable type. Rheostats shall be placed in approved cases or cabinets which enclose all live parts, having only the operating handles exposed.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

B. FIXED STAGE SWITCHBOARD

E 520.21 Dead front. Stage switchboards shall be of the dead-front type.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 520.22 Guarding back of switchboard. Stage switchboards having exposed live parts on the back of such boards shall be enclosed by the building walls, wire mesh grills, or by other approved methods. The entrance to this enclosure shall be by means of a self-closing door.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 520.23 Control and overcurrent protection of receptacle circuits. Means shall be provided at the stage switchboard for the control and individual overcurrent protection of branch circuits to stage and gallery receptacles used for portable stage equipment.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 520.24 Metal hood. A stage switchboard that is not completely enclosed dead-front and dead-rear or recessed into a wall shall be provided with a metal hood extending the full length of the board to protect all equipment on the board from falling objects.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 520.25 Dimmers. Dimmers shall conform to the following:

(1) DISCONNECTION AND OVERCURRENT PROTECTION. Where dimmers are installed in ungrounded conductors, each dimmer shall have overcurrent protection not greater than 125% of the dimmer rating, and shall be disconnected from all ungrounded conductors when the master or individual switch or circuit-breaker supplying such dimmer is in the open position.

(2) RESISTANCE OR REACTOR TYPE DIMMERS. Resistance or series reactor type dimmers may be placed in either the grounded or the ungrounded conductor of the circuit. Where designed to open either the supply circuit to the dimmer or the circuit controlled by it, the dimmer shall then comply with section E 380.01.

Note: It is recommended that resistance or reactor type dimmers be placed in the grounded neutral conductor of the circuit provided they do not open the circuit.

(3) AUTO-TRANSFORMER TYPE DIMMERS. The circuit supplying an auto-transformer type dimmer shall not exceed 150 volts between conductors. The grounded conductor shall be common to the input and output circuits. See Wis. Adm. Code section E 200.04.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

C. STAGE EQUIPMENT—FIXED

E 520.41 Circuit loads. Footlights, border lights, and proscenium side lights shall be so arranged that no branch circuit supplying such equipment will carry a load exceeding 20 amperes; provided that where heavy-duty lampholders only are used, such circuits may conform to the provisions of chapter E 210 for circuits supplying heavy-duty lampholders.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 520.42 Conductor insulation. Foot, border, proscenium, or portable strip light fixtures shall be wired with conductors having insulation suitable for the temperatures at which the conductors will be operated and not less than 125°C. (257°F.). See table E 310.02 (1).

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 520.43 Footlights. (1) Where metal trough construction is employed for footlights, the trough containing the circuit conductors shall be made of sheet metal not lighter than No. 20 MS (USS Revised) gauge treated to prevent oxidation. Lampholder terminals shall be kept at least ½ inch from the metal of the trough. The circuit conductors shall be soldered to the lampholder terminals.

(2) Where the metal trough construction specified in subsection (1) is not used, footlights shall consist of individual outlets with lampholders, wired with rigid or flexible metal conduit, type ALS cable or type MI cable. The circuit conductors shall be soldered to the lampholder terminals. Disappearing footlights shall be so arranged that the current supply shall be automatically disconnected when the footlights are replaced in the recess designed therefor.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 520.44 Borders and proscenium sidelights. (1) CONSTRUCTION AND DESIGN. Borders and proscenium sidelights shall be constructed as prescribed in section E 520.43, shall be suitably stayed and supported, and shall be so designed that the flanges of the reflectors or other adequate guards will protect the lamps from mechanical injury and from accidental contact with scenery or other combustible material.

(2) CABLES FOR BORDER LIGHTS. Cables for supply to border lights shall be types S, SO, or ST flexible cord. See table E 400.11. The

cables shall be suitably supported. Such cables shall be employed only where flexible conductors are necessary.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 520.45 Receptacles. Receptacles intended for the supply of arc lamps shall have not less than 50 amperes capacity and shall be supplied by conductors not smaller than No. 6. Receptacles intended for the supply of incandescent lamps shall have not less than 20 amperes capacity and shall be supplied by conductors not smaller than No. 12. Plugs for arc and incandescent receptacles shall not be interchangeable.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 520.46 Stage pockets. Receptacles intended for the connection of portable stage lighting equipment shall be mounted in suitable pockets or enclosures, and shall comply with the requirements of section E 520.45.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 520.47 Lamps in scene docks. Lamps installed in scene docks shall be so located and guarded as to be free from mechanical injury and provide an air space of not less than 2 inches between such lamps and any combustible material.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 520.48 Curtain motors. Curtain motors having brushes or sliding contacts shall comply with one of the following conditions:

(1) Be of the totally-enclosed, enclosed-fan-cooled, or enclosed-pipe-ventilated types.

(2) Be enclosed in separate rooms or housings built of non-combustible materials so constructed as to exclude flyings or lint, and properly ventilated from a source of clean air.

(3) Have brush or sliding-contact end of motor enclosed by solid metal covers.

(4) Have brushes or sliding contacts enclosed in substantial, tight, metal housings.

(5) Have the upper half of brush or sliding-contact end of the motor enclosed by a wire screen or perforated metal and the lower half enclosed by solid metal covers.

(6) Have wire screens or perforated metal placed at the commutator or brush ends. No dimension of any opening in the wire screen or perforated metal shall exceed .05 inch, regardless of the shape of the opening and of the material used.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 520.49 Flue-damper control. Where stage flue dampers are released by an electrical device, the circuit operating the latter shall be normally closed and shall be controlled by at least 2 externally-operable switches, one switch being placed at the electrician's station and the other where designated by the administrative authority. The device shall be designed for the full voltage of the circuit to which it is connected, no resistance being inserted. The device shall be located in the loft above the scenery and shall be enclosed in a suitable iron box having a tight, self-closing door.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

D. PORTABLE SWITCHBOARDS ON STAGE

E 520.51 Supply. Portable switchboards shall be supplied only from outlets especially provided for this purpose. Such outlets shall include externally operable, enclosed fused switches or circuit-breakers mounted on the stage wall or at the switchboard in locations readily accessible from the stage floor.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 520.52 Overcurrent protection. Circuits from portable switchboards directly supplying equipment containing incandescent lamps of not over 300 watts shall be protected by overcurrent devices having a rating or setting of not more than 20 amperes. Circuits for lampholders over 300 watts may be used where overcurrent protection conforms to the provisions of chapter E 210. Other circuits shall be provided with overcurrent devices with a rating or setting not higher than the current required for the connected load.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 520.53 Construction. Portable switchboards for use on stages shall comply with the following:

(1) ENCLOSURE. Portable switchboards shall be placed within an enclosure of substantial construction which may be so arranged that the enclosure is open during operation. Enclosures of wood shall be completely lined with sheet metal of not less than No. 24 MS (USS Revised) gauge, and shall be well galvanized, enameled, or otherwise properly coated to prevent corrosion or be of a corrosion-resistant material.

(2) LIVE PARTS. Except as provided for dimmer face plates in subsection (5), there shall be no exposed live parts within the enclosure.

(3) SWITCHES AND CIRCUIT-BREAKERS. All switches and circuit-breakers shall be of the externally-operable, enclosed type.

(4) CIRCUIT PROTECTION. Overcurrent devices shall be provided in each ungrounded conductor of every circuit supplied through the switchboard. Enclosures shall be provided for all overcurrent devices in addition to the switchboard enclosure.

(5) DIMMERS. The terminals of dimmers shall be provided with enclosures, and dimmer face plates shall be so arranged that accidental contact cannot be readily made with the face-plate contacts.

(6) INTERIOR CONDUCTORS. All conductors within the switchboard enclosure shall be stranded and, except for cables feeding to or from the switchboard, shall be asbestos-colored type AA or other types approved for a maximum operating temperature of 200°C. (392°F.). Each conductor shall have an ampacity at least equal to the rating of the circuit-breaker, switch or fuse which it supplies, except for conductors for incandescent lamp circuits having overcurrent protection not exceeding 20 amperes. Conductors shall be enclosed in metal troughs or securely fastened in position and shall be bushed where they pass through metal.

(7) PILOT LIGHT. A pilot light shall be provided within the enclosure and shall be so connected to the circuit supplying the board that

the opening of the master switch will not cut off the supply to the lamp. This lamp shall be on an independent circuit having overcurrent protection of a rating or setting of not more than 15 amperes.

(8) SUPPLY CONNECTIONS. The supply to a portable switchboard shall be by means of flexible cord (types S, SO, or ST) terminating within the switchboard enclosure or in an externally-operable fused master switch or circuit-breaker. The supply cable shall have sufficient ampacity to carry the total load on the switchboard and shall be protected by overcurrent devices.

(9) CABLE ARRANGEMENT. Cables shall be protected by bushings where they pass through enclosures and shall be so arranged that tension on the cable will not be transmitted to the connections.

(10) TERMINALS. Terminals to which stage cables are connected shall be so located as to permit convenient access to the terminals. At terminals not provided with approved pressure connectors the following construction shall be employed:

(a) For conductors of No. 10 or larger, solder lugs shall be used.

(b) For conductors smaller than No. 10, the strands shall be soldered together where connected to clamps or binding screws not specifically approved as pressure connectors.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E. STAGE EQUIPMENT—PORTABLE

E 520.61 Arc lamps. The construction of arc lamps shall be approved by the authorities having jurisdiction.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 520.62 Portable plugging boxes. Portable plugging boxes shall conform to the following:

(1) ENCLOSURE. The construction shall be such that no current-carrying part will be exposed.

(2) RECEPTACLES AND OVERCURRENT PROTECTION. Each receptacle shall have a rating of not less than 30 amperes, and shall have overcurrent protection which shall be installed in an enclosure equipped with self-closing doors.

(3) BUSBARS AND TERMINALS. Busbars shall have an ampacity equal to the sum of the ampere ratings of all the receptacles. Lugs shall be provided for the connection of the master cable.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 520.63 Lights on scenery. (1) Brackets on scenery shall be wired internally and the fixture stem shall be carried through to the back of the scenery where a bushing shall be placed on the end of the stem, except that externally wired brackets or other fixtures may be used when wired with cords designed for hard usage which shall extend through scenery and without joint or splice in canopy of fixture back and terminate in an approved type stage connector located within 18 inches of the fixture, unless such location is impractical.

(2) Fixtures shall be securely fastened in place.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 520.64 Portable strips. Portable strips shall be constructed in accordance with the requirements for border lights and proscenium side lights in section E 520.44 (1). The supply cable shall be protected by bushings where it passes through metal and shall be so arranged that tension on the cable will not be transmitted to the connections. See section E 520.42 for wiring of portable strips.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 520.65 Festoons. Joints in festoon wiring shall be staggered where practicable. Lamps enclosed in lanterns or similar devices of combustible material shall be equipped with approved guards.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 520.66 Special effects. Electrical devices used for simulating lightning, waterfalls, and the like, shall be so constructed and located that flames, sparks, or hot particles cannot come in contact with combustible material.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 520.67 Cable connectors. Cable connectors for flexible conductors shall be so constructed that tension on the cord or cable will not be transmitted to the connections. See section E 400.10. The female half of the connector shall be attached to the line end of the cord or cable.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 520.68 Conductors for portables. Flexible conductors used to supply portable stage equipment shall be types S, SO or ST, except that reinforced cord may be used to supply stand lamps where the cord is not liable to severe physical damage and has overcurrent protection rated at not over 20 amperes.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

F. DRESSING ROOMS

E 520.71 Pendent lampholders. Pendent lampholders shall not be installed in dressing rooms.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 520.72 Lamp guards. All incandescent lamps in dressing rooms, where less than 8 feet from the floor, shall be equipped with open-end guards riveted to the outlet box cover or otherwise sealed or locked in place.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 520.73 Switches required. All lights and receptacles in dressing rooms shall be controlled by wall switches installed in the dressing rooms. Each switch controlling receptacles shall be provided with a pilot light to indicate when the receptacle or receptacles are energized.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

G. GROUNDING

E 520.81 Grounding. All metal raceways shall be grounded. The metal frames and enclosures of equipment including border lights shall be grounded, except the frames and enclosures of portable equipment on grounded circuits operating at not over 150 volts to ground and not within reach of grounded surfaces. Grounding, when employed, shall be done in the manner specified in chapter E 250.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

CHAPTER E 530

MOTION PICTURE STUDIOS AND SIMILAR LOCATIONS

A. GENERAL

E 530.01 Scope. (1) The requirements of this chapter shall apply to television studios (except as covered in section E 520.01), motion picture studios, exchange, factory, laboratory, stage, or a portion of the building in which motion picture films more than ⅞ inch in width are manufactured, exposed, developed, printed, cut, edited, rewound, repaired or stored.

(2) For the purpose of this chapter, a motion picture studio is one in which photographic film is used to record action. A television studio shall mean one which employs the use of electronic cameras only.

Note: For recommendations for protection against cellulose nitrate film hazards refer to NFPA Standard for the Storage and Handling of Cellulose Nitrate Motion Picture Film (No. 40).

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

B. STAGE OR SET

E 530.11 Permanent wiring. The permanent wiring shall be in approved metal raceways, type ALS cable or type MI cable.

(1) EXCEPTION. Communication circuits, and sound recording and reproducing equipment may be wired as permitted by the chapters covering those installations. (See Wis. Adm. Code chapters E 640 and E 800.)

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 530.12 Portable wiring. The wiring for stage set lighting and stage effects, and other wiring which is not fixed as to location, shall be done with approved portable cables and approved flexible cords. This requirement shall not apply to portable lamps or other electrical equipment used as properties in a motion picture set, on a studio stage or lot, or on location.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 530.13 Stage lighting and effects control. Switches used for studio stage set lighting and effects (on the stages and lots and on location) shall be of the externally-operable type. When contactors are used as the disconnecting means for fuses, an individual externally-operable type switch (such as a tumbler switch) for the control of each contactor, shall be located at a distance of not more than 6 feet from the contactor, in addition to remote-control switches.

(1) EXCEPTION: A single externally-operable switch may be used to simultaneously disconnect all the contactors on any one location board, where located at a distance of not more than 6 feet from the location board.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 530.14 Plugging boxes. Each receptacle of plugging boxes shall have an ampacity of not less than 30 amperes.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 530.15 Enclosing and guarding live parts. (1) Live parts shall be enclosed or guarded to prevent accidental contact by persons and objects.

(2) All switches shall be of the externally-operable type.

(3) Rheostats shall be placed in approved cases or cabinets which enclose all live parts, having only the operating handles exposed.

(4) Current-carrying parts of "bull-switches", "location boards", "spiders", and plugging boxes shall be so enclosed, guarded, or located that persons cannot accidentally come into contact with them or bring conducting materials into contact with them.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 530.16 Portable lamps. Portable lamps and work lights shall be equipped with approved portable cords, approved composition or metal-sheathed porcelain sockets and substantial guards.

(1) EXCEPTION. The requirements of this section shall not apply to portable lamps used as properties in a motion picture set or television stage set, on a studio stage or lot, or on location.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 530.17 Portable arc lamps. Portable arc lamps shall be substantially constructed. The arc shall be provided with an enclosure designed to retain sparks and carbons and to prevent persons or materials from coming into contact with the arc or bare live parts. The enclosures shall be ventilated. All switches shall be of the externally-operable type.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 530.18 Overcurrent protection; short time rating.* (1) GENERAL. Automatic overcurrent protective devices (circuit-breakers or fuses) for feeders, and subfeeders for moving-picture studio stage set lighting and the stage cables for such stage set lighting, shall be rated or set to operate at not more than 400% of the values given in table E 310.12 and table E 400.09 (2).

* Special consideration is given to motion picture studios because filming periods are of only a few minutes duration and are rarely longer than 10 minutes.

(2) FEEDERS. The feeders from the substations to the stages shall be protected by means of overcurrent devices having suitable ampacity (generally located in the substation). The overcurrent devices may be double-pole, or two single-pole devices may be used. There need be no pole or overcurrent coil in the neutral conductor. The overcurrent device setting for each feeder shall not exceed 400% of the ampacity of the feeder, as given in table E 310.12 for the kind of insulation used.

(3) LOCATION BOARDS. Overcurrent protection (fuses or circuit-breakers) shall be provided at the location boards. The fuses in the location boards shall be not larger in rating than 400% of the ampacity of the cables between the location boards and the plugging boxes.

(4) PLUGGING BOXES. Where plugging boxes are not provided with overcurrent protective devices, each cable or cord smaller than No. 8 supplied through a plugging box shall be attached to the plugging box by means of a plug containing 2 cartridge fuses or a circuit-breaker. The rating of the fuses or the setting of the circuit-breaker shall be not more than 400% of the safe ampacity of the cables or cords as given in tables E 310.12, E 310.13 and E 400.09 (2) for the kind of insulation used.

(5) LIGHTING. Work-lights, stand-lamps, and fixtures shall be connected to plugging boxes by means of plugs containing 2 cartridge fuses not larger than 20 amperes, or they may be connected to special outlets on circuits protected by fuses or circuit-breaker settings of not more than 20 amperes. Plug fuses shall not be used unless they are on the load side of the fuses or circuit-breakers on the location boards.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 530.19 Grounding. Conduit, armored cable or metal raceways, and all noncurrent-carrying metal parts of appliances, devices and equipment shall be grounded as prescribed in chapter E 250. This shall not apply to pendent and portable lamps, nor to stage lighting and stage sound equipment, nor to other portable or semiportable special stage equipment, operating at not more than 150 volts to ground.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

C. DRESSING ROOMS

E 530.31 Dressing rooms. Fixed wiring in dressing rooms shall be installed in accordance with wiring methods covered in chapter E 300. Wiring for portable dressing rooms shall be of an approved type.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

D. VIEWING, CUTTING AND PATCHING TABLES

E 530.41 Lamps at tables. Only approved composition or metal-sheathed porcelain keyless lampholders, equipped with suitable means to guard lamps from physical damage and from film and film scrap, shall be used at patching, viewing and cutting tables.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E. FILM STORAGE VAULTS

E 530.51 Lamps in cellulose nitrate film storage vaults. Lamps in cellulose nitrate film storage vaults shall be rigid fixtures of the glass enclosed and gasketed type. Lamps shall be controlled by a switch having a pole in each ungrounded conductor. This switch shall be located outside of the vault and provided with a pilot light to indicate whether the switch is on or off. This switch shall disconnect from all sources of supply all ungrounded conductors terminating in any outlet in the vault.

History: Cr. Register, January, 1968, No. 145, eff. 2–1–68.

E 530.52 Motors and other electrical equipment in film storage vaults. No electric motors, heaters, portable lights, or other portable electric equipment shall be located in the film storage vaults.

History: Cr. Register, January, 1968, No. 145, eff. 2–1–68.

F. SUBSTATIONS

E 530.61 Substations. Wiring and equipment above 600 volts shall conform to Wis. Adm. Code chapter E 710.

History: Cr. Register, January, 1968, No. 145, eff. 2–1–68.

E 530.62 Low-voltage switchboards. On 600 volts or less switchboards shall conform to chapter E 384.

History: Cr. Register, January, 1968, No. 145, eff. 2–1–68.

E 530.63 Overcurrent protection of DC generators. Three-wire DC generators shall have protection consisting of overcurrent devices having current ratings or settings in accordance with the generator rating. The overcurrent protective devices may be single-pole or 2-pole and need not have a pole or overcurrent coil in the neutral lead (whether it is grounded or ungrounded).

History: Cr. Register, January, 1968, No. 145, eff. 2–1–68.

E 530.64 Working space and guarding. Working space and guarding in permanent fixed substations shall conform to Wis. Adm. Code sections E 195.16 and E 195.17. For guarding of live parts on motors and generators, see sections E 430.011 and E 430.014. Switchboards for voltage of not more than 250 volts DC between conductors when located in substations or switchboard rooms accessible to qualified persons only need not be dead-front.

History: Cr. Register, January, 1968, No. 145, eff. 2–1–68.

E 530.65 Portable substations. Wiring and equipment in portable substations shall conform to the rules applying to installations in permanent fixed substations, but, due to the limited space available, the working spaces may be reduced, provided that the equipment shall be so arranged that the operator may do his work safely, and so that other persons in the vicinity cannot accidentally come into contact with current-carrying parts or bring conducting objects into contact with them while they are energized.

History: Cr. Register, January, 1968, No. 145, eff. 2–1–68.

E 530.66 Grounding at substations. Noncurrent-carrying metal parts shall be grounded except the frames of DC circuit-breakers installed on switchboards.

History: Cr. Register, January, 1968, No. 145, eff. 2–1–68.

Chapter E 540

MOTION PICTURE PROJECTORS

A. GENERAL

E 540.01 Scope. This chapter applies to motion picture projectors and associated equipment of the professional and non-professional types.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

B. EQUIPMENT AND PROJECTORS OF THE PROFESSIONAL TYPE

E 540.10 Professional projector; definition. The professional projector employs a 35-millimeter film which is 1⅜ inch wide and has on each edge 5.4 perforations per inch.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 540.11 Enclosure. The professional type of projector, such as is commonly used in theatres and motion-picture houses, shall be located in an approved enclosure. Such enclosure shall not be considered as a hazardous location as defined in chapter E 500.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 540.12 Motor-driven projectors. Motor-driven projectors shall be approved for the purpose as an assembly or shall comply with all of the following conditions:

(1) An approved projector shall be used.

(2) An approved projector lamp shall be used.

(3) Motors shall be so designed or guarded as to prevent ignition of film by sparks or arcs.

(4) Projectors shall be in charge of a qualified operator.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 540.13 Conductor size. Conductors supplying outlets for arc projectors of the professional type shall not be smaller than No. 8 and shall be of sufficient size for the projector employed. Conductors for incandescent type projectors shall conform to normal wiring standards as provided in section E 210.25.

History: Cr. Register, January, 1968, No. 145, eff. 2–1–68.

E 540.14 Conductors on lamps and hot equipment. Asbestos covered conductors type AA or other types of insulated conductors having a maximum operating temperature of 200° C. (392° F.) shall be used on all lamps or other equipment where the ambient temperature at the conductors as installed will exceed 50° C. (122° F.).

History: Cr. Register, January, 1968, No. 145, eff. 2–1–68.

E 540.15 Flexible cords. Cords approved for hard service in table E 400.11 shall be used on portable equipment.

History: Cr. Register, January, 1968, No. 145, eff. 2–1–68.

E 540.16 Lamp guards. Incandescent lamps in projection rooms or booths shall be provided with an approved lamp guard unless otherwise protected by noncombustible shades or other enclosures.

History: Cr. Register, January, 1968, No. 145, eff. 2–1–68.

E 540.17 Location of equipment. Motor-generator sets, transformers, rectifiers, rheostats, and similar equipment, for the supply or control of current to arc lamps on projectors shall, if practicable, be located in separate rooms. Where placed in the projector room, they shall be so located or guarded that arcs or sparks cannot come in contact with film, and motor-generator sets shall have the commutator end or ends protected as provided in section E 520.48.

History: Cr. Register, January, 1968, No. 145, eff. 2–1–68.

E 540.18 Construction and ventilation. It is recommended that the administrative authority having jurisdiction over the construction and ventilation of rooms for professional type projectors refer to the NFPA Standard for the Storage and Handling of Cellulose Nitrate Motion Picture Film (NFPA No. 40).

History: Cr. Register, January, 1968, No. 145, eff. 2–1–68.

E 540.19 Equipment prohibited. Switches, overcurrent devices, or other equipment not normally required or used for projectors, sound reproduction, flood, or other special effect lamps or other equipment shall not be installed in such booths or rooms.

(1) EXCEPTION: Remote-control switches for the control of auditorium lights or a switch for the motor operating the curtain at the motion-picture screen.

History: Cr. Register, January, 1968, No. 145, eff. 2–1–68.

E 540.20 Approval. Projectors and enclosures for arc or incandescent lamps, rectifiers, transformers, rheostats, and similar equipment, shall be of an approved type.

History: Cr. Register, January, 1968, No. 145, eff. 2–1–68.

E 540.21 Marking. Projectors and other equipment as set forth in section E 540.20 shall be marked with the name or trademark of the maker and with the voltage and current for which they are designed.

History: Cr. Register, January, 1968, No. 145, eff. 2–1–68.

E 540.22 Rewinding, examination and storage of extra films. It is recommended that the administrative authority having jurisdiction refer to the NFPA Standard for the Storage and Handling of Cellulose Nitrate Motion Picture Film (NFPA No. 40).

Note: See sections E 530.51 and E 530.52. Also see section E 530.41 for viewing tables.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

C. NON-PROFESSIONAL TYPE PROJECTORS

E 540.30 Definition. The non-professional projector employs film other than that used on professional type projectors.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 540.31 Booth not required. Projectors of the non-professional or miniature type, when employing only approved slow-burning (cellulose acetate or equivalent) film, may be operated without a booth.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 540.32 Approval. Projectors, lamp enclosures, and current-controlling devices and similar devices shall be approved as component parts of the projector equipment.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 540.33 Source of illumination. The source of illumination shall be a lamp of a type approved for stereopticon use or for motion-picture projection.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 540.34 Marking. Projectors shall be marked with name or trademark of the maker, with the current and voltage for which they are designed, and for projectors of this type using the standard 35-millimeter film, with the wording "For use with slow-burning films only".

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 540.35 Non-professional film marking. The slow-burning (cellulose acetate or equivalent) film shall have a permanent distinctive marker for its entire length identifying the manufacturer and the slow-burning character of the film stock.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

D. SOUND RECORDING AND REPRODUCTION

E 540.50 Sound recording and reproduction. Sound recording and reproduction equipment shall comply with chapter E 640.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

Chapter E 550

MOBILE HOMES

E 550.01 Scope. (1) The provisions of this chapter cover the electric conductors and equipment installed within or on mobile homes and also the conductors that connect mobile homes to a supply of electricity.

(a) Wherever the requirements of other chapters of the Wisconsin state electrical code and chapter E 550, the requirements of chapter E 550 shall apply.

(2) A mobile home not intended as a dwelling unit, as for example, equipped for sleeping purposes only, contractor's on-site offices, construction job dormitories, mobile studio dressing rooms, banks, clinics, mobile stores or intended for the display or demonstration of merchandise or machinery, shall not be required to meet the provisions of this chapter pertaining to the number or capacity of circuits reuired. It shall, however, meet all other applicable requirements of this chapter if provided with an electrical installation intended to be energized from a 115 volt or 115/230 volt AC power supply system.

(3) The provisions of this chapter apply to mobile homes intended for connection to a wiring system nominally rated 115/230 volts, 3-wire AC, with grounded neutral.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 550.02 Definitions. The following definitions apply only to the requirements of this chapter.

(1) FEEDER: That part of the electric distribution system from the service entrance equipment to the mobile home.

(2) MOBILE HOME: A vehicular, portable structure built on a chassis and designed to be used without a permanent foundation as a dwelling when connected to indicated utilities.

(3) MOBILE HOME PARK: The location of 2 or more mobile home spaces.

(4) PERMANENT MOBILE HOME SPACE: The location of an individual trailer that is not part of a mobile home park.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 550.03 Service lateral, service entrance conductors and service equipment. (1) SERVICE LATERAL: The service lateral shall terminate in a terminal box if more than one mobile home is served or in the service entrance equipment if a single mobile home is served.

(2) SERVICE ENTRANCE CONDUCTORS. (a) *Feeding mobile home service equipment.* All service entrance conductors and service equipment shall be 3-wire (2 ungrounded conductors and one neutral) with conductor ratings specified as follows:

1. The service entrance conductors serving one mobile home service equipment shall be rated not less than 50 amperes, 3-wire.

2. The service entrance conductors serving 2, 3, or 4 sets of service equipment shall be rated not less than 100 amperes, 3-wire.

3. Where the service entrance conductors serve more than 4 sets of service equipment, apply a minimum demand of 50 amperes for each set and then apply a demand factor of 50% to the total demand to dettermine the minimum size service entrance conductors.

(b) *Feeding mobile home.* The feeder between the service equipment and the mobile home shall consist of not more than 2 mobile home service cords each rated 50 amperes or permanently installed circuits as permitted by subsection (2) (b) 4.

1. Exception: A mobile home that is factory-equipped with gas or oil-fired central heating equipment and cooking appliances may be provided with a mobile home supply cord rated 40 amperes, minimum.

2. Each mobile home supply cord shall be approved for the purpose and have four conductors, one of which shall be identified by a continuous green color or a continuous green color with a yellow stripe. The attachment plug, connectors and mating receptacles shall be of a 3-pole, 4-wire grounding type approved by the administrative authority. The mobile home power-supply cord shall be permanently attached to the mobile home distribution panel. A suitable clamp or the equivalent shall be provided at the distribution panel to afford strain relief for the cord to prevent strain from being transmitted to the terminals. The power supply cord shall be not more than 26½ feet long.

Note: It is the policy of the administrative authority to approve grounding type attachment plugs, connectors and mating receptacles covered by American Standard C73 Attachment Plugs and Receptacles.

3. Second supply cord. Where the calculated load of the mobile home is in excess of 50 amperes, or where a separately metered appliance is installed in the mobile home, a second 50 ampere mobile home supply cord shall be installed. Where 2 cord supply systems are installed, they shall not be interconnected on either the line side or the load side except that the grounding circuits and grounding means shall be electrically interconnected.

4. Permanent wiring. Permanent wiring may be used between the service equipment and mobile home in the case of a permanent mobile home space, or where the calculated load exceeds 100 amperes, or between the service disconnecting means and receptacle when they are in separate enclosures. The permanent wiring method shall consist of 4 permanently installed conductors in an approved wiring method, one conductor being identified by a continuous green color or a continuous green color with a yellow stripe.

(3) SERVICE EQUIPMENT. The mobile home service equipment shall

be located adjacent to the mobile home and not mounted in or on the mobile home. The service equipment shall consist of disconnecting means, overcurrent protective device and receptacle as specified in section E 550.03 (3) (a).

(a) Each mobile home space shall be provided with a disconnecting means, overcurrent protective device and 3-pole, 4-wire grounding type receptacle, each rated not less than 50 amperes. The receptacle may be omitted where permanent wiring is permitted in subsection (2) (b) 4.

(b) The mobile home grounding conductor shall be bonded to the system neutral conductor within the disconnecting means enclosure. (See section E 550.09). A separate common grounding conductor shall be run from a grounding electrode to the disconnecting means enclosure where it shall be bonded to the system neutral and mobile home grounding conductor. The grounding electrode shall always be a metallic underground water piping system where such a piping system is available.

History: Cr. Register, January, 1968, No. 145, eff. 2–1–68.

E 550.04 Disconnecting means and branch circuit protective equipment. (1) The branch circuit equipment may be combined with the disconnecting means as a single assembly. Such a combination may be designated as a distribution panel.

(2) Plug fuses and fuseholders shall be tamper-resistant, type "S," enclosed in dead-front fuse panels.

(3) Disconnecting means. (a) Disconnecting means shall be provided in each mobile home and shall be approved service entrance equipment consisting of circuit-breakers or a switch and fuses and their accessories installed in a readily accessible location near the point of entrance of the supply cord or conductors into the mobile home. This equipment shall contain a solderless type of grounding connector or bar for the purposes of grounding with sufficient terminals for all grounding conductors. The neutral bar termination of the grounded circuit conductors shall be insulated. The disconnecting equipment shall have a rating suitable for the connected load.

(b) Where 2 power supply cords are installed disconnecting means shall be provided for each cord and may be combined in a single equipment but without electrical interconnections other than for grounding purposes.

(c) A distribution panel main circuit-breaker shall be rated 50 ampere and employ a 2-pole circuit breaker rated 40 amperes for a 40-ampere supply cord, or 50 amperes for a 50-ampere supply cord. A distribution panel employing a disconnect switch and fuses shall be rated 60 amperes and shall employ a single 2-pole 60 ampere fuseholder with 40- or 50-ampere main fuses for 40- or 50-ampere supply cords, respectively. The outside of the distribution panel shall be plainly marked with the fuse size. The main circuit breakers or fuses shall be plainly marked "Main."

(4) Branch circuit protective equipment. (a) Branch circuit distribution equipment shall be installed in each mobile home and shall include overcurrent protection for each branch circuit consisting of either circuit breakers or fuses.

(b) Where circuit breakers are provided for branch-circuit protection, 230-volt circuits shall be protected by 2-pole common or companion trip, or handle-tied paired circuit breakers.

(c) The branch-circuit overcurrent devices shall be rated:

1. Not more than the circuit conductors; and

2. Not more than 150% of the rating of a single appliance rated 10 amperes or more; but

3. Not more than the fuse size marked on the air conditioner or other motor-operated appliance.

(5) Electrical nameplates. A metal nameplate on the outside adjacent to the supply cord entrance shall read, "This Mobile Home is Wired for 115/230 Volt, 3-wire, 60 Cycle Supply. Supply Cord 40 (or 50) amp." The voltage marking may read 120/240 Volts instead of 115/230 Volts.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 550.05 Branch circuits. The number of branch circuits required shall be determined in accordance with the following:

(1) LIGHTING. Based on 3 watts per square foot times outside dimensions of the mobile home (hitch excluded) divided by 115 volts to determine number of 15 or 20 ampere lighting area circuits, e.g.,

$$\frac{3 \times \text{Length} \times \text{Width}}{115 \times 15 \text{ (or 20)}} = \text{No. of 15 (or 20) ampere circuits.}$$

(2) PORTABLE APPLIANCES. There shall be a minimum of two 20 ampere branch circuits for receptacle outlets in the kitchen area, which may supply other receptacle outlets in the dining, laundry, and patio areas. These circuits shall supply only portable appliances.

(3) GENERAL APPLIANCES. (Including furnace, water heater, range, and central or room air conditioner, etc.) There shall be one or more circuits of adequate rating in accordance with the following:

(a) Ampere rating of fixed appliances not over 50% of circuit rating if lighting outlets (receptacles, other than kitchen, dining area, and laundry, considered as lighting outlets) are on same circuit;

(b) For fixed appliances on a circuit without lighting outlets, the sum of rated amperes shall not exceed the branch-circuit rating for other than mtor loads or 80% of the branch-circuit rating for air conditioning or other motor loads;

(c) The rating of a single portable appliance on a circuit having no other outlets shall not exceed 80% of the circuit rating;

(d) The rating of range branch circuit shall be based on the range demand as specified for ranges in section E 550.11 (2) (e).

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 550.06 Receptacle outlets. (1) All receptacle outlets:

(a) Shall be of grounding type:

(b) Shall be installed according to section E 210.07; and

(c) Except when supplying specific appliances, receptacles shall be parallel blade, 15-ampere, 125-volt, either single or duplex.

(2) There shall be an individual outlet of the grounding type for each cord-connected fixed appliance installed.

(3) Except in the bath and hall areas, receptacle outlets shall be installed at all wall spaces 2 feet wide or more, so that no point

along the floor line is more than 6 feet, measured horizontally, from an outlet in that space. Except as explained in the following, receptacle outlets are not required for wall spaces occupied by kitchen or wardrobe cabinets.

(a) In addition, a receptacle outlet shall be installed:

1. Over counter tops in the kitchen (at least one on each side of the sink if counter tops are on each side);

2. Adjacent to the refrigerator and free-standing gas-range space;

3. At counter top spaces for built-in vanities;

4. At counter top spaces under wall-mounted cabinets.

(4) Receptacle outlets shall not be installed within or adjacent to a shower or bathtub space.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 550.07 Fixtures and appliances. (1) Water heaters, refrigerators, air conditioning equipment, ranges, electric heaters, washers, dryers and other like appliances shall be of an approved type and shall be connected in an approved manner and securely fastened in position. (See section E 550.09 for provisions on grounding.)

(2) (a) Specifically approved pendant-type fixtures or pendant cords may be installed in mobile homes.

(b) If a lighting fixture is provided over a bathtub or in a shower stall, it shall be of the approved enclosed and gasketed type.

(c) Switches shall not be located inside the tub or shower space.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 550.08 Wiring methods and materials. Except as specifically limited in this section the wiring methods and materials included in the Wisconsin state electrical code shall be used in mobile homes.

(1) Nonmetallic outlet boxes are acceptable only with nonmetallic sheathed cable.

(2) Nonmetallic cable located 15 inches or less above the floor, if exposed, shall be protected from physical damage by covering boards, guard strips, or conduit. Cable likely to be damaged by stowage shall be so protected in all cases.

(3) Metal-clad and nonmetallic cables may be passed through the centers of the wide side of 2 by 4 studs. However, they shall be protected where they pass through 2 by 2 studs or at other studs or frames where the cable or armor would be less than 1½ inches from the inside or outside surface. Steel plates on each side of the cable, or a tube, with not less than No. 16 manufacturer's standard gage wall thickness, are required to protect the cable. These plates or tubes shall be securely held in place.

(4) Where metallic faceplates are used they shall be effectively grounded.

(5) If the range, clothes dryer, or similar appliance is connected by armored cable or flexible conduit, a length of free cable or conduit should be provided to permit moving the appliance. The cable of flexible conduit should be adequately secured to the wall. Clearance space behind a range may provide the required protection when a range is connected by type SE cable. When used, type SE cable shall have an identified and insulated neutral plus an equipment grounding conductor. Nonmetallic cable (type NM) shall not be used to connect a range.

(6) Rigid metal conduit shall be provided with a locknut inside and outside the box, and a conduit bushing shall be used on the inside. Inside ends of the conduit shall be reamed.

(7) Switches shall be rated as follows: (a) For lighting circuits, switches shall have a 10-ampere 125 volt rating; or higher, if needed for the connected load.

(b) For motors or other loads, switches shall have ampere or horsepower ratings or both adequate for loads controlled. (An "AC general use" snap switch may control a motor 2 horsepower or less with full-load current not over 80% of the switch ampere rating.)

(8) At least 4 inches of free conductor shall be left at each outlet box except where conductors are intended to loop without joints.

(9) Under chassis wiring (exposed to weather). (a) When outdoor or under chassis wiring is exposed to moisture and physical damage it shall be protected by rigid metal conduit or liquid-tight flexible metal conduit, except electrical metallic tubing may be used when closely routed against frames and equipment enclosures.

(b) The conductors shall be type NMC, RW, TW, or equivalent.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 550.09 Grounding. Grounding of both electrical and non-electrical metal parts in a mobile home is through connection to a grounding bus in the mobile home distribution panel. The grounding bus is grounded through the green-colored conductor in the supply cord or the feeder wiring to the service ground in the service entrance equipment located adjacent to the mobile home location. Neither the frame of the mobile home nor the frame of any appliance may be connected to the neutral conductor in the mobile home.

(1) INSULATED NEUTRAL. (a) The grounded circuit conductor (neutral) shall be insulated from the grounding conductors and from equipment enclosures and other grounded parts. The grounded (neutral) circuit terminals in the distribution panel and in ranges, clothes dryers, counter-mounted cooking units, and wall-mounted ovens are to be insulated from the equipment enclosure. Bonding screws, straps, or buses in the distribution panel or in appliances are to be removed and discarded.

(b) Connection of ranges and clothes dryers shall be made with 4 conductor cord and 3-pole, 4-wire grounding type plugs, or by armored cable or conductors enclosed in flexible steel conduit.

(2) EQUIPMENT GROUNDING MEANS. (a) The green-colored grounding wire in the supply cord or permanent feeder wiring shall be connected to the grounding bus in the distribution panel or disconnecting means.

(b) The chassis shall be grounded. The grounding conductor may be solid or stranded, insulated or bare, and shall be an armored grounding conductor or routed in conduit if No. 8 AWG. The conductor, if No. 6 AWG or larger, may be run without metal covering. The grounding conductor shall be connected between distributing panel grounding terminal and a terminal on the chassis. Grounding terminals shall be of the solderless type and approved as pressure terminal connectors recognized for the wire size employed.

(c) In the electrical system, all exposed metal parts, enclosures, frames, lamp fixture canopies, etc. shall be effectively bonded to the grounding terminal or enclosure of the distribution panel.

(d) Cord-connected appliances, such as washing machines, clothes dryers, refrigerators, and the electrical system of gas ranges, etc. shall be grounded by means of an approved cord with grounding conductor and grounding type plug.

(3) GROUNDING OF NON-CURRENT-CARRYING METAL PARTS. All major exposed metal parts that may become energized, including the water, gas and waste plumbing, the roof and outer metallic covering, the chassis and metallic circulating air ducts, shall be effectively bonded to the grounding terminals or enclosure of the distribution panel or to the metal chassis. See subsection (2) (b) for bonding of the chassis to the distribution panel grounding terminal.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 550.10 Testing. Dielectric strength test. The wiring of each mobile home shall be subjected to a 1-minute, 900-volt, dielectric strength test (with all switches closed) between live parts (including neutral) and the mobile home ground. Alternatively, the test may be performed at 1,088 volts for 1 second. This test shall be performed after branch circuits are complete and after fixtures or appliances are installed.

(1) EXCEPTION: Fixtures or appliances which are approved shall not be required to withstand the dielectric strength test.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 550.11. Calculations. The following method is to be employed in computing the supply cord and distribution panel load for each power supply assembly for each mobile home in lieu of the procedure shown in Wis. Adm. Code chapter E 220 and is based on 3-wire, 115/230 volt supply with 115 volt loads balanced between the two legs of the 3-wire system.

(1) Lighting and small appliance load. Lighting watts: Length times width of mobile home (outside dimensions, exclusive of hitch) times 3 watts per square foot; e.g.,

Length × width × 3 = ______ lighting watts.

Small appliance watts: Number of circuits times 1,500 watts for each 20-ampere appliance receptacle circuit (see definition of appliance, portable with note); e.g.,

Number of circuits × 1,500 = ______ small appliance watts.

Total: Lighting watts plus small appliance = ______ total watts.

First 3,000 total watts at 100 per cent plus remainder at 35 per cent = ______ watts to be divided by 230 volts to obtain current (amperes) per leg.

(2) Total load for determining power supply is the summation of:

(a) Lighting and small appliance load as calculated in subsection E 550.11 (1).

(b) Name plate amperes for motors and heater loads (exhaust fans, air conditioners,* electric, gas or oil heating).**

* Omit smaller of these two, except include blower motor if used as air conditioner evaporator motor.
** When an air conditioner is not installed and a 40-ampere power supply cord is provided, allow 15 amperes per leg for air conditioning.

(c) 25% of current of largest motor in (b).

(d) Total of nameplate amperes for: disposal, dishwasher, water heater, clothes dryer, wall-mounted oven, cooking units.

Where number of these appliances exceeds 3 use 75% of total.

(e) Derive amperes for free standing range (as distinguished from separate ovens and cooking units) by dividing values below by 230 volts.

Name Plate Rating	Use
10,000 w x or less	80 per cent of rating
10,001-12,500 w	8,000 w
12,501-13,500 w	8,400 w
13,501-14,500 w	8,800 w
14,501-15,500 w	9,200 w
15,501-16,500 w	9,600 w
16,501-17,500 w	10,000 w

(f) If outlets or circuits are provided for other than factory installed appliances include the anticipated load.

See following example for illustration of application of this calculation.

EXAMPLE

A mobile home ix 70 x 10 feet and has two portable appliance circuits, a 1000 watt 230 volt heater, a 200 watt 115 volt exhaust fan, a 400 watt 115 volt dishwasher and a 7000 watt electric range.

Lighting and small appliance load
Lighting 70 × 10 × 3 = 2100 watts
Small appliance 1500 × 2 = 3000 watts

5100 watts

1st 3000 watts at 100%	3000
Remainder (5,100 — 3,000 = 2,100) at 25%	735
	3735

$$\frac{3735}{230} = 16 \text{ amperes per leg}$$

1000 watt (heater) ÷ 230 = 4.4 amp.
200 watt (fan) ÷ 115 = 1.7 amp
400 watt (dishwasher) ÷ 115 = 3.5 amp
7000 watt (range) × .8 ÷ 230 = 24. amp

	Amperes per leg A	B
Lighting and appliances	16	16
Heater (230 volt)	4	4
Fan (115 volt)	2	--
Dishwasher (115 volt)	--	4
Range	24	24
Totals	46	48

Based on the higher current calculated for either leg, use one 50 ampere supply cord.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

Chapter E 551

TRAVEL HOMES

E 551.01 Scope. (1) The provisions of this chapter cover the electric conductors and equipment installed within or on travel homes and also on conductors that connect them to a supply of electricity.

(a) Wherever the requirements of other chapters of the Wisconsin state electrical code and chapter E 551 differ, the requirements of chapter E 551 shall apply.

(2) A travel home not intended as a dwelling unit as for example, for use as a mobile store, an office, a schoolroom or designed for the display or demonstration of merchandise or machinery shall not be required to meet the provisions of this chapter pertaining to the number or capacity of circuits required. It shall, however, meet all other applicable requirements of this chapter if provided with an electrical installation intended to be energized from a 115 volt, AC power supply system.

(3) The provisions of this chapter apply to the electrical equipment and materials of travel homes intended for connection to a wiring system nominally rated 115 volts, 2-wire, AC, with a grounded neutral.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 551.02 Definitions. The following definitions apply only to the requirements of this chapter.

(1) SUPPLY FEEDER: That part of the electric distribution system from the supply point to the travel home service equipment.

(2) TRAVEL HOME: A vehicular portable structure built on a chassis, designed to be used as a temporary dwelling for travel, recreational, and vacation use; a travel type mobile home, hereafter called a "Travel Home." When factory equipped for the road, it shall have a body width not exceeding 8 feet and body length not exceeding 32 feet.

(3) TRAVEL HOME PARK: The location of 2 or more travel home spaces.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 551.03 Power supply conductors and service equipment. (1) POWER SUPPLY CONDUCTORS. (a) *Feeding travel home service equipment.* All supply feeders shall have ratings specified as follows:

1. A supply feeder serving one travel home service equipment shall be rated not less than 20 amperes.

2. A supply feeder serving 2, 3 or 4 sets of service equipment shall be rated not less than 40 amperes.

3. Where a supply feeder serves more than 4 sets of service equipment, figure a minimum demand of 20 amperes for each set and then apply a demand factor of 50% to the total demand to determine the minimum supply feeder ampere rating.

(b) *Feeding travel home.* The conductors between the service equipment and the travel home shall be a feeder circuit supply cord approved for the purpose rated 15 or 20 amperes, 115 volts, and shall have 3 conductors, one of which shall be identified by a continuous green color or a continuous green color with a yellow stripe. The attachment plug, connectors, and mating receptacles shall be of a 2-pole, 3-wire grounding type approved by the administrative authority. The supply cord shall not be less than 20 feet or more than 26½ feet long and shall be either separable or permanently attached.

Note: It is the policy of the administrative authority to approve grounding type attachment plugs, connectors and mating receptacles covered by American Standard C73 Attachment Plugs and Receptacles.

(c) *Separable cord set.* When a separable cord set, consisting of a cord, male and female fittings, is provided by the travel home manufacturer, the travel home shall be equipped with a permanently-mounted, approved, male recessed-type attachment plug (motor base receptacle) wired directly to the distribution panel in an approved manner by means of approved service cable. The supply end of the cord set shall be equipped with an attachment plug of the type described in subsection (1) (b).

(d) *Permanently connected power cord.* The cord shall be connected directly to the terminals of the distribution panel and provided with means to prevent strain from being transmitted to the terminals. The supply end of the cord shall be equipped with an attachment plug of the type described in subsection (1) (b).

(e) Supply cords shall be as follows:

1. 15 ampere No. 14/3 AWG for travel homes which have a single 15 ampere purpose branch circuit and gas or oil-fired heating and cooking appliances.

2. 20 ampere No. 12/3 AWG for travel homes which have a single 12 ampere general purpose branch circuit and gas or oil-fired heating and cooking appliance.

(2) SERVICE EQUIPMENT. The travel home service equipment shall be located adjacent to the travel home parking location and not mounted in or on the travel home. The service equipment shall consist of disconnecting means, overcurrent protective device and receptacle as specified in subsection (2) (a).

(a) Each travel home space shall be provided with a disconnecting means, overcurrent protective device and 2-pole, 3-wire grounding type receptacle, each rated not less than 20 amperes.

(b) The travel home grounding conductor shall be bonded to the system neutral conductor within the disconnecting means enclosure. See section E 551.09. A separate common grounding conductor shall be run from a grounding electrode to the disconnecting means enclosure where it shall be bonded to the system neutral and travel home grounding conductor. The grounding electrode shall always be a metallic underground water piping system where such a piping system is available.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 551.04 Disconnecting means and branch circuit protective equipment. (1) The branch circuit equipment may be combined with the disconnecting means as a single assembly. Such a combination may be designated as a distribution panel.

(2) Plug fuses and fuseholders shall be tamper-resistant, type "S" enclosed in dead-front fuse panels.

(3) Disconnecting Means. (a) Disconnecting means shall be provided in each travel home and shall be approved service entrance equipment consisting of circuit-breakers or a switch and fuses and their accessories installed in a readily accessible location near the point of entrance of the supply cord or conductors into the travel home. This equipment shall contain a solderless type of grounding connector or bar for the purposes of grounding with sufficient terminals for all grounding conductors. The neutral bar termination of the grounded circuit conductors shall be insulated.

(b) The disconnecting equipment shall have a rating suitable for the connected load. Travel homes in which only a single branch circuit is installed may use a branch-circuit breaker or pull-out type of fuse-holder as disconnecting means if approved for use as service equipment.

(4) Branch circuit protective equipment. (a) Branch circuit distribution equipment shall be installed in each travel home and shall include over-current protection for each branch circuit consisting of either circuit breakers or fuses.

(b) The branch-circuit overcurrent devices shall be rated:

1. Not more than the circuit conductors; and

2. Not more than 150% of the rating of a single appliance rated 10 amperes or more.

(5) Labeling at electrical entrance. Each travel home shall have permanently affixed to the exterior skin, at or near the point of entrance of the power supply cord, a metal tag reading: "This travel home is wired for 110/125 volt AC service. Do not connect to higher voltage."

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 551.05 Branch circuits. (1) Travel homes with not more than 6 general appliance and receptacle outlets combined shall have not less than either:

(a) One general purpose (lighting) branch circuit, 15 amperes, No. 14 AWG circuit, to supply these outlets, or

(b) One general purpose (lighting and appliance) branch circuit, 20 amperes, No. 12 AWG circuit, to supply these outlets, provided that the total rating of fixed appliances connected to this circuit shall not exceed 5 amperes or 600 watts.

Note: Travel homes, wired in accordance with (a) and (b) shall be equipped with gas or oil-fired heating and cooking appliances.

(2) Travel homes with more than 6 general appliance and receptacle outlets combined shall have not less than:

(a) One general purpose (lighting and appliance) branch circuit, 20 amperes of No. 12 gage conductors, minimum, which shall supply current to lighting outlets and receptacles only (shall not supply receptacles in cooking and dining areas) and may supply fixed or portable appliances such as electric water heaters. The total rating of such fixed or factory installed appliances shall not exceed 9 amperes or 1,000 watts, and

(b) One appliance branch circuit, as follows: 20 amperes, No. 12 gage conductors, minimum, which shall supply current to receptacle outlets only in cooking and dining areas.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 551.06 Receptacle outlets. (1) All receptacle outlets: (a) shall be of the grounding type; (b) shall be installed according to Wis. Adm. Code section E 210.07; and (c) shall be of the parallel blade, 15 ampere, 125 volt type either single or duplex.

(2) There shall be an individual outlet of the grounding type for each cord-connected fixed appliance installed.

(3) Except in the bath area, receptacle outlets shall be installed at all wall spaces 2 feet wide or more, so that no point along the floor line is more than 6 feet, measured horizontally, from an outlet in that space. Except as explained in the following, receptacle outlets are not required for wall spaces that are partially or fully occupied by kitchen cabinets, wardrobes, built-in furniture, or similar facilities.

(a) In addition, a receptacle outlet shall be installed:

1. Over counter tops in the kitchen and dining area.

2. Adjacent to the refrigerator space, except when a gas-operated refrigerator containing no electrical circuit is factory installed.

3. Adjacent to a gas range space, except when a gas cooking appliance containing no electrical circuit is factory installed.

4. At counter top spaces for built-in vanities.

(4) No receptacle outlet shall be provided adjacent to a shower or bathtub.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 551.07 Fixtures and appliances. (1) FIXED APPLIANCES:

(a) All fixed appliances shall be of an approved type and shall be connected in an approved manner and securely fastened in position. (See section E 551.09 for provisions on grounding.)

(2) LIGHTING FIXTURES.

(a) Pendant-type fixtures or pendant cords shall not be installed.

(b) If a lighting fixture is provided over a bathtub or in a shower stall, it shall be of the approved enclosed and gasketed type.

(c) Switches shall not be located inside the tub or shower space.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 551.08 Wiring methods and materials. Except as specifically limited in this section, the wiring methods and materials included in the Wisconsin state electrical code shall be used in travel homes.

(1) Nonmetallic outlet boxes are acceptable only with nonmetallic sheathed cable.

(2) Nonmetallic cable located 15 inches or less above the floor, if exposed, shall be protected from physical damage by covering boards,

guard strips, or conduit. Cable likely to be damaged by stowage shall be so protected in all cases.

(3) Metal-clad and nonmetallic cables may be passed through the centers of the wide side of 2 by 4 studs. However, they shall be protected where they pass through 2 by 2 studs or at other studs or frames where the cable or armor would be less than 1½ inches from the inside or outside surface. Steel plates on each side of the cable, or a tube, with not less than No. 16 manufacturer's standard gage wall thickness, are required to protect the cable. These plates or tubes shall be securely held in place. When the thickness of studs or frames make it impractical or impossible to use metal plates or tubes, particular care shall be exercised in the design and production of the travel home so as to avoid contacting the cables with nails, screws, or other fasteners, such care in design shall include appropriate routing of the cables through studs or frames at locations where the likelihood of their being contacted by nails, screws, or other fasteners subsequent to production is remote.

(4) Where metallic faceplates are used they shall be effectively grounded.

(5) Switches shall be rated as follows:

(a) For lighting circuits, switches shall have a 10-ampere, 125 volt rating: or higher, if needed for the connected load.

(b) For motors or other loads, switches shall have ampere or horsepower ratings or both adequate for loads controlled. (An "AC general use" snap switch may control a motor 2 horsepower or less with full-load current not over 80% of the switch ampere rating.)

(6) At least 4 inches of free conductor shall be left at each outlet box except where conductors are intended to loop wiithout joints.

(7) Under chassis wiring (exposed to weather.)

(a) When outdoor or under chassis wiring is exposed to moisture and physical damage it shall be protected by rigid metal conduit or liquid-tight flexible metal conduit, except electrical metallic tubing may be used when closely routed against frames and equipment enclosures.

(b) The conductors shall be type NMC, RW, TW, or equivalent.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 551.09 Grounding. Grounding of both electrical and nonelectrical metal parts in a travel home is through connection to a grounding bus in the travel home distribution panel. The grounding bus is grounded through the green-colored conductor in the supply cord of the feeder wiring to the service ground in the service entrance equipment located adjacent to the travel home location. Neither the frame of the travel home nor the frame of any appliance may be connected to the neutral conductor in the travel home.

(1) INSULATED NEUTRAL. The ground circuit conductor (neutral) shall be insulated from the grounding conductors and from equipment enclosures and other grounded parts. The grounded (neutral) circuit terminals in the distribution panel and in counter mounted cooking units are to be insulated from the equipment enclosure. Bonding screws, straps or buses in the distribution panel or in appliances are to be removed and discarded.

(2) EQUIPMENT GROUNDING MEANS. (a) The green-colored grounding wire in the supply cord or permanent feeder wiring shall be connected to the grounding bus in the distribution panel or disconnecting means.

(b) The chassis shall be grounded. The grounding conductor may be solid or stranded, insulated or bare, and shall be an armored grounding conductor or routed in conduit if No. 10 AWG. The conductor, if No. 8 AWG stranded or larger, may be run without metal covering. The grounding conductor shall be connected between distribution panel grounding terminal and a terminal on the chassis. Grounding terminals shall be of the solderless type and approved as pressure terminal conductors recognized for the wire size employed. The grounding conductors shall be routed so as not to be exposed to physical damage; protection can be afforded by following the configuration of the chassis.

(c) In the electrical system, all exposed metal parts, enclosures, frames, lamp fixture canopies, etc. shall be effectively bonded to the grounding terminal or enclosure of the distribution panel.

(d) Cord-connected appliances, such as refrigerators, and the electrical system of gas ranges, shall be grounded by means of an approved cord with grounding conductor and grounding type plug.

(3) GROUNDING OF NONCURRENT CARRYING METAL PARTS. All major exposed metal parts that may become energized, including the water, gas, and waste plumbing, the roof and outer metallic covering, the chassis and metallic circulating air ducts, shall be effectively bonded to the grounding terminal or enclosure of the distribution panel or to the metal chassis. See subsection (2) (b).

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 551.10 Testing. Dielectric strength: The wiring of each travel home shall be capable of withstanding, without breakdown, for a period of 1 minute, the application of an alternating potential of 900 volts between live parts and noncurrent-carrying metal parts.

(1) EXCEPTION. Fixtures or permanently installed appliances shall not be required to withstand the dielectric test if they have been approved.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

Chapter E 560

FARM AND RURAL WIRING

E 560.01 General. Farms and other rural locations contain a variety of conditions ranging from dry to corrosive and are generally located in areas where it is difficult to obtain low resistance grounds. The housing and handling of animals, feed and machinery present problems which may not be covered adequately in other sections of the code. Other rules in this code are applicable to farm and rural wiring when not in conflict with this chapter.

History: Cr. Register, January, 1968, No. 145, eff. 2–1–68.

E 560.02 Service. The electric service at a farm or other rural location shall be installed in accordance with subsections (1), (2) or (3).

(1) DISCONNECTION OF CONDUCTORS. It is recommended that an isolating means be provided at the point where the electric utilities service conductors terminate and be arranged to disconnect all ungrounded conductors from the service. The operating means for the disconnect shall be accessible from the ground. The isolating means recommended by this section may be the service disconnect specified in subsection (2) (a) or some other device such as a pole-top isolating switch.

(a) Exception. A water pump may be connected in such a way that opening of other than its own circuit protection will not interrupt service to the pump. A service disconnect for a water pump shall not be counted as one of the 6 disconnects referred to in subsection (2) (a).

(2) SERVICE EQUIPMENT AT ONE POINT. The electric service may be brought to one point or building and complete service equipment including disconnecting means placed at that point.

(a) The service disconnecting means, located at one point, shall consist of no more than 6 fused disconnect switches or circuit breakers except for the residence which shall have a single main disconnecting means. In addition, a disconnecting means shall be placed at each building to permit disconnecting the entire supply to the building with no more than 6 operations of the hand. The building disconnecting means shall be grouped at one point.

Note: A pole-top isolating switch is not approved as service equipment and cannot take the place of the service disconnecting means required by this subsection.

(b) Overhead supply conductors to other buildings or structures shall be treated the same as service drops with respect to clearances and conductor size and insulation. Conductors on the load side of the service disconnecting means, whether overhead or underground, shall be protected against overcurrent in accordance with Wis. Adm. Code sections E 240.05 and E 240.15.

(3) SERVICE EQUIPMENT AT DIFFERENT POINTS. (a) The electric service may be brought to one point and metered but with service disconnecting means located at other points on the premises and installed in accordance with the requirements of chapter E 230.

(b) Overhead conductors from a central metering point to other buildings or structures are considered service drops and shall comply with chapter E 230, part C, except they shall be sized not smaller than No. 8 copper or equivalent. Underground services from a central metering point to other buildings or structures shall comply with chapter E 230, part C, and section E 310.06.

Note 1: Directly buried conductors running from central metering point are service conductors and must be type USE. Type UF cable is not permitted.

Note 2: Separate service conductors are permitted to be run to silos even though they may be attached to other buildings.

(4) FARM OR RURAL DWELLINGS. The service or supply to a farm or rural dwelling shall comply with chapter E 230.

(5) ADDITIONAL SERVICE. An additional service of the required size may be installed to supply a device for converting single phase power to multi-phase power.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 560.03 Farm feeder and service load calculations. (1) FEEDERS. Feeders supplying farm buildings (excluding dwellings), structures or loads consisting of 2 or more branch circuits shall have a minimum capacity computed in accordance with the following table:

TABLE E 560.03 (1)

DEMAND COMPUTATION FOR FARM BUILDINGS, STRUCTURES OR LOADS

LOAD IN AMPERES AT 230 VOLTS	Percent of Connected Load
Loads expected to operate without diversity, but not less than first 60 amperes	100
Next 60 amperes of all other load	50
Remainder of other load	20

Note 1: The feeder load to a farm dwelling shall be based on Wis. Adm. Code sections E 220.02 to E 220.07 with a 100 ampere minimum.

Note 2: For service at main point of delivery to farmstead, see sections E 560.03 (2) and (3).

(2) SERVICE AT ONE POINT (See section E 560.02 (1)). Minimum capacity of service conductors and service equipment at the main point of delivery to farms (including dwellings) shall be determined in accordance with the following formula:

100% of the largest demand computed in accordance with subsection (1) plus;

75% of the second largest demand computed in accordance with subsection (1) plus;

65% of the third largest demand computed in accordance with subsection (1) plus;

50% of the demands of remaining loads computed in accordance with subsection (1).

Note 1: Consider as a single computed demand the total of the computed demands of all buildings or loads having the same function.

Note 2: The demand of the farm dwelling, if included in the demands of this formula, should be computed in accordance with Note 1 of Table E 560.03 (1).

(3) SERVICE AT EACH BUILDING (See section E 560.02 (2)). Service equipment and service entrance conductors for individual farm buildings or structures (excluding dwellings) shall have minimum capacity computed in accordance with subsection (1).

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 560.04 Grounding. (1) The neutral conductor shall be grounded at the entrance of each building housing livestock, equipment required to be grounded or utilizing 2 or more branch circuits. The ground connection shall be made to a metallic underground water piping system, if one is available. If the buried portion of the water piping system is less than 50 feet, excluding wall casings or has a resistance to ground of more than 3 ohms, the water system shall be augmented at each service by at least 2 grounding electrodes recognized in Wis. Adm. Code section E 250.083.

(2) Any metal raceway system shall be bonded to the neutral at the entrance to the building. In addition, a separate grounding conductor shall be carried back from metal enclosures of electrical equipment to the point where the neutral is grounded. The ground for non-current carrying metal parts and the neutral shall be tied together at the grounding point.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 560.05 Wiring. The wiring methods for farm and rural locations shall be in accordance with the following subsections.

(1) In spaces where livestock is housed, milk houses, pump houses, root cellars, silos and poultry house, types NMC, UF or other nonabsorbent nonmetallic sheathed cable shall be used. In addition, insulated boxes, lampholders, ducts and bushings should be used. If some metal boxes must be used they shall be mounted on insulating material out of contact with the masonry.

Note: It is recommended that at least a ¾ inch clearance be maintained between the insulating material and masonry.

(2) In dwellings, workshops, storage sheds, shelters or tobacco sheds, any type wiring system recognized by this code may be used.

(3) In hay mows and granaries, any type wiring system recognized by this code may be used. All lamps shall be installed in a vertical position and protected with a dust-tight fixture. Switches and receptacles shall be a type designed to prevent the entrance of dust. All electrical equipment shall be arranged or enclosed to keep hay and grain away, and ducts if used shall be arranged to reduce condensation and drain.

(4) All electrical equipment installed outside of a building or in extremely wet locations, such as silo rooms, shall be of weatherproof construction.

(5) The wiring of a gasoline dispensing pump shall comply with the appropriate sections of chapter E 514.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 560.06 Disconnect for power units. A disconnecting means shall be installed within 3 feet of the power units of silo unloaders and be wired to disconnect all power to the units.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

SPECIAL EQUIPMENT

Chapter E 600

ELECTRIC SIGNS AND OUTLINE LIGHTING

A. GENERAL

E 600.01 Scope. The provisions of this chapter shall apply to the installation of conductors and equipment for electric signs and outline lighting as defined in Wis. Adm. Code chapter E 100.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 600.02 Disconnect required. Electric signs of other than the portable type and outline lighting installations shall be controlled by an externally operable switch or breaker which will open all ungrounded conductors. The switch or breaker required by this section may control one or more signs or outline lighting installations.

(1) IN SIGHT OF SIGN. The switch or breaker required by section E 600.02 shall be within sight of the signs or outline lighting which it controls or be capable of being locked in the open position.

(2) CONTROL SWITCH RATING. Switches, flashers, and similar devices controlling transformers shall be either of a type approved for the purpose, or have a current rating not less than twice the current rating of the transformers. On alternating-current circuits, general use alternating-current snap switches may be used to control inductive loads other than motors, not exceeding the ampere rating of switch. See Wis. Adm. Code section E 380.14.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 600.03 Sign enclosures as raceways. A sign enclosure shall not be used as a pull box or raceway for conductors supplying other signs or equipment.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 600.05 Grounding. (1) Signs, troughs, tube terminal boxes and other metal frames shall be grounded in the manner specified in chapter E 250 of this code, unless they are insulated from ground and from other conducting surfaces and are inaccessible to unauthorized persons.

