further information, see UL 943, Standard for Ground-Fault Circuit Interrupters.

Ground-Fault Current Path. An electrically conductive path from the point of a ground fault on a wiring system through normally non-current-carrying conductors, equipment, or the earth to electrical supply source.

FPN: Examples of ground-fault current paths are any combination of equipment grounding conductors, metallic raceways, metallic cable sheaths, electrical equipment, and any other electrically conductive material such as metal, water, and gas piping; stucco mesh; metal ducting; reinforcing steel; shields of communications cables; and the earth itself.

Ground-Fault Protection of Equipment. A system intended to provide protection of equipment from damaging line-to-ground fault currents by operating to cause a disconnecting means to open all ungrounded conductors of the faulted circuit. This protection is provided at current levels less than those required to protect conductors from damage through the operation of a supply circuit overcurrent device.

Grounding Conductor, Equipment (EGC). The conductive path(s) that provides a ground-fault current path and connects normally non-current-carrying metal parts of equipment together and to the system grounded conductor or to the grounding electrode conductor, or both.

FPN No. 1: It is recognized that the equipment grounding conductor also performs bonding.

FPN No. 2: See 2.50.6.9 for the list of acceptable equipment grounding conductors.

Grounding Electrode. A device that establishes an electrical connection to the earth.

Grounding Electrode Conductor. The conductor used to connect the grounding electrode(s) to the equipment grounding conductor, to the grounded conductor, or to both, at the service, at each building or structure where supplied by a feeder(s) or branch circuit(s), or at the source of a separately derived system.

Guarded. Covered, shielded, fenced, enclosed, or otherwise protected by means of suitable covers, casings, barriers, rails, screens, mats, or platforms to remove the likelihood of approach or contact by persons or objects to a point of danger.

Guest Room. An accommodation combining living, sleeping, sanitary, and storage facilities within a compartment.

Guest Suite. An accommodation with two or more contiguous rooms comprising a compartment, with or without doors between such rooms, that provides living, sleeping, sanitary, and storage facilities.

Handhole Enclosure. An enclosure identified for use in underground systems, provided with an open or closed bottom, and sized to allow personnel to reach into, but not enter, for the purpose of installing, operating, or maintaining equipment or wiring or both.

Hermatic Refrigerant Motor-Compressor. A combination consisting of a compressor and motor, both of which are enclosed in the same housing, with no external shaft or shaft seals, with the motor operating in the refrigerant.

Hermetically Sealed [as applied to Hazardous (Classified) Locations]. Equipment sealed against the entrance of an exter- nal atmosphere where the seal is made by fusion, for example, soldering, brazing, welding, or the fusion of glass to metal.

FPN: For further information, see ANSI/ ISA-12.12.01-2013, *Nonincendive Electrical Equipment for Use in Class I and II, Division 2, and Class III, Divisions 1 and 2 Hazardous (Classified) Locations*.

Hoistway. Any shaftway, hatchway, well hole, or other vertical opening or space in which an elevator or dumbwaiter is designed to operate.

Hybrid System. A system comprised of multiple power sources. These power sources could include photovoltaic, wind, micro-hydro generators, engine-driven generators, and others, but do not include electric power production and distribution network systems. Energy storage systems such as batteries, flywheels, or superconducting magnetic storage equipment do not constitute a power source for the purpose of this definition. The energy regenerated by an overhauling (descending) elevator does not constitute a power source for the purpose of this definition.

Identified (as applied to equipment). Recognizable as suitable for the specific purpose, function, use, environment, application, and so forth, where described in a particular *Code* requirement.

FPN: Some examples of ways to determine suitability of equipment for a specific purpose, environment, or application include investigations by a qualified testing laboratory (listing and labeling), an inspection agency, or other organizations concerned with product evaluation.

In Sight From (Within Sight From, Within Sight). Where this Code specifies that one equipment shall be "in sight from," "within sight from," or "within sight," and so forth, of another equipment, the specified equipment is to be visible and not more than 15 m distant from the other.

Industrial Control Panel. An assembly of two or more components consisting of one of the following: (1) power circuit components only, such as motor controllers, overload relays, fused disconnect switches,

and circuit breakers; (2) control circuit components only, such as push buttons, pilot lights, selector switches, timers, switches, and control relays; (3) a combination of power and control circuit components. These components, with associated wiring and terminals, are mounted on, or contained within, an enclosure or mounted on a subpanel.

The industrial control panel does not include the controlled equipment.

Information Technology Equipment (ITE). Equipment and systems rated 1000 volts or less, normally found in offices or other business establishments and similar environments classified as ordinary locations, that are used for creation and manipulation of data, voice, video, and similar signals that are not communications equipment as defined in Part 1.0.1 and do not process communications circuits as defined in 8.0.1.2.

FPN: For information on listing requirements for both information technology equipment and communications equipment, see UL 60950-1-2014, *Information Technology Equipment — Safety — Part 1: General Requirements* or UL 62368-1-2014, *Audio/Video Information and Communication Technology Equipment Part 1: Safety Requirements*.

Innerduct. A nonmetallic raceway placed within a larger raceway.

Interactive Inverter. An inverter intended for use in parallel with an electric utility to supply common loads that may deliver power to the utility.

Interactive System. An electric power production system that is operating in parallel with and capable of delivering energy to an electric primary source supply system.

Interrupting Rating. The highest current at rated voltage that a device is intended to interrupt under standard test conditions.

FPN: Equipment intended to interrupt current at other than fault levels may have its interrupting rating implied in other ratings, such as horsepower or locked rotor current.

Intersystem Bonding Termination. A device that provides a means for connecting intersystem bonding conductors for communications systems to the grounding electrode system.

Intrinsically Safe Apparatus. Apparatus in which all the circuits are intrinsically safe.

Intrinsically Safe System [as applied to Hazardous (Classified) Locations]. An assembly of interconnected intrinsically safe apparatus, associated apparatus, and interconnecting cables, in that those parts of the system that may be used in hazardous (classified) locations are intrinsically safe circuits.

FPN: An intrinsically safe system may include more than one intrinsically safe circuit.

Isolated (as applied to location). Not readily accessible to persons unless special means for access are used.

Kitchen. An area with a sink and permanent provisions for food preparation and cooking.

Labeled. Equipment or materials to which has been attached a label, symbol, or other identifying mark of an organization that is concerned with product evaluation, that maintains periodic inspection of production of labeled equipment or materials, and by whose labeling the manufacturer indicates compliance with appropriate standards or performance in a specified manner.

Lighting Outlet. An outlet intended for the direct connection of a lampholder, a luminaire (lighting fixture), or a pendant cord terminating in a lampholder.

Lighting Track (Track Lighting). A manufactured assembly designed to support and energize luminaires that are capable of being readily repositioned on the track. Its length can be altered by the addition or subtraction of sections of track.

Listed. Equipment, materials, or services included in a list published by an organization that is concerned with evaluation of products or services, that maintains periodic inspection of production of listed equipment or materials or periodic evaluation of services, and whose listing states that the equipment, material, or services either meets appropriate designated standards or has been tested and found suitable for a specified purpose.

FPN: The means for identifying listed equipment may vary for each organization concerned with product evaluation, some of which do not recognize equipment as listed unless it is also labeled. Use of the system employed by the listing organization allows the Office of the Building Official/EE to identify a listed product.

Live Parts. Energized conductive components.

FPN: Examples of such locations include partially protected locations under canopies, marquees, roofed open porches, and like locations, and interior locations subject to moderate degrees of moisture, such as some basements, some barns, and some cold-storage warehouses.

Location, Damp. Locations protected from weather and not subject to saturation with water or other liquids but subject to moderate degrees of moisture.

FPN: Examples of such locations include partially protected locations under canopies, marquees, roofed open porches, and like locations, and interior locations subject to moderate degrees of moisture, such as some basements, some barns, and some cold-storage warehouses.

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.

Location, Wet. Installations underground or in concrete slabs or masonry in direct contact with the earth; in locations subject to saturation with water or other liquids, such as vehicle washing areas; and in unprotected locations exposed to weather.

Luminaire. A complete lighting unit consisting of a lamp or lamps together with the parts designed to distribute the light, to position and protect the lamps and ballast (where applicable), and to connect the lamps to the power supply.

Mobile Equipment. Equipment with electrical components suitable to be moved only with mechanical aids or is provided with wheels for movement by person(s) or powered devices.

Motor Control Center. An assembly of one or more enclosed sections having a common power bus and principally containing motor control units.

Multioutlet Assembly. A type of surface, flush, or freestanding raceway designed to hold conductors and receptacles, assembled in the field or at the factory.

National Electrical Engineering Law. A law enacted by Congress providing for a more responsive and comprehensive regulation for the practice, licensing and registration of electrical engineers and electricians otherwise referred to as Republic Act 7920 (RA 7920) or a future law that supersedes it.

Neutral Conductor. The conductor connected to the neutral point of a system that is intended to carry current under normal conditions.

Neutral Point. The common point on a wye-connection in a polyphase system or midpoint on a single-phase, 3-wire system, or midpoint of a single-phase portion of a 3-phase delta system, or a midpoint of a 3-wire, direct-current system.

FPN: At the neutral point of the system, the vectorial sum of the nominal voltages from all other phases within the system that utilize the neutral, with respect to the neutral point, is zero potential.

Nonautomatic. Requiring human intervention to perform a function.

Nonconductive Optical Fiber Cable. A factory assembly of one or more optical fibers having an overall covering and containing no electrically conductive materials.

Nonincendive Circuit [as applied to Hazardous (Classified) Locations]. A circuit, other than field wiring, in which any arc or thermal effect produced under intended operating conditions of the equipment, is not capable, under specified test conditions, of igniting the flammable gas–air, vapor–air, or dust–air mixture.

FPN: Conditions are described in ANSI/ ISA-12.12.01-2013, *Nonincendive Electrical Equipment for Use in Class I and II, Division 2, and Class III, Divisions 1 and 2 Hazardous (Classified) Locations.*

Nonincendive Component [as applied to Hazardous (Classified) Locations]. A component having contacts for making or breaking an incendive circuit and the contacting mechanism is constructed so that the component is incapable of igniting the specified flammable gas–air or vapor–air mixture. The housing of a nonincendive component is not intended to exclude the flammable atmosphere or contain an explosion.

FPN: For further information, see ANSI/ ISA-12.12.01-2013, *Nonincendive Electrical Equipment for Use in Class I and II, Division 2, and Class III, Divisions 1 and 2 Hazardous (Classified) Locations.*

Nonincendive Equipment [as applied to Hazardous (Classified) Locations]. Equipment having electrical/ electronic circuitry that is incapable, under normal operating conditions, of causing ignition of a specified flammable gas–air, vapor–air, or dust–air mixture due to arcing or thermal means.

FPN: For further information, see ANSI/ ISA-12.12.01-2013, *Nonincendive Electrical Equipment for Use in Class I and II, Division 2, and Class III, Divisions 1 and 2 Hazardous (Classified) Locations.*

Nonincendive Field Wiring [as applied to Hazardous (Classified) Locations]. Wiring that enters or leaves an equipment enclosure and, under normal operating conditions of the equipment, is not capable, due to arcing or thermal effects, of igniting the flammable gas–air, vapor–air, or dust–air mixture. Normal operation includes opening, shorting, or grounding the field wiring.

Nonincendive Field Wiring Apparatus [as applied to Hazardous (Classified) Locations]. Apparatus intended to be connected to nonincendive field wiring.

FPN: For further information, see ANSI/ ISA-12.12.01-2013, *Nonincendive Electrical Equipment for Use in Class I and II, Division 2, and Class III, Divisions 1 and 2 Hazardous (Classified) Locations.*

Nonlinear Load. A load where the wave shape of the steady-state current does not follow the wave shape of the applied voltage.

FPN: Electronic equipment, electronic/electric-discharge lighting, adjustable-speed drive systems, and similar equipment may be nonlinear loads.

Oil Immersion [as applied to Hazardous (Classified) Locations]. Electrical equipment immersed in a protective liquid in such a way that an explosive atmosphere that may be above the liquid or outside the enclosure cannot be ignited.

Optical Fiber Cable. A factory assembly or field assembly of one or more optical fibers having an overall covering.

FPN: A field-assembled optical fiber cable is an assembly of one or more optical fibers within a jacket. The jacket, without optical fibers, is installed in a manner similar to conduit or raceway. Once the jacket is installed, the optical fibers are inserted into the jacket, completing the cable assembly.

Outlet. A point on the wiring system at which current is taken to supply utilization equipment.

Outline Lighting. An arrangement of incandescent lamps, electric discharge lighting, or other electrically powered light sources to outline or call attention to certain features such as the shape of a building or the decoration of a window.

Overcurrent. Any current in excess of the rated current of equipment or the ampacity of a conductor. It may result from overload, short circuit, or ground fault.

FPN: A current in excess of rating may be accommodated by certain equipment and conductors for a given set of conditions. Therefore, the rules for overcurrent protection are specific for particular situations.

Overcurrent Protective Device, Branch-Circuit. A device capable of providing protection for service, feeder, and branch circuits and equipment over the full range of overcurrents between its rated current and its interrupting rating. Such devices are provided with interrupting ratings appropriate for the intended use but no less than 5000 amperes.

Overcurrent Protective Device, Supplementary. A device intended to provide limited overcurrent protection for specific applications and utilization equipment such as luminaires and appliances. This limited protection is in addition to the protection provided in the required branch circuit by the branch-circuit overcurrent protective device.

Overload. Operation of equipment in excess of normal, full-load rating, or of a conductor in excess of rated ampacity that, when it persists for a sufficient length of time, would cause damage or dangerous overheating. A fault, such as a short circuit or ground fault, is not an overload.

Panelboard. A single panel or group of panel units designed for assembly in the form of a single panel, including buses and automatic overcurrent devices, and equipped with or without switches for the control of light, heat, or power circuits; designed to be placed in a cabinet or cutout box placed in or against a wall, partition, or other support; and accessible only from the front.

Photovoltaic (PV) System. The total components and subsystem that, in combination, convert solar energy into electric energy suitable for connection to a utilization load.

Plenum. A compartment or chamber to which one or more air ducts are connected and that forms part of the air distribution system.

Portable Equipment. Equipment with electrical components suitable to be moved by a single person without mechanical aids.

Power Outlet. An enclosed assembly that may include receptacles, circuit breakers, fuseholders, fused switches, buses, and watt-hour meter mounting means; intended to supply and control power to mobile homes, recreational vehicles, park trailers, or boats or to serve as a means for distributing power required to operate mobile or temporarily installed equipment.

Premises Wiring (System). That interior and exterior wiring, including power, lighting, control, and signal circuit wiring together with all their associated hardware, fittings, and wiring devices, both permanently and temporarily installed, that extends from the service point or source of power, such as a battery, a solar photovoltaic system, or a generator, transformer, or converter windings, to the outlet(s).

Such wiring does not include wiring internal to appliances, luminaires (fixtures), motors, controllers, motor control centers, and similar equipment.

FPN: Power sources include, but are not limited to, interconnected or stand-alone batteries, solar photovoltaic systems, other distributed generation systems, or generators.

Pressurized [as applied to Hazardous (Classified) Locations]. The process of supplying an enclosure with a protective gas with or without continuous flow, at sufficient pressure to prevent the entrance of combustible dust or ignitible fibers/ flyings.

Process Seal [as applied to Hazardous (Classified) Locations]. A seal between electrical systems and flammable or combustible process fluids where a failure could allow the migration of process fluids into the premises' wiring system.

Purged and Pressurized [as applied to Hazardous (Classified) Locations]. The process of (1) purging, supplying an enclosure with a protective gas at a sufficient flow and positive pressure to reduce the concentration of any flammable gas or vapor initially present to an acceptable level; and (2) pressurization, supplying an enclosure with a protective gas with or without continuous flow at sufficient pressure to prevent the entrance of a flammable gas or vapor, a combustible dust, or an ignitible fiber.

Qualified Person. One who has qualifications, skills and knowledge related to the construction and operation of the electrical equipment and installations and has received safety training to recognize and avoid the hazards involved.

FPN. Qualifications can include those included in the Republic Act 7920 or national electrical engineering law.

Raceway. An enclosed channel of metallic or nonmetallic materials designed expressly for holding wires, cables, or busbars, with additional functions as permitted in this Code.

FPN: A raceway is identified within specific article definitions.

Rainproof. Constructed, protected, or treated so as to prevent rain from interfering with the successful operation of the apparatus under specified test conditions.

Raintight. Constructed or protected so that exposure to a beating rain will not result in the entrance of water under specified test conditions.

Receptacle. A contact device installed at the outlet for the connection of an attachment plug, or for the direct connection of electrical utilization equipment designed to mate with the corresponding contact device. A single receptacle is a single contact device with no other contact device on the same yoke. A multiple receptacle is two or more contact devices on the same yoke.

Receptacle Outlet. An outlet where one or more receptacles are installed.

Remote-Control Circuit. Any electric circuit that controls any other circuit through a relay or an equivalent device.

Retrofit Kit. A general term for a complete subassembly of parts and devices for field conversion of utilization equipment.

Sealable Equipment. Equipment enclosed in a case or cabinet that is provided with a means of 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.

FPN: The equipment may or may not be operable without opening the enclosure.

Separately Derived System. An electrical source, other than a service, having no direct connection(s) to circuit conductors of any other electrical source other than those established by grounding and bonding connections.

Service. The conductors and equipment for delivering electric energy from the serving utility to the wiring system of the premises served.

Service Cable. Service conductors made up in the form of a cable.

Service Conductors. The conductors from the service point to the service disconnecting means.

Service Conductors, Overhead. The overhead conductors between the service point and the first point of connection to the service-entrance conductors at the building or other structure.

Service Conductors, Underground. The underground conductors between the service point and the first point of connection to the service-entrance conductors in a terminal box, meter, or other enclosure, inside or outside the building wall.

FPN: Where there is no terminal box, meter, or other enclosure, the point of connection is considered to be the point of entrance of the service conductors into the building.

Service Drop. The overhead conductors between the utility electric supply system and the service point.

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 or overhead service conductors.

Service-Entrance Conductors, Underground System. The service conductors between the terminals of the service equipment and the point of connection to the service lateral or underground service conductors.

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

Service Equipment. The necessary equipment, usually consisting of a circuit breaker(s) or switch(es) and fuse(s) and their accessories, connected to the load end of service conductors to a building or other structure, or an otherwise designated area, and intended to constitute the main control and cutoff of the supply.

Service Lateral. The underground conductors between the utility electric supply system and the service point.

Service Point. The point of connection between the facilities of the serving utility and the premises wiring.

FPN: The service point can be described as the point of demarcation between where the serving utility ends and the premises wiring begins. The serving utility generally specifies the location of the service point based on the conditions of service.

Service Protective Device. Enclosed fusible switch or circuit breaker installed ahead of the service equipment, nearest the service point (usually, immediately after the metering equipment), intended to provide short circuit fault protection for service-entrance conductors.

Short-Circuit Current Rating. The prospective symmetrical fault current at a nominal voltage to which an apparatus or system is able to be connected without sustaining damage exceeding defined acceptance criteria.

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.

Signaling Circuit. Any electric circuit that energizes signaling equipment.

Simple Apparatus [as applied to Hazardous (Classified) Locations]. An electrical component or combination of components of simple construction with well-defined electrical parameters that does not generate more than 1.5 volts, 100 mA, and 25 mW, or a passive component that does not dissipate more than 1.3 watts and is compatible with the intrinsic safety of the circuit in which it is used.

FPN: The following apparatus are examples of simple apparatus:

(1) Passive components; for example, switches, junction boxes, resistance temperature devices, and simple semiconductor devices such as LEDs

(2) Sources of stored energy consisting of single components in simple circuits with well-defined parameters; for example, capacitors or inductors, whose values are considered when determining the overall safety of the system

(3) Sources of generated energy; for example, thermocouples and photocells, that do not generate more than 1.5 volts, 100 mA, and 25 mW

Stand-Alone System. A system that supplies power independently of an electrical production and distribution network.

Structure. That which is built or constructed, other than equipment.

Surge Arrester. A protective device for limiting surge voltages by discharging or bypassing surge current; it also prevents continued flow of follow current while remaining capable of repeating these functions.

Surge-Protective Device (SPD). A protective device for limiting transient voltages by diverting or limiting surge current; it also prevents continued flow of follow current while remaining capable of repeating these functions and is designated as follows:

Type 1: Permanently connected SPDs intended for installation between the secondary of the service transformer and the line side of the service disconnect overcurrent device.

Type 2: Permanently connected SPDs intended for installation on the load side of the service disconnect overcurrent device, including SPDs located at the branch panel.

Type 3: Point of utilization SPDs.

Type 4: Component SPDs, including discrete components, as well as assemblies.

FPN: For further information on Type 1, Type 2, Type 3, and Type 4 SPDs, see UL 1449, Standard for Surge Protective Devices.

Switch, Bypass Isolation. A manually operated device used in conjunction with a transfer switch to provide a means of directly connecting load conductors to a power source and of disconnecting the transfer switch.

Switch, General-Use. 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.

Switch, General-Use Snap. A form of general-use switch constructed so that it can be installed in device boxes or on box covers, or otherwise used in conjunction with wiring systems recognized by this Code.

Switch, Isolating. 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.

Switch, Motor-Circuit. A switch rated in horsepower that is capable of interrupting the maximum operating overload current of a motor of the same horsepower rating as the switch at the rated voltage.

Switch, Transfer. An automatic or nonautomatic device for transferring one or more load conductor connections from one power source to another.

Switchboard. A large single panel, frame, or assembly of panels on which are mounted on the face, 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.

Switchgear. An assembly completely enclosed on all sides and top with sheet metal (except for ventilating openings and inspection windows) and containing primary power circuit switching, interrupting devices, or both, with buses and connections. The assembly may include control and auxiliary devices. Access to the interior of the enclosure is provided by doors, removable covers, or both.

FPN: All switchgear subject to PEC I requirements is metal enclosed. Switchgear rated below 1000 V or less may be identified as "low-voltage power circuit breaker switchgear." Switchgear rated over 1000 V may be identified as "metal-enclosed switchgear" or "metal-clad switchgear." Switchgear is available in non–arc-resistant or arc-resistant constructions.

Thermal Protector (as applied to motors). A protective device for assembly as an integral part of a motor or motor-compressor that, when properly applied, protects the motor against dangerous overheating due to overload and failure to start.

FPN: The thermal protector may consist of one or more sensing elements integral with the motor or motor-compressor and an external control device.

Thermally Protected (as applied to motors). The words *Thermally Protected* appearing on the nameplate of a motor or motor-compressor indicate that the motor is provided with a thermal protector.

Unclassified Locations [as applied to Hazardous (Classified) Locations]. Locations determined to be neither Class I, Divi- sion 1; Class I, Division 2; Class I, Zone 0; Class I, Zone 1; Class I, Zone 2; Class II, Division 1; Class II, Division 2; Class III, Division 1; Class III, Division 2; Zone 20; Zone 21; Zone 22; nor any combination thereof.

Ungrounded. Not connected to ground or to a conductive body that extends the ground connection.

Uninterruptible Power Supply. A power supply used to provide alternating current power to a load for some period of time in the event of a power failure.

FPN: In addition, it may provide a more constant voltage and frequency supply to the load, reducing the effects of voltage and frequency variations.

Utilization Equipment. Equipment that utilizes electric energy for electronic, electromechanical, chemical, heating, lighting, or similar purposes.

Ventilated. Provided with a means to permit circulation of air sufficient to remove an excess of heat, fumes, or vapors.

Volatile Flammable Liquid. A flammable liquid having a flash point below 38°C, or a flammable liquid whose temperature is above its flash point, or a Class II combustible liquid that has a vapor pressure not exceeding 276 kPa at 38°C and whose temperature is above its flash point.

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

FPN: Some systems, such as 3-phase 4-wire, single-phase 3-wire, and 3-wire direct current, may have various circuits of various voltages.

Voltage, Nominal. A nominal value assigned to a circuit or system for the purpose of conveniently designating its voltage class (e.g., 230, 230/115, 460, 460Y/265, 400Y/230, 216Y/125). The actual voltage at which a circuit operates can vary from the nominal within a range that permits satisfactory operation of equipment.

FPN No. 1: See ANSI C84.1-1995, Voltage Ratings for Electric Power Systems and Equipment (60 Hz).

FPN No. 2: Certain battery units may be consid- ered to be rated at nominal 48 volts dc, but may have a charging float voltage up to 58 volts. In dc applications, 60 volts is used to cover the entire range of float voltages.

Voltage to Ground. For grounded circuits, the voltage between the given conductor and that point or conductor of the circuit that is grounded; for ungrounded circuits, the greatest voltage between the given conductor and any other conductor of the circuit.

Watertight. Constructed so that moisture will not enter the enclosure under specified test conditions.

Weatherproof. Constructed or protected so that exposure to the weather will not interfere with successful operation.

FPN: Rainproof, raintight, or watertight equipment can fulfill the requirements for weatherproof where varying weather conditions other than wetness, such dust, or temperature extremes, are not a factor.

1.1.2 Over 1000 Volts, Nominal

Electronically Actuated Fuse. An overcurrent protective device that generally consists of a control module that provides current sensing, electronically derived time–current characteristics, energy to initiate tripping, and an interrupting module that interrupts current when an overcurrent occurs. Electronically actuated fuses may or may not operate in a current-limiting fashion, depending on the type of control selected.

Fuse. An overcurrent protective device with a circuit-opening fusible part that is heated and severed by the passage of overcurrent through it.

FPN: A fuse comprises all the parts that form a unit capable of performing the prescribed functions. It may or may not be the complete device necessary to connect it into an electrical circuit.

Controlled Vented Power Fuse. A fuse with provision for controlling discharge circuit interruption such that no solid material may be exhausted into the surrounding atmosphere.

FPN: The fuse is designed so that discharged gases will not ignite or damage insulation in the path of the discharge or propagate a flashover to or between grounded members or conduction members in the path of the discharge where the distance between the vent and such insulation or conduction members conforms to manufacturer's recommendations.

Expulsion Fuse Unit (Expulsion Fuse). A vented fuse unit in which the expulsion effect of gases produced by the arc and lining of the fuseholder, either alone or aided by a spring, extinguishes the arc.

Nonvented Power Fuse. A fuse without intentional provision for the escape of arc gases, liquids, or solid particles to the atmosphere during circuit interruption.

Power Fuse Unit. A vented, nonvented, or controlled vented fuse unit in which the arc is extinguished by being drawn through solid material, granular material, or liquid, either alone or aided by a spring.

Vented Power Fuse. A fuse with provision for the escape of arc gases, liquids, or solid particles to the surrounding atmosphere during circuit interruption.

Multiple Fuse. An assembly of two or more single-pole fuses.

Substation. An assemblage of equipment (e.g., switches, interrupting devices, circuit breakers, buses, and transformers) through which electric energy is passed for the purpose of distribution, switching, or modifying its characteristics.

Switching Device. A device designed to close, open, or both, one or more electric circuits.

Circuit Breaker. A switching device capable of making, carrying, and interrupting currents under normal circuit conditions, and also of making, carrying for a specified time, and interrupting currents under specified abnormal circuit conditions, such as those of short circuit.

Cutout. An assembly of a fuse support with either a fuseholder, fuse carrier, or disconnecting blade. The fuseholder or fuse carrier may include a conducting element (fuse link) or may act as the disconnecting blade by the inclusion of a nonfusible member.

Disconnecting (or Isolating) Switch (Disconnector, Isolator). A mechanical switching device used for isolating a circuit or equipment from a source of power.

Disconnecting Means. A device, group of devices, or other means whereby the conductors of a circuit can be disconnected from their source of supply.

Interrupter Switch. A switch capable of making, carrying, and interrupting specified currents.

Oil Cutout (Oil-Filled Cutout). A cutout in which all or part of the fuse support and its fuse link or disconnecting blade is mounted in oil with complete immersion of the contacts and the fusible portion of the conducting element (fuse link) so that arc interruption by severing of the fuse link or by opening of the contacts will occur under oil.

Oil Switch. A switch having contacts that operate under oil (or askarel or other suitable liquid).

Regulator Bypass Switch. A specific device or combination of devices designed to bypass a regulator.

ARTICLE 1.2 — PERMITS AND INSPECTION CERTIFICATES

1.2.1 Electrical Permits

1.2.1.1 Electrical Permit Needed Before Work is Started. Before starting any installation work, alternation, repair or extension on any electrical system, the owners, lessors, operators, occupants, or licensed electrical practitioners shall obtain Electrical Permit for buildings, trailers, mobile homes, or other premises from the Office of the Building Official (OBO), and for watercrafts from the authority for maritime concerns. In securing the electrical permit, the services of a licensed electrical practitioner is required under the Republic Act 7920 or national electrical engineering law.

1.2.1.2 Requirement for Electrical Permit: Signatures and submittals.

(A) The Electrical Permit shall include the following minimum information:

1. Applicant.

2.Professional Electrical Engineer who signed and sealed electrical plans and specifications, with photocopy of valid Professional Tax Receipt (PTR) and valid Professional Regulation Commission (PRC) License.

3. Licensed Electrical Practitioner who is in-charge of electrical works, with photocopy of valid PTR and valid PRC License.

4. Building Owner.

5. Lot Owner.

6. Building Official

FPN: Refer to Appendix E.

(B) Five (5) sets of complete electrical plans and specifications signed and sealed by Professional Electrical Engineer.

1.2.1.3 Electrical Permit to Be Issued Immediately.

(A) The application, upon receipt, shall be checked immediately by the electrical engineer of the local building office or his representatives for compliance with

the requirements. If complying, the Electrical Permits shall be issued upon payment of the corresponding electrical fees.

(B) If the project is extensive and requires more time for checking of the routinary fiscal and ministerial requirements, the issuance of the Electrical Permit need not be issued immediately. The delay shall not be longer than five (5) working days, after which time, the application together with the accompanying plans shall be considered as complying with all the requirements and the electrical permit shall be issued immediately thereafter.

1.2.1.4 Posting of Electrical Permit. A copy of the Electrical Permit, upon issuance, shall be posted at a conspicuous location at the job site and shall not be removed until final inspection and approval of the work shall have been made.

Licensed Electrical Practitioner in-charge of the design, and the licensed electrical practitioner in-charge of the installation shall post a copy of their respective valid Professional Regulation Commission (PRC) identification card together with the electrical permit at all times.

1.2.2 Electrical Inspection

1.2.2.1 Application for Inspection. An application for inspection shall be filed with the Office of the Building Official (OBO) before a preliminary and/or final inspection is done.

1.2.2.2 Certificate of Inspection. No electrical installation, alteration, and/or addition shall be connected or reconnected to any power supply or any other source of electrical energy without a Certificate of Final Electrical Inspection/Completion obtained from the Office of the Building Official (OBO) signed by the Office of the Building Official/EE (OBO/EE).

Exception: A temporary Certificate of Inspection may be signed by the Office of the Building Official/EE (OBO/EE) for the purpose of testing and commissioning the installed equipment within the premises. Validity date shall be indicated in such certificate.

1.2.3 Special

1.2.3.1 Temporary Installation. For temporary electrical installation, the same procedure as stated above shall be followed. At the end of the period covered by the certificate of inspection, the temporary installation shall be removed. Extended use of the temporary installation shall require an extension or renewal of the electrical permit from the Office of the Building Official (OBO) signed by the Office of the Building Official/EE (OBO/EE).

1.2.3.4 Reconnection of Disconnected Services. In cases where service has been cut off for more than one (1) year, a new certificate of final electrical inspection shall be required before reconnection.

ARTICLE 1.3 — ELECTRICAL PLANS AND SPECIFICATIONS

1.3.1 General

1.3.1.1 Drawing Sheet Sizes.

(A) Electrical plans and drawings shall be drawn on drawing sheets of the following standard sizes:

760 mm	x	1000 mm
600 mm	x	900 mm
500 mm	x	760 mm

(B) In cases such as projects of large magnitude, exemption in the use of the standard drawing sheets may be granted by the office of the local building official.

(C) For a dwelling unit having a floor area of not more than 50 square meters with a total load not exceeding 3680 VA, a drawing sheet of size 297 mm x 420 mm (A3 size) is permitted.

1.3.1.2 Drawing Scale. Appropriate metric drawing scales shall be used.

1.3.1.3. Graphic Scale. Since the size of the drawing sheet can be changed photographically, graphic scale shall be shown on each drawing sheet.

FPN: Graphic scale denotes nominal or average plan scale and remains true when plans are photographically reduced.

1.3.2 Plans and Specifications

1.3.2.1 Plan Requirements.

(A) Location and Site Plans. Location and site plans, with proposed structure and owner's land drawn to appropriate metric scale shall show:

(1) Bordering areas showing public or well-known streets, landmarks and/or structures which need not be drawn to scale unless they extend into the area concerned;

(2) Location of service drop, service equipment and nearest pole of the utility company furnishing electrical energy; location of the meter as well as sizes of service entrance wires, conduits and service equipment; and

(3) Clearance of the path or run of service drops and entrance wires to adjacent existing and/or proposed structures.

(B) Legend or Symbols. Refer to Appendix A – Electrical Symbols

(C) General Notes and/or Specifications. General Notes and/or Specifications, written on the plans or submitted on separate standard size sheets shall show:

(1) Nature of electrical service, including number of phases, number of wires, voltage and frequency;

(2) Type of wiring;

a. Service entrance

b. Feeders, sub-feeders and branch circuit wires for lighting and/or power load

c. Fire alarm system, if required by law

d. Signaling and communication

(3) Special equipment to be installed, indicating ratings and classification of service or duty cycle of;

a. Rectifiers

b. Heaters

c. X-ray apparatus

d. Electric welding equipment

e. Others

(4) System or method of grounding;

(5) Type and rating of main disconnecting means, overcurrent protection (OCP) and branch circuit wiring;

(6) Clearances of service drop, burial depth for service lateral, mounting height and clearance for service equipment, mounting height and clearance for kWh meter.

(D) Electrical Layout. Floor plan showing location of equipment and devices, and their interconnection wiring.

(1) **Plan for Power.** Layout and wiring plans for power on the floor plans drawn to scale, shall show:

a. Sizes and location of service entrance conductors, raceways, metering equipment, main switchboard, layout of feeders and distribution panels or switches and their sizes, types and ratings;

b. Complete circuits of motors and other electrical equipment, their controlling devices, their locations and ratings;

c. Complete wiring of emergency power system, if any;

d. Nature of processes/activities carried out in each room or area

FPN: In residences, apartment houses and small commercial establishments, layout of equipment and motors of one horsepower or less may be incorporated in the layout for General Lighting and Receptacle Outlets. In general, layout of motors and power outlets not exceeding a total of ten, may be included in the lighting layout provided such inclusion will not make reading, interpretation and/or checking of said plan difficult.

(2) **Plan for Lighting and Receptacle Outlets.** Layout and wiring plans for general lighting and receptacle outlets on floor plans drawn to scale, shall show:

a. Location, type and rating of lighting fixtures, indicating illumination in lux in each room or area. In residences, hotels, apartment houses, and churches, the illumination level in each room or area need not be shown nor computed;

b. Location of switches for each fixtures or group of fixtures;

c. Location of receptacle outlets and appliances to be served and their ratings;

d. Complete circuits of the lighting and receptacle outlets;

e. Complete wiring of emergency lighting system, if any;

f. A separate drawing showing layout of receptacle outlets may be made at the discretion of the design engineer.

(3) **Plan for Fire Alarm Circuits.** Layout and wiring plans of fire alarm station, fire alarm bell, fire alarm control panel, and other shall be drawn to scale and show:

a. Location of outlets, equipment and/or apparatus and controls;

b. Complete circuit showing no. and size of raceway and wire;

(E) Schedule of Loads. Schedule of load in tabulated form shall indicate:

(1) Motor Loads;

a. Motors as numbered or identified in power layout

b. Type of motor

c. Horsepower/kilowatt/kilovolt ampere rating

d. Voltage rating

e. Full-load current rating

f. Frequency rating other than 60 hertz

g. Number of phases

h. Type and size of wiring

i. Protective device rating

(2) Lighting and Receptacle Loads;

a. Panel as numbered in the feeder diagram

b. Circuit designation number

c. Number of lighting outlets in each circuit

d. Number of switches in each circuit

e. Number of receptacles outlets (convenience outlets)

f. Voltage of circuit

g. Type and size of wiring

h. Protective device rating

(3) Other Loads.

a. Designation number on plan

b. Description of load

c. Classification of service duty, if required

d. Rating of kilovolt-ampere or kilowatt

e. Phase loading indicating full load line current

f. Voltage rating

g. Type and size of wiring

h. Protective device rating

(F) Design Analysis. Design analysis shall be included on the drawings or shall be submitted on separate sheets of standard size, and shall show:

(1) Branch circuits, sub-feeders, feeders, busways, and service entrance;

(2) Types, ratings, and trip settings of overload protective devices;

(3) Calculation of voltage drops.

(4) Calculation of short circuit current for determining the interrupting capacity of overurrent protective device for residential, commercial, and industrial establishment;

(5) Protection coordination of overcurrent protective devices;

(6) Arc-Flash Hazard Analysis to determine the required personal protective equipment (PPE) in other than dwelling place - (see Appendix H for PPE)

FPN No. 1: This analysis is not required for dwelling units but required for service equipment and other electrical equipment not part of the individual dwelling units of residential condominiums and individual detached dwelling units.

FPN No. 2: Arc-flash hazard analysis required is intended for concerned parties to be informed and made aware of the importance of personal protective equipment (PPE) and its type for the flash hazard risk category determined by the analysis. Further overcurrent protective devices coordination coupled with flash hazard analysis can reduce the severity of PPE needed but is not required under this arc-flash hazard analysis.

FPN No. 3: IEEE Std 1584-2002, Guide for Performing Arc-Flash Hazard Calculations provides guidelines for arc-flash hazard analysis.

(G) One Line Diagram. One line diagram shall indicate:

(1) Lighting and Receptacle Outlet Loads;

a. Single line or schematics diagram of lighting and receptacles panelboards showing mains and branch circuit rating;

b. Size of conductors for feeders.

(2) Motor Loads;

a. Rating in kilowatts/horsepower/kilovolt ampere

b. Full load current

c. Locked rotor current

d. Phase connection for 1-phase motor on a 3-phase system

e. Rated voltage

f. Type and size of wiring, indicating load in amperes

g. Electric motors shall be numbered consecutively to correspond to their numbers in the layout

(3) Feeders and Subfeeders;

a. Identification and/or labeling of feeders and subfeeders

b. Size and type of wires and raceway

c. Protective devices and controls

d. The allowable ampacity of the conductor over the designed load current in amperes expressed as a ratio and indicated along side the conductor

(4) Load Center.

a. Identification and/or labeling of load center showing type and rating of transformer, switches, circuit breaker and other related devices

b. Incoming and outgoing feeders, type, size and voltage

c. Equipment grounding

1.3.2.2 Title Block. Title block or nameplate of plans and drawing shall be a standard strip of 40 mm high at the bottom of the sheet.

It shall contain the following:

(A) Name and location of installation or project;

(B) Name, signature and address of owner/manager/ operator;

(C) Title of sheet;

(D) Name, signature and seal of Professional Electrical Engineer together with Professional Regulation Commission professional license number and validity, Professional Tax Receipt Number, and Tax Identification Number;

(E) Scale used, date drawn; and

(F) Sheet number.

1.3.2.3 Other Details.

(A) Exposed conductors shall show:

(1) Means of support and types of insulators; and

(2) Spacings and clearances.

(B) Auxiliary gutters, wireways, busways, cabinets, boxes, metallic raceways, underground installations, other than specified in the *Code* shall show:

(1) Installation details;

(2) Conductor supports, separators, and attachments where required by this *Code*; and

(3) Dimensions and description or specifications.

(C) Private pole installations shall show:

(1) Construction and installation details and dimensions;

(2) Pole top wiring details including line hardware; and

(3) Guying details.

(D) Low energy power and low voltage power installation shall show:

(1) Details of battery installation and/or other source of low voltage or low energy power;

(2) Equipment, wiring, actuating mechanism and protective devices; and

(3) Ventilation details whenever necessary.

1.3.3 Substation Plans and Specifications

1.3.3.1 Indoor Substation. Indoor substation plans shall show:

(A) Location and dimensions of;

(1) Substation in building plan drawn to scale,

(2) Building with respect to entire compound or property,

(3) Incoming and outgoing lines, and

(4) Windows, doors, and other openings.

(B) Substation structural requirements;

(1) Materials and construction of walls, floors, roof, windows, enclosures, doors, and their dimensions, and

(2) Ventilation and drainage systems and other safeguards.

(C) Substation electrical requirements such as;

(1) Plan view showing location and sizes of equipment installed,

(2) Clearances and spacings between exposed current-carrying and noncurrent-carrying portions and grounding equipment, and

(3) Grounding system.

(D) Cross sectional views showing;

(1) Horizontal and vertical clearances between exposed parts and adjacent surfaces,

(2) Horizontal and vertical clearances of exposed parts from floor/ceiling,

(3) Finished floor level and ground level.

(E) Miscellaneous;

(1) Specification of equipment,

(2) Wