

## Chapter E 230

## SERVICES

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## 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, April, 1964, No. 100, eff. 5-1-64.

**E 230.002 Number of services to a building.** In general, a building 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) Buildings of multiple occupancy may have 2 or more separate sets of service-entrance conductors which are tapped from one service drop, or 2 or more sub-sets of service-entrance conductors may be tapped from a single set of main service conductors. See subsections E 230.070 (2) and E 230.090 (1) (d).

(4) EXCEPTION No. 4. CAPACITY REQUIREMENTS. Where capacity requirements make multiple services desirable.

(5) EXCEPTION No. 5. BUILDINGS OF LARGE AREA. By special permission, where more than one service drop is necessary due to the area over which a single building extends.

(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.

**History:** Cr. Register, April, 1964, No. 100, eff. 5-1-64.

**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 subsection E 230.070 (4).

**History:** Cr. Register, April, 1964, No. 100, eff. 5-1-64.

## 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.

**History:** Cr. Register, April, 1964, No. 100, eff. 5-1-64.

**E 230.005 Size of service conductors.** Service conductors shall have adequate current-carrying capacity to safely conduct the current for the loads supplied without a temperature rise detrimental to the in-

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 230.041.

**History:** Cr. Register, April, 1964, No. 100, eff. 5-1-64.

### 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, April, 1964, No. 100, eff. 5-1-64.

**E 230.022 Service drop conductors.** (1) Conductors in multiple-conductor cables shall be rubber-covered or thermoplastic-covered 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 rubber-covered, thermoplastic-covered, or weatherproof-covered.

**History:** Cr. Register, April, 1964, No. 100, eff. 5-1-64.

**E 230.023 Minimum size of service drop conductors.** 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 subsection E 230.041 (4), where they may be not smaller than No. 12 and shall then be of hard drawn copper or equivalent.

**Note:** Conductors to a building from a pole on which a meter or service switch is installed shall be considered as a service drop and installed accordingly.

**History:** Cr. Register, April, 1964, No. 100, eff. 5-1-64.

**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 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 GROUND.** Conductors shall have a clearance of not less than 10 feet from the ground or from any platform or projection from which they might be reached. See 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 OVER STORAGE TANKS.** Open conductors shall not pass over above-ground 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.

(5) **CLEARANCE FROM WELLS.** Conductors shall not pass over wells and shall have a horizontal clearance of  $\frac{3}{4}$  the required vertical clearance of the conductor.

**History:** Cr. Register, April, 1964, No. 100, eff. 5-1-64.

**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, April, 1964, No. 100, eff. 5-1-64.

**E 230.026 Point of attachment to buildings.** (1) The point of attachment of a service drop to a building 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 sidewalks, 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, April, 1964, No. 100, eff. 5-1-64.

**E 230.027 Means of attachment.** Multiple-conductor cables used for service drops shall be attached to buildings by fittings approved for the purpose. Open conductors shall be attached to non-combustible, nonabsorptive insulators securely attached to the building, or by fittings approved for the purpose.

**History:** Cr. Register, April, 1964, No. 100, eff. 5-1-64.

#### 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, April, 1964, No. 100, eff. 5-1-64.

**E 230.031 Size of underground service conductors.** Same as required for service entrance conductor. See section E 230.041.

**History:** Cr. Register, April, 1964, No. 100, eff. 5-1-64.

**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 subsection E 310.01 (2) and sections E 310.05 and E 310.06. Also see 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, April, 1964, No. 100, eff. 5-1-64.

**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, April, 1964, No. 100, eff. 5-1-64.

**E 230.034 Grounding raceways and cable sheaths.** See section E 230.063.

**History:** Cr. Register, April, 1964, No. 100, eff. 5-1-64.

**E 230.035 Termination at service equipment.** See section E 230.042, exception No. 3, and section E 230.053.

**History:** Cr. Register, April, 1964, No. 100, eff. 5-1-64.

#### **E. SERVICE-ENTRANCE CONDUCTORS**

**E 230.040 Insulation of service-entrance conductors.** (1) Service-entrance conductors extending along the exterior of, or entering, buildings 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 on the exterior of the building only, the conductors may be weatherproof-covered.

(2) Open individual conductors which enter the building shall be rubber-covered or thermoplastic-covered.

**History:** Cr. Register, April, 1964, No. 100, eff. 5-1-64.

**E 230.041 Size of service-entrance conductors.** Service-entrance conductors, including underground services, shall have a current-carrying capacity sufficient to carry the load as determined by 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, and each unit requiring more than two 2-wire branch circuits shall have a 3-wire service. For neutral size on 100 ampere services in dwelling occupancies, see subsection 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 a current-carrying capacity in conformity with subsection E 220.04 (5), but shall not be smaller than the ungrounded conductors when these are No. 8 or smaller.

**History:** Cr. Register, April, 1964, No. 100, eff. 5-1-64.

**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, exception No. 3 (2) 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, April, 1964, No. 100, eff. 5-1-64.

**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, April, 1964, No. 100, eff. 5-1-64.

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Register, April, 1964, No. 100

**F. INSTALLATION OF SERVICE-ENTRANCE CONDUCTORS**

**E 230.044 Wiring methods.** Service-entrance conductors extending along the exterior, or entering buildings, 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, April, 1964, No. 100, eff. 5-1-64.

**E 230.045 Conductor considered outside building.** 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.

**History:** Cr. Register, April, 1964, No. 100, eff. 5-1-64.

**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, April, 1964, No. 100, eff. 5-1-64.

**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, April, 1964, No. 100, eff. 5-1-64.

**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, April, 1964, No. 100, eff. 5-1-64.

**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, April, 1964, No. 100, eff. 5-1-64.

**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, April, 1964, No. 100, eff. 5-1-64.

**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 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 attached to or carried along the surface of a building.

**History:** Cr. Register, April, 1964, No. 100, eff. 5-1-64.

**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, April, 1964, No. 100, eff. 5-1-64.

**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, April, 1964, No. 100, eff. 5-1-64.

**E 230.054 Grounding service raceways and cable armor.** See section E 230.063.

**History:** Cr. Register, April, 1964, No. 100, eff. 5-1-64.

#### G. SERVICE EQUIPMENT

**E 230.060 Hazardous locations.** Service equipment installed in hazardous locations shall comply with the requirements of chapters E 500 to E 517 inclusive.

**History:** Cr. Register, April, 1964, No. 100, eff. 5-1-64.

**E 230.061 Service equipment grouped.** Where supplied at the same side of the building by more than one overhead service drop or more than one set of underground service conductors, the service equipments, except for services as permitted in section E 230.002, shall be grouped and equipment marked to indicate the load it serves.

**History:** Cr. Register, April, 1964, No. 100, eff. 5-1-64.

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Register, April, 1964, No. 100



## 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 ignitable material. Such an enclosure shall be provided with means for locking or sealing doors giving access to live parts.

**History:** Cr. Register, April, 1964, No. 100, eff. 5-1-64.

**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, April, 1964, No. 100, eff. 5-1-64.

## J. DISCONNECTING MEANS

**E 230.070 General.** Each set of service-entrance conductors shall be provided with a readily accessible means of disconnecting all conductors from the source of supply.

(1) **SWITCH AND CIRCUIT-BREAKER.** (a) The disconnecting means shall be manually operable. It may consist of not more than 6\* switches or 6\* circuit-breakers in a common enclosure, or in a group of separate enclosures, located at a readily accessible point nearest to the entrance of the conductors, either inside or outside the building wall. Two or three single pole switches or breakers, capable of individual operation, may be installed on multi-wire circuits, one pole for each ungrounded conductor, as one multi-pole disconnect (where applicable, see section E 230.070 (1) (d)) provided they are equipped with "handle ties", "handles within  $\frac{1}{8}$  inch proximity", a "master handle", or "other means", making it practical to disconnect all conductors of the service with no more than 6\* operations of the hand. The disconnecting means shall be of a type approved for service

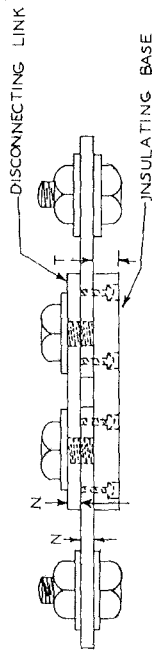
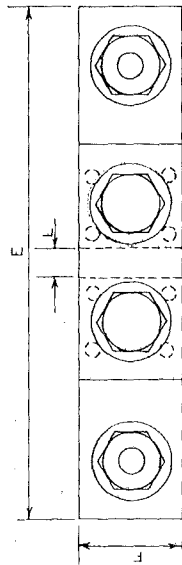
\* Main disconnects for fire pumps, emergency lighting or fire alarm systems shall not be counted as disconnecting means so far as the limit of 6 disconnecting means is concerned.

equipment and for prevailing conditions. 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.

(b) For service 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.

(c) Where the meter is not of the socket type or where current transformers or large self-contained meters are used, the main disconnecting means may consist of not more than 6\* switches or man-

\* Main disconnects for fire pumps, emergency lighting or fire alarm systems shall not be counted as disconnecting means so far as the limit of 6 disconnecting means is concerned.



AMP	E	F	L	N	T
200	6 5/8"	3 1/4"	5/8"	1 1/2"	1 1/2"
400	10"	2 3/4"	3/4"	1 1/4"	1 1/2"

MATERIAL  
 INSULATING BASE - APPROVED GLASS "A" INSULATION  
 STUDS, BOLTS, NUTS & WASHERS - BRASS  
 BARS AND LINK - COPPER BUS CONDUCTOR

CONSTRUCTION SPECIFICATIONS  
 BOLTED LINK TYPE DISCONNECTING  
 MEANS

E-230, 07001(c) 1.a.

ually-operated circuit-breakers, provided one of the following disconnecting means is installed ahead of the meter or the metering transformers:

1. An approved bolted link type disconnecting means for services not to exceed 250 volts and for capacities up to and including 400 amperes.
2. Manually operated disconnecting switches or circuit-breakers.
  - a. For services rated 250 volts or less having a capacity above 400 amperes.
  - b. For all services rated in excess of 250 volts.

*Note:* If such disconnecting means is incapable of being operated under full load, the service on which it is installed must be sealed or otherwise rendered inaccessible to other than qualified persons.

(d) *Simultaneous openings.* The disconnecting means shall simultaneously disconnect all ungrounded conductors, except for 3-wire direct-current or single-phase circuits or multi-wire circuits that do not supply polyphase motors.

*Note:* See subsection E 200.05 (1).

(2) **MULTIPLE-OCCUPANCY.** In a multiple-occupancy building, each occupant 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, the disconnecting means consisting of not more than 6\* switches or 6\* circuit-breakers. 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 (Exception No. 3) and each such service may have not more than 6\* switches or circuit-breakers.

(3) **DISCONNECTION OF GROUNDED CONDUCTOR.** If 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.

(4) **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.

(5) **SAFEGUARDING EMERGENCY SUPPLY.** If an emergency supply is provided to feed the conductors controlled by the service disconnecting means, the disconnecter 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.

**History:** Cr. Register, April, 1964, No. 100, eff. 5-1-64.

**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

\* Main disconnects for fire-pumps, emergency lighting or fire alarm systems shall not be counted as disconnecting means so far as the limit of 6 disconnecting means is concerned.

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 subsection E 230.070 (1), the combined rating shall not be less than required for a single switch or breaker.

**History:** Cr. Register, April, 1964, No. 100, eff. 5-1-64.

**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, April, 1964, No. 100, eff. 5-1-64.

**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, April, 1964, No. 100, eff. 5-1-64.

## K. OVERCURRENT PROTECTION

**E 230.090 Where required.** Each ungrounded service-entrance conductor shall have overcurrent protection.

(1) **UNGROUNDING 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 carrying capacity 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 subsections 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\* circuit-breakers or 6 sets of fuses 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\* circuit-breakers or 6 sets of fuses. 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, exception No. 3 (b) and each such service may have not more than 6\* circuit-breakers or 6 sets of fuses.

*Note:* A set of fuses is all the fuses required to protect all the ungrounded conductors of a circuit. Single pole breakers may be grouped as in subsection E 230.070 (1) as one multiple-protective device.

(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.

(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, April, 1964, No. 100, eff. 5-1-64.

**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, April, 1964, No. 100, eff. 5-1-64.

**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, April, 1964, No. 100, eff. 5-1-64.

**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, April, 1964, No. 100, eff. 5-1-64.

**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.

\* Main disconnects for fire-pumps, emergency lighting or fire alarm systems shall not be counted as disconnecting means so far as the limit of 6 disconnecting means is concerned.

(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, April, 1964, No. 100, eff. 5-1-64.

#### 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 to E 450.43, and under the sole control of the supply company.
- d. Where the transformer primary disconnecting means is in a locked enclosure, accessible to authorized personnel alone.

**Note 2.** 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, April, 1964, No. 100, eff. 5-1-64.

**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 clad switchgear or a transformer vault conforming to the requirements of sections E 450.41 through E 450.48.

(9) **ENCLOSED BY CONCRETE OR BRICK.** Conductors within a building 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.

**History:** Cr. Register, April, 1964, No. 100, eff. 5-1-64.

**E 230.102 Warning signs.** High voltage signs shall be posted where unauthorized persons might come in contact with live parts.

**History:** Cr. Register, April, 1964, No. 100, eff. 5-1-64.

**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.

**History:** Cr. Register, April, 1964, No. 100, eff. 5-1-64.

**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, April, 1964, No. 100, eff. 5-1-64.

**E 230.105 Equipment in secondaries.** If the primary service equipment supplies one or more transformers whose secondary windings feed a single set of mains, and the primary circuit-breaker is manually operable from a point outside the transformer vault or accessible to qualified persons only, the disconnecting means and overcurrent pro-

tection may be omitted from the secondary circuit, provided the setting of the primary circuit-breaker is such as to protect the secondary circuit. If not manually operable from outside the vault, means shall be provided to trip the breaker from outside the vault. In all other cases the secondary circuit shall be provided with a disconnecting means and overcurrent protection as required by various paragraphs of this rule.

*Note:* "Manually operable" calls for a mechanical, rather than only electrical, linkage between the circuit-breaker and the point of operation, and refers to both the opening and closing operations.

*History:* Cr. Register, April, 1964, No. 100, eff. 5-1-64.

**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 sections E 450.41 to E 450.48, or consists of metal-enclosed switchgear, the requirements for overcurrent protection and disconnecting means may be fulfilled by the following:

(a) On circuits of 15,000 volts or less, oil-filled or other fuses of suitable rating and type and complying with subsection E 230.070 (1) (d) may be used without switch or circuit-breaker provided they may be operated as a disconnecting means.

(b) Where the voltage is 25,000 or less, a non-automatic oil switch, an air load-interrupter switch, or other approved switches, capable of interrupting the rated circuit load and suitable fuses may be used.

(c) Automatic-trip circuit-breakers may also be used under the limitations outlined in subsections E 230.106 (1) (a) and (b). Where these limitations are exceeded, an automatic-trip circuit-breaker shall be installed in compliance with the requirements of subsection E 230.106 (2).

(d) Where the voltage is 15,000 or less, a switch capable of interrupting the no-load current of the transformer and suitable fuses may be used, provided the switch is interlocked with a circuit-breaker in the secondary circuit of the transformer so that the switch cannot be opened when the circuit-breaker is closed.

(e) Vaults shall conform to the provisions of sections E 450.41 to E 450.48.

(f) Metal-enclosed switchgear shall consist of a substantial steel structure and a steel enclosure of thickness not less than  $\frac{1}{8}$  inch, over the sides and top. The enclosure shall be furnished as an integral part of the equipment. Where installed over a wood floor, suitable protection thereto shall be provided.

(2) **SERVICE EQUIPMENT NOT IN VAULT OR METAL ENCLOSURE.** Where the service equipment is not in a vault or metal enclosure, requirement for the overcurrent protection and disconnecting means may be fulfilled by the following:

(a) Circuits of not over 25,000 volts, air load-interrupter switches or other approved switches, capable of interrupting the rated circuit load may be used with suitable fuses on a pole outside the building.

(b) On circuits of any voltage, an automatic trip circuit-breaker of suitable current-carrying and interrupting capacity with an overcurrent unit in each ungrounded conductor and so arranged that the operation of any one device will open all ungrounded conductors may



be used. The circuit-breaker shall be located as near as possible to where the service conductors enter the building, or else on a pole outside the building.

(3) **FUSES.** Fuses used as permitted in subsections E 230.106 (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.

**History:** Cr. Register, April, 1964, No. 100, eff. 5-1-64.

**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, April, 1964, No. 100, eff. 5-1-64.