(2) Isolated non-current-carrying metal parts of outline lighting may be bonded by No. 14 conductors and grounded in accordance with chapter E 250.

(3) Signs of the portable incandescent or fluorescent-lamp type in which the open circuit voltage does not exceed 150 volts to ground are not required to be grounded.

History: Cr. Register, January, 1968, No. 145, eff. 2–1–68.

E 600.06 Load of branch circuit. (1) Circuits shall be so arranged that the load imposed by outlets, lamps, and transformers connected to them, shall in no case exceed the rating of the branch circuit.

(2) Circuits which supply lamps, ballasts, and transformers or combinations thereof may be rated not to exceed 20 amperes.

(3) Circuits containing electric discharge lighting transformers exclusively shall not be rated in excess of 30 amperes.

(4) Branch circuit fuseholders, if on or within the body of the sign, shall be mounted in a separate accessible compartment.

History: Cr. Register, January, 1968, No. 145, eff. 2–1–68.

E 600.07 Marking. (1) Signs shall be marked with the maker's name, and for incandescent-lamp signs with the number of lampholders, and for electric discharge signs with input amperes at full load and input voltage. The marking of the sign shall be visible for inspection after installation.

(2) Transformers shall be marked with the maker's name, and transformers for electric discharge signs shall be marked with the input rating in amperes or volt-amperes, the input voltage and the open-circuit high-tension voltage.

History: Cr. Register, January, 1968, No. 145, eff. 2–1–68.

E 600.08 Enclosures. Enclosures for signs and outline lighting shall conform to the following:

(1) CONDUCTORS AND TERMINALS. Conductors and terminals in sign boxes, cabinets and outline troughs shall be enclosed in metal or other noncombustible material.

(2) CUTOUTS, FLASHERS, ETC. Cutouts, flashers, and similar devices shall be enclosed in metal boxes the doors of which shall be arranged so that they can be opened without removing obstructions or finished parts of the enclosure.

(3) STRENGTH. Enclosures shall have ample strength and rigidity.

(4) MATERIAL. Except for portable signs of the indoor type, signs and outline lighting shall be constructed of metal or other noncombustible material. Wood may be used for external decoration if placed not less than 2 inches from the nearest lampholder or current-carrying part.

(5) MINIMUM THICKNESS; ENCLOSURE METAL. Sheet copper shall be at least 20 ounce (0.028 inch). Sheet steel may be of No. 28 MS (USS Revised) gauge except that for outline lighting and for electric discharge signs sheet steel shall be of No. 24 MS (USS Revised) gauge, unless ribbed, corrugated or embossed over its entire surface, when it may be of No. 26 MS (USS Revised) gauge.

(6) Protection of metal. All steel parts of enclosures shall be galvanized or otherwise protected from corrosion.

(7) Enclosures exposed to the weather. Enclosures for outside use shall be weatherproof and shall have an ample number of drain holes, each not larger than ½ inch or smaller than ¼ inch. Wiring connections shall not be made through the bottoms of enclosures exposed to the weather unless the enclosures are of the raintight type.

History: Cr. Register, January, 1968, No. 145, eff. 2–1–68.

E 600.09 Portable gas tube signs. All gas tube signs not coming within the definition of portable shall be wired in accordance with the code rule. Satisfactory portable signs may be installed by connection with portable cord.

Note: As applied to Neon or gas tube signs, portable means less than 75 pounds in weight and 10 square feet over the largest surface, with all high tension wires and tube terminals within the sign enclosure proper, and the tubes or lamps fastened only to and not extending beyond the sign surface or background. All portable gas tube signs shall have the metal enclosure grounded by a 3-wire cord connected to a 3-point receptacle and the portable cord shall be limited to 6 feet in length.

History: Cr. Register, January, 1968, No. 145, eff. 2–1–68.

E 600.11 Tube terminals. The terminals shall be so designed that the tubing can be replaced without the necessity of exposing uninsulated live parts. If the spring contact type of receptacle is used, it shall be so designed that, even with the tube removed, the live spring will be recessed a distance equal to 3 times the diameter of the receptacle opening. It is recommended that the primary circuit be controlled by a relay that will open the circuit when a tube in the secondary circuit is broken or removed. Live parts shall be protected by barriers which require other than ordinary tools such as pliers and screw-drivers for removal unless access to the parts requires the disconnection of the primary circuits. (See section E 410.80).

History: Cr. Register, January, 1968, No. 145, eff. 2–1–68.

E 600.12 Clearance of signs from electric lines. The clearance of electric lines from buildings shall govern the clearance between signs and electric lines. See Wis. Adm. Code section E 129.03 (3), volume 1. 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.

History: Cr. Register, January, 1968, No. 145, eff. 2–1–68.

B. SIGNS AND OUTLINE LIGHTING—600 VOLTS OR LESS

E 600.21 Installation of conductors. Conductors shall be installed as follows:

(1) Wiring method. Conductors shall be installed as open conductors on insulators, in rigid metal conduit, flexible metal conduit, electrical metallic tubing, metal-clad cable, metal troughing, type ALS cable or type MI cable.

(2) Insulation and size. Conductors shall be of a type approved for general use and shall be no smaller than No. 14.

(a) *Exception No. 1.* Conductors in portable signs, short leads permanently attached to lampholders or ballasts, and leads in wiring channels which are permanently attached to electric discharge lampholders or electric discharge ballasts and which are not longer than 8 feet may be smaller than No. 14 but shall not be smaller than No. 18 and shall be of a type approved for the purpose.

(b) *Exception No. 2.* Conductors, for signs with multiple incandescent lamps requiring one conductor from a control to one or more lamps whose total load does ot exceed 250 watts, may be smaller than No. 14 but shall not be smaller than No. 18 if in an approved cable assembly of 2 or more conductors.

(3) EXPOSED TO THE WEATHER. Conductors in raceways, armored cable or enclosures exposed to the weather, shall be of the lead-covered type or other type specially approved for the conditions, except where rigid conduit, electrical metallic tubing or enclosures are made raintight and arranged to drain.

(4) NUMBER OF CONDUCTORS IN RACEWAY. Number of conductors in raceway for sign flashers may be in accordance with table 1 of chapter E 900.

(5) OPEN CONDUCTORS. Open conductors on insulators shall comply with the provisions of Wis. Adm. Code sections E 300.02 to E 300.22 inclusive, and, if outdoors, chapter E 730, except that the separation between conductors need be only 2 inches.

(a) *Exception:* Open conductors may be supported by lampholders located not more than 1 foot apart.

(6) CONDUCTORS SOLDERED TO TERMINALS. Where the conductors are fastened to lampholders other than of the pin type, they shall be soldered to the terminals and the exposed parts of conductors and terminals shall be treated to prevent corrosion. Where the conductors are fastened to pin-type lampholders which protect the terminals from the entrance of water, and which have been found acceptable for sign use, the conductors shall be of the stranded type but need not be soldered to the terminals.

History: Cr. Register, January, 1968, No. 145, eff. 2–1–68.

E 600.22 Lampholders. Lampholders shall be of the unswitched type having bodies of suitable insulating material and shall be so constructed and installed as to prevent turning. Miniature lampholders shall not be employed for outdoor signs and outline lighting.

History: Cr. Register, January, 1968, No. 145, eff. 2–1–68.

C. SIGNS AND OUTLINE LIGHTING—EXCEEDING 600 VOLTS

E 600.31 Installation of conductors. Conductors shall be installed as follows:

(1) WIRING METHOD. Conductors shall be installed as open work, as concealed conductors on insulators, in rigid or flexible metal conduit, or in electrical metallic tubing.

(2) INSULATION AND SIZE. Conductors shall be of a type approved for the purpose and for the voltage of the circuit and shall be not smaller than No. 14.

(a) *Exception No. 1.* Leads in wiring channels which are permanently attached to electric discharge lampholders or electric discharge ballasts and which are not longer than 8 feet may be smaller than No. 14 but shall not be smaller than No. 18 and shall be of a type approved for the purpose.

(b) *Exception No. 2.* Leads in show-window displays or small portable signs that run from the line ends of the tubing to the secondary windings of the transformer where they are permanently attached within the transformer enclosure and which are not longer than 8 feet may be smaller than No. 14, but shall not be smaller than No. 18 and shall be of the type approved for the purpose.

(3) BENDS IN CONDUCTORS. Sharp bends in the conductors shall be avoided.

(4) OPEN CONDUCTORS; INDOORS. Open conductors indoors shall be mounted on noncombustible, nonabsorptive insulators. Insulators of porcelain shall be glazed on all exposed surfaces. A separation of at least 1½ inches shall be maintained between conductors and between conductors and other objects. Conductors shall not be located where subject to physical damage.

(5) CONCEALED CONDUCTORS ON INSULATORS; INDOORS. Concealed conductors on insulators shall be separated from each other and from all objects other than the insulators on which they are mounted by a spacing of not less than 1½ inches for voltages above 10,000 volts, and not less than 1 inch for voltages of 10,000 or less. They shall be installed in channels lined with noncombustible material and used for no other purpose, except that the primary circuit conductors may be in the same channel. The insulators shall be of noncombustible, nonabsorptive material.

(6) CONDUCTORS IN RACEWAYS. Where the conductors are covered with lead or other metal sheathing, the covering shall extend beyond the end of the raceway, and the surface of the cable shall not be injured where the covering terminates.

(a) In damp or wet locations, the insulation on all conductors shall extend beyond the metal covering or raceway at least 4 inches for voltages over 10,000, 3 inches for voltages over 5,000 but not exceeding 10,000, and 2 inches for voltages of 5,000 or less.

(b) In dry locations the insulation shall extend beyond the end of the metal covering or raceways not less than 2½ inches for voltages over 10,000, 2 inches for voltages over 5,000 but not exceeding 10,000, and 1½ inches for voltages of 5,000 or less.

(c) For conductors at grounded midpoint terminals, no spacing is required.

(d) A metal raceway containing a single conductor from one secondary terminal of a transformer shall not exceed 20 feet in length.

(7) OPEN CONDUCTORS; OUTDOORS. (a) Open conductors outdoors shall be mounted on noncombustible, nonabsorptive insulators. Insulators of porcelain shall be glazed on all exposed surfaces. A separation of at least 2 inches shall be maintained between conductors, and between conductors and other objects.

(b) Where subject to physical damage, or where within reach from ground, roof, or window, conductors shall be enclosed in raceways or suitably guarded. Where guarded, a spacing of not less than 1½ inches shall be maintained between conductors and the enclosure unless the enclosure is nonconducting and noncombustible.

(8) SHOW-WINDOWS AND SIMILAR LOCATIONS. Conductors that hang freely in the air, away from combustible material, and where not subject to physical damage, as in some show-window displays, need not be otherwise protected.

(9) CONDUCTORS TO TRANSFORMERS MIDPOINT. Conductors may be run from the ends of tubing to the grounded midpoint of transformers specifically designed for the purpose and provided with terminals at the midpoint. Where such connections are made to the transformer grounded midpoint, the connections between the high-voltage terminals of the transformer and the line ends of the tubing shall be as short as possible.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 600.32 Transformers. Transformers shall comply with the following:

(1) VOLTAGE. The transformer secondary open-circuit voltage shall not exceed 15,000 volts with an allowance on test of 1,000 volts additional. In end-grounded transformers the secondary, open-circuit voltage shall not exceed 7,500 volts with an allowance on test of 500 volts additional.

(2) TYPE. (a) Transformers shall be of a type approved for the purpose and shall be limited in rating to a maximum of 4,500 volt-amperes.

(b) Open core-and-coil type transformers shall be limited to 5,000 volts with an allowance on test of 500 volts, and to indoor applications in small portable signs.

(c) Transformers for outline lighting installations shall have secondary current ratings not in excess of 30 milliamperes except where they and all wiring connected to them are installed in accordance with the provisions of chapter E 410 for electric discharge lighting of the same voltage.

(3) EXPOSED TO WEATHER. Transformers used outdoors shall be of the weather-proof type or shall be protected from the weather by enclosure in the sign body or in a separate metal box.

(4) TRANSFORMER SECONDARY CONNECTIONS. The high-voltage windings of transformers shall not be connected in parallel; and shall not be connected in series, except that 2 transformers each having one end of its high-voltage winding connected to the metal enclosure may have their high-voltage windings connected in series to form the equivalent of a midpoint grounded transformer. The grounded ends shall be connected by insulated conductors not smaller than No. 14.

(a) *Exception:* Transformers for small portable signs, show windows, and similar locations that are equipped with leads permanently attached to the secondary winding of the transformer enclosure and that do not extend more than 8 feet beyond the enclosure for attaching to the line ends of the tubing may have leads smaller than No. 14, but shall not be smaller than No. 18 and shall be of a type approved for the purpose.

(5) ACCESSIBILITY. Transformers shall be accessible.
History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 600.33 Electric discharge tubing. Electric discharge tubing shall conform to the following:

(1) DESIGN. The tubing shall be of such length and design as not to cause a continuous over-voltage on the transformer.

(2) SUPPORT. Tubing shall be adequately supported on noncombustible, nonabsorptive supports. Tubing supports should, where practicable, be adjustable.

(3) CONTACT WITH FLAMMABLE MATERIAL AND OTHER SURFACES. The tubing shall be free from contact with flammable material and shall be located where not normally exposed to physical damage. Where operating in excess of 7,500 volts, the tubing shall be supported on noncombustible, nonabsorptive, insulating supports which maintain a spacing of not less than ¼ inch between the tubing and the nearest surface.
History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 600.34 Terminals and electrode receptacles for electric discharge tubing. Terminals and electrode receptacles for electric discharge tubing shall comply with the following:

(1) TERMINALS. Terminals of the tubing shall be inaccessible to unqualified persons and isolated from combustible material and grounded metal or shall be enclosed. Where enclosed they shall be separated from grounded metal and combustible material by noncombustible, nonabsorptive insulating material approved for the purpose or by 1½ inches of air. Terminals shall be relieved from stress by the independent support of the tubing.

(2) TUBE CONNECTIONS OTHER THAN WITH RECEPTACLES. Where tubes do not terminate in receptacles designed for the purpose, all live parts of tube terminals and conductors shall be so supported as to maintain a separation of at least 1½ inches between conductors or between conductors and any grounded metal.

(3) RECEPTACLES. Electrode receptacles for the tubing shall be of noncombustible, nonabsorptive insulating material approved for the purpose.

(4) BUSHINGS. Where electrodes enter the enclosure of outdoor signs or of an indoor sign operating at a voltage in excess of 7,500 volts, bushings shall be used unless receptacles are provided or the sign is wired with bare wire mounted on approved supports which maintain the tubing in proper position. Bushings shall be of noncombustible, nonabsorptive material. Where bare wiring is used, the conductor shall be not less than No. 14 solid copper, shall be supported so as to prevent sagging and lessening of the spacing required elsewhere in this chapter, and electrode terminal assemblies shall be of an approved type and supported not more than 6 inches from the electrode terminals.

(5) SHOW-WINDOWS. In the exposed type of show-window signs, terminals shall be (a) enclosed by receptacles approved for the purpose or (b) where hanging in air, free from grounded surfaces, en-

closed in sleeves of vulcanized fiber, phenolic composition, or other suitable material which overlaps all live parts by at least ½ inch.

(6) RECEPTACLES AND BUSHING SEALS. A flexible, non-conducting seal may be used to close the opening between the tubing and the receptacle or bushing against the entrance of dust or moisture. This seal shall not be in contact with grounded conductive material and shall not be depended upon for the insulation of the tubing.

(7) ENCLOSURES OF METAL. Enclosures of metal for electrodes shall be of not less than No. 24 MS (USS Revised) gauge sheet metal.

(8) ENCLOSURES OF INSULATING MATERIAL. Enclosures of insulating material shall be noncombustible, nonabsorptive and approved for the voltage of the circuit.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 600.35 Switches on doors. Doors or covers giving access to uninsulated parts of indoor signs or outline lighting exceeding 600 volts and accessible to the general public, shall either be provided with interlock switches which on the opening of the doors or covers disconnect the primary circuit, or shall be so fastened that the use of other than ordinary tools will be necessary to open them.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

Chapter E 610

CRANES AND HOISTS

A. SCOPE AND USE

E 610.01 Scope. The provisions of this chapter shall apply to the installation of cranes, crane runways, hoists and monorails, and shall be additional to, or amendatory of, the requirements prescribed in Wis. Adm. Codes chapters E 100 to E 480, inclusive.

Note: For definition of various kinds of cranes and hoists see American Standard Safety Code for Cranes, Derricks, and Hoists, ASA B30.2–1943.

History: Cr. Register, January, 1968, No. 145, eff. 2–1–68.

E 610.02 Particular locations. (1) IGNITIBLE MATERIAL HAZARDS. Installations in hazardous locations shall comply with the provisions of section E 503.13.

(2) COMBUSTIBLE MATERIALS. Where a crane operates over readily combustible material, the resistors shall be placed in a well-ventilated cabinet composed of noncombustible material so constructed that it will not emit flames or molten metal.

(a) *Exception:* Resistors may be located in a cage or cab constructed of noncombustible material which encloses the sides of the cage or cab from the floor to a point at least 6 inches above the top of the resistors.

History: Cr. Register, January, 1968, No. 145, eff. 2–1–68.

B. WIRING

E 610.11 Wiring method. Conductors shall be enclosed in raceways or be type ALS cable or type MI cable.

(1) EXCEPTION NO. 1. BARE CONDUCTORS. Bare conductors used as contact conductors.

(2) EXCEPTION NO. 2. OPEN CONDUCTORS. Short lengths of open conductors at resistors, collectors, and other equipment.

(3) EXCEPTION NO. 3 FLEXIBLE CONNECTIONS. Where flexible connections are necessary to motors and similar equipment, flexible metal conduit, liquid-tight flexible metal conduit, metal-clad cable, multiple conductor rubber-covered cable or an approved nonmetallic enclosure may be employed.

(4) EXCEPTION NO. 4. PENDENT PUSH-BUTTON STATIONS. Where multiple conductor cable is used with a suspended pushbutton station, the station must be supported in some satisfactory manner that will protect the electrical conductors against strain.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 610.12 Raceway terminal fittings. Conductors leaving raceways shall comply with the provisions of section E 300.16.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 610.13 Types of conductors. Conductors shall be of the rubber-covered or the thermoplastic type except:

(1) EXCEPTION NO. 1. CONTACT CONDUCTORS. Contact conductors along runways, crane bridges and monorails may be bare and may be of hard drawn copper, or aluminum, or steel in the form of tees, angles, tee rails, or other stiff shapes.

(2) EXCEPTION NO. 2. FLEXIBLE CONDUCTORS. Flexible conductors may be used to convey current and where practicable, cable reels or take-up devices may be employed.

(3) EXCEPTION NO. 3. VARNISHED CAMBRIC CONDUCTORS. Varnished-cambric conductors (type V) or asbestos varnished cambric (types AVA and AVB) may be used in dry locations.

(4) EXCEPTION NO. 4. TYPE MI CABLE. Type MI cable may be used in wet or dry locations within its specified temperature ratings.

(5) EXCEPTION NO. 5. EXPOSED TO HIGH TEMPERATURES. Conductors exposed to external heat or connected to resistors shall have an insulation approved for the temperature and location as specified in section E 310.02. Where conductors not having a flame-resistant outer covering are grouped together, the group shall be covered with a flame-resistant tape.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 610.14 Conductors. (1) AMPACITY. The allowable ampacity of conductors shall be as shown in table E 610.14 (1). For the ampacities of conductors between controllers and resistors, see section E 430.023.

Other insulations shown in section E 310.02 and approved for the temperatures and location may be substituted for those shown in table E 610.14 (1). The allowable ampacity of conductors used with 15-minute motors shall be the 30-minute ratings increased by 12%.

TABLE E 610.14 (1)

AMPACITIES OF INSULATED CONDUCTORS IN RACEWAY OR CABLE USED WITH SHORT TIME RATED CRANE AND HOIST MOTORS

Max. Operating Temp.	60°C		75°C		90°C		110°C	
Size AWG MCM	Type R, RW, T, TW		Type RH, RHW, THW, THWN		Type AVB, FEP, FEPB, RHN, SA, TA, THNM		Type AVA	
	60 min	30 min	60 min	30 min	60 min	30 min	60 min	30 min
16	10	10	10	12	----	----	----	----
14	20	20	25	26	31	32	38	40
12	25	25	30	33	36	40	45	50
10	35	35	40	43	49	52	60	65
8	45	50	55	60	63	69	73	80
6	57	70	76	86	83	94	93	105
5	65	80	85	95	95	106	109	121
4	77	95	100	117	111	130	126	147
3	90	115	120	141	131	153	145	168
2	107	130	137	160	148	173	163	190
1	130	150	143	175	158	192	177	215
0	160	180	190	233	211	259	239	294
00	195	225	222	267	245	294	275	331
000	245	280	280	341	305	372	339	413
0000	295	350	300	369	319	399	352	440
250	350	375	364	420	400	461	447	516
300	410	475	455	582	497	636	554	707
350	460	550	486	646	542	716	616	809
400	515	580	538	688	593	760	666	856
450	565	640	600	765	660	836	740	930
500	620	700	660	847	726	914	815	1004

(2) MINIMUM. Conductors shall not be smaller than No. 14.

(a) *Exception:* No. 16 may be used for crane and hoist motor and control circuits only when the application meets subsection (1) ampacity, and provided the conductors are protected against physical damage.

(3) CONTACT CONDUCTORS. The size of contact wires shall be not less than the following:

Distance between end strain insulators	Size of wire
0–30 feet	No. 6
31–60 feet	No. 4
over 60 feet	No. 2

(4) CALCULATION OF MOTOR LOAD. The ampacity of the power supply conductors on the crane shall be not less than the combined short time full load ampere rating of the largest motor or group of motors for any single crane motion plus 50% of the combined short time full load ampere rating of the next largest motor or group of motors.

(5) OTHER LOADS. Additional loads, such as heating, lighting, and air conditioning, shall be provided for by application of the appropriate sections of this code.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 610.15 Common return. Where a crane or hoist is operated by more than one motor, a common-return conductor of proper ampacity may be used.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

C. CONTACT CONDUCTORS

E 610.21 Installation of contact conductors. Bare contact conductors shall conform to the following:

(1) CONTACT WIRES. Wires that are used as contact conductors shall be secured at the ends by means of approved strain insulators and shall be so mounted on approved insulators that the extreme limit of displacement of the wire will not bring the latter within less than 1½ inches from the surface wired over.

(2) SUPPORTS ALONG RUNWAYS. Main contact conductors carried along runways shall be supported on insulating supports placed at intervals not exceeding 20 feet, and these supports shall be insulating except for grounded rail conductors as provided in subsection (5). Such conductors shall be separated not less than 6 inches except for monorail hoists where a spacing of not less than 3 inches may be used. Where necessary, intervals between insulating supports may be increased up to 40 feet, the separation between conductors being increased proportionately.

(3) SUPPORTS ON BRIDGES. Bridge contact conductors shall be kept at least 2½ inches apart and, where the span exceeds 80 feet, insulating saddles shall be placed at intervals not exceeding 50 feet.

Note: It is recommended that the distance between wires be greater than 2½ inches where practicable.

(4) SUPPORTS FOR RIGID CONDUCTORS. Conductors along runways and crane bridges, which are of the rigid type specified in section E 610.13, exception No. 1, shall be carried on insulating supports spaced at intervals of not more than 80 times the vertical dimension of the conductor, but in no case greater than 15 feet, and spaced apart sufficiently to give a clear electrical separation of conductors or adjacent collectors of not less than 1 inch. Hardwood supports covered with, or impregnated with, insulating paint shall be acceptable insulators.

(5) TRACK AS CIRCUIT CONDUCTOR. Monorail, tramrail or crane-runway tracks may be used as a conductor of current for one phase of a 3-phase alternating-current system furnishing power to the carrier, crane or trolley, provided all of the following conditions are fulfilled:

(a) The conductors for supplying the other 2 phases of the power supply shall be insulated.

(b) The power for all phases shall be obtained from an insulating transformer.

(c) The voltage shall not exceed 300 volts.

(d) The rail serving as a conductor shall be effectively grounded at the transformer and may also be grounded by the fittings used for the suspension or attachment of the rail to a building or structure.

(6) Electrical continuity of contact conductors. All sections of bare rigid contact conductors shall be mechanically joined to provide a continuous electrical connection.

(7) Not to supply other equipment. Contact conductors shall not be used as feeders for any equipment other than the crane or cranes which they are primarily designed to serve.

(8) Locating or guarding contact conductors. Contact conductors shall be located or guarded in such a manner that unqualified persons cannot inadvertently touch energized current-carrying parts.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 610.22 Collectors. Collectors shall be so designed as to reduce to a minimum sparking between them and the contact conductor, and when operated in rooms used for the storage of easily ignitible combustible fibers and materials the requirements of section E 503.13 shall be complied with.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

D. CONTROL

E 610.31 Runway conductor disconnecting means. A disconnecting means shall be provided between the runway contact conductors and the power supply. Such disconnecting means shall consist of a motor-circuit switch or circuit-breaker, except that a general-use switch may be used when the disconnecting means is provided in accordance with section E 610.32. This disconnecting means shall be readily accessible and operable from the ground, shall be arranged to be locked in the open position, shall open all ungrounded conductors simultaneously, and shall be placed within sight of the crane or hoist and the runway contact conductors.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 610.32 Disconnecting means for crane. A motor-circuit switch or circuit breaker shall be provided in the leads from the runway contact conductors on all bridge cranes. Where this disconnecting means is not readily accessible from the crane operating station, means shall be provided at the crane operating station to open the power circuit to the crane motors.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 610.33 Rating of disconnecting means for crane. On both alternating-current and direct-current crane protective panels, the continuous ampacity of the switch or circuit-breaker required by section E 610.32, and mainline contractors, shall be not less than 50% of the combined short-time ampere ratings of the motors, nor less than 75% of the sum of the short-time ampacities of the motors required for any single crane motion.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 610.34 Limit switch. A limit switch shall be provided for upper limit of travel of crane hoists.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E. OVERCURRENT PROTECTION

E 610.41 Contact conductors. The main contact conductors shall be protected by an overcurrent device.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 610.42 Crane motors. Where more than one motor is employed on a crane, each motor shall have individual overcurrent protection as provided in chapter E 430, except that where two motors operate a single hoist, carriage, truck, or bridge, and are controlled as a unit by one controller, the pair of motors with their leads may be protected by a single overcurrent device. Where the overcurrent device is not readily accessible, it shall be enclosed or guarded until it is electrically disconnected from the source of supply. See subsection E 240.16 (1).

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

F. GROUNDING

E 610.51 Grounding. All exposed metal parts of cranes, hoists, and accessories, including pendant controls, shall be metallically joined together into a continuous electrical conductor so that the entire crane or hoist will be grounded on installation in accordance with chapter E 250. Moving parts, other than removable accessories or attachments having metal-to-metal bearing surfaces, i.e., such as bridge wheels running on a track, shall be considered to be electrically connected to each other through the bearing surfaces for grounding purposes.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

Chapter E 615

TROLLEY CONDUCTORS

E 615.01 Scope. The provisions of this chapter shall apply to installations of trolley wires and feeders for supplying electric locomotives and cars.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 615.02 Insulation of trolley wires. Trolley wires shall have at least 2 separate and distinct insulations from the ground. A wooden pole or structure shall be considered as one insulation.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 615.03 Control of trolley wires and feeders. Trolley wires and feeders shall be provided with a means by which they can be disconnected from their source of current.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

Chapter E 620

ELEVATORS, DUMBWAITERS, ESCALATORS, AND MOVING WALKS OR RAMPS

E 620.01 Scope. This chapter shall apply to electrical equipment and wiring used in connection with elevators, dumbwaiters, escalators, and moving walks or ramps.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 620.02 Motor circuit conductors. (1) Conductors supplying elevator, dumbwaiter, escalator, moving walk or ramp motors shall have an ampacity conforming to subsections (a), (b) and (c) below, based on the nameplate current rating of the motor. With generator field control, the ampacity shall be based on the nameplate current rating of the driving motor of the motor-generator set which supplies power to the elevator motor.

Note: The heating of conductors depends on root mean square current values which, with generator field control, are reflected by the nameplate current rating of the motor-generator set driving motor rather than by the rating of the elevator motor which represents actual but short time and intermittent full-load current values.

(a) *Conductors supplying a single motor.* Conductors supplying a single motor shall have an ampacity in conformance with section E 430.022, table E 430.022 (1) EXCEPTION.

(b) *Conductors supplying several motors.* Conductors supplying two or more motors shall have an ampacity of not less than 125% of the nameplate current rating of the highest rated motor in the group plus the sum of the nameplate current ratings of the remainder of the motors in the group.

(c) *Feeder demand factor.* Feeder conductors of less capacity than required by subsection (b) above may be furnished subject to the requirements of section E 430.026.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 620.03 Prohibited equipment in hoistways. (1) No wires, cables, pipes or conductor enclosures shall be installed in any hoistway except those needed to serve the elevator or dumbwaiter equipment, including wiring for heating, ventilation, lighting the car or hoistway and wiring for communication with the car.

(a) *Exception No. 1.* Other raceways or cables may in exceptional cases be installed in the hoistway only if approved in writing by the industrial commission providing that all openings, terminals, outlet or junction boxes are located outside the hoistway.

(b) *Exception No. 2.* In existing installations, pipes in hoistways may remain unless carrying noxious gases, or steam with a pressure exceeding 15 pounds.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 620.04 Disconnecting means. (1) An externally operated circuit-breaker or fused disconnecting switch opening all lines, shall be installed separately in the supply circuit of every elevator, escalator, and moving walk or ramp. This breaker or switch shall be of the enclosed type, and shall be provided with proper overcurrent protection, and shall not be made to close from any other part of the building, and shall be located to be visible from the elevator machine in the machine room at the lock-jamb side of the entrance door. This switch shall be a horsepower rated motor circuit switch for motors up to and including 50 horsepower.

(2) An externally operated circuit-breaker or fused disconnecting switch opening all lines, shall be installed separately in the supply circuit of every power dumbwaiter hereafter installed. This breaker or switch shall be of the enclosed type and shall be provided with proper overcurrent protection and shall conform with the requirements as outlined in the following subsections.

(a) Where the hoisting machine is located in the hoistway, directly above or below the dumbwaiter, the controller and circuit-breaker or switch shall be mounted on the outside of the hoistway, on the hoistway wall.

(b) Where a machine room is provided and isolated from the hoistway enclosure, the circuit-breaker or switch shall be mounted adjacent to the controller.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 620.05 Lighting. (1) Lighting and convenience outlets shall be provided to conform with requirements outlined in this section.

(a) *Landing lights.* Every elevator hoistway landing entrance within or in connection with an occupied building shall be provided with illumination of an intensity of not less than 5 foot-candles at the landing sill.

(b) *Machine room, penthouse and overhead lighting.* Every machine room and penthouse shall be provided with uniform artificial illumination of an intensity of not less than 5 foot-candles at the floor. Every area about a ceiling-type machine, including overhead sheave rooms or lofts shall be amply lighted. Control of such lighting shall be at the approach to the machine room, penthouse or overhead equipment.

(c) *Work lights.* Every power elevator hereafter installed shall be equipped with a work light receptacle and convenience outlet located in the hoistway approximately level with the lowest terminal landing floor if hoistway landing doors are used.

(d) *Outlet.* An outlet shall be provided in the hoistway for the car lighting.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

Chapter E 630

ELECTRIC WELDERS

A. GENERAL

E 630.01 Scope. This chapter covers electric arc welding, resistance welding apparatus, and other similar welding equipment that is connected to an electrical supply system.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 630.02 Other chapters. This chapter amplifies or modifies parts of Wis. Adm. Code chapters E 100 to E 400 inclusive of this code in order to properly cover the operating conditions to which electric welder installations are subjected. Accordingly the appropriate provisions of chapters E 100 to E 400 inclusive apply to the component parts of electric welder installations except as otherwise provided in this chapter.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

B. AC TRANSFORMER AND DC RECTIFIER ARC WELDERS

E 630.11 Ampacities of supply conductors. The ampacity of conductors shall be as follows:

(1) INDIVIDUAL WELDERS. The rated ampacity of the supply conductors shall be not less than the current values determined by multiplying the rated primary current in amperes, given on the welder nameplate, and the following factor based upon the duty cycle or time rating of the welders:

Rated Percent Duty Cycle of Welders	Multiplying Factor
20 or less	0.45
30	0.55
40	0.63
50	0.71
60	0.78
70	0.84
80	0.89
90	0.95
100	1.00

For a welder having a time rating of one hour, the multiplying factor shall be 0.75.

(2) GROUP OF WELDERS. The rated ampacity of conductors which supply a group of welders may be less than the sum of the currents, as determined in accordance with subsection (1) of the welders supplied. The conductor rating shall be determined in each case according to the welder loading based on the use to be made of each welder and the allowance permissible in the event that all the welders supplied by the conductors will not be in use at the same time. The load value used for each welder shall take into account both the magnitude and the duration of the load while the welder is in use.

Note: Conductor ratings based on 100% of the current, as determined in accordance with subsection E 630.11 (1), of the two largest welders, 85% for the third largest welder, 70% for the fourth largest welder, and 60% for all the remaining welders, should provide an ample margin of safety under high production conditions with respect to the maximum permissible temperature of the conductors. Percentage values lower than those given are permissible in cases where the work is such that a high operating duty cycle for individual welders is impossible.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 630.12 Overcurrent protection. Overcurrent protection shall be as provided in subsections E 630.12 (1) and (2). Where the nearest standard rating of the overcurrent device used is under the value specified in this rule, or where the rating or setting specified results in unnecessary opening of the overcurrent device, the next higher rating or setting may be used.

(1) FOR WELDERS. Each welder shall have overcurrent protection rated or set at not more than 200% of the rated primary current of the welder, except that an overcurrent device is not required for a welder having supply conductors protected by an overcurrent device rated or set at not more than 200% of the rated primary current of the welder.

(2) FOR CONDUCTORS. Conductors which supply one or more welders shall be protected by an overcurrent device rated or set at not more than 200% of the conductor rating.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 630.13 Disconnect means. (1) A disconnect means shall be provided in the supply connection of each welder which is not equipped with a disconnect mounted as an integral part of the welder.

(2) The disconnect means shall be a switch or circuit-breaker and its rating shall be not less than that necessary to accommodate overcurrent protection as specified under section E 630.12.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 630.14 Marking. A nameplate giving the following information shall be provided: name of manufacturer; frequency; primary voltage; rated primary current; maximum open-circuit secondary voltage; rated secondary current; basis of rating, i.e., the duty cycle, number of phases, 60-minute rating.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

C. MOTOR-GENERATOR ARC WELDERS

E 630.21 Other rules which apply. Motor-generator arc welder installations are covered by the appropriate rules of Wis. Adm. Code chapters E 100 to E 400 inclusive applicable to conductors, motors generators and associated equipment. Referring specifically to the motor supply connections, the following rules apply in addition to such other provisions as may be applicable. Conductor rating, sections E 430.022 and E 430.026. Overcurrent protection for motors, section E 430.033; for conductors, section E 430.052. Controllers, sections E 430.007, E 430.008 and E 430.083. Disconnecting means, section E 430.111.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

D. RESISTANCE WELDERS

E 630.31 Ampacities of supply conductors. The ampacity of the supply conductors necessary to limit the voltage drop to a value permissible for the satisfactory performance of the welder is usually greater than that required to prevent over-heating as prescribed in subsections (1) and (2).

(1) INDIVIDUAL WELDERS. The rated ampacity for conductors for individual welders shall conform to the following:

(a) *Varying operations.* The rated ampacity of the supply conductors for a welder which may be operated at different times at different values of primary current or duty cycle shall be not less than 70% of the rated primary current for seam and automatically fed welders, and 50% of the rated primary current for manually-operated non-automatic welders.

(b) *Specific operation.* The rated ampacity of the supply conductors for a welder wired for a specific operation for which the actual primary current and duty cycle are known and remain unchanged shall be not less than the product of the actual primary current and the multiplier given below for the duty cycle at which the welder will be operated.

Duty Cycle (per cent)	50	40	30	25	20	15	10	7.5	5.0 or less
Multiplier	.71	.63	.55	.50	.45	.39	.32	.27	.22

(2) GROUPS OF WELDERS. The rated ampacity of conductors which supply 2 or more welders shall be not less than the sum of the value obtained as explained in subsection (1) for the largest welder supplied, and 60% of the values obtained as explained in subsection (1) for all the other welders supplied.

(3) EXPLANATION OF TERMS. (a) The rated primary current is the rated kva multiplied by 1,000 and divided by the rated primary voltage, using values given on the nameplate. (b) The actual primary current is the current drawn from the supply circuit during each welder operation at the particular heat tap and control setting used. (c) The duty cycle is the percentage of the time during which the welder is loaded. For instance, a spot welder supplied by a 60-cycle system (216,000 cycles per hour) making four hundred 15-cycle welds per hour would have a duty cycle of 2.8% (400 multiplied by 15, divided by 216,000, multiplied by 100). A seam welder operating 2 cycles "on" and 2 cycles "off" would have a duty cycle of 50%.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 630.32 Overcurrent protection. Overcurrent protection shall be as provided in subsections E 630.32 (1) and (2). Where the nearest standard rating of the overcurrent device used is under the value specified in this rule, or where the rating or setting specified results in unnecessary opening of the overcurrent device, the next higher rating or setting may be used.

(1) FOR WELDERS. Each welder shall have an overcurrent device rated or set at not more than 300% of the rated primary current of the welder, except that an overcurrent device is not required for a welder having a supply circuit protected by an overcurrent device rated or set at not more than 300% of the rated primary current of the welder.

(2) FOR CONDUCTORS. Conductors which supply one or more welders shall be protected by an overcurrent device rated or set at not more than 300% of the conductor rating.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 630.33 Disconnecting means. A switch or circuit-breaker shall be provided by which each welder and its control equipment can be isolated from the supply circuit. The ampacity of this disconnecting means shall be not less than the supply conductor rating determined as explained in this chapter. The supply circuit switch may be used as the welder disconnecting means where the circuit supplies only one welder.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 630.34 Marking. A nameplate giving the following information shall be provided: name of manufacturer, frequency, primary voltage, rated kva at 50% duty cycle, maximum and minimum open-circuit secondary voltage, short-circuit secondary current at maximum secondary voltage and specified throat and gap setting.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

Chapter E 640

SOUND-RECORDING AND SIMILAR EQUIPMENT

E 640.01 Scope. This chapter shall apply to installations of equipment and wiring used for sound-recording and reproduction, centralized distribution of sound, public address, speech-input systems and electronic organs.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 640.02 Application of other chapters. (1) Except as modified by this chapter, wiring and equipment from source of power to and between devices connected to the interior wiring systems shall comply with the requirements of Wis. Adm. Code chapters E 100 to E 400, inclusive, of this code.

(2) Wiring and equipment for public-address, speech-input, radio-frequency, audio-frequency systems, and amplifying equipment associated with radio receiving stations in centralized distribution systems, shall comply with chapter E 725.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 640.03 Number of conductors in raceway. The number of conductors in a conduit or other raceway shall comply with tables 1 to 7 inclusive of chapter E 900 except as follows:

(1) EXCEPTION No. 1. Special permission may be granted for the installation of two 2-conductor lead-covered cables in ¾-inch conduit, provided the cross-sectional area of each cable does not exceed .11 square inch.

(2) EXCEPTION No. 2. Special permission may be granted for the installation of two 2-conductor No. 19 lead-covered cables in ½-inch conduit, provided the sum of the cross-sectional areas of the cables does not exceed 32% of the internal cross-sectional area of the conduit.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 640.04 Wireways and auxiliary gutters. (1) Wireways and auxiliary gutters shall comply with the requirements of chapters E 362 and E 374.

(2) Where used for sound-recording and reproduction the following exceptions are made:

(a) *Exception No. 1. Number of conductors in raceway.* Conductors in wireways or gutters shall not fill the raceway to more than 75% of its depth.

(b) *Exception No. 2. Auxiliary-gutter covers.* Where the cover of auxiliary gutters is flush with the flooring and is subject to the moving of heavy objects it shall be of steel at least ¼-inch in thickness; where not subject to moving of heavy objects, as in the rear of patch or other equipment panels, the cover shall be at least No. 10 MS (USS Revised) gauge.

(c) *Exception No. 3. Metal-trough raceways.* Metal-trough raceways may be installed in concealed places provided they are run in a straight line between outlets or junction boxes. Covers of boxes must be accessible. Edges of metal must be rounded at outlet or junction boxes and all rough projections smoothed to prevent abrasion of insulation or conductors. Raceways made of sections shall be bonded and grounded as prescribed in section E 250.076.

(d) *Exception No. 4. Grounding wireways and auxiliary gutters.* Metal wireways and auxiliary gutters shall be grounded in accordance with the requirements of chapter E 250. Where the wireway or auxiliary gutter does not contain power supply wires, the grounding conductor need not be larger than No. 14 copper or its equivalent. Where the wireway or auxiliary gutter contains power supply wires, the grounding conductor shall not be smaller than the size called for in section E 250.095.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 640.05 Conductors. Amplifier output circuits carrying audio-program signals of 70 volts or less and whose open circuit voltage will not exceed 100 volts, may employ class 2 wiring as covered in chapter E 725.

Note: The above is based on amplifiers whose open-circuit voltage will not exceed 100 volts when driven with a signal at any frequency from 60 to 100 cps sufficient to produce rated output (70.7 volts) into its rated load. This also accepts the known fact that the average program material is 12 db below the amplifier rating—thus the average RMS voltage for an open-circuit 70 volt output would be only 25 volts.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 640.06 Grouping of conductors. Conductors of different systems grouped in the same conduit or other metallic enclosure, or in portable cords or cables, shall comply with the following requirements:

(1) POWER-SUPPLY CONDUCTORS. Power-supply conductors shall be properly indicated and shall be used solely for supplying power to the equipment to which the other conductors are connected.

(2) LEADS TO MOTOR-GENERATOR OR ROTARY CONVERTER. Input leads to a motor-generator or rotary converter shall be run separately from the output leads.

(3) CONDUCTOR INSULATION. The conductors shall be insulated individually, or collectively in groups, by insulation at least equivalent to that on the power-supply and other conductors.

(a) *Exception:* Where the power-supply and other conductors are separated by a lead sheath or other continuous metallic covering.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 640.07 Flexible cords. Flexible cords and cables shall be of types P, K, S, SJ, ST, SJO, and SJT or other types specifically approved for the purpose for which they are to be used. The conductors of flexible cords, other than power-supply conductors, may be of a size not smaller than No. 26 provided such conductors are not in direct electrical connection with the power-supply conductors and are equipped with current-limiting means so that the maximum power under any condition will not exceed 150 watts.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 640.08 Terminals. Terminals shall be marked to show their proper connections. Terminals for conductors other than power-supply conductors shall be separated from the terminals of the power-supply conductors by a spacing at least as great as the spacing between power-supply terminals of opposite polarity.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 640.09 Storage batteries. Storage batteries shall comply with the following:

(1) INSTALLATION. Storage batteries shall be installed in accordance with chapter E 480.

(2) CONDUCTOR INSULATION. Storage-battery leads shall be rubber-covered or thermoplastic-covered.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 640.10 Overcurrent protection of "A", "B" and "C" circuits. Overcurrent protection shall be provided as follows:

(1) "A" circuit, where supplied by branch-lighting circuits, or by storage batteries of more than 20-ampere-hour capacity, shall have overcurrent protection not exceeding 15 amperes.

(2) "B" circuits shall have overcurrent protection not exceeding one ampere. The overcurrent protection shall be placed in each positive lead.

(3) "C" circuits where supplied from branch lighting circuits or from storage batteries of more than 20-ampere-hour capacity shall have overcurrent protection not exceeding one ampere.

(4) Overcurrent devices shall be located as near as practicable to the battery.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 640.11 Amplifiers and rectifiers; type. (1) They shall be suitably housed and shall be of a type approved for the purpose unless otherwise expressly permitted by the administrative authority.

(2) Amplifiers and rectifiers shall be so located as to be readily accessible.

(3) Amplifiers and rectifiers shall be so located as to provide sufficient ventilation to prevent undue temperature rise within the housing.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 640.12 Hazardous locations. Equipment used in hazardous locations shall be specifically approved for the purpose.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 640.13 Protection against physical damage. Amplifiers, rectifiers, loud-speakers and other equipment shall be so located or protected as to guard against physical damage such as might result in fire or personal hazard.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

Chapter E 650

ORGANS

E 650.01 General. This chapter shall apply to those electric circuits and parts of electrically operated organs which are employed for the control of the sounding apparatus and keyboards. Electronic organs shall comply with the appropriate provisions of chapter E 640.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 650.02 Source of energy. The source of energy shall have a potential of not over 15 volts and shall be a self-excited generator, a 2-coil-transformer type rectifier or a primary battery.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 650.03 Insulation; grounding. The generator shall be effectively insulated from the ground and from the motor driving it, or both the generator and the motor frames shall be grounded in the manner prescribed in chapter E 250.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 650.04 Conductors. Conductors shall comply with the following:

(1) SIZE. No conductor shall be smaller than No. 26, and the common-return conductor shall be not smaller than No. 14.

(2) INSULATION. Conductors shall have rubber, thermoplastic, asbestos, cotton, or silk insulation, except the common-return conductor which shall be rubber-covered, thermoplastic, asbestos-covered (types AA, AI, or AIA), or slow-burning (type SB). The cotton or silk may be saturated with paraffin if desired.

(3) CONDUCTORS TO BE CABLED. Except the common-return conductor, and conductors inside the organ proper, the organ sections and the organ console, conductors shall be cabled. The common-return conductor may be placed under an additional covering enclosing both cable and return conductor, or may be installed as a separate conductor and may be in contact with the cable.

(4) CABLE COVERING. The cable shall be provided with one or more braided outer coverings, provided that a tape may be used in place of an inner braid. Where not installed in metal raceways the outer braid shall be flame-retardant or shall be covered with a closely-wound fireproof tape.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 650.05 Installation of conductors. Cables shall be securely fastened in place and may be attached directly to the organ structure without insulating supports. Cables shall not be placed in contact with other conductors.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 650.06 Overcurrent protection. Circuits shall be so arranged that all conductors, except the main supply conductors and the common-return conductor, shall be protected from overcurrent by an overcurrent device of not greater than 15-ampere rating.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

Chapter E 660

X-RAY EQUIPMENT

A. SCOPE AND INSTALLATION

E 660.01 Scope. The provisions of this chapter shall apply to all X-ray equipment operating at any frequency or voltage for medical or industrial use, or for any other purpose.

Note 1. Nothing in this chapter shall be construed as specifying safeguards against the useful beam or stray X-ray radiation.

Note 2. Recommendations for radiation protection by the National Committee on Radiation Protection and Measurement are published as National Bureau of Standards Handbooks obtainable from Superintendent of Documents, Washington 25, D. C.

History: Cr. Register, January, 1968, No. 145, eff. 2–1–68.

E 660.02 Hazardous locations or 600 volt supply. Unless approved for the location, X-ray and related equipment shall not be installed or operated in hazardous locations or operated on a supply potential of more than 600 volts.

History: Cr. Register, January, 1968, No. 145, eff. 2–1–68.

E 660.03 Connection to supply circuit. (1) STATIONARY EQUIPMENT. X-ray equipment permanently installed shall be connected to the power supply by means of a wiring method meeting the general requirements of this code, except that equipment properly supplied by branch circuits not larger than a 30-ampere branch circuit may be supplied through suitable plug and hard service cable or cord.

(2) PORTABLE AND TRANSPORTABLE. Individual branch circuits shall not be required for portable X-ray equipment requiring a capacity not exceeding 50 amperes. Portable type X-ray equipment of any capacity shall be supplied through a suitable plug and hard service cable or cord. Transportable X-ray equipment of any capacity may be connected to its power supply by suitable temporary connections and hard service cable or cord.

History: Cr. Register, January, 1968, No. 145, eff. 2–1–68.

E 660.04 Disconnecting means. (1) A disconnecting means of adequate capacity for at least 50% of the input required for the momentary rating of the X-ray equipment shall be provided in the supply circuit and it shall be operable from a location readily accessible from the X-ray control. For equipment requiring 125 volt line fuses of 30 ampere or less, a plug and receptacle of proper size and of an approved make may serve as a disconnecting means. Disconnecting means shall not be required for portable X-ray equipment of any capacity which complies with section E 660.11.

(a) *Definitions:* 1. Continuous rating. Continuous rating is a constant load which can be carried for an indefinite period of time.

2. Long time rating. A long time rating is the rating based on an operating interval of 5 minutes or longer.

3. Momentary rating. A momentary rating is the rating based on an operating interval that does not exceed 5 seconds.

(2) The capacity of the branch circuit conductors and the ratings of disconnecting means and overcurrent protection for X-ray equipment is usually recommended by the manufacturer for the specific installation.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 660.05 Branch circuit and overcurrent protection requirements. Fifty per cent of the momentary rating of the X-ray equipment shall be used in determining the ampacity requirements for branch circuits and overcurrent protection devices.

Note: The ampacities of the branch circuit conductors and the ratings of disconnecting means and overcurrent protection for X-ray equipment is usually recommended by the manufacturer for the specific installation.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 660.06 Wiring terminals. Unless provided with a permanently attached cord or a cord set, X-ray equipment shall be provided with suitable wiring terminals or leads for the connection of conductors of at least the size required by the input load corresponding to the long time rating of the equipment.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 660.07 Number of conductors in raceway. The number of control circuit conductors installed in a raceway may be in accordance with table 1 of chapter E 900.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 660.08 X-ray installations. (1) SHOCKPROOF INSTALLATIONS. All new equipment used on new installations of X-ray equipment, or used or reconditioned equipment moved to and re-installed at a new location shall be of the approved shockproof type, except as provided for in subsection (2). All controls, tables, X-ray tube stands, transformer tanks, shockproof cables, and X-ray tube heads, etc., shall be suitably grounded to prevent accidental shock to patient or operator.

(2) NON-SHOCKPROOF RE-INSTALLATIONS. No non-shockproof X-ray equipment shall be re-installed in a new location without special permission from the administrative authority. Any such equipment shall be re-installed in an approved manner.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 660.09 On fluoroscopic tables. Where permitted in accordance with subsection E 660.08 (2), leads on fluoroscopic tables shall be adequately insulated or be provided with barriers which will guard against inadvertent contact.

History: Cr. Register, January, 1968, No. 145, eff. 2–1–68.

B. CONTROL

E 660.10 Stationary equipment. A manually controlled device shall be incorporated in the X-ray control supply or in the primary circuit to the high voltage transformer, and shall be adequate to control the load resulting from failures in the high voltage circuit. This device shall be a part of the X-ray equipment, but may be located in a separate enclosure immediately adjacent to the X-ray control unit.

History: Cr. Register, January, 1968, No. 145, eff. 2–1–68.

E 660.11 Portable equipment. Portable equipment shall comply with section E 660.10, but the manually controlled device shall be located in or on the equipment.

History: Cr. Register, January, 1968, No. 145, eff. 2–1–68.

E 660.12 General. (1) RADIOGRAPHIC TYPE. There shall be provided a timer or automatic exposure terminating device and also a switch of a type which opens automatically except when held closed by the operator.

(2) FLUOROSCOPIC TYPE. A switch shall be provided which shall be designed to open automatically except when held closed by the operator.

(3) THERAPY. A timer or automatic exposure terminating device shall be provided which is not of the repeating type.

History: Cr. Register, January, 1968, No. 145, eff. 2–1–68.

C. INDUSTRIAL APPARATUS

E 660.13 Industrial X-ray apparatus. (1) RADIOGRAPHIC AND FLUOROSCOPIC TYPES. A switch which shall be designed to open automatically except when held closed by the operator, or a timer, shall be provided except on equipment or installations effectively enclosed or provided with interlocks to prevent ready access to live current-carrying parts during operation.

(2) INDUSTRIAL OR LABORATORY APPARATUS; DIFFRACTION OR IRRADIATION TYPES. Positive indication of energization by pilot lights, readable meter deflections or equivalent means shall be provided except on equipment or installations effectively enclosed or provided with interlocks to prevent ready access to live current-carrying parts during operation.

History: Cr. Register, January, 1968, No. 145, eff. 2–1–68.

E 660.14 Independent control. Where more than one piece of apparatus is operated from the same high-voltage circuit, each piece or each group of apparatus as a unit shall be provided with a high-voltage switch or equivalent disconnecting means. This disconnecting means shall be constructed, enclosed, or located so as to avoid contact by persons with its live parts.

History: Cr. Register, January, 1968, No. 145, eff. 2–1–68.

D. TRANSFORMERS AND CAPACITORS

E 660.15 General. Transformers and capacitors which are part of an X-ray apparatus shall not be required to conform to the requirements of Wis. Adm. Code chapters E 450 and E 460.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 660.16 Draining capacitor charge. Capacitors shall be provided with an automatic means for discharge and grounding the plates whenever the transformer primary is disconnected from the source of supply.

(1) EXCEPTION No. 1. Where all current-carrying parts of capacitors, and of the conductors connected therewith, are at least 8 feet from the floor and are inaccessible to unauthorized persons.

(2) EXCEPTION No. 2. Where within 8 feet from the floor, are within enclosures of grounded metal or insulating material.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E. GUARDING AND GROUNDING

E 660.17 General. (1) HIGH VOLTAGE PARTS. All high voltage parts, including X-ray tubes, shall be mounted within grounded enclosures. Either air, oil, gas or other suitable insulating media may be used to insulate the high voltage from the grounded enclosure. The connections from the high voltage equipment to X-ray tubes and other high voltage components shall be made with high voltage cables of the shockproof type.

(2) LOW VOLTAGE CABLES. Low voltage connecting cables to oil filled units such as transformers, condensers, oil coolers, and high voltage switches which are not completely sealed shall be of the oil resistant type.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 660.18 Grounding. Non-current-carrying metal parts of tube stands, fluoroscopic and other equipment shall be grounded in the manner prescribed in Wis. Adm. Code chapter E 250.

(1) PORTABLES. Portable equipment shall be provided with an approved grounding type plug.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

Chapter E 665

INDUCTION AND DIELECTRIC HEATING EQUIPMENT

A. SCOPE AND GENERAL

E 665.01 Scope. The provisions of this chapter shall apply to the construction and installation of induction and dielectric heating equipment and accessories for industrial, scientific and medical applications, but not for appliances.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 665.02 Definitions. (1) The term "heating equipment" as used in this chapter includes any equipment used for heating purposes whose heat is generated by induction or dielectric methods.

(2) Induction heating is the heating of a nominally conducting material due to its own i^2R losses when the material is placed in a varying electro-magnetic field.

(3) Dielectric heating is the heating of a nominally insulating material due to its own dielectric losses when the material is placed in a varying electric field.

(4) The term "therapeutic high frequency equipment" as used in this chapter shall be understood to mean generating equipment capable of producing alternating currents having frequencies greater than those frequencies which elicit neuromuscular response. In order to comply with the above, the output frequency of the therapeutic high frequency equipment shall not be less than 2 megacycles.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 665.03 Application of other chapters. Wiring from the source of power to the heating equipment shall comply with Wis. Adm. Code chapters E 100 to E 400 inclusive. Circuits and equipment operating on a supply circuit of more than 600 volts shall comply with the provisions of chapter E 710.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 665.04 Hazardous locations. Induction and dielectric heating equipment shall not be installed in hazardous locations as defined in chapter E 500 unless the equipment and wiring is designed and approved for the locations.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

B. MOTOR-GENERATOR EQUIPMENT

E 665.05 Scope. Motor generator equipment shall include all rotating equipment designed to operate from an AC or DC motor, or by mechanical drive from a prime mover, producing an alternating current of any frequency for induction and/or dielectric heating.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 665.06 Ampacities of supply conductors. Ampacities of supply conductors shall be determined by Wis. Adm. Code chapter E 430.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 665.07 Overcurrent protection. Overcurrent protection shall be provided as specified in chapter 430 of this code for the electrical supply circuit.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 665.08 Disconnecting means. The disconnecting means shall be provided as specified in chapter E 430 of this code. (1) A readily accessible disconnecting means shall be provided by which each heating equipment can be isolated from the supplying circuit. The ampacity of this disconnecting means shall be not less than the nameplate current rating of the equipment. The supply circuit disconnect means may be used as a heating equipment disconnecting means where the circuit supplies only one equipment.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 665.09 Output circuit definition. The output circuit shall include all high frequency output components external to the generator, including contactors, transformers, bus-bars, and transmission lines. The same definition shall apply to all off line frequencies obtained from motor generators, or generators used with induction heating loads.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 665.10 Output circuits. Output circuits shall conform to the following: (1) GENERATOR OUTPUT. (a) The output circuit shall be isolated from ground, except for the capacitive coupling inherent in the generator, which, in effect causes the generator terminals to have voltages from terminal to ground that are equal.

(b) When rated at more than 500 volts, the output circuit shall incorporate a DC ground protector unit. The DC inpressed on the output circuit shall not exceed 30 volts and shall not exceed a current capability of 5 milliamperes.

(c) An isolating transformer for matching the load and the source may be used in the output circuit wherein the secondary is not at DC ground potential.

(2) COMPONENT INTERCONNECTIONS. The various components required for a complete induction heating equipment installation shall

be connected by properly protected multiconductor cable, bus bar, or coaxial cable. Cables shall be installed in non-ferrous conduit raceways. Bus bar shall be protected where required by nonferrous enclosures.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 665.11 Control-enclosures. Low frequency AC or DC may be used in the control portion of the heating equipment. This shall be limited to a value of 150 volts. Solid or stranded wire, properly sized in No. 18 AWG or larger shall be used. Sixty cycle components may be used to control HF when properly rated by the induction heating equipment manufacturer. Electronic circuits utilizing solid state devices and tubes may use printed circuits or wire sizes, properly sized smaller than No. 18 AWG.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 665.12 Remote control. (1) When remote controls are used for applying power, a "Local-Remote" switch shall be provided and interlocked so as to prevent the possibility of applying power from other than one selected control point or points.

(2) Switches operated by foot pressure shall be provided with a shield over the contact button to avoid accidental closing.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

C. EQUIPMENT OTHER THAN MOTOR GENERATOR

E 665.13 Scope. Equipment other than motor generator includes all static multipliers and oscillator type units utilizing vacuum tubes and/or solid state devices. The equipment shall be capable of converting AC, or DC to a frequency suitable for induction and/or dielectric heating.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 665.14 Ampacities of supply conductors. Ampacities of supply conductors shall be determined as follows: (1) the ampacity of the circuit, shall be not less than the nameplate current rating of the equipment.

(2) The ampacities of conductors supplying 2 or more equipments shall be not less than the sum of nameplate current ratings on all equipment except as follows: Where, when supplying 2 or more equipments from the same feeder, simultaneous operation of said equipments is not possible, the ampacity of the feeder shall be not less than the sum of the nameplate currents for the largest group of machines capable of simultaneous operation, plus 100% of the standby currents of the remaining machines supplied.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 665.15 Overcurrent protection. Overcurrent protection shall be provided as specified in chapter E 430 for the equipment as a whole. This overcurrent protection shall be provided separately or as a part of the equipment.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 665.16 Disconnecting means. A readily accessible disconnecting means shall be provided by which each heating equipment can be isolated from the supplying circuit. The ampacity of this disconnecting means shall not be less than the nameplate current rating of the equipment. The supply circuit disconnect means may be used for disconnecting the heating equipment where the circuit supplies only one equipment.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 665.17 Output circuit definition. The output circuit shall include all high frequency output components external to the converting device including contactors, transformers, bus-bars, and transmission lines. The same definition shall apply to all off line frequencies obtained from the converting device, or devices used with induction and/or dielectric heating loads.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 665.18 Output circuits. Output circuits shall conform to the following: (1) CONVERTER OUTPUT. The output circuit (direct or coupled) shall be at DC ground potential.

(2) CONVERTER AND APPLICATOR CONNECTION. When the connections between the converter and the work applicator exceed 2 feet in length the connections shall be enclosed or guarded with noncombustible material.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 665.19 Line frequency in converter equipment output. Commercial frequencies of 25 to 60 cycle alternating current output may be coupled for control purposes, but shall be limited to a value of 150 volts available only during periods of circuit operation.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 665.20 Keying. Where high-speed keying circuits dependent on the effect of "oscillator blocking" are employed, the peak R.F. output voltage during the blocked portion of the cycle shall not exceed 100 volts in units employing R.F. converters.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 665.21 Remote control. (1) When remote controls are used for applying power, a "Local Remote" switch shall be provided and interlocked so as to prevent the possibility of applying power from other than one selected control point or points.

(2) Switches operated by foot pressure shall be provided with a shield over the contact button to avoid accidental closing.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

D. GUARDING AND GROUNDING

E 665.22 Enclosures. The converting apparatus (including the DC line) and high frequency electrical circuits (excluding the output circuits and remote control circuits), shall be completely contained in an enclosure or enclosures of noncombustible material.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 665.23 Panel controls. All panel controls shall be of "dead front" construction.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 665.24 Access to internal equipment. Doors or detachable panels may be employed for internal access. Where doors are used giving access to voltages from 500 to 1000 volts AC or DC, either door locks shall be provided or interlocking shall be installed with the choice of precaution optional. Where doors are used giving access to voltages above 1000 volts AC or DC, either mechanical lockouts, with a disconnect means to prevent access until voltage is removed from the cubicle, or both door interlocking and mechanical door locks shall be provided. Detachable panels not normally used for access to such parts shall be fastened in a manner which will make them inconvenient to remove.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 665.25 Warning labels. "Danger" labels shall be attached on the equipment, and shall be plainly visible even when doors are opened or panels are removed from compartments containing voltages above 250 volts AC or DC.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 665.26 Capacitors. (1) when capacitors in excess of 0.1 Mfd. are used in DC circuits, either as rectifier filter components, or suppressors, etc., having circuit voltages exceeding 230 volts above ground, bleeder resistors or grounding switches shall be used as grounding devices. The time of discharge shall be in accordance with section E 460.06 (1).

(2) Where auxiliary rectifiers are used with filter capacitors in the output for bias supplies, tube keyers, etc., bleeder resistors shall be used even though the DC voltage may not exceed 230 volts.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 665.27 Work applicator shielding. Protective cages or adequate shielding shall be used to guard work applicators other than induction heating coils. Induction heating coils may be protected by insulation and/or refractory materials. Interlock switches shall be used on all hinged access doors, sliding panels or other easy access to the applicator. All interlock switches shall be connected in such a manner as to remove all power from the applicator when any one of the access doors or panels is open. Interlocks on access doors or panels are not required when the applicator is an induction heating coil at DC ground potential or operating at less than 150 volts AC.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 665.28 Grounding and bonding. Grounds and/or inter-unit bonding shall be used wherever required for circuit operation and for limiting to a safe value radio frequency potentials between all exposed noncurrent-carrying parts of the equipment and earth ground, also between all equipment parts and surrounding objects and between such objects and earth ground. Such grounding and bonding shall be installed in accordance with Wis. Adm. Code chapter E 250.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 665.29 Marking. Each heating equipment shall be provided with a nameplate, giving the manufacturer's name and model identification, and the following input data: line volts, frequency, number of phases, maximum current, full load KVA and full load power factor.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E. THERAPEUTIC EQUIPMENT

E 665.30 Installation. (1) Where portability is not essential, equipment shall be permanently installed in accordance with Wis. Adm. Code chapters E 100 to E 300 inclusive.

(2) Where portability is essential, the power supply cord shall be a three-conductor hard service type with an ampacity not less than the marked rating of the equipment. One conductor having a continuous green color or a continuous green color with a yellow stripe insulation shall be used solely for equipment grounding. The cord shall terminate in an approved grounding attachment-plug cap as described in section E 250.059 (2).

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 665.31 Applicators for therapeutic equipment. Application of the high frequency power to the patient may be made by means of an electric field or of an induction field. Current-carrying parts of applicators shall be so insulated or enclosed that reliable isolation of the patient shall be assured.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 665.32 Enclosure. The converting apparatus including the DC line, and high frequency electrical circuits, but excluding the line cord for portable units and the output circuits, shall be contained in an enclosure of noncombustible material.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 665. 33 Panel controls. All panel controls shall be of "dead front" construction.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 665.34 Access to internal equipment. Access shall be through panels not conveniently removable. Panels which need removal for access to fuses, tubes, adjustments, overload reset devices, internal top switches, and the like, shall be labeled to indicate danger if and when removed, or shall be provided with suitable electrical interlock devices.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

Chapter E 670

METALWORKING MACHINE TOOLS

E 670.01 Scope. The provisions of this chapter apply to metal working machine tools and includes size and overcurrent protection of supply conductors and nameplate data required on each such tool.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 670.02 Standard for metalworking machine tools. Electrical equipment, apparatus and wiring furnished as part of metalworking machine tools shall comply with a standard acceptable to the administrative authority.

Note: The administrative authority considers NFPA Standard on Metalworking Machine Tools (No. 79)–1965 to be an acceptable standard.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 670.03 Definition of metalworking machine tools. For the purpose of this chapter, metalworking machine tools are defined as follows:

(1) A metal cutting machine tool is a power driven machine, not portable by hand, used for the purpose of removing metal.

(2) A metal forming machine tool is a power driven machine, not portable by hand, used to press, forge, emboss, hammer, blank, or shear metal.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 670.04 Machine tool nameplate data. (1) A permanent nameplate listing supply voltage, phase, frequency, full load currents, ampere rating of largest motor, short circuit interrupting capacity of the machine overcurrent protective device if furnished, and diagram number shall be attached to the control equipment enclosure or machine where plainly visible after installation.

(2) The full load current shall be not less than the sum of the full load currents required for all motors and other equipment which may be in operation at the same time under normal conditions of use. Where unusual type loads, duty-cycles, etc., require oversized conductors, the required capacity shall be included in the marked "full load current".

(3) Where more than one incoming supply circuit is to be provided, the nameplate shall state the above information for each circuit.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 670.05 Conductors supplying a machine tool. (1) The supply circuit conductors shall have a current-carrying capacity of not less than the marked full load current rating plus 25% of the full load current rating of the highest rated motor as indicated on the nameplate. For the protection of supply conductors to the machine tool, refer to section E 240.05.

(2) A machine tool conforming with a standard acceptable to the administrative authority shall be considered individual unit equipment. It is provided with a disconnecting means and may be supplied by branch circuits protected by either fuses or circuit-breakers.

Note: The administrative authority considers NFPA Standard No. 79 an acceptable standard.

(3) The disconnecting means may or may not incorporate overcurrent protection. Where the machine tool nameplate is marked "Overcurrent protection provided at machine supply terminals", the supply conductors are to be considered either as feeders, or taps as covered by section E 240.15.

Note: "Overcurrent protection provided at machine supply terminals" means that provision has been made in the machine tool for each set of supply conductors to terminate in a single circuit-breaker or set of fuses.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

Chapter E 680

SWIMMING POOLS

E 680.01 Scope. The provisions of this chapter apply to the construction and installation of electric wiring for equipment in or adjacent to swimming, wading, physical therapy and similar pools, to metallic appurtenances in or within 5 feet of the pool, and to the auxiliary equipment such as pumps, filters and similar equipment. No electric appliances or wiring shall be installed in the water or in the enclosing walls of a swimming, wading, physical therapy or similar pool, except as provided for in this chapter. Movable pools need not comply with the requirements of this chapter.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 680.02 Approval of equipment. All equipment shall be approved for the purpose.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 680.03 Application of other chapters. Except as modified by this chapter, wiring and equipment in or adjacent to swimming pools shall comply with the applicable requirements of Wis. Adm. Code chapters E 100 to E 400, inclusive.

Note: See chapter E 720 for low voltage lighting.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 680.04 Wiring method and lighting. (1) All wiring supplying pool lighting boxes shall be in threaded rigid metal conduit and all boxes, fittings and joints shall be threaded for connection to the conduit. The provisions of the following subsections apply to lighting fixtures installed below the pool surface.

(2) No lighting fixture shall be installed for operation at more than 150 volts.

(3) A nonmetallic fixture shall not be used with a grounded power supply.

(4) All noncurrent carrying metal parts of lighting fixtures shall be grounded whether exposed or enclosed in nonconducting materials. The fixture shall be secured and grounded to the forming shell by a positive locking device which will assure a low resistance contact and which will require a tool to remove the fixture from the forming shell.

(a) *Definition.* A forming shell is a metal housing designed to contain a lighting fixture assembly for mounting into a swimming pool structure. The forming shell provides a bond between the raceway and the noncurrent carrying metal parts of the fixture.

(5) Fixtures approved for the purpose may be installed outside the walls of the pool in closed recesses which are adequately drained and accessible for maintenance.

(6) Approved metal fixture housings (forming shells) shall be installed for the mounting of all wet niche underwater fixtures and shall be equipped with provisions for threaded conduit entries. Metal parts of the fixtures and fixture housings in contact with the pool water and the supply conduit below grade level shall be of brass or other approved corrosion-resistant metal. The rigid conduit shall extend from the fixture housing (forming shell) to a suitable junction box located as provided in section E 680.05.

(7) Underwater lighting fixtures shall perform reliably under any likely combination of fault conditions so that there is no shock hazard. Compliance with this requirement shall be assured by one of the following:

(a) The design and construction of the fixtures; or

(b) The use of differential type circuit protection; or

(c) The use of a transformer complying with section E 680.04 (8) and further provided with a ground detector if the circuit voltage is greater than 15 volts; or

(d) Other acceptable means.

(8) Transformers used for the supply of fixtures, together with the transformer enclosure, shall be approved for the purpose. The transformers shall be a two-winding type having a grounded metal barrier between the primary and secondary voltage windings.

(9) Within the fixture the cord termination, all splices, and the ground connection shall be covered with a suitable compound to protect them from the deteriorating effect of exposure to pool water in the event of a failure causing water to enter the fixture.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 680.05 Junction boxes and transformer enclosures. (1) Junction boxes installed on the supply side of conduits extending to underwater pool lights shall be provided with threaded hubs for conduit connection. These boxes shall be located not less than 8 inches above ground, pool deck, or maximum pool water level, whichever provides the greatest elevation, nor less than 4 feet from the perimeter of the pool unless part of an approved fixture assembly. Junction boxes mounted above the grade of the finished walkway around the pool shall not be located in the walkway unless afforded additional protection such as by location under diving boards, adjacent to fixed structures, and the like.

(2) Transformer enclosures shall be located not less than 12 inches above ground, pool deck, or maximum pool water level, whichever provides the greatest elevation, nor less than 4 feet from the perimeter of the pool. Transformer enclosures mounted above the grade of the finished walkway around the pool shall not be located in the walkway unless afforded additional protection such as by location under diving boards, adjacent to fixed structures, and the like.

(3) Boxes shall be provided with means for independently terminating not less than two grounding conductors.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 680.06 Attachment plug receptacles. No attachment plug receptacles shall be installed within 10 feet of the inside walls of the swimming pool.

(1) EXCEPTION. Attachment plug receptacles of other than the standard 15 ampere parallel slot type may be installed where an integral part of the lighting fixture assembly and where used for the installation, maintenance, or servicing of the fixture.

Note: In determining the 10-foot dimension, the distance to be measured is the shortest path which the supply cord of an appliance connected to the receptacle would follow without piercing a building floor, wall or ceiling.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 680.07 Grounding. (1) All metallic conduit, piping systems, pool reinforcing steel, lighting fixtures, lighting fixture housings, metal parts of ladders, diving boards and their supports and the like shall be bonded together and grounded to a common ground. The bonding conductor shall be not smaller than No. 8 copper.

(a) *Exception:* The usual steel tie wires are considered suitable for bonding the reinforcing steel together and welding or special clamping will not be required.

(2) An unbroken No. 12 AWG, or larger, insulated copper wire shall be provided for a grounding conductor from the junction box to the distribution panel ground. This conductor shall be installed in rigid metallic conduit with the circuit conductors from the pool junction box to the distribution panel ground terminal.

(3) Metallic raceways shall not be depended upon for grounding. Where exposed to pool water and in other corrosive areas such as in pump houses or adjacent to water treating and other equipment, the grounding of the noncurrent carrying parts shall be by means of an insulated copper conductor sized in accordance with section E 250.095 and not smaller than No. 12 AWG.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 680.08 Methods of grounding and bonding. (1) Metal wiring enclosures shall be grounded in accordance with chapter E 250, in addition to other requirements of this chapter.

(2) In addition to other requirements of this chapter, lighting fixtures that are supplied by flexible cord or cable shall have all metal parts grounded by means of an insulated grounding conductor that is an integral part of the cord or cable. This grounding conductor shall be connected to a grounding terminal in the supply junction box. This conductor shall be equal in size to the supply conductors but not smaller than No. 16 AWG.

(3) Nonelectrical equipment shall be grounded to a common ground in accordance with section E 680.07.

Note: Structural reinforcing steel may be used as a common bonding conductor for nonelectrical parts where connections can be made in accordance with section E 250.113.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 680.09 Clearances. A horizontal clearance of at least ten feet shall be maintained between service drops or other open overhead wiring, and swimming pools, diving structures, observation stands, towers or platforms.

Note: See section E 190.02 (1) (b).

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

SPECIAL CONDITIONS

Chapter E 700

EMERGENCY SYSTEMS

A. GENERAL

E 700.01 Scope. The provisions of this chapter apply to the installation, operation and maintenance of circuits, systems and equipment intended to supply illumination and power in the event of failure of the normal supply or in the event of accident to elements of a system supplying power and illumination essential for safety to life and property where such systems or circuits are legally required by municipal, state, federal or other codes, or by any governmental agency having jurisdiction.

Note 1. Emergency systems are generally installed in places of assembly where artificial illumination is required, such as buildings subject to occupancy by large numbers of persons, hotels, theaters, sports arenas, hospitals and similar institutions. Emergency systems may provide power for such functions as essential refrigeration, operation of mechanical breathing apparatus, ventilation when essential to maintain life, illumination and power for hospital operating rooms, fire pumps, fire alarm systems, industrial processes where current interruption would produce serious hazards, public address systems and similar functions.

Note 2. See Wis. Adm. Code sections Ind 54.06 (2), Ind 55.11 (1), sections Ind 56.08, Ind 51.15 and Ind 57.11 for specification of locations where emergency lighting is considered essential to life safety.

Note 3. The methods of supplying exit and emergency illumination in existing buildings will be determined in each individual case.

History: Cr. Register, January, 1968, No. 145, eff. 2–1–68.

E 700.02 Other requirements. All requirements of the Wisconsin state electrical code shall apply to emergency systems, except as modified by this chapter.

History: Cr. Register, January, 1968, No. 145, eff. 2–1–68.

E 700.03 Equipment approval, tests and maintenance. (1) All equipment shall be approved for use on emergency systems.

(2) The authority having jurisdiction shall conduct or witness a test on the complete system upon installation and periodically afterward.

(3) Systems shall be tested periodically on a schedule acceptable to the authority having jurisdiction to assure their maintenance in proper operating condition.

(4) Where battery systems or unit equipments are involved, including batteries used for starting or ignition in auxiliary engines, the authority having jurisdiction shall require periodic maintenance.

(5) A written record shall be kept of such tests and maintenance.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 700.04 Capacity. Emergency systems shall have adequate capacity and rating for the emergency operation of all equipment connected to the system.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

B. SOURCES OF POWER

E 700.05 Systems. (1) Current supply shall be such that in event of failure of the normal supply to or within the building or group of buildings concerned, emergency lighting, or emergency power, or both emergency lighting and power will be immediately available. The supply system for emergency purposes may comprise one or more of the types of system covered in sections E 700.07 to E 700.10. The normal building supply, as referred to in section E 700.07 (1) and section E. 700.08 may be obtained from the normal building service, a building feeder or branch circuit. Unit equipments in accordance with section E 700.22 shall satisfy the applicable requirements of this chapter.

(2) Emergency auxiliary service supply from a storage battery, generator, etc., when used to replace a part or all of normal service, shall be provided with a double throw switch or throw over switches mechanically interlocked to prevent energy from flowing into the normal source of supply.

(3) Consideration must be given to the type of service to be rendered, whether of short time duration, as for exit lights of a theater, or of long duration as for supplying emergency power and lighting due to a long period of current failure from trouble either inside or outside the building, as in the case of a hospital.

(4) The emergency service switch shall be identified.

Note: Assignment of degree of reliability of the recognized emergency supply system depends upon the careful evaluation of the variables at each particular installation.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 700.06 Standby emergency power. Standby emergency power of a type recognized by sections E 700.07, E 700.08 or E 700.22 shall be provided as a source of supply for emergency lighting or power in occupancies where people are housed, assembled, confined or congregated as follows:

Number of Persons	Typical Occupancies
1. Over 30	Hospitals, homes for the aged, nursing homes, children's homes, asylums, natatoriums and similar buildings.
2. Over 200	Theater, assembly halls, dining rooms, libraries, stores, hotels, motels and similar buildings.
3. Over 400	Apartment buildings, dormitories, office buildings, convents, factories and similar buildings.

Note: The figures in the following table shall be used to determine the capacity of buildings or parts of buildings, when determining if standby emergency power is required. The square foot figures noted below are based on net area which would include internal room and corridor areas. The area occupied by toilets, stairwells, elevator shafts, janitor's closets, boiler and equipment rooms, and similar areas need not be included in calculating the minimum area. Areas within rooms occupied by furniture, machinery or display counters must be included. The area occupied by a bar or serving counter such as is found in a tavern, restaurant, or drug store and the area behind them where employees work need not be included.

Number of Persons	Occupancy	Minimum Total Area or Capacity
1. Over 30	a. Hospitals, homes for the aged, children's homes, asylums, jails and similar occupancies.	30 patient or inmate beds.
	b. Natatoriums.	450 square feet.
2. Over 200	a. Assembly halls with stage, lecture halls, school auditoriums.	1,400 square feet.
	b. Theaters and theater lobbies.	1,400 square feet. (Theater and lobby must be combined in determining total area.)
	c. Arenas and field houses.	800 square feet. (Use seated space only.)
	d. Gymnasiums and lodge halls.	1,200 square feet for seated space. 3,000 square feet for unseated space. (For combined areas use 6 square feet per person for seated space and 15 square feet per person for unseated space.)
	e. Exhibition buildings, museums and art galleries.	20,000 square feet.
	f. Libraries.	4,000 square feet for reading rooms. 20,000 square feet for balance. (For combined areas use 20 square feet per person for reading rooms and 100 square feet per person for the balance.)
	g. Church dining rooms and fellowship halls, dance halls, banquet halls, dining rooms, restaurants, taverns, night clubs, school multipurpose rooms and similar occupancies.	2,000 square feet.
	h. Stores.	6,000 square feet for first floor or basement. 12,000 square feet for second floor and above. (For combined areas use 30 square feet per person for first floor and basement and 60 square feet per person for second floor and above.)

Number of Persons	Occupancy	Minimum Total Area or Capacity
	i. Skating rinks.	3,000 square feet.
	j. Hotels, motels and rooming houses.	200 rooms.
	k. Bowling alleys.	200 persons based on 5 persons per alley plus number of spectator seats and area for bar and dining areas in accordance with above item g.
3. Over 400	a. Apartment buildings.	200 apartments.
	b. Dormitories, including those in detention schools and convents.	400 beds.
	c. Office buildings, banks and factories.	30,000 square feet.
	d. Warehouses.	120,000 square feet.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 700.07 Storage battery. (1) A normal building supply and a storage battery of suitable rating and capacity to supply and maintain at not less than 91% of system voltage of the total load of the circuits supplying emergency lighting and emergency power for a period of at least ½ hour. An automatic battery charging means shall be provided.

(2) Batteries whether of the acid or alkali type shall be designed and constructed to meet the requirements of emergency service. When of the lead-acid type, this shall include low gravity acid (1.20 to 1.22 SP-GR), relatively thick and rugged plates and separators, and a transparent jar.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 700.08 Generator set. A normal building supply and a generator set driven by some form of prime mover and of sufficient capacity and proper rating to supply circuits carrying emergency lighting or lighting and power, with suitable means for automatically starting the prime mover on failure of the normal building supply. For hospitals, the transition time from instant of failure of the normal power source to the emergency generator source shall not exceed 10 seconds.

Note: See section E 700.03.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 700.09 Separate service. Two services, each in accordance with Wis. Adm. Code chapter E 230, widely separated electrically and physically to minimize the possibility of simultaneous interruption of supply.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 700.10 Connection ahead of service disconnecting means. Connections on the line side of the main service if sufficiently separated from main service to prevent simultaneous interruption of supply through an occurrence within the building or group of buildings served. Feeder conductors entering a separate building may be considered service conductors as far as emergency supply is concerned.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 700.11 Auxiliary source. The requirements of sections E 700.04 and E 700.05 shall also apply to installations where the entire electrical load on a service or sub-service is arranged to be supplied from a second source. Current supply from a standby power plant shall satisfy the requirements of availability in section E 700.05.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 700.12 Derangement signals. Audible and visual signal devices shall be provided where practicable for the following purposes:

(1) To give warning of derangement of the emergency or auxiliary source.

(2) To indicate that the battery or generator set is carrying load.

(3) To indicate when battery charger is properly functioning.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

C. EMERGENCY CIRCUITS FOR LIGHTING AND POWER

E 700.13 Loads on emergency branch circuits and feeders. No appliances and no lamps, other than those specified as required for emergency use shall be supplied by emergency lighting branch circuits and feeders.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 700.14 Emergency illumination. Emergency illumination shall include all required exit lights and all other lights specified as necessary to provide sufficient illumination. When standby emergency power is required by section E 700.06, the required exit lights and general emergency lights shall be supplied from the standby source.

Note: Emergency lighting systems should be so designed and installed that the failure of any individual lighting element, such as the burning out of a light bulb, cannot leave any space in total darkness.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 700.15 Circuits for emergency lighting. Branch circuits intended to supply emergency lighting shall be so installed as to provide service immediately when the normal supply for lighting is interrupted. Such installations shall provide either one of the following:

(1) An emergency lighting supply, independent of the general lighting system with provisions for automatically transferring, by means of devices approved for the purpose, the emergency lights upon the event of failure of the general lighting system supply.

(2) Two or more separate and complete systems with independent power supply, each system providing sufficient current for emergency lighting purposes. Unless both systems are used for regular lighting purposes and are both kept lighted, means shall be provided for automatically energizing either system upon failure of the other. Either or both systems may be part of the general lighting system of the protected occupancy if circuits supplying lights for emergency illumination are installed in accordance with other rules of this chapter.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 700.16 Circuits for emergency power. For branch circuits which supply equipment classed as emergency, there shall be an emergency supply source to which the load will be transferred automatically and immediately upon the failure of the normal supply.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 700.17 Independent wiring. Emergency circuit wiring shall be in approved raceways, kept entirely independent of all other wiring and equipment and shall not enter the same raceway, box or cabinet with other wiring.

(1) EXCEPTION NO. 1. In transfer switches.

(2) EXCEPTION NO. 2. In exit or emergency lighting fixtures supplied from 2 sources.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

D. CONTROL

E 700.18 Switch requirements. (1) The switch or switches installed in emergency lighting circuits shall be so arranged that only authorized persons will have control of emergency lighting except:

(a) *Exception No. 1.* Where 2 or more single throw switches are connected in parallel to control a single circuit, at least one of these switches shall be accessible only to authorized persons.

(b) *Exception No. 2.* Additional switches which act only to put emergency lights into operation but not disconnect them are permissible.

(2) Switches connected in series or 3 and 4-way switches shall not be used. The emergency service switch shall be identified.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 700.19 Switch location. (1) All manual switches for controlling emergency circuits shall be in locations convenient to authorized persons responsible for their actuation. In places of assembly such as theaters a switch for controlling emergency lighting systems shall be located in the lobby or at a place conveniently accessible thereto.

(2) In no case shall a control switch for emergency lighting in a theater or motion picture theater be placed in a motion picture projection booth or on a stage, except that where multiple switches are provided, one such switch may be installed in such location when so arranged that it can energize, but not disconnect the circuit.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 700.20 Other switches. (1) EXTERIOR LIGHTS. Those lights on the exterior of the building which are not required for illumination when there is sufficient daylight may be controlled by an automatic light-actuated device approved for the purpose.

(2) HOSPITAL CORRIDORS. Switching arrangements to transfer corridor lighting in patient areas of hospitals from overhead fixtures to fixtures designed to provide night lighting may be permitted, provided the switching system is so designed that switches can only select between two sets of fixtures and cannot extinguish both sets at the same time.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E. OVERCURRENT PROTECTION

E 700.21 Accessibility. The branch-circuit overcurrent devices in emergency circuits shall be accessible to authorized persons only.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

F. UNIT EQUIPMENTS

E 700.22 Unit equipments. (1) In lieu of other methods specified elsewhere in this chapter, individual unit equipments for emergency illumination shall consist of (a) a storage battery, (b) battery charging means, (c) one or more lamps, and (d) a relaying device arranged to energize the lamps automatically upon failure of the normal supply to the building. The batteries shall be of suitable rating and capacity to supply and maintain at not less than 91% of rated lamp voltage the total lamp load associated with the unit for a period of at least ½ hour. Storage batteries whether of the acid or alkali type shall be designed and constructed to meet the requirements of emergency service. When of the lead-acid type the storage battery shall have a transparent jar.

(2) Unit equipments shall be permanently fixed in place (i.e. not portable) and shall have all wiring to each unit installed in accordance with the requirements of any of the wiring methods in chapter E 300. They shall not be connected by flexible cord. The supply circuit between the unit equipment and the service, feeders, or the branch circuit wiring shall be installed as required by section E 700.17. Emergency illumination fixtures which obtain power from a unit equipment and are not part of the unit equipment shall be wired to the unit equipment as required by section E 700.17 and by one of the wiring methods of chapter E 300.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 700.23 Fire alarm wiring. (1) The energy for operation of fire alarm systems shall be taken from sources suited to the design of the system. Batteries shall not be used.

(2) A 3-wire 120–240 volt or 120–208 volt (3-phase, 4-wire) service shall be provided for required electrical fire alarm systems. The system shall be supervised with the operating current secured from one ungrounded conductor and the neutral or grounded conductor and the current for operating trouble signal or signals secured from the other ungrounded conductor and the neutral or grounded conductor.

(3) Electrical wiring in connection with fire alarm systems shall be installed in rigid metal conduit, flexible metal conduit, electrical metallic tubing or surface metal raceway. Fire alarm systems are considered emergency wiring and shall comply with section E 700.17. Metal-clad cable may be used where it can be fished in hollow spaces of walls or partitions in apartments or rooming houses not over 3 stories in height. Where the wiring is subject to excessive moisture or severe mechanical injury, rigid metal conduit shall be used. The smallest size conductor to be used in any fire alarm system in a building over 3 stories in height shall be No. 14 AWG or No. 16 AWG for buildings not over 3 stories in height. The wires shall be provided with insulation suitable for use on circuits not exceeding 600 volts. Fire alarm systems shall be connected to the line side of the main service switch or to the emergency feeder through 2 single pole breakers or switches used for no other purpose and arranged so they can be locked in the "on" position, and under the supervision of a qualified person. The breaker and switches shall be identified by a red color. Two pole breakers shall not be used.

Note: See Wis. Adm. Code section Ind 51.24 for general requirements covering fire alarm systems.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

Chapter E 710

OVER 600 VOLTS; GENERAL

A. GENERAL

E 710.01 Scope. This chapter applies in general to all circuits and equipment operated at more than 600 volts. For specific installation see the chapters referred to in section E 710.02.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 710.02 Installations covered in other chapters. Provisions applicable to specific types of installations are included in Wis. Adm. Code chapter E 230, Services; chapter E 346, Rigid Metal Conduit; chapter E 347, Rigid Nonmetallic Conduit; chapter E 430, Motors, Motor Circuits and Controllers; chapter E 450, Transformers and Transformer Vaults; chapter E 460, Capacitors; chapter E 730, Outside Branch Circuits and Feeders; chapter E 410, Lighting Fixtures, Lampholders, Lamps, Receptacles and Rosettes; chapter E 600, Electric Signs and Outline Lighting; chapter E 660, X-ray Equipment, and chapter E 665, Inductive and Dielectric Heat Generating Equipment.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 710.03 Wiring methods. Circuit conductors shall be suitable for the voltage and the conditions under which they are installed. They shall be installed in rigid metal conduit, in raceways or ducts or as open runs of metal armored cable suitable for the use and purpose.

(1) EXCEPTION. In locations accessible to qualified persons only, open runs of non-metallic sheathed cable, bare conductors and bare bus bars may also be used.

(2) When installed in the ground they shall be suitable for the purpose and buried at least 36 inches deep. An approved concentric neutral type of direct burial multiple or single conductor cable may be buried to a minimum depth of 30 inches. Where these methods are impractical the cable may be not less than 24 inches deep provided they are installed in suitable raceways or encased in 2 inches of concrete. See chapters E 346 and E 347.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 710.04 Braid-covered insulated conductors; open installation. Open runs of braid-covered insulated conductors shall have a flame-retardant braid. When the conductors used do not have this protection a flame-retardant saturant shall be applied to the braid covering after installation. This treated braid covering shall be stripped back a safe distance at conductor terminals, according to the operating voltage. This distance should be not less than one inch for each kilovolt of the conductor-to-ground voltage of the circuit, where practicable.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 710.05 Shielding of rubber-insulated conductors. Where rubber-insulated conductors for permanent installations operate at voltages higher than those indicated in table E 710.05 and under the conditions mentioned, they shall be of a type having metallic shielding for the purpose of confining their dielectric field.

TABLE E 710.05

SHIELDING OF RUBBER-INSULATED CONDUCTORS

Method of Installation	Voltage in Kv (L-L) Above which Shielding is Required			
	Neutral Grounded		Neutral Ungrounded	
	Fibrous Covered	Ozone Resistant Jacket Covering	Fibrous Covered	Ozone Resistant Jacket Covering
In metallic conduit or trough above grade ocated indoors and in dry locations				
Single conductor	2	5*	2	3
Multi-conductor	2	5	2	5
Underground ducts and conduits and other wet locations				
Single conductor	2	3**	2	3
Multi-conductor	2	5	2	5
On insulators—				
Only multi-conductor	Not required under 5 Kv.		3	5
Directly in soil—				
Single conductor	----------	3	----------	3
Multi-conductor	----------	5	----------	5

*It is presumed that installation conditions will be such as to maintain a high level of jacket surface resistivity and so minimize the possibility of destructive discharge. Pulling dry or the use of insulating type pulling lubricants will help attain these conditions. Where surface contamination cannot be prevented and high surface resistivity cannot be maintained, metallic shielding shall be used at over 3 kv.

**For 3 single conductor cables, cabled together without overall outer covering, the value is 5 kv.

Note: Metallic sheathed single or 3-conductor cables require no metallic shielding for voltages 5 kv and less. In the case of portable equipment cables it is good practice to specify shielding for all voltages above 2 kv.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 710.06 Grounding of shielding tape. The metallic shielding or any other static voltage shields on shielded cable shall be stripped back to a safe distance according to the circuit voltage, at all terminations of the shielding, as in potheads and joints. At such points, suitable methods such as the use of potheads, terminators, stress cones or similar devices shall be employed for stress reduction and the metallic shielding tape shall be grounded.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 710.07 Grounding. Wiring and equipment installations shall conform with the applicable provisions of chapter E 250.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 710.08 Moisture or mechanical protection for metal sheathed cables. Where cable conductors emerge from a metal sheath and where protection against moisture or mechanical injury is necessary, the insulation of the conductors shall be protected by a pothead or other approved means.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

B. EQUIPMENT—GENERAL PROVISIONS

E 710.10 Indoor installations. Indoor electrical equipment installations shall conform with subsections (1) and (2).

(1) IN PUBLIC PLACES OR PLACES FREQUENTED BY UNQUALIFIED PERSONS EMPLOYED ON THE PREMISES. Exposed live parts of electrical equipment shall be guarded against accidental contact by enclosure or by locating the equipment as follows:

(a) In a room or enclosure which is accessible only to qualified persons;

(b) On a suitable balcony, gallery or platform, so elevated and arranged as to exclude unqualified persons;

(c) Elevated in accordance with clearances of Table E 710.34 (6).

Note 1: For the purposes of this chapter a qualified person is one who has been trained in the construction, operation and hazards of equipment operating in excess of 600 volts and who is regularly employed in the installation, operation or maintenance of such equipment.

Note 2: The term "guarded" requires specific guards around live parts and does not include building walls, railings or fences used to exclude the public.

(2) IN PLACES ACCESSIBLE TO QUALIFIED PERSONS ONLY. Electrical installations shall conform with sections E 710.31 and E 710.34, inclusive.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 710.11 Outdoor installations. Outdoor installations having exposed live parts shall be accessible to qualified persons only. Installations are considered to be accessible to qualified persons only where enclosed as provided in section E 710.31 or when isolated by elevation. Live parts are deemed to be isolated by elevation (1) where the clearance to ground and to buildings conforms with chapter E 730 for outdoor installations, and (2) as provided in section E 710.34 (6) for locations accessible to qualified persons only.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 710.12 Metal enclosed equipments. Installations consisting of metal enclosed equipments such as metal clad switchgear, transformers, and the like, which have no exposed live parts, need not comply with section E 710.31. Ventilating or similar openings in equipment shall be so designed that foreign objects inserted through these openings will be deflected from energized parts. Where exposed to physical damage from vehicular traffic suitable guards shall be provided.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

C. EQUIPMENT—SPECIFIC PROVISIONS

(See also references to specific types of installations in section E 710.02)

E 710.21 Circuit interrupting devices. (1) CIRCUIT BREAKERS. (a) Indoor installations shall consist of metal-enclosed units or fire-resistant cell-mounted units except that open mounting of circuit breakers is permissible in locations accessible to qualified persons only.

(b) Circuit breakers shall be trip-free in all positions. In every installation the circuit breaker rating in respect to closing, carrying or interrupting capabilities shall not be less than the short circuit duty at the point of application.

(c) Circuit breakers used to control oil-filled transformers should be located outside the transformer vault.

(d) Circuit breakers shall have a means of indicating the open and closed position of the breaker at the point(s) from which they may be operated.

(e) Oil circuit breakers shall be so arranged or located that adjacent readily combustible structures or materials are safeguarded in an approved manner. Adequate space separation, fire-resistant barriers or enclosures, trenches containing sufficient coarse crushed stone and properly drained oil enclosures such as dikes or basins are recognized as suitable for this purpose.

(2) FUSEHOLDERS AND FUSES. (a) Fuses which expel flame in opening the circuit shall be so designed or arranged that they will function properly without hazard to persons or property.

(b) Fuseholders shall be designed so that they can be de-energized while replacing a fuse unless the fuse and fuseholder are designed to permit fuse replacement by qualified persons using equipment designed for the purpose without de-energizing the fuseholder.

(c) When high voltage fused cutouts are installed in a building or a transformer vault, they shall be of a type designed for use in buildings. Where such cutouts are not suitable to interrupt the circuit manually while carrying full load, an approved switch or contactor shall be provided which is capable of interrupting the entire load. In addition, the cutouts shall be interlocked with the approved interrupter or bear a conspicuous sign reading "Do Not Open Cutout Under Load".

(d) The cutouts shall be so located that they may be readily and safely operated and re-fused. Fuses shall be accessible from a clear floor space.

(3) LOAD INTERRUPTERS. Load interrupter switches may be used providing suitable fuses or circuit-breakers are applied in conjunction with these devices to interrupt fault currents. When these devices are used in combination they shall be so coordinated electrically that they

will safely withstand the effects of closing, carrying or interrupting all possible currents up to the assigned maximum short-circuit rating.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 710.22 Isolating means. Means shall be provided to completely isolate an item of equipment. The use of isolating switches is not necessary where there are other ways of deenergizing the equipment for inspection and repairs such as metal-enclosed switchgear units, and removable truck panels. Isolating switches should be interlocked with the associated circuit interrupting device to prevent their being opened under load; otherwise signs warning against opening them under load shall be provided. Barriers should be provided on both sides of each pole of indoor open-type isolating switches. A fuseholder and fuse, designed for the purpose, may be used as an isolating switch.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

D. INSTALLATIONS ACCESSIBLE TO QUALIFIED PERSONS ONLY

E 710.31 Enclosure for electrical installations. Electrical installations in a vault, room, closet or in an area surrounded by a wall, screen or fence, access to which is controlled by lock and key or other approved means, are considered to be accessible to qualified persons only. The height of the wall, screen or fence shall not be less than 6 feet overall, unless designed to provide an equivalent degree of isolation. Fences shall be of a type that cannot be readily climbed and the six foot minimum height is excluding any barbed wire. The type of enclosure used in a given case shall be designed and constructed according to the nature and degree of the hazard(s) associated with the installation. Chapter E 450 covers minimum construction requirements for oil-filled transformer vaults.

Note: Isolation by elevation is covered in sections E 710.11 and E 710.34.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 710.32 Circuit conductors. (1) They may be installed in conduit; in duct systems; as metal-armored cable; as bare wire, cable and buses, or as non-metallic sheathed cables or conductors as provided in sections E 710.03 to E 710.06 inclusive. Bare live conductors shall conform with sections E 710.33 to E 710.36 inclusive.

(2) Insulators, together with their mounting and conductor attachments, when used as supports for wires, single conductor cables and bus bars, shall be capable of safely withstanding the maximum magnetic forces which would prevail if 2 or more conductors of a circuit were subjected to short-circuit current.

(3) Open runs of insulated wires and cables, having a bare lead sheath or a braided outer covering, shall be supported in a manner designed to prevent physical damage to the braid or sheath. Supports for lead covered cables shall be designed to prevent electrolysis of the sheath.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 710.33 Minimum space separation between live parts and adjacent surfaces. The minimum indoor air separation between bare live conductors and between such conductors and adjacent surfaces shall be not less than the values given below. This rule applies to interior wiring design and construction. It does not apply to the space separation provided in electrical apparatus and wiring devices.

TABLE E 710.33

MINIMUM AIR SEPARATION IN INCHES, INDOORS*

Circuit Voltage	Between Bare Live Conductors	Between Bare Live Conductors and Adjacent Surfaces
5,000	3.5	2.5
15,000	7	5.5
25,000	11	8.5

*The values given are the minimum permissible space separation under favorable service conditions. They should be increased under unfavorable service conditions or wherever space limitations permit. Proportional values may be used for intermediate voltages.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 710.34 Work space and guarding. (1) WORKING SPACE. The minimum clear working space in front of electrical equipment, such as switchboards, control panels, switches, circuit breakers, motor controllers, relays and similar equipment shall not be less than set forth in the following table unless otherwise specified in this code.

TABLE 710.34 (1)

MINIMUM CLEAR WORKING SPACE IN FRONT OF ELECTRICAL EQUIPMENT

Voltage to Ground	Conditions		
	1	2	3
601–2,500	3 ft.	4 ft.	5 ft.
2,501–7,500	4 ft.	5 ft.	6 ft.
Over 7,500	5 ft.	6 ft.	9 ft.

(a) Where the "Conditions" are as follows:

1. Exposed live parts on one side and no live or grounded parts on the other side of the working space or exposed live parts on both sides effectively guarded by suitable wood or other insulating materials. Insulated wire or insulated bus bars operating at not more than 300 volts shall not be considered live parts.

2. Exposed live parts on one side and grounded parts on the other side. Concrete, brick or tile walls will be considered as grounded surfaces.

3. Exposed live parts on both sides of the work space (not guarded as provided in condition 1) with the operator between.

(b) Exception: Working space is not required in back of assemblies such as dead-front switchboards or control assemblies when there are no renewable or adjustable parts such as fuses or switches on the back and when all connections are accessible from other locations than the back.

(2) Separation from low-potential equipment. When switches, cutouts or other equipment operating at 600 volts or less are installed in a room or enclosure where there are exposed live parts, or exposed wiring operating at more than 600 volts the high potential equipment shall be effectively separated from the space occupied by the low poten- equipment by a suitable partition, fence, or screen.

(a) Exception: Switches or other equipment operating at 600 volts or less and serving only equipment within the high-voltage vault, room or enclosure may be installed in the high-voltage enclosure, room or vault if accessible to qualified persons only.

(3) Locked rooms or enclosure. The entrances to all buildings, rooms or enclosures containing exposed live parts or exposed conductors operating in excess of 600 volts shall be kept locked, except where such entrances are at all times under the observation of a qualified attendant.

(a) Where the voltage exceeds 600 volts permanent and conspicuous warning signs shall be provided, reading substantially as follows: "Warning—High voltage—Keep Out."

(4) Illumination. Adequate illumination shall be provided for all working spaces about electrical equipment. The light outlets shall be be so arranged that persons changing lamps or making repairs on the lighting system will not be endangered by live parts or other equipment.

(a) The points of control shall be so located that persons are not liable to come into contact with any live part or moving part of the equipment while turning on the lights.

(5) Headroom. The minimum headroom above working spaces about switching equipment where there are live parts exposed at any time shall not be less than 6½ feet.

(6) Elevation of unguarded live parts. Unguarded live parts above working space shall be maintained at elevations not less than required by the following table.

TABLE 710.34 (6)

ELEVATION OF UNGUARDED LIVE PARTS ABOVE THE WORKING SPACE

Voltage Between Phases	Minimum Vertical Clearance of Unguarded Parts	
	Feet	Inches
601– 6,600	8	0
6,601– 11,000	9	0
11,001– 22,000	9	3
22,001– 33,000	9	6
33,001– 44,000	9	10
44,001– 66,000	10	5
66,001– 88,000	11	0
88,001–110,000	11	7
110,001–132,000	12	2

History: Cr. Register, January, 1968, No. 145, eff. 2–1–68.

Chapter E 720

CIRCUITS AND EQUIPMENT OPERATING AT LESS THAN 50 VOLTS

E 720.01 General. This chapter shall apply to installations operating at less than 50 volts, direct current or alternating current, except such as are treated in Wis. Adm. Code in chapters E 650 and E 725.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 720.02 Hazardous locations. Circuits or equipment coming within the scope of this chapter and installed in hazardous locations shall comply with the appropriate provisions of chapters E 500-E 517 inclusive.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 720.03 Larger current at lower voltage. Conductors, devices, and equipment shall have current ratings sufficient for the greater current required to deliver equal power at the lower voltage than at usual voltages.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 720.04 Conductors. Conductors shall be not smaller than No. 12, and for appliance branch circuits supplying more than one appliance or appliance receptacle, conductors shall be not smaller than No. 10. (See section E 300.01.)

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 720.05 Lampholders. Standard lampholders of rating not less than 660 watts shall be used.

Note: This requirement does not apply to limited low voltage industrial lighting systems. Smaller lampholders may be used for low voltage lamps in connection with sewing machines and similar devices.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 720.06 Receptacle rating. Receptacles shall have a rating not less than 15 amperes.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 720.07 Receptacles required. Receptacles of not less than 20-ampere rating shall be provided in kitchens, laundries, and other locations where portable appliances are likely to be used.

History: Cr. Register, January, 1968, No. 145, eff 2-1-68.

E 720.08 Overcurrent protection. Overcurrent protection shall comply with the provisions of chapter E 240.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 720.09 Batteries. See chapter E 480.
History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 720.10 Grounding. See section E 250.008 and section E 250.045 (3).
History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

Chapter E 725

REMOTE-CONTROL, LOW-ENERGY POWER, LOW-VOLTAGE AND SIGNAL CIRCUITS

A. SCOPE AND GENERAL

E 725.01 Scope. Provisions of this chapter shall apply to remote-control circuits, including low-voltage relay switching, low-energy power circuits, low-voltage power circuits and signal circuits, as defined in Wis. Adm. Code chapter E 100, Definitions.

Note: The provisions of this chapter are not intended to apply to remote-control, low-energy or signal circuits which form an integral part of a device or appliance.

History: Cr. Register, January, 1968, No. 145, eff. 2–1–68.

E 725.02 Hazardous locations. Circuits or equipment coming within the scope of this chapter and installed in hazardous locations shall also comply with the appropriate provisions of chapters E 500–E 517 inclusive.

History: Cr. Register, January, 1968, No. 145, eff. 2–1–68.

E 725.03 Classification. Remote-control and signal circuits shall be classified as follows:

(1) CLASS 1 CIRCUITS. Control and signal circuits in which power is not limited in accordance with section E 725.31.

(2) CLASS 2 CIRCUITS. Control and signal circuits in which the power is limited in accordance with section E 725.31.

History: Cr. Register, January, 1968, No. 145, eff. 2–1–68.

E 725.04 Low-energy power circuits. Circuits which are neither remote-control nor signal circuits, but which have the power limited in accordance with section E 725.31 shall, for the purpose of this code, be treated as class 2 remote-control circuits.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 725.05 Low-voltage power circuits. Circuits which are neither remote-control nor signal circuits but which operate at not more than 30 volts, where the current is not limited in accordance with section E 725.31, and which are supplied from a source not exceeding 1000 volt-amperes, shall for the purpose of this code, be treated as class 1 remote-control circuits.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 725.06 Safety-control devices. Remote-control circuits to safety-control devices, the failure of operation of which would introduce a direct fire or life hazard, shall be considered as class 1 circuits.

Note: Room thermostats, service hot-water temperature regulating devices, and similar controls used in conjunction with electrically-controlled domestic heating equipment, are not considered to be safety-control devices.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 725.07 Remote-control and signal circuits in communication cables. Remote-control and signal circuits which use conductors in the same cable with communication circuits shall, for the purpose of this chapter, be classified as communication circuits and meet the requirements of chapter E 800 of this code.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

B. CLASS 1 SYSTEM

E 725.11 Wiring method. Conductors and equipment of class 1 remote-control and signal systems and low-voltage power circuits shall be installed in accordance with the requirements of chapters E 300 to E 391 inclusive of this code, except as provided in sections E 725.12 to E 725.15 inclusive.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 725.12 Other chapters. The wiring method required in section E 725.11 does not apply where other chapters of this code specifically permit or require other methods for remote-control or signal circuits. See chapter E 620, Elevators, for example.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 725.13 Conductor sizes. Nos. 18 and 16 gauge conductors may be used provided they are installed in a raceway or a cable approved for the purpose, or in flexible cords in accordance with the provisions of chapter E 400.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 725.14 Conductor insulation. Conductors larger than No. 16 shall be rubber-covered type R, thermoplastic-covered type T, or other approved type. Fixed conductors Nos. 18 and 16 gauge shall have an insulation at least equal to that of type TF thermoplastic-covered fixture wire. Conductors approved for the purpose having insulation of a thickness less than specified above or having other kinds of insulation may be used.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 725.15 Number of conductors in raceways. The number of conductors of remote-control or signal circuits in a raceway may be determined according to section E 300.17 and note 8 of tables E 310.12 through E 310.15 need not be observed. Where there are four or more conductors in a raceway, some of which are remote-control, as permitted by section E 300.03, the provisions of note 8 of tables E 310.12 through E 310.15 shall apply, as determined by the number of power and lighting circuit conductors only.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 725.16 Conductors of different systems. Conductors of 2 or more class 1 remote-control and/or signal circuits may occupy the same enclosure or raceway without regard to whether the individual systems or circuits are alternating or direct current, provided all conductors are insulated for the maximum voltage of any conductor in the enclosure or raceway. Conductors of remote-control, low-energy power and signal circuits, in which the current is limited as for class 2 systems, shall be considered as class 1 system conductors for the purpose of this requirement if insulated and installed in accordance with the provisions of class 1 system conductors. Power supply conductors may occupy the same enclosure or raceway with class 1 system conductors when supplying only equipment to which class 1 system conductors are connected.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 725.17 Mechanical protection of remote-control circuits. Where damage to a remote-control circuit would introduce a hazard as covered in section E 725.06, all conductors of such remote-control circuits shall be installed in conduit, electrical metallic tubing, type MI cable or be otherwise suitably protected from physical damage.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 725.18 Overcurrent protection. Conductors shall be protected against overcurrent in accordance with the ampacities of tables E 310.12 through E 310.15 except as follows:

(1) EXCEPTION NO. 1. OTHER CHAPTERS. Where other chapters of this code specifically permit or require other overcurrent protection. See section E 430.072.

(2) EXCEPTION NO. 2. CONDUCTORS OF NOS. 18 AND 16. Conductors of Nos. 18 and 16 shall be considered as protected by overcurrent devices of 20-ampere rating or setting.

(3) EXCEPTION NO. 3. OMISSION OF OVERCURRENT PROTECTION. In remote-control and signal circuits having main and branch circuits, the branch circuits need not be individually protected against overcurrent where the operating voltage does not exceed 30 volts.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 725.19 Location of overcurrent protection. Overcurrent devices shall be located at the point where the conductor to be protected receives its supply unless the overcurrent device protecting the larger conductor also protects the smaller conductor in accordance with tables E 310.12 through E 310.15.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 725.20 Circuits extending beyond one building. Class 1 circuits which extend aerially beyond one building shall also meet the requirements of chapter E 730.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 725.21 Grounding. Class I remote-control and signal circuits and equipment shall be grounded in accordance with chapter E 250.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

C. LIMITATION OF LOW-VOLTAGE POWER CIRCUIT

E 725.22 Overcurrent protection. Transformer devices supplying low-voltage power circuits shall be provided with overcurrent protection in the secondary circuit rated or set at not more than 250% of the rated secondary current of the transformer. Such protection and mounting shall be approved for the purpose. Overcurrent protection required shall not be interchangeable with protection of a higher rating. The overcurrent protection may be an integral part of a transformer or other power supply device approved for the purpose.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 725.23 Transformer rating. Transformer devices supplying low-voltage power circuits shall be approved for the purpose and be restricted in their rated output to not exceeding 1000 volt-amperes and to not exceeding 30 volts. They shall be marked where plainly visible to show their rated output and the voltage to be applied to the circuit.

Note: A transformer is considered as meeting the 1000 volt-ampere requirement where the approximate temperature limit is reached at 1000 volt-ampere load.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

D. CLASS 2 SYSTEM VOLTAGE AND CURRENT LIMITS

E 725.31 Limits of class 2 systems. Class 2 remote-control and signal systems, depending on the voltage shall have the current limited as follows:

(1) MAXIMUM 15 VOLTS: 5 AMPERES. Circuits in which the open-circuit voltage does not exceed 15 volts and having overcurrent protection of not more than 5-amperes rating. Where the current supply is from a transformer or other device having energy-limiting characteristics and approved for the purpose, the overcurrent protection may be omitted.

(2) 15 TO 30 VOLTS: 3.2 AMPERES. Circuits in which the open-circuit voltage exceeds 15 volts but does not exceed 30 volts and having overcurrent protection of not more than 3.2 amperes rating. Where the current supply is from a transformer or other device having energy-limiting characteristics and approved for the purpose, the overcurrent protection may be omitted.

(3) 30 TO 60 VOLTS: 1.6 AMPERES. Circuits in which open-circuit voltage exceeds 30 volts but does not exceed 60 volts and having overcurrent protection of not more than 1.6 amperes rating. Where the current supply is from a transformer or other device having energy-

limiting characteristics and approved for the purpose, the overcurrent protection may be omitted.

(4) 60 to 150 VOLTS. 1 AMPERE. Circuits in which the open-circuit voltage exceeds 60 volts but does not exceed 150 volts, and having overcurrent protection of not more than 1-ampere rating, provided that such circuits are equipped with current-limiting means other than overcurrent protection which will limit the current as a result of a fault to not exceeding 1 ampere.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 725.32 Overcurrent protection and mounting. Where current is limited in class 2 systems by means of overcurrent protection, such protection and its mounting shall be approved for the purpose. Overcurrent protection required shall not be interchangeable with protection of a higher rating. The overcurrent protection may be an integral part of a transformer or other power supply device approved for the purpose.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 725.33 Transformer rating. Transformer devices supplying class 2 systems shall be approved for the purpose and be restricted in their rated output to not exceeding 100 volt-amperes. Such devices shall not be paralleled or otherwise interconnected. They shall be marked where plainly visible to show the voltage to be applied to the circuit.

Note: A transformer is considered as meeting the 100-volt-ampere requirement if the approximate temperature limit is reached at a 100-volt-ampere load.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 725.34 Transformer leads. The primary leads of transformers supplying class 2 remote-control and signal circuits may be smaller than No. 14 but not smaller than No. 18, provided they are not over 12 inches long, have insulation at least equal to type RF-2 rubber-covered fixture wire, or approved equivalent.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E. INSTALLATION OF CLASS 2 REMOTE-CONTROL AND SIGNAL CIRCUITS

E 725.41 On supply side of overcurrent protection, transformers or current-limiting devices. Conductors and equipment on supply side of overcurrent protection, transformers or current-limiting devices shall be installed in accordance with the appropriate requirements of chapters E 300 to E 391, inclusive, of this code. Transformers or other devices supplied from electric light and power circuits shall be protected by an overcurrent device with a rating or setting not exceeding 20 amperes.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 725.42 On load side of overcurrent protection, transformer or current-limiting devices. Conductors on load side of overcurrent protection, transformer or current-limiting devices shall be insulated and shall comply with the following:

(1) SEPARATION FROM OTHER CONDUCTORS. Conductors shall be separated from conductors of electric light and power circuits as follows:

(a) *Open conductors.* Conductors shall be separated at least 2 inches from any light or power conductors not in a raceway unless permanently separated from the conductors of the other system by a continuous and firmly fixed nonconductor, such as porcelain tubes or flexible tubing, additional to the insulation on the wire.

(b) *In raceways and boxes.* Conductors of class 2 remote-control and signal circuits shall not be placed in any raceway, compartment, outlet box or similar fitting with conductors for either light and power circuits or class 1 signal and control circuits, unless the conductors of the different systems are separated by a partition; provided that this shall not apply to conductors in outlet boxes, junction boxes or similar fittings or compartments where power supply conductors are introduced solely for supplying power to the remote control or signal equipment to which the other conductors in the enclosure are connected. (See section E 725.16).

(c) *In shafts.* Conductors may be run in the same shaft with conductors for light and power where the conductors of the two systems are separated at least 2 inches, or where the conductors of either system are encased in noncombustible tubing.

(2) VERTICAL RUNS. Conductors in a vertical run in a shaft or partition shall have a fire-resistant covering capable of preventing the carrying of fire from floor to floor except where conductors are encased in tubing or other outer covering of noncombustible material or are located in a fireproof shaft having fire stops at each floor.

Note: Where 3 or more conductors are used, it is recommended that such conductors be grouped under a common braid or covering.

(3) CONDUCTOR INSULATION. Conductor insulation shall comply with the following:

(a) *30 volts or less.* The insulation shall be suitable for the particular application.

Note: The kind of insulation for the conductors is not specified in further detail as reliance is placed on current limitation to stop dangerous currents.

(b) *30 to 150 volts.* 1. Conductors of a cable shall be of solid or stranded copper not smaller than No. 22 Awg, and shall have thermoplastic insulation of not less than 0.012 inch nominal (0.010 inch minimum) thickness. The cable conductors shall have a thermoplastic jacket overall having a nominal thickness of not less than 0.035 inch (0.030 inch minimum). Where the number of conductors in a cable exceeds 4, the thickness of the thermoplastic jacket overall shall be increased so as to provide equivalent performance characteristics. Similarly, where the size of conductors in a cable exceds No. 16 gauge, the thickness of the conductor insulation shall be increased so as to provide equivalent performance characteristics.

2. Two-conductor assemblies of No. 16 gauge or smaller, may be in flat parallel construction with 3/64 inch nominal integral-insulation jacket and a 0.047 inch minimum web. Approved low-energy circuit cable may be used.

3. Other insulation having equivalent performance characteristics may be acceptable.

4. Where single conductors are used they shall be not smaller than No. 18 Awg and shall be insulated in conformity with section E 725.14.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 725.43 Circuits extending beyond one building. Class 2 remote-control and signal circuits which extend beyond one building and are so run as to be subject to accidental contact with light or power conductors operating at a potential exceeding 300 volts, shall also meet the requirements of Wis. Adm. Code sections E 800.02, E 800.11 and E 800.12.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 725.44 Grounding. Class 2 remote control and signal circuits and equipment shall be grounded in accordance with chapter E 250.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

Chapter E 730

OUTSIDE BRANCH CIRCUITS AND FEEDERS

E 730.01 Scope. This chapter applies to electrical equipment and wiring for the supply of utilization equipment located on or attached to the outside of public and private buildings, or run between buildings, structures or poles on other premises served; but, shall not apply to equipment or wiring of an electric or communication utility used in exercise of its function as a utility.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 730.02 Application of other chapters. Application of other chapters, including additional requirements to specific cases of equipment and conductors, are as follows:

CHAPTERS

- E 200—Polarity Identification.
- E 210—Branch Circuits.
- E 215—Feeders.
- E 230—Services.
- E 250—Grounding.
- E 500—Hazardous Locations, General.
- E 510—Hazardous Locations, Specific.
- E 600—Signs and Outline Lighting.
- E 710—Circuits and Equipment Operating at More Than 600 Volts.
- E 725—Remote Control and Signal Circuits.
- E 800—Communication Circuits.
- E 810—Radio and Television Circuits.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 730.03 Calculation of load. (1) BRANCH CIRCUITS. The load on every outdoor branch circuit is to be determined by the applicable provisions of chapter E 220.

(2) FEEDERS. The load to be expected on every outdoor feeder is to be determined by the procedure specified in chapter E 220.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 730.04 Conductor covering. (1) INSULATION. Where within 10 feet of any building or structure, open conductors supported on insulators shall be insulated or covered. Conductors in cables or raceways, except type MI cable, shall be of the rubber-covered, thermoplastic or thermosetting type and in wet locations comply with Wis. Adm. Code section E 310.05. Conductors for festoon lighting shall be of the rubber-covered, thermoplastic or thermosetting type.

(2) BARE NEUTRAL. Approved factory assembled cables consisting of one or more insulated conductors lashed or twisted with an uninsulated and effectively grounded messenger or neutral may be used for outdoor overhead branch circuits and feeders. The uninsulated conductor when used as a neutral shall not be used as an equipment grounding conductor.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 730.05 Size of conductors. The ampacity of outdoor branch circuits and feeder conductors shall be according to the rating in tables E 310.12 through E 310.15 in order to carry the loads determined under section E 730.03.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 730.06 Minimum size of conductor. (1) OVERHEAD SPANS. Overhead conductors shall not be smaller than No. 10 for spans up to 50 feet in length, and not smaller than No. 8 for longer spans.

(2) FESTOON LIGHTING. Overhead conductors for festoon lighting shall not be smaller than No. 12 unless supported by messenger wires. (See section E 730.25).

(3) OVER 600 VOLTS. Overhead conductors operating at more than 600 volts shall not be smaller than No. 6 when open individual conductors nor smaller than No. 8 when in cable.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 730.07 Lighting equipment on a pole. (1) For the supply of lighting equipment installed on a single pole or structure, the branch circuits shall comply with the requirements of chapter E 210.

(2) For multiwire branch circuits, a common neutral may be employed for the branch circuits, provided not more than 8 ungrounded conductors are used. Such a common neutral shall have an ampacity of not less than the maximum load of all the ungrounded conductors connected to any phase or polarity.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 730.08 Disconnection. (1) For branch circuits as required in chapter E 210.

(2) For feeders as requireed in chapter E 215. (At each building supplied by a feeder see section E 230.076.)

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 730.09 Overcurrent protection. (1) For branch circuits as required in chapter E 210.

(2) For feeders as required in chapter E 215.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 730.10 Wiring on buildings. Outside wiring on surfaces of buildings may be installed, for circuits of 600 volts or less, as open conductors on insulating supports, as multiple-conductor cable approved for the purpose, as aluminum sheathed cable, in rigid metal conduit, in busways as provided in chapter E 364, or in electrical metallic tubing. Circuits of more than 600 volts shall be installed as provided for services in section E 230.101. Circuits for sign and outline lighting shall be installed as provided in chapter E 600.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 730.11 Circuit exits and entrances. Where outside branch and feeder circuits exit from or enter into buildings the installation shall comply with those requirements of chapter E 230 which apply to service entrance conductors.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 730.12 Open conductor supports. Open conductors shall be supported on glass or porcelain knobs, racks, brackets, or strain insulators, approved for the purpose.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 730.13 Festoon supports. In spans exceeding 40 feet the conductors shall be supported by a messenger wire supported by approved strain insulators. Conductors or messenger wires shall not be attached to any fire escape, downspout, or plumbing equipment.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 730.14 Open conductor spacings. Conductors shall conform to the following spacings:

(1) OPEN CONDUCTORS EXPOSED TO THE WEATHER. As provided in section E 230.047.

(2) OPEN CONDUCTORS NOT EXPOSED TO WEATHER. As provided in section E 230.048.

(3) OVER 600 VOLTS. As provided in section E 230.101. (3).

(4) SEPARATION FROM OTHER CIRCUITS. Open conductors shall be separated from open conductors of other circuits or systems by not less than 4 inches.

(5) CONDUCTORS ON POLES. Conductors on poles shall have a separation of not less than 1 foot except when placed on racks or brackets. Conductors supported on poles shall provide a horizontal climbing space not less than the following:

(a) Power conductors, below communication conductors__30 inches

(b) Power conductors alone or above communication conductors:

Less than 300 volts ____________________________24 inches

Exceeding 300 volts ____________________________30 inches

(c) Communication conductors below power conductors.................................same as power conductors

(d) Communication conductors alone or above power conductors.....................................no requirement

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 730.15 Supports over buildings. See section E 230.025.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 730.16 Point of attachment to buildings. See section E 230.026.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 730.17 Means of attachment to buildings. See section E 230.027.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 730.18 Clearance from ground. Open conductors of not over 600 volts shall conform to the following:

MINIMUM VERTICAL CLEARANCES OF WIRES (IN FEET) FROM GROUND OR RAILS (z)

Location of Wires and Cables	Guys, Communication Cables, Messengers and Wires, Grounded Supply Cables, Messengers, and Lightning Protection Wires (a) (b) (o)	Open Supply Line Wires, Service Drops and Utilization Wiring (o) 0-600 V.
Over track rails of railroads (e)	27 (f) (q)	27 (f) (q)
Over streets, alleys or roads (g)	18 (r)	18
Along streets or alleys in urban districts (g)	18 (h) (r)	18 (h)
Along roads in rural districts (g)	14 (h) (t)	15 (h)
Over areas used for agricultural purposes	15	15
Over fenced or otherwise guarded rights of way in which only authorized persons are permitted (l)	15 (j)	15 (x)
Over normal high water of lakes, streams or ponds. See (y)	18	18
Over parking lots and drive-ins	12	15
Over driveways to:		
Residence garages	12	15 (s)
Commercial and industrial areas	15	15
Farm areas	15	15
Over footwalks and spaces accessible to pedestrians only	15 (w)	15 (x)*
Over spaces or ways not covered above:		
In rural districts (p)	10 (j)	15 (x)
In urban districts (p)	10 (j)	18 (x)

(a) Including supply line guys where effectively grounded or insulated against 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 an effectively grounded continuous metal sheath supported by a continuous grounded messenger and to insulated conductors lashed to or twisted with an effectively grounded messenger or neutral. This does not include a so-called cable where a messenger supports separate conductors with an insulating yoke.

(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 E 112.05).

(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.

(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 E 128.07 (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, 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 circuit 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 E 126.02 (7).

(r) Where communication wires or 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 13 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 cable having effectively grounded continuous metal sheath or for 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 contract 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 E 122.01 (2) (c)	10 feet

(y) Lines shall not obstruct, or endanger navigation or activities associated therewith. Application of section 30.15 Wis. Stats. may require greater clearances than shown and clearances specified by the Army Engineers over water considered navigable by the United States may be greater. The largest requirement shall be complied with.

(z) For limitations of temperature and span length, or for clearances for other types of lines see E 123.03 Volume 1.

*This clearance may be reduced to 10 feet for utilization wiring limited to 150 volts to round.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 730.19 Clearances from buildings for conductors not in excess of 600 volts. (1) OVER ROOFS. Open conductors shall not be less than 8 feet from the highest point of roofs. Conductors attached to roof structures shall be substantially supported. Wherever practicable, conductors crossing over buildings shall be supported on structures which are independent of the building. Where a branch circuit or feeder conduit extends through a roof, the branch circuit or feeder conductors, if operating at less than 300 volts between conductors, may have a clearance of not less than 18 inches vertically above the roof providing such conductors do not extend more than 45 inches across the roof.

Note: For service drop conductors, see section E 230.024 (1).

(2) HORIZONTAL CLEARANCES. Open conductors not attached to a building shall have a minimum horizontal clearance of 36 inches.

(3) FINAL SPANS. Final spans of feeders or branch circuits to buildings which they supply or from which they are fed may be attached to the building but they shall be kept 3 feet from windows, doors, porches, fire escapes or similar locations. The clearance from windows refers only to those portions of windows which are normally

capable of being opened. Conductors run above a window are considered inaccessible from that window. No clearance is required from windows consisting of glass block or fixed panes which cannot be opened.

(4) ZONE FOR FIRE LADDERS. Where buildings exceed 3 stories, or 50 feet in height, overhead lines shall be arranged where practicable so that a clear space (or zone) at least 6 feet wide will be left either adjacent to the buildings or beginning not over 8 feet from them, to facilitate the raising of ladders when necessary for fire fighting.

Note: For clearance of conductors over 600 volts, consult volume 1 of the Wisconsin State Electrical Code.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 730.20 Mechanical protection of conductors. Mechanical protection of conductors on buildings, structures or poles shall be as provided for services, section E 230.046.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 730.21 Conductors entering buildings. Conductors entering buildings shall be as provided for services, sections E 230.044, E 230.049 and E 230.051.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 730.22 Multiple conductor cables on exterior surfaces of buildings. Multiple conductor cables on exterior surfaces of buildings shall be as provided for service cable, section E 230.050.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 730.23 Raceways on exterior surfaces of buildings. Raceways on exterior surfaces of buildings shall be made raintight and suitably drained.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 730.24 Underground circuits. Underground circuits shall be as provided for services, sections E 230.032 to E 220.034.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 730.25 Outdoor lighting equipment; lampholders. Lampholders shall be of molded composition, or other approved material of the weatherproof type, and where they are attached as pendants shall have the connections to the circuit wires staggered. Where lampholders have terminals of a type which puncture the insulation and make contact with the conductors, they shall be attached only to conductors of the stranded type.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 730.26 Outdoor lighting equipment; location of lamps. Location of lamps for outdoor lighting shall be below all live conductors, transformers, or other electrical equipment, unless clearances or other safeguards are provided for relamping operations, or unless the installation is controlled by a disconnecting means which can be locked in the open position.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

COMMUNICATION SYSTEMS

Chapter E 800

COMMUNICATION CIRCUITS

A. GENERAL

E 800.01 Scope. The provisions of this chapter shall apply to telephone, telegraph (except radio), district messenger, fire and burglar alarms and similar central station systems and to telephone systems not connected to a central station system but using similar type of equipment, methods of installation and maintenance.

Note 1. Such protective measures as are essential to safeguard these systems under the various conditions to which they are subjected are outlined in these rules.

Note 2. For detailed service requirements for fire alarm, sprinkler supervisory or watchman systems, see the Standards of the National Fire Protection Association. The NFPA standards on fire alarm and supervisory systems are published by the NFPA in the National Fire Codes, Vol. V and in separate pamphlet form by the NFPA Nos. 71, 72 and 73.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

B. PROTECTION

E 800.02 Protective devices. A protector approved for the purpose shall be provided on each circuit, aerial or underground, so located within the block containing the building served as to be liable to accidental contact with light or power conductors operating at a potential exceeding 300 volts, and on each circuit run partly or entirely in aerial wire or cable not confined within a block. Underground circuits buried without separation from power conductors in accordance with Wis. Adm. Code section E 129.05 (2) of Volume 1 shall be provided with protectors.

Note: The word "block" as used in this chapter shall be construed to mean a square or portion of a city, town, or village enclosed by streets and including the alleys so enclosed but not any street.

(1) CATV CIRCUITS. In lieu of a protector on community antenna television circuits, the following will be accepted:

(a) The television distribution cable shall have an effectively grounded metallic sheath or effectively grounded outer conductor of a coaxial cable and,

(b) The metallic sheath of the television distribution cable or outer conductor of a coaxial cable shall be connected to ground at the entrance to the building served in accordance with chapter E 250.

(2) LOCATION. The protector shall be located in or on the building as near as practicable to the point where the conductors enter. In

the case of an underground entrance the protector may be located at the junction of the underground and the aerial wires.

(3) HAZARDOUS LOCATIONS. The protector shall not be located in any hazardous location as defined in chapter E 500, nor in the vicinity of easily ignitible material.

(4) PROTECTOR REQUIREMENTS. The protector shall be mounted on a noncombustible, nonabsorptive insulating base and shall consist of an arrester between each line conductor and the ground, and a fuse in each line conductor, the fuses protecting the arrester except as specified in section E 800.02 (4). The protector terminals shall be plainly marked to indicate line, instrument and ground.

(5) OMISSION OF FUSES. A protector without fuses may be used under any of the following conditions:

(a) Where circuits enter a building through metal-sheathed cable, or through a nonmetallic sheathed cable having a metal grounding shield between the sheath and the conductor assembly, provided the metal sheath or shield of the cable is effectively grounded and the conductors in the cable shall safely fuse at currents less than the ampacity of the protector, the asociated insulated conductors, and the protector grounding conductor.

(b) Where insulated conductors in accordance with section E 800.11 (3) (a) and (b) are used to extend circuits to a building from a metal-sheathed cable or from a nonmetallic-sheathed cable having a metal grounding shield between the sheath and the conductor assembly provided the metal sheath or shield is effectively grounded and the conductors in the cable or cable stud shall safely fuse at currents less than the ampacity of the protector, and associated insulated conductors, and the protector grounding conductor.

(c) Where insulated conductors, in accordance with section E 800.11 (3) (a) and (b) are used to extend circuits to a building from other than grounded metal-sheathed or shielded cable, provided 1. the protector is approved for this purpose and 2. the protector grounding conductor is connected to a water pipe electrode or the grounding conductor or grounding electrode of a multi-grounded neutral power system and 3. the connections of the insulated conductors to the exposed plant or the conductors of the exposed plant shall safely fuse at currents less than the ampacity of the protector, the associated insulated conductors and the protector grounding conductor.

(d) Where insulated conductors in accordance with sections E 800.11 (3) (a) and (b) are used to extend circuits aerially to a building from an unexposed buried or underground circuit.

Note: Effectively grounded means permanently connected to earth through a ground connection of sufficiently low impedance and having sufficient ampacity to prevent the building up of voltages which may result in undue hazard to connected equipment or to persons.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 800.03 Installation of conductors. Conductors from the protector to the equipment or, where no protector is required, conductors attached to the outside of, or inside the building shall comply with the following:

(1) SEPARATION FROM OTHER CONDUCTORS. Conductors shall be separated from conductors of electric light and power circuits as follows:

(a) *Open conductors.* Conductors shall be separated at least 2 inches from any light or power conductors not in metallic raceways or metal sheathed cable unless permanently separated from the conductors of the other system by a continuous and firmly fixed nonconductor, additional to the insulation on the wire, such as porcelain tubes or flexible tubing.

(b) *In raceways and boxes.* Communication conductors shall not be placed in any raceway, compartment, outlet box, junction box or similar fitting with conductors for light and power circuits or class 1 signal and control circuits unless the conductors of the different systems are separated by a partition; provided that this shall not apply to conductors in outlet boxes, junction boxes or similar fittings or compartments where such conductors are introduced solely for power supply to communication equipment or for connection to remote-control equipment.

(c) *In shafts.* Conductors may be run in the same shaft with conductors for light and power provided the conductors of the two systems are separated at least 2 inches, or where the conductors of either system are encased in noncombustible tubing.

(2) VERTICAL RUNS. Conductors bunched together in a vertical run in a shaft shall have a fire-resistant covering capable of preventing the carrying of fire from floor to floor, except where conductors are encased in noncombustible tubing or are located in a fireproof shaft having fire stops at each floor.

Note: The conductors referred to in this rule would ordinarily be insulated but the kind of insulation is not specified as reliance is placed on the protective device to stop all dangerous voltages and currents.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

C. OUTSIDE CONDUCTORS

E 800.11 Overhead conductors. Overhead conductors entering buildings shall comply with the following:

(1) ON POLES. Where communication conductors and light or power conductors are supported by the same pole, the following conditions shall be met:

(a) *Relative location.* The conductors should preferably be located below the light or power conductors.

(b) *Attachment to crossarms.* Conductors shall not be attached to a crossarm which carries light or power conductors.

(c) *Climbing space.* The climbing space through signal conductors shall comply with the requirements of section E 730.14.

(2) ON ROOFS. Conductors passing over buildings shall be kept at least 8 feet above any roof having a pitch of 3 inches or less per foot except small auxiliary buildings such as garages and the like.

(3) CIRCUITS REQUIRING PROTECTORS. Circuits which require protectors (see section E 800.02) shall comply with the following:

(a) *Insulation, single or paired conductors.* Each conductor, from the last outdoor support to the protector, shall have 1/32-inch rubber insulation, except that when such conductors are entirely within a block the insulation on the conductor may be less than 1/32-inch, but not less than 1/40-inch in thickness. In addition, the conductor, either individually or over the pair, shall be covered with a substantial fibrous covering or equivalent protection. Conductors approved for the purpose having rubber insulation of a thickness less than specified above, or having other kinds of insulation may be used.

(b) *Insulation, cables.* Conductors within a cable of the metal-sheathed type, or within a cable having a rubber sheath of at least 1/32-inch thickness and covered with a substantial fibrous covering, may have paper or other suitable insulation. Where the metal or rubber sheath is omitted, each conductor shall be insulated as required in subsection (3) (a), and the bunched conductors shall be covered with a substantial fibrous covering or equivalent covering.

(c) *On buildings.* Open conductors shall be separated at least 4 inches from light or power conductors not in conduit or cable, unless permanently separated from conductors of the other system by a continuous and firmly fixed non-conductor additional to the insulation on the wires, such as porcelain tubes or flexible tubing. Open conductors exposed to accidental contact with light and power conductors operating at over 300 volts, and attached to buildings, shall be separated from woodwork by being supported on glass, porcelain or other insulating material approved for the purpose except that such separation is not required where fuses are omitted, as provided for in subsection E 800.02 (4), or where conductors approved for the purpose are used to extend circuits to a building from a cable having a grounded metal sheath.

(d) *Entering buildings.* Where a protector is installed inside the building, the conductors shall enter the building either through a noncombustible, nonabsorptive insulating bushing, or through a metal raceway. The insulating bushing may be omitted where the entering conductors 1. are in metal-sheathed cable, 2. pass through masonry, 3. are approved for the purpose and fuses are omitted as provided for in subsection E 800.02 (4), or 4. are approved for the purpose and are used to extend circuits to a building from a cable having a grounded metal sheath. Raceways or bushings shall slope upward from the outside or, where this cannot be done, drip loops shall be formed in the conductors immediately before they enter the building. Raceways shall be equipped with an approved service head. More than one conductor may enter through a single raceway or bushing. Conduits or other metallic raceways located ahead of the protector shall be grounded.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 800.12 Lightning conductors. Where practicable, a separation of at least 6 feet shall be maintained between open conductors of communication systems on buildings and lightning conductors.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

D. UNDERGROUND CIRCUITS

E 800.21 Underground circuits. Underground conductors of communication circuits entering buildings shall comply with the following:

(1) WITH ELECTRIC LIGHT OR POWER CONDUCTORS. See Wis. Adm. Code chapter E 129 of volume 1 of the Wisconsin state electrical code.

(2) UNDERGROUND BLOCK DISTRIBUTION. Where the entire street circuit is run underground and the circuit within the block is so placed as to be free from liability of accidental contact with electric light or power circuits of over 300 volts, the insulation requirements of sections E 800.11 (3) (a) and E 800.11 (3) (d) shall not apply, the conductors need not be placed on insulating supports and no bushings shall be required where the conductors enter the building.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E. GROUNDING

E 800.31 Grounding. Equipment shall be grounded as follows:

(1) CABLE SHEATH. The metal sheath of aerial cables entering buildings which are liable to contact with electric light or power conductors shall be grounded or shall be interrupted close to the entrance to the building by an insulating joint or equivalent device.

(2) PROTECTOR GROUND. The protector ground shall comply with the following:

(a) *Insulation.* The grounding conductor shall have a 1/32-inch rubber insulation and shall be covered by a substantial fibrous covering. Conductors approved for the purpose having less than 1/32-inch rubber insulation or having other kinds of insulation may be used.

(b) *Size.* The grounding conductor shall not be smaller than No. 18 copper.

(c) *Run in straight line.* The grounding conductor shall be run in as straight a line as practicable to the grounding electrode.

(d) *Physical damage.* Where necessary, the grounding conductor shall be guarded from physical damage.

(e) *Electrode.* The grounding conductor shall preferably be connected to a water pipe electrode. Where a water pipe is not readily available and the grounded conductor of the power service is connected to the water pipe at the building, the protector grounding conductor may be connected to the power service conduit, service equipment enclosures, or grounding conductor of the power service. In the absence of a water pipe, connection may be made to a continuous and extensive underground gas piping system, to an effectively grounded metallic structure, or to a ground rod or pipe driven into permanently damp earth. Steam or hot water pipes, or lightning rod conductors shall not be employed as electrodes for protectors. A driven rod or pipe used for grounding power circuits shall not be used for grounding communication circuits unless the driven rod or pipe is connected to the grounded conductor of a multi-grounded neutral power system. The requirements for separate made electrodes for power and lighting system grounds, those for communication systems, and those for a lightning rod installation shall not prohibit the bonding together of all such made electrodes. (See section E 250.086).

Note: It is recommended that all separate electrodes be bonded together to limit potential differences between them and between their associated wiring systems.

(f) *Electrode connection.* The grounding conductor shall be attached to a pipe electrode by means of a bolted clamp to which the conductor is soldered or otherwise connected in an effective manner. Where a gas pipe electrode is used, connection shall be made between the gas meter and the street main. In every case the connection to the grounding electrode shall be made as close to the earth as practicable.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

Chapter E 810

RADIO AND TELEVISION EQUIPMENT

A. GENERAL

E 810.01 Scope. This chapter shall apply to radio and television receiving equipment and to amateur radio transmitting and receiving equipment, but shall not apply to equipment and antennas used for coupling carrier current to power line conductors.

Note 1: It is recommended that the administrative authority be freely consulted as to the specific methods to be followed in any case of doubt relative to installation of antenna conductors and that the National Electrical Safety Code, part 5, be followed:

Note 2: See Wis. Adm. Code section Ind 52.22 for additional requirements for receiving antennas.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 810.02 Application of other chapters. Wiring from the source of power to and between devices connected to the interior wiring system shall comply with Wis. Adm. Code chapters E 100 to E 400, inclusive, except as modified by sections E 640.03, E 640.04 and E 640.05. Wiring for radio-frequency and audio-frequency equipment and loud speakers shall comply with chapter E 640.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 810.03 Community television antenna. The antenna shall comply with the requirements of this chapter. The distribution system shall comply with chapter E 800.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 810.04 Radio noise suppressors. Radio interference eliminators, interference capacitors or radio noise suppressors connected to power supply leads shall be of a type approved for the purpose. They shall not be exposed to physical damage.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

B. RECEIVING EQUIPMENT ONLY

Antenna Systems—General

E 810.11 Material. Antenna and lead-in conductors shall be of hard-drawn copper, bronze, aluminum alloy, copper-clad steel or other high-strength, corrosion-resistant material. Soft-drawn or medium-drawn copper may be used for lead-in conductors where the maximum span betwen points of support is less than 35 feet.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 810.12 Supports. Outdoor antenna and lead-in conductors shall be securely supported. They shall not be attached to service entrance masts, poles or similar structures carrying electric light, power or trolley wires. Insulators supporting the antenna conductors shall have sufficient mechanical strength to safely support the conductors. Lead-in conductors shall be securely attached to the antenna.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 810.13 Avoidance of contacts with conductors of other systems. Outdoor antenna and lead-in conductors from an antenna to a building shall not cross over electric light or power circuits and shall be kept well away from all such circuits so as to avoid the possibility of accidental contact. Where proximity to electric light and power service conductors of less than 250 volts between conductors cannot be avoided, the installation shall be such as to provide a clearance of at least 2 feet. It is recommended that antenna conductors be so installed as not to cross under electric light or power conductors.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 810.14 Splices. Splices and joints in antenna spans shall be made with approved splicing devices or by such other means as will not appreciably weaken the conductors.

Note: Soldering may ordinarily be expected to weaken the conductor. Therefore, the joint should be mechanically secure before soldering.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 810.15 Grounding. Masts and metal structures supporting antennas shall be permanently and effectively grounded, without intervening splice or connection.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

Antenna Systems—Receiving Station

E 810.16 Size of wire-strung antenna. (1) Outdoor antenna conductors for receiving stations shall be of a size not less than given in table E 810.16(1).

(2) SELF-SUPPORTING ANTENNAS. Outdoor antennas, such as vertical rods or dipole structures, shall be of noncorrodible materials and of strength suitable to withstand ice and wind loading conditions, and shall be located well away from overhead conductors of electric light and power circuits of over 150 volts to ground so as to avoid the possibility of the antenna or structure falling into or accidental contact with such circuits.

TABLE E 810.16 (1)

SIZE OF RECEIVING-STATION OUTDOOR ANTENNA CONDUCTORS

Material	Minimum Size of Conductors When Maximum Open Span Length is		
	Less than 35 feet	35 feet to 150 feet	Over 150 feet
Aluminum alloy, hard-drawn copper	19	14	12
Copper-clad steel, bronze or other high strength material	20	17	14

Note: For very long span lengths larger conductors will be required, depending on the length of the span and the ice and wind loading.

History: Cr. Register, January, 1968, No. 145, eff. 2–1–68.

E 810.17 Size of lead-in. Lead-in conductors from outside antenna for receiving stations, shall, for various maximum open span lengths, be of such size as to have a tensile strength at least as great as that of the conductors for antenna as specified in section E 810.16. Where the lead-in consists of 2 or more conductors which are twisted together or are enclosed in the same covering or are concentric, the conductor size shall, for various maximum open span lengths, be such that the tensile strength of the combination will be at least as great as that of the conductors for antenna as specified in section E 810.16.

History: Cr. Register, January, 1968, No. 145, eff. 2–1–68.

E 810.18 Clearances. (1) ON BUILDINGS OUTSIDE. Lead-in conductors attached to buildings shall be so installed that they cannot swing closer than 2 feet to the conductors of circuits of 250 volts or less between conductors, or 10 feet to the conductors of circuits of more than 250 volts between conductors except that in the case of circuits not exceeding 150 volts between conductors, where all conductors involved are supported so as to insure permanent separation, the clearance may be reduced but shall not be less than 4 inches. The clearance between lead-in conductors and any conductor forming a part of a lightning rod system shall be not less than 6 feet unless the bonding referred to in section E 250.086 is accomplished.

(2) ANTENNAS AND LEAD-INS—INDOORS. Indoor antennas and indoor lead-ins shall not be run nearer than 2 inches to conductors of other wiring systems in the premises unless:

(a) Such other conductors are in metal raceways or cable armor, or

(b) Unless permanently separated from such other conductors by a continuous and firmly fixed nonconductor such as porcelain tubes or flexible tubing.

History: Cr. Register, January, 1968, No. 145, eff. 2–1–68.

E 810.19 Electric supply circuits used in lieu of antenna. Where an electric supply circuit is used in lieu of an antenna, the device by which the radio receiving set is connected to the supply circuit shall be specially approved for the purpose.

History: Cr. Register, January, 1968, No. 145, eff. 2–1–68.

Lightning Arresters

E 810.20 Lightning arresters; receiving stations. Each conductor of a lead-in from an outdoor antenna shall be provided with a lightning arrester approved for the purpose, except that where the lead-in conductors are enclosed in a continuous metallic shield the lightning arrester may be installed to protect the shield or may be omitted where the shield is permanently and effectively grounded. Lightning arresters shall be located outside the building, or inside the building between the point of entrance of the lead-in and the radio set or transformers, and as near as practicable to the entrance of the conductors to the building. The lightning arrester shall not be located near combustible material nor in a hazardous location as defined in chapter E 500.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

Grounding Conductors—General

E 810.21 Material. The grounding conductor shall, unless otherwise specified, be of copper, aluminum, copper-clad steel, bronze, or other corrosion-resistant material.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 810.22 Insulation. The grounding conductors may be uninsulated.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 810.23 Supports. The grounding conductors shall be securely fastened in place and may be directly attached to the surface wired over without the use of insulating supports. Where proper support cannot be provided the size of the grounding conductor shall be increased proportionately.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 810.24 Mechanical protection. The grounding conductor shall be protected where exposed to physical damage or the size of the grounding conductor shall be increased proportionately to compensate for the lack of protection.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 810.25 Run in straight line. The grounding conductor shall be run in as straight a line as practicable from the antenna mast and/or lightning arrester to the grounding electrode.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 810.26 Grounding electrode. The grounding conductor shall be connected to a metallic underground water piping system as specified in section E 250.081. Where the building is not supplied with a water system the connection shall be made to the metal frame of the building when effectively grounded or to a grounding electrode as specified in section E 250.083. At a penthouse or similar location the ground conductor may be connected to a water pipe or rigid conduit.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

Grounding Conductors—Receiving Stations

E 810.27 Inside or outside building. The grounding conductor may be run either inside or outside the building.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 810.28 Size. The grounding conductor shall be not smaller than No. 10 copper or No. 8 aluminum or No. 17 copper-clad steel or bronze.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 810.29 Common ground. A single grounding conductor may be used for both protective and operating purposes.

Note: Where a single conductor is so used, the ground terminal of the equipment should be connected to the ground terminal of the protective device.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

C. Amateur Transmitting and Receiving Stations

Antenna System

E 810.51 Other rules. In addition to conforming to the requirements of part C, antenna systems for amateur transmitting and receiving stations shall also comply with sections E 810.11 to E 810.15 inclusive.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 810.52 Size of antenna. Antenna conductors for amateur transmitting and receiving stations shall be of a size not less than given in table E 810.52.

TABLE E 810.52

SIZE OF AMATEUR-STATION OUTDOOR ANTENNA CONDUCTORS

Material	Minimum Size of Conductors When Maximum Open Span Length is	
	Less than 150 feet	Over 150 feet
Hard-drawn copper	14	10
Copper-clad steel, bronze or other high strength material	14	12

Note: For very long span length larger conductors will be required, depending on the span length and the ice and wind loadings.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 810.53 Size of lead-in conductors. Lead-in conductors for transmitting stations shall, for various maximum span lengths, be of a size at least as great as that of conductors for antenna as specified in section E 810.52.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 810.54 Clearance on building. Antenna conductors for transmitting stations, attached to buildings, shall be firmly mounted at least 3 inches clear of the surface of the building on nonabsorptive insulating supports, such as treated pins or brackets, equipped with insulators having not less than 3-inch creepage and air-gap distances. Lead-in conductors attached to buildings shall also conform to these requirements, except when they are enclosed in a continuous metallic shield which is permanently and effectively grounded. In this latter case the metallic shield may also be used as a conductor.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 810.55 **Entrance to building.** Except where protected with a continuous metallic shield which is permanently and effectively grounded, lead-in conductors for transmitting stations shall enter buildings by one of the following methods:

(1) Through a rigid, noncombustible, nonabsorptive insulating tube or bushing.

(2) Through an opening provided for the purpose in which the entrance conductors are firmly secured so as to provide a clearance of at least 2 inches.

(3) Through a drilled window pane.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 810.56 **Protection against accidental contact.** Lead-in conductors to radio transmitters shall be so located or installed as to make accidental contact with them difficult.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 810.57 Lightning arresters; transmitting stations. Each conductor of a lead-in for outdoor antenna shall be provided with a lightning arrester or other suitable means which will drain static charges from the antenna system.

(1) EXCEPTION NO. 1. Where protected by a continuous metallic shield which is permanently and effectively grounded.

(2) EXCEPTION NO. 2. Where the antenna is permanently and effectively grounded.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

Grounding Conductors—General

E 810.58 Other rules. All grounding conductors for amateur transmitting and receiving stations shall comply with sections E 810.21 to E 810.27 inclusive.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 810.59 **Size of protective ground.** The protective ground conductor for transmitting stations shall be as large as the lead-in, but not smaller than No. 10 copper, bronze, or copper-clad steel.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 810.60 Size of operating grounding conductor. The operating grounding conductor for transmitting stations shall be not less than No. 14 copper or its equivalent.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

Interior Installation—Transmitting Stations

E 810.70 Clearance from other conductors. Except as provided in chapter E 640, all conductors inside the building shall be separated at least 4 inches from the conductors of any other light or signal circuit unless separated therefrom by conduit or some firmly fixed nonconductor such as porcelain tubes or flexible tubing.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

E 810.71 General. Transmitters shall comply with the following:

(1) ENCLOSING. The transmitter shall be enclosed in a metal frame

or grille, or separated from the operating space by a barrier or other equivalent means, all metallic parts of which are effectually connected to ground.

(2) GROUNDING OF CONTROLS. All external metallic handles and controls accessible to the operating personnel shall be effectually grounded.

Note: No circuit in excess of 150 volts between conductors should have any parts exposed to direct contact. A complete dead-front type of switchboard is preferred.

(3) INTERLOCKS ON DOORS. All access doors shall be provided with interlocks which will disconnect all voltages in excess of 350 volts between conductors when any access door is opened.

(4) AUDIO-AMPLIFIERS. Audio-amplifiers which are located outside the transmitter housing shall be suitably housed and shall be so located as to be readily accessible and adequately ventilated.

History: Cr. Register, January, 1968, No. 145, eff. 2-1-68.

Chapter E 900

TABLES AND EXAMPLES

A. TABLES

Where conduit nipples having a maximum length not to exceed 6 inches are installed between boxes, cabinets, gutters, switch cases and similar enclosures, the conductor fill in such nipples may be increased to not more than 60% o fthe internal cross-sectional area of the conduit, and note 8 of tables E 310.12 through E 310.15 does not apply to this condition.

TABLE 1

MAXIMUM NUMBER OF CONDUCTORS IN TRADE SIZES OF CONDUIT OR TUBING

New Work or Rewiring—Types RF-2, RFH-2, R, RH, RW, RHH

NEW WORK—FEP, FEPB, RUH, RUW, T, TF, THHN, THW, THWN, TW

Derating Factors for more than three conductors in raceways
See note 8, tables E 310.12 through E 310.15

(See section E 300.17, E 300.18, E 346.06 and E 348.06)

New Work or Rewiring

Size AWG or MCM	Maximum Number of Conductors in Conduit or Tubing (Based upon % conductor fill, Table 3, Chapter E-900, for new work)											
	½ Inch	¾ Inch	1 Inch	1¼ Inch	1½ Inch	2 Inch	2½ Inch	3 Inch	3½ Inch	4 Inch	5 Inch	6 Inch
18	7	12	20	35	49	80	115	176				
16	6	10	17	30	41	68	98	150				
14	4	6	10	18	25	41	58	90	121	155		
12	3	5	8	15	21	34	50	76	103	132	208	
10	2	4	7	13	17	29	41	64	86	110	173	
8	1	3	4	7	10	17	25	38	52	67	105	152
6	1	1	3	4	6	10	15	23	32	41	64	93
4	1	1	1	3*	5	8	12	18	24	31	49	72
3		1	1	3	4	7	10	16	21	28	44	63
2		1	1	3	3	6	9	14	19	24	38	55
1		1	1	1	3	4	7	10	14	18	29	42
0			1	1	2	4	6	9	12	16	25	37
00			1	1	1	3	5	8	11	14	22	32
000			1	1	1	3	4	7	9	12	19	27
0000				1	1	2	3	6	8	10	16	23
250				1	1	1	3	5	6	8	13	19
300				1	1	1	3	4	5	7	11	16
350				1	1	1	1	3	5	6	10	15
400					1	1	1	3	4	6	9	13
500					1	1	1	3	4	5	8	11
600						1	1	1	3	4	6	9
700						1	1	1	3	3	6	8
750						1	1	1	3	3	5	8
800						1	1	1	2	3	5	7
900						1	1	1	1	3	4	7
1000						1	1	1	1	3	4	6
1250							1	1	1	1	3	5
1500								1	1	1	3	4
1750								1	1	1	2	4
2000								1	1	1	1	3

*Where an existing service run of conduit or electrical metallic tubing does not exceed 50 ft. in length and does not contain more than the equivalent of two quarterbends from end to end, two No. 4 insulated and one No. 4 bare conductors may be installed in 1-inch conduit or tubing.

TABLE 1A

MAXIMUM NUMBER OF CONDUCTORS IN TRADE SIZES OF CONDUIT OR TUBING

Rewiring—Types TF, T, THW, TW, RUH, RUW

Derating Factors for more than three conductors in raceways
See note 8, tables E 310.12 through E 310.15

(See section E 300.17, E 300.18, E 346.06 and E 348.06)

Rewiring

Size AWG or MCM	Maximum Number of Conductors in Conduit or Tubing (Based upon % Conductor-fill, Table 3, Chapter 9, for new work)											
	½ Inch	¾ Inch	1 Inch	1¼ Inch	1½ Inch	2 Inch	2½ Inch	3 Inch	3½ Inch	4 Inch	5 Inch	6 Inch
18	13	24	38	68	93	152	-----	-----	-----	-----	-----	-----
16	11	19	31	55	75	123	176	270	-----	-----	-----	-----
14	5	10	16	29	40	65	93	143	192	-----	-----	-----
12	4	8	13	24	32	53	76	117	157	202	-----	-----
10	4	6	11	19	26	43	61	95	127	163	257	-----
8	1	4	6	11	15	25	36	56	75	96	152	219
6	1	2	4	7	10	16	23	36	48	62	97	141
4	1	1	3	5	7	12	17	27	36	46	73	106
3	1	1	2	4	6	10	15	23	31	40	63	91
2	1	1	1	4	5	9	13	20	27	34	54	78
1	-----	1	1	2	4	6	9	14	19	25	39	57
0	-----	1	1	2	3	5	8	12	16	21	33	48
00	-----	1	1	1	3	4	7	10	14	18	28	41
000	-----	-----	1	1	2	4	5	9	12	15	24	35
0000	-----	-----	1	1	1	3	5	7	10	13	20	29
250	-----	-----	-----	1	1	2	4	6	8	10	16	23
300	-----	-----	-----	1	1	2	3	5	7	9	14	20
350	-----	-----	-----	1	1	1	3	4	6	8	12	18
400	-----	-----	-----	1	1	1	2	4	5	7	11	16
500	-----	-----	-----	-----	1	1	1	3	4	6	9	14
600	-----	-----	-----	-----	1	1	1	3	4	5	7	11
700	-----	-----	-----	-----	-----	1	1	2	3	4	7	10
750	-----	-----	-----	-----	-----	1	1	2	3	4	6	9
800	-----	-----	-----	-----	-----	1	1	1	3	4	6	9
900	-----	-----	-----	-----	-----	1	1	1	2	3	5	8
1000	-----	-----	-----	-----	-----	1	1	1	2	3	5	7
1250	-----	-----	-----	-----	-----	-----	1	1	1	2	4	6
1500	-----	-----	-----	-----	-----	-----	1	1	1	1	3	5
1750	-----	-----	-----	-----	-----	-----	1	1	1	1	3	4
2000	-----	-----	-----	-----	-----	-----	-----	1	1	1	2	4

TABLE 1B

MAXIMUM NUMBER OF CONDUCTORS IN TRADE SIZES OF CONDUIT OR TUBING

Rewiring—Types FEP, FEPB,* THHN, THWN

Derating Factors for more than three conductors in raceways See note 8, tables E 310.12 through E 310.15

(See section E 300.17, E 300.18, E 346.06 and E 348.06)

Rewiring

Size AWG or MCM	Maximum Number of Conductors in Conduit or Tubing (Based upon % Conductor-fill, Table 3, Chapter 9, for new work)											
	½ Inch	¾ Inch	1 Inch	1¼ Inch	1½ Inch	2 Inch	2½ Inch	3 Inch	3½ Inch	4 Inch	5 Inch	6 Inch
14	13	24	39	69	94	154	220	-----	-----	-----	-----	-----
12	10	18	29	51	70	114	164	252	-----	-----	-----	-----
10	6	11	18	32	44	72	104	160	215	276	-----	-----
8	3	6	10	19	26	42	60	93	125	160	252	-----
6	1	4	6	11	15	25	37	56	76	98	154	222
4	1	2	4	7	9	16	22	35	47	60	94	136
3	1	1	3	6	8	13	19	29	39	51	80	116
2	1	1	3	5	7	11	16	25	33	43	67	97
1	1	1	1	3	5	8	12	18	25	32	50	72
0	-----	1	1	3	4	7	10	15	21	27	42	61
00	-----	1	1	2	3	6	8	13	17	22	35	51
000	-----	1	1	1	3	5	7	11	14	18	29	42
0000	-----	-----	1	1	2	4	6	9	12	15	24	35
250	-----	-----	1	1	1	3	4	7	9	12	20	28
300	-----	-----	1	1	1	3	4	6	8	11	17	24
350	-----	-----	-----	1	1	2	3	5	7	9	15	21
400	-----	-----	-----	1	1	1	3	5	6	8	13	19
500	-----	-----	-----	1	1	1	2	4	5	7	11	16

*Type FEPB sizes AWG No. 14–8, inclusive. Use table 1A for FEPB sizes larger than AWG No. 8.

TABLE 2

TRADE SIZES OF CONDUIT OR TUBING FOR NUMBER OF CONDUCTORS

Lead-Covered Types RL and RHL-600 V

(See sections E 346.06 and E 348.06)

Size AWG MCM	Number of Single Conductor Cables				Number of 2-Conductor Cables				Number of 3-Conductor Cables			
	1	2	3	4	1	2	3	4	1	2	3	4
14	½	¾	¾	1	¾	1	1	1¼	¾	1¼	1½	1½
12	½	¾	¾	1	¾	1	1¼	1¼	1	1¼	1½	2
10	½	¾	1	1	¾	1¼	1¼	1½	1	1½	2	2
8	½	1	1¼	1½	1	1¼	1½	2	1	2	2	2½
6	¾	1¼	1½	1½	1¼	1½	2	2½	1¼	2½	3	3
4	¾	1¼	1½	1½	1¼	2	2½	2½	1½	3	3	3½
3	¾	1¼	1½	2	1¼	2	2½	3	1½	3	3	3½
2	1	1¼	1½	2	1¼	2	2½	3	1½	3	3½	4
1	1	1½	2	2	1½	2½	3	3½	2	3½	4	5
0	1	2	2	2½	2	2½	3	3½	2	4	5	5
00	1	2	2	2½	2	3	3½	4	2½	4	5	5
000	1¼	2	2½	2½	2	3	3½	4	2½	5	5	6
0000	1¼	2½	2½	3	2½	3	3½	5	3	5	6	6
250	1¼	2½	3	3	-----	-----	-----	-----	3	6	6	-----
300	1½	3	3	3½	-----	-----	-----	-----	3½	6	6	-----
350	1½	3	3	3½	-----	-----	-----	-----	3½	6	6	-----
400	1½	3	3	3½	-----	-----	-----	-----	3½	6	6	-----
500	1½	3	3½	4	-----	-----	-----	-----	4	6	-----	-----
600	2	3½	4	5	-----	-----	-----	-----	-----	-----	-----	-----
700	2	4	4	5	-----	-----	-----	-----	-----	-----	-----	-----
750	2	4	4	5	-----	-----	-----	-----	-----	-----	-----	-----
800	2	4	5	5	-----	-----	-----	-----	-----	-----	-----	-----
900	2½	4	5	5	-----	-----	-----	-----	-----	-----	-----	-----
1000	2½	5	5	6	-----	-----	-----	-----	-----	-----	-----	-----
1250	3	5	5	6	-----	-----	-----	-----	-----	-----	-----	-----
1500	3	5	6	6	-----	-----	-----	-----	-----	-----	-----	-----
1750	3	6	6	-----	-----	-----	-----	-----	-----	-----	-----	-----
2000	3½	6	6	-----	-----	-----	-----	-----	-----	-----	-----	-----

The above sizes apply to straight runs or with nominal offsets equivalent to not more than 2 quarter-bends.

See section E 346.10 for bends in conduit.

TABLE 3

COMBINATION OF CONDUCTORS

(See sections E 346.06, E 346.11 and E 348.06)

For groups or combinations of conductors not included in table 1, chapter E 900, for new work, or tables 1, 1A or 1B chapter E 900, for rewiring, the conduit or tubing shall be of such size that the sum of the cross-sectional areas of the individual conductors will not be more than the percentage of the interior cross-sectional area of the conduit or tubing shown in the following table:

PER CENT AREA OF CONDUIT OR TUBING

	Number of Conductors				
	1	2	3	4	Over 4
Conductors (not lead covered)	53	31	40	40	40
Lead-covered conductors	55	30	40	38	35

For ampacity of more than three conductors in a conduit or tubing, see tables E 310. 12 through E 310.15, note 8.

See tables 4 through 8, chapter E 900 for dimensions of conductors, conduit and tubing.

Tables 4 through 8. Chapter E 900. Tables 4 through 8 give the nominal size of conductors and conduit or tubing recommended for use in computing size of conduit or tubing for various combinations of conductors. The dimensions represent average conditions only, and while variations will be found in dimensions of conductors and conduits of different manufacture, these variations will not affect the computation.

TABLE 4

DIMENSIONS AND PER CENT AREA OF CONDUIT AND OF TUBING

Areas of conduit or tubing for the combinations of wires permitted in table 3, chapter E 900

Trade Size	Internal Diameter Inches	Area—Square Inches								
		Total 100%	Not Lead Covered			Lead Covered				
			1 Cond. 53%	2 Cond. 31%	3 Cond. and Over 40%	1 Cond. 55%	2 Cond. 30%	3 Cond. 40%	4 Cond. 38%	Over 4 Cond. 35%
½	.622	.30	.16	.09	.12	.17	.09	.12	.11	.11
¾	.824	.53	.28	.16	.21	.29	.16	.21	.20	.19
1	1.049	.86	.46	.27	.34	.47	.26	.34	.33	.30
1¼	1.380	1.50	.80	.47	.60	.83	.45	.60	.57	.53
1½	1.610	2.04	1.08	.63	.82	1.12	.61	.82	.78	.71
2	2.067	3.36	1.78	1.04	1.34	1.85	1.01	1.34	1.28	1.18
2½	2.469	4.79	2.54	1.48	1.92	2.63	1.44	1.92	1.82	1.68
3	3.068	7.38	3.91	2.29	2.95	4.06	2.21	2.95	2.80	2.58
3½	3.548	9.90	5.25	3.07	3.96	5.44	2.97	3.96	3.76	3.47
4	4.026	12.72	6.74	3.94	5.09	7.00	3.82	5.09	4.83	4.45
5	5.047	20.00	10.60	6.20	8.00	11.00	6.00	8.00	7.60	7.00
6	6.065	28.89	15.31	8.96	11.56	15.89	8.67	11.56	10.98	10.11

TABLE 5

DIMENSIONS OF RUBBER-COVERED AND THERMOPLASTIC-COVERED CONDUCTORS

Size AWG MCM	Types RF-2, RFH-2, R, RH, RHH,‡ RHW,‡ RH:RW, RW		Types TF, T, THW, TW, RU,** RUH,** RUW**		Types THHN, THWN		Types FEP, FEPB	
	Approx. Diam. Inches	Approx. Area Sq. In.	Approx. Diam. Inches	Approx. Area Sq. In.	Approx. Diam. Inches	Approx. Area Sq. In.	Approx. Diam. Inches	Approx. Area Sq. In.
Col. 1	Col. 2	Col. 3	Col. 4	Col. 5	Col. 6	Col. 7	Col. 8	Col. 9
18	.146	.0167	.196	.0088				
16	.158	.0196	.118	.0109				
14	2/64 in. .171	.0230	.131	.0135	.105	.0087	.105 .105	.0087 .0087
14	3/64 in. .204*	.0327*						
14			.162†	.0206†				
12	2/64 in. .188	.0278	.148	.0172	.122	.0117	.121 .121	.0115 .0115
12	3/64 in. .221*	.0384*						
12			.179†	.0251†				
10	---- .242	.0460	.168	.0224	.153	.0184	.142 .142	.0159 .0159
10			.199†	.0311†				
8	---- .311	.0760	.288	.0408	.201	.0317	.189 .169	.0280 .0225
8			.259†	.0526†				
6	.397	.1238	.323	.0819	.257	.0519	.244 .302	.0467 .0716
4	.452	.1605	.372	.1087	.328	.0845	.292 .350	.0669 .0962
3	.481	.1817	.401	.1263	.356	.0995	.320 .378	.0803 .1122
2	.513	.2067	.433	.1473	.388	.1182	.352 .410	.0973 .1316
1	.588	.2715	.508	.2027	.450	.1590		
0	.629	.3107	.549	.2367	.491	.1893		
00	.675	.3578	.595	.2781	.537	.2265		
000	.727	.4151	.647	.3288	.588	.2715		
0000	.785	.4840	.705	.3904	.646	.3278		

TABLE 5

DIMENSIONS OF RUBBER-COVERED AND THERMOPLASTIC-COVERED CONDUCTORS—Continued

Size AWG MCM	Types RF-2, RFH-2, R, RH, RHH,‡ RHW,‡ RH-RW, RW		Types TF, T, THW, TW, RU,** RUH,** RUW**		Types THHN, THWN		Types FEP, FEPB	
	Approx. Diam. Inches	Approx. Area Sq. In.	Approx. Diam. Inches	Approx. Area Sq. In.	Approx. Diam. Inches	Approx. Area Sq. In.	Approx. Diam. Inches	Approx. Area Sq. I
Col. 1	Col. 2	Col. 3	Col. 4	Col. 5	Col. 6	Col. 7	Col. 8	Col. 9
250	.868	.5917	.788	.4877	.716	.4026		
300	.933	.6837	.843	.5581	.771	.4669		
350	.985	.7620	.895	.6291	.822	.5307		
400	1.032	.8365	.942	.6969	.869	.5931		
500	1.119	.9834	1.029	.8316	.955	.7163		
600	1.233	1.1940	1.143	1.0261				
700	1.304	1.3355	1.214	1.1575				
750	1.339	1.4082	1.249	1.2252				
800	1.372	1.4784	1.282	1.2908				
900	1.435	1.6173	1.345	1.4208				
1000	1.494	1.7531	1.404	1.5482				
1250	1.676	2.2062	1.577	1.9532				
1500	1.801	2.5475	1.702	2.2748				
1750	1.916	2.8895	1.817	2.5930				
2000	2.021	3.2079	1.922	2.9013				

*The dimensions of types RHH, RH-RW, RHW, and RW wire. Also, these dimensions to be used for new work in computing size of conduit or tubing for combinations of wires not shown in table 1, chapter E 900.

**No. 14 to No. 2.

†Dimensions of THW wire in sizes 14 to 8. No. 6 THW wire and larger is the same dimension as T wire.

‡Dimensions of RHH and RHW without outer covering are the same as THW.

No. 18 to No. 8, solid; No. 6 and larger, stranded.

The dimensions of rubber-covered conductors in column 3 of this table are to be used in computing the size of conduit or tubing for new work for combinations not shown in table 1. For rewiring existing raceways, the areas in columns 3, 5, 7 and 9 are to be used.

TABLE 6
DIMENSIONS OF LEAD-COVERED CONDUCTORS
Types RL, RHL, and RUL

Size AWG MCM	Single Conductor		Two Conductor		Three Conductor	
	Diam. Inches	Area Sq. Ins.	Diam. Inches	Area Sq. Ins.	Diam. Inches	Area Sq. Ins.
14	.28	.062	.28 x .47	.115	.59	.273
12	.29	.066	.31 x .54	.146	.62	.301
10	.35	.096	.35 x .59	.180	.68	.363
8	.41	.132	.41 x .71	.255	.82	.528
6	.49	.188	.49 x .86	.369	.97	.738
4	.55	.237	.54 x .96	.457	1.08	.916
2	.60	.283	.61 x 1.08	.578	1.21	1.146
1	.67	.352	.70 x 1.23	.756	1.38	1.49
0	.71	.396	.74 x 1.32	.859	1.47	1.70
00	.76	.454	.79 x 1.41	.980	1.57	1.94
000	.81	.515	.84 x 1.52	1.123	1.69	2.24
0000	.87	.593	.90 x 1.64	1.302	1.85	2.68
250	.98	.754	------------	----------	2.02	3.20
300	1.04	.85	------------	----------	2.15	3.62
350	1.10	.95	------------	----------	2.26	4.02
400	1.14	1.02	------------	----------	2.40	4.52
500	1.23	1.18	------------	----------	2.59	5.28

Note: No. 14 to No. 8, solid conductors: No. 6 and larger, stranded conductors. Data for 2/64-inch insulation not yet compiled.

TABLE 7
DIMENSIONS OF ASBESTOS-VARNISHED-CAMBRIC INSULATED CONDUCTORS
Types AVA, AVB, and AVL

Size AWG MCM	Type AVA		Type AVB		Type AVL	
	Approx. Diam. Inches	Approx. Area Sq. In.	Approx. Diam. Inches	Approx. Area Sq. In.	Approx. Diam. Inches	Approx. Area Sq. In.
14	.245	.047	.205	.033	.320	.080
12	.265	.055	.225	.040	.340	.091
10	.285	.064	.245	.047	.360	.102
8	.310	.075	.270	.057	.390	.119
6	.395	.122	.345	.094	.430	.145
4	.445	.155	.395	.123	.480	.181
2	.505	.200	.460	.166	.570	.255
1	.585	.268	.540	.229	.620	.300
0	.625	.307	.580	.264	.660	.341
00	.670	.353	.625	.307	.705	.390
000	.720	.406	.675	.358	.755	.447
0000	.780	.478	.735	.425	.815	.521
250	.885	.616	.855	.572	.955	.715
300	.940	.692	.910	.649	1.010	.800
350	.995	.778	.965	.731	1.060	.885
400	1.040	.850	1.010	.800	1.105	.960
500	1.125	.995	1.095	.945	1.190	1.118
550	1.165	1.065	1.135	1.01	1.265	1.26
600	1.205	1.140	1.175	1.09	1.305	1.34
650	1.240	1.21	1.210	1.15	1.340	1.41
700	1.275	1.28	1.245	1.22	1.375	1.49
750	1.310	1.35	1.280	1.29	1.410	1.57
800	1.345	1.42	1.315	1.36	1.440	1.63
850	1.375	1.49	1.345	1.43	1.470	1.70
900	1.405	1.55	1.375	1.49	1.505	1.78
950	1.435	1.62	1.405	1.55	1.535	1.85
1000	1.465	1.69	1.435	1.62	1.565	1.93

Note: No. 14 to No. 8, solid, No. 6 and larger, stranded; except AVL where all sizes are stranded.

VARNISHED-CAMBRIC INSULATED CONDUCTORS

Type V

The insulation thickness for varnished-cambric conductors, type V, is the same as for rubber-covered conductors, type RH, except for Nos. 14 and 12 which have 3/64-inch insulation for varnished-cambric and 2/64 insulation for rubber-covered conductors and for No. 8 which has 3/64-inch insulation for varnished-cambric, and 4/64-inch insulation for rubber-covered conductors. See table E 310.02 (2). Tables 1 and 2 may, therefore, be used for the number of varnished-cambric insulated conductors in a conduit or tubing.

TABLE 8

PROPERTIES OF CONDUCTORS

Size AWG MCM	Area Cir. Mils	Concentric Lay Stranded Conductors		Bare Conductors		D. C. Resistance Ohms/M Ft. at 25°C. 77°F.		
						Copper		Alumi-num
		No. Wires	Diam. Each Wire Inches	Diam. Inches	*Area Sq. Inches	Bare Cond.	Tin'd. Cond.	
18	1,624	Solid	.0403	.0403	.0013	6.51	6.79	10.7
16	2,583	Solid	.0508	.0508	.0020	4.10	4.26	6.72
14	4,107	Solid	.0641	.0641	.0032	2.57	2.68	4.22
12	6,530	Solid	.0808	.0808	.0051	1.62	1.68	2.66
10	10,380	Solid	.1019	.1019	.0081	1.018	1.06	1.67
8	16,510	Solid	.1285	.1285	.0130	.6404	.659	1.05
6	26,250	7	.0612	.184	.027	.410	.427	.674
4	41,740	7	.0772	.232	.042	.259	.269	.424
3	52,640	7	.0867	.260	.053	.205	.213	.336
2	66,370	7	.0974	.292	.067	.162	.169	.266
1	83,690	19	.0664	.332	.087	.129	.134	.211
0	105,500	19	.0745	.373	.109	.102	.106	.168
00	133,100	19	.0837	.418	.137	.0811	.0843	.133
000	167,800	19	.0940	.470	.173	.0642	.0668	.105
0000	211,600	19	.1055	.528	.219	.0509	.0525	.836
250	250,000	37	.0822	.575	.260	.0431	.0449	.0708
300	300,000	37	.0900	.630	.312	.0360	.0374	.0590
350	350,000	37	.0973	.681	.364	.0308	.0320	.0505
400	400,000	37	.1040	.728	.416	.0270	.0278	.0442
500	500,000	37	.1162	.814	.520	.0216	.0222	.0354
600	600,000	61	.0992	.893	.626	.0180	.0187	.0295
700	700,000	61	.1071	.964	.730	.0154	.0159	.0253
750	750,000	61	.1109	.998	.782	.0144	.0148	.0236
800	800,000	61	.1145	1.031	.835	.0135	.0139	.0221
900	900,000	61	.1215	1.093	.938	.0120	.0123	.0197
1000	1,000,000	61	.1280	1.152	1.042	.0108	.0111	.0177
1250	1,250,000	91	.1172	1.289	1.305	.00863	.00888	.0142
1500	1,500,000	91	.1284	1.412	1.566	.00719	.00740	.0118
1750	1,750,000	127	.1174	1.526	1.829	.00616	.00634	.0101
2000	2,000,000	127	.1255	1.631	2.089	.00539	.00555	.00885

*Area given is that of a circle having a diameter equal to the overall diameter of a stranded conductor.

The values given in the table are those given in Circular 31 of the National Bureau of Standards except that those shown in the 8th column are those given in Specification B33 of the American Society for Testing and Materials.

The resistance values given in the last three columns are applicable only to direct current. When conductors larger than No. 4/0 are used with alternating current the multiplying factors in table 9, chapter E 900 should be used to compensate for skin effect.

TABLE 9

MULTIPLYING FACTORS FOR CONVERTING D. C. RESISTANCE TO 60 CYCLE A. C. RESISTANCE

Size	Multiplying Factor: For Nonmetallic Sheathed Cables in Air or Nonmetallic Conduit		For Metallic Sheathed Cables or All Cables in Metallic Raceways	
	Copper	Aluminum	Copper	Aluminum
Up to 3 AWG	1.	1.	1.	1.
2	1.	1.	1.01	1.00
1	1.	1.	1.01	1.00
0	1.001	1.000	1.02	1.00
00	1.001	1.001	1.03	1.00
000	1.002	1.001	1.04	1.01
0000	1.004	1.002	1.05	1.01
250 MCM	1.005	1.002	1.06	1.02
300 MCM	1.006	1.003	1.07	1.02
350 MCM	1.009	1.004	1.08	1.03
400 MCM	1.011	1.005	1.10	1.04
500 MCM	1.018	1.007	1.13	1.06
600 MCM	1.025	1.010	1.16	1.08
700 MCM	1.034	1.013	1.19	1.11
750 MCM	1.039	1.015	1.21	1.12
800 MCM	1.044	1.017	1.22	1.14
1000 MCM	1.067	1.026	1.30	1.19
1250 MCM	1.102	1.040	1.41	1.27
1500 MCM	1.142	1.058	1.53	1.36
1750 MCM	1.185	1.079	1.67	1.46
2000 MCM	1.233	1.100	1.82	1.56

B. EXAMPLES

Selection of Conductors. In the following examples, the size of conductor has been selected on the basis of the allowable current-carrying capacities tabulated in the second column of table E 310.12. If other types of insulated conductors are used, or if the conductors are run open, or with more than 3 conductors in a raceway, the size of conductor may vary from those shown. Tables E 310.12 through E 310.15 and notes thereto should be consulted in selecting the size of conductor for a particular installation.

Voltage. For uniform application of the provisions of chapters E 210, E 215 and E 220 a nominal voltage of 115 and 230 volts shall be used in computing the ampere load on the conductor.

Fractions of an Ampere. Where the computations result in a fraction of an ampere, such fractions may be dropped.

Ranges. For the computation of the range loads in these examples column A of table E 220.05 has been used. For optional methods, see columns B and C of table E 220.05.

Example No. 1. Single Family Dwelling

Dwelling has a floor area of 1500 sq. ft. exclusive of unoccupied cellar, unfinished attic, and open porches. It has a 12 kw range.

Computed Load (see E 220.04)

General Lighting Load:

1500 sq. ft. at 3 watts per sq. ft. = 4500 watts.

Minimum Number of Branch Circuits Required (see E 220.03)

General Lighting Load:

4500 ÷ 115 = 39.1 amperes; or three 15 ampere 2-wire circuits; or two 20 ampere 2-wire circuits.

Small Appliance Load: Two 2-wire 20 ampere circuits (E 220.03 (2).

Minimum Size Feeders Required (see E 220.04)

Computed Load

General Lighting	4500 watts
Small Appl. Load	3000 watts
Total (without range)	7500 watts
3000 watts at 100%	3000 watts
7500 — 3000 = 4500 watts at 35%	1575 watts
Net computed (without range)	4575 watts
Range Load (see table E 220.05)	8000 watts
Net computed (with range)	12,575 watts

For 115/230 volt 3-wire system feeders, 12,575 ÷ 230 = 55 amperes.

Therefore, feeder size for total load may be selected on basis of 55 ampere load (see E 215.02).

The service conductors shall be 100 ampere (see E 230.041(1) Exception No. 1).

Example No. 1 (a). Single Family Dwelling

Same conditions as example No. 1, plus addition of one 6 ampere 230 volt room air conditioning unit and three 12 ampere 115 volt room air conditioning units. See chapter E 422, Part F.

From Example No. 1, feeder current is 55 amperes (3-wire, 230 volt)

Line A	Neutral	Line B	
55		55	amperes from Example No. 1
6		6	one 230 volt air cond. motor
12		12	two 115 volt air cond. motors
--		12	one 115 volt air cond. motor
3		3	25% of largest motor (E 430.024)
76		88	amperes per line

Therefore, feeder size for total load may be selected on basis of 88 ampere load.

For feeder overcurrent protection see E 215.04 and E 430.063.

Example No. 1 (b). Single Family Dwelling

Optional Calculation for One-Family Dwelling (E 220.07)

Dwelling has a floor area of 1,500 square feet exclusive of unoccupied cellar, unfinished attic and open porches. It has a 12 KW range, a 2.5 KW water heater, a 1.2 KW dishwasher, 9 KW of electric space heating installed in five rooms with separate controls in each room, a 4.5 KW clothes dryer, and a 6 amp. 230 volt room air conditioning unit.

Air conditioner kw is 6 × 230 ÷ 1000 = 1.38 kw

1.38 kw is less than the connected load of 9 kw of space heating; therefore, the air conditioner load need not be included in the service calculation (see E 220.04 (12)).

1500 sq. ft. at 3 watts	4.5 kw
Two 20 amp. appliance outlet circuits at 1500 watts each	3.0 kw
Range (at nameplate rating)	12.0 kw
Water heater	2.5 kw
Dishwasher	1.2 kw
Space heating	9.0 kw
Clothes dryer	4.5 kw
	36.7 kw

First 10 kw at 100% = 10.00 kw
Remainder at 40% (26.7 kw × .4) = 10.68 kw

Calculated load for service size 20.68 kw = 20,680 watts
20,680 ÷ 230 = 90 amperes
Therefore, this dwelling may be served by a 100 ampere service.

Example No. 1 (c). Single Family Dwelling

Optional Calculation for One-Family Dwelling (See E 220.07)

Dwelling has a floor area of 1500 sq. ft. exclusive of unoccupied cellar, unfinished attic and open porches. It has three-20 ampere small appliance circuits, two 4 kw wall-mounted ovens, one 5.1 kw counter-mounted cooking unit, a 4.5 kw water heater, a 1.2 kw dishwasher, a 4.2 kw combination clothes washer and dryer, six-7 ampere 230 volt room air conditioning units and a 1.5 kw permanently installed bathroom space heater.

Air Conditioning kw Calculation

Total amperes 6 × 7 = 42.00 amperes
25% of largest motor .25 × 7 = 1.75 amperes

43.75 amperes
43.75 × 230 ÷ 1000 = 10.1 kw of air conditioner load

Load Included at 100%

Air conditioning	10.1 kw
Space heater (omit, see E 220.04 (12))	

Other Load

1500 sq. ft. at 3 watts	4.5	
Three 20 amp. small appliance circuits at 1500 watts	4.5	
2 ovens	8.	
1 cooking unit	5.1	
Water heater	4.5	
Dishwasher	1.2	
Washer/Dryer	4.2	
Total other load	32.0	
1st 10 kw at 100%		10.0 kw
Remainder at 40% (22 kw × .4)		8.8 kw
Total calculated load		28.9 kw = 28,900 watts

28,900 ÷ 230 = 126 amperes (service rating)

Example No. 2. Small Roadside Fruitstand With No Show Windows

A small roadside fruitstand with no show windows has a floor area of 150 square feet. The electrical load consists of general lighting and a 1000 watt floodlight. There are no other outlets.

Computed Load (E 220.04)

*General Lighting

150 sq. ft. at 3 watts/sq. ft. × 1.25 = 562 watts

(3 watts/sq. ft. for stores)

562 watts ÷ 115 = 4.88 amperes

One 15 ampere 2-wire branch circuit required (E 220.03)

Minimum Size Service Conductor Required (E 230.041(2) Exception No. 2).

Computed load	562 watts
Floodlight load	1000 watts
Total load	1562 watts

1562 ÷ 115 = 13.6 amperes

Use No. 8 service conductor (E 230.041(2) Exception No. 2).

Use a 30 ampere service switch or breaker (E 230.071(1) (b) Exception No. 2).

Example No. 3. Store Building

A store 50 feet by 60 feet, or 3,000 square feet, has 30 feet of show window.

Computed Load (E 220.02)

*General lighting load:

3,000 square feet at 3 watts per square foot × 1.25 — 11,250 watts

**Show window lighting load:

30 feet of 200 watts per foot — 6,000 watts

Minimum Number of Branch Circuits Required (E 220.03)

***General lighting load: 11,250 ÷ 230 = 49 amperes for 3-wire, 115/230 volts; or 98 amperes for 2-wire, 115 volts:

Three 30 ampere, 2-wire; and one 15 ampere, 2-wire circuits; or
Five 20 ampere, 2-wire circuits; or
Three 20 ampere, 2-wire, and three 15 ampere, 2-wire circuits; or
Seven 15 ampere, 2-wire, circuits; or
Three 15 ampere, 3-wire, and one 15 ampere, 2-wire circuits.

Special lighting load (show window): (E 220.02(5)(b) Exception No. 2): 6,000 ÷ 230 = 26 amperes for 3-wire, 115/230 volts; or 52 amperes for 2-wire, 115 volts:

Four 15 ampere, 2-wire circuits; or
Three 20 ampere, 2-wire circuits, or
Two 15 ampere, 3-wire circuits.

Minimum Size Feeders (or Service Conductors) Required (E 215.02):

For 115/230 volt, 3-wire system:

Ampere load: 49 plus 26 = 75 amperes. (E 220.04):

Size of each feeder, No. 3

For 115 volt system:

Ampere load: 98 plus 52 = 150 amperes (E 220.04):

Size of each feeder, No. 3/0

* The above examples assume that the entire general lighting load is likely to be used for long periods of time and the load is therefore increased by 25% in accordance with E 220.02. The 25% increase is not applicable to any portion of the load not used for long periods.

** If show window load computed as per E 220.02, the unit load per outlet to be increased 25%.

*** The load on each general lighting branch circuit not to exceed 80% of the branch circuit rating (subsection E 210.23 (2)).

Example No. 4. Multi-Family Dwelling

Multi-family dwelling having a total floor area of 32,000 square feet with 40 apartments.

Meters in two banks of 20 each and individual sub-feeders to each apartment.

One-half of the apartments are equipped with electric ranges of not exceeding 12 kw each.

Area of each apartment is 800 square feet.

Computed Load for Each Apartment (Chapter E 220):

General lighting load:
800 square feet at 3 watts per square foot ....2,400 watts

Special appliance load:
Electric range ....8,000 watts

Minimum Number of Branch Circuits Required for Each Apartment (E 220.03):

General lighting load: 2,400 ÷ 115 = 21 amperes or two 15 ampere, 2-wire circuits; or two 20 ampere, 2-wire circuits.

Small appliance load: Two 2-wire circuits of No. 12 wire. (See E 220.03 (2)).

Range Circuit: 8,000 ÷ 230 = 34 amperes or a circuit of two No. 8s and one No. 10 as permitted by E 210.19(3).

Minimum Size Sub-Feeder Required for Each Apartment (E 215.02):

Computed load (Chapter E 220):
General lighting load ....2,400 watts
Small appliance load, two 20 ampere circuits ....3,000 watts

Total computed load (without ranges) ....5,400 watts

Application of Demand Factor:
3,000 watts at 100% ....3,000 watts
2,400 watts at 35% .... 840 watts

Net computed load (without ranges) ....3,840 watts
Range load ....8,000 watts

Net computed load (with ranges) ....11,840 watts

For 115/230 volt, 3-wire system (without ranges):
Net computed load, 3,840 ÷ 230 = 16.7 amperes.
Size of each sub-feeder (see E 215.02).

For 115/230 volt, 3-wire system (with ranges):
Net computed load, 11,840 ÷ 230 = 51.5 amperes.
Size of each ungrounded sub-feeder, No. 6.

Neutral Sub-Feeder:
Lighting and small appliance load ....3,840 watts
Range load, 8,000 watts at 70% (see E 220.04 (5)) ..5,600 watts

Net computed load (neutral) ....9,440 watts

9,440 ÷ 230 = 41 amperes
Size of neutral sub-feeder, No. 6

Minimum Size Feeders Required from Service Equipment to Meter Bank (For 20 Apartments—10 with Ranges):

Total Computed Load:

Lighting and small appliance load, 20 × 5,400 ---- 108,000 watts

Application of Demand Factor:

3,000 watts at 100% ---- 3,000 watts
105,000 watts at 35% ---- 36,750 watts

Net computed lighting and small appliance load ---- 39,750 watts
Range load, 10 ranges (less than 12 kw; Col. A, table E 220.05) ---- 25,000 watts

Net computed load (with ranges) ---- 64,750 watts

For 115/230 volt, 3-wire system:

Net computed load, 64,750 ÷ 230 = 282 amperes.
Size of each ungrounded feeder to each meter bank: 500,000 c.m.

Neutral Feeder:

Lighting and small appliance load ---- 39,750 watts
Range load: 25,000 watts at 70% (see E 220.04 (5)) ---- 17,500 watts

Computed load (neutral) ---- 57,250 watts

57,250 ÷ 230 = 249 amperes.

Further Demand Factor (E 220.04 (5)):

200 amperes at 100% = 200 amperes
49 amperes at 70% = 34 amperes

Net computed load (neutral) 234 amperes
Size of neutral feeder to each meter bank: 300,000 c.m.

Minimum Size Main Feeder (or Service Conductors) Required (For 40 Apartments—20 with Ranges):

Total computed load:

Lighting and small appliance load, 40 × 5,400 ---- 216,000 watts

Application of Demand Factor:

3,000 watts at 100% ---- 3,000 watts
117,000 watts at 35% ---- 40,950 watts
96,000 watts at 25% ---- 24,000 watts

Net computed lighting and small appliance load ---- 67,950 watts
Range load, 20 ranges (less than 12 kw, Col. A, table E 220.05) ---- 35,000 watts

Net computed load ---- 102,950 watts

For 115/230 volt, 3-wire system:

Net computed load, 102,950 ÷ 230 = 448 amperes.

Size of each ungrounded main feeder: 1,000,000 c.m.

Neutral Feeder:

Lighting and small appliance load ---- 67,950 watts
Range load, 35,000 watts at 70% (see E 220.04 (5)) ---- 24,500 watts

Computed load (neutral) ---- 92,450 watts

92,450 ÷ 230 = 402 amperes.

Further Demand Factor (see E 220.04 (5)):

200 amperes at 100%	= 200 amperes
202 amperes at 70%	= 141 amperes
Net computed load (neutral)	341 amperes

Size of neutral main feeder: 600,000 c.m.
See tables E 310.12 through E 310.15, notes 8 and 12.

Example No. 5. Calculation of Neutral Feeder
(See E 220.04(5))

The following example illustrates the method of calculating size of neutral feeder for the computed load of a 5-wire, 2-phase system, where it is desired to modify the load in accordance with provisions of E 220.04.

An installation consisting of a computed load of 250 amperes connected between neutral feeder and each ungrounded feeder.

Neutral Feeder (maximum unbalance of load 250 amp. × 140% = 350 amperes):

200 amperes (first)	at 100%	= 200 amperes
150 amperes (excess)	at 70%	= 105 amperes
Computed load		305 amperes

Size of neutral feeder: 500,000 c.m.

Example No. 6. Maximum Demand for Range Loads

Table E 220.05, column A applies to ranges not over 12 kw. The application of Note 1 to ranges over 12 kw (and not over 21 kw) is illustrated in the following examples:

A. Ranges all of same rating.
Assume 24 ranges each rated 16 kw.
From Column A the maximum demand for 24 ranges of 12 kw rating is 39 kw.
16 kw exceeds 12 kw by 4.
5% × 4 = 20% (5% increase for each kw in excess of 12).
39 kw × 20% = 7.8 kw increase.
39 + 7.8 = 46.8 kw: value to be used in selection of feeders.

B. Ranges of unequal rating.
Assume 5 ranges each rated 11 kw.
2 ranges each rated 12 kw.
20 ranges each rated 13.5 kw.
3 ranges each rated 18 kw.

5 × 12 = 60 Use 12 kw for range rated less than 12.
2 × 12 = 24
20 × 13.5 = 270
3 × 18 = 54

408 kw

408 ÷ 30 = 13.6 kw (average to be used for computation)

From Column A the demand for 30 ranges of 12 kw rating is 15 + 30 = 45 kw.
13.6 exceeds 12 by 1.6 (use 2.).
5% × 2 = 10% (5% increase for each kw in excess of 12).
45 kw × 10% = 4.5 kw increase.
45 + 4.5 = 49.5 kw = value to be used in selection of feeders.

Example No. 7. Ranges on a 3-Phase System

(See E 220.04 (10))

Thirty ranges rated at 12 kw each are supplied by a 3-phase, 4-wire, 120/208-volt feeder, 10 ranges on each phase.

As there are 20 ranges connected to each ungrounded conductor, the load should be calculated on the basis of 20 ranges (or in case of unbalance, twice the maximum number between any two phase wires) since diversity applies only to the number of ranges connected to adjacent phases and not the total.

The current in any one conductor will be one-half the total watt load of two adjacent phases divided by the line-to-neutral voltage. In this case, 20 ranges, from table E 220.05, will have a total watt load of 35,000 watts for two phases; therefore, the current in the feeder conductor would be:

$$17{,}500 \div 120 = 146 \text{ amperes.}$$

On a 3-phase basis the load would be:

$$3 \times 17{,}500 = 52{,}500 \text{ watts.}$$

and the current in each feeder conductor—

$$\frac{52{,}500}{208 \times 1.73} = 146 \text{ amperes.}$$

Example No. 8. Motors, Conductors, and Overcurrent Protection

(See E 430.022, E 430.024, E 430.032 and E 430.052)

Determine the size of conductors, the motor-running overcurrent protection, the branch circuit protection, and the feeder protection, for one 25-h.p. squirrel-cage induction motor (full-voltage starting), and two 30-h.p. wound-rotor induction motors, on a 440-volt, 3-phase, 60-cycle supply.

Conductor Sizes

The full-load current of the 25-h.p. motor is 32 amperes (table E 430.150). A full-load current of 32 amperes × 1.25 (E 430.022) requires a No. 8, Type R, rubber-covered conductor (table E 310.12). The full-load current of the 30-h.p. motor is 39 amperes (table E 430.150). A full-load current of 39 amperes × 1.25 (E 430.022) requires a No. 6, Type R, rubber-covered conductor (table E 310.12).

The feeder conductor capacity will be 125 per cent of 39, plus 39, plus 32, or 120 amperes (E 430.024). In accordance with table E 310.12, this would require a No. 0, Type R, rubber-covered feeder.

Note: For Type R conductors run open in air, or for conductors with insulations other than Type R, see tables E 310.12 through E 310.15.

Overcurrent Protection

Running. The 25-h.p. motor, with full-load current of 32 amperes, must have running overcurrent protection of not over 40 amperes (Columns 2 and 3, table E 430.146). The 30-h.p. motor with full-load current of 39 amperes must have running overcurrent protection of not over 50 amperes (Columns 2 and 3, table E 430.146).

Branch Circuit. The branch circuit of the 25-h.p. motor must have branch-circuit overcurrent protection of not over 100 amperes (Column 4, table E 430.146). The branch circuit of the 30-h.p. motor must have branch-circuit overcurrent protection of not over 60 amperes (Column 7, table E 430.146).

Feeder Circuit. The rating of the branch-circuit fuse for a 25-h.p. squirrel-cage motor is 300 per cent of 32 amperes, or 96 amperes, which necessitates the use of a 100 ampere standard size fuse (table E 430.153); and for a 30-h.p. wound-rotor motor is 150 per cent of 39 amperes, or 59 amperes (table E 430.153). The rating of the feeder fuse is, therefore, 100 plus 39 plus 39 which equals 178 amperes, and a 200 ampere fuse is the maximum size which may be used (see E 430.062).

The setting of a motor-branch-circuit circuit-breaker for a 25-h.p. squirrel-cage motor is 250 per cent of 32 amperes or 80 amperes (table E 430.153); for a 30-h.p. wound-rotor motor is 150 per cent of 39 amperes or 59 amperes (table E 430.153). The maximum setting of a feeder circuit-breaker is 80 + 39 + 39 = 158 amperes (see E 430.062).

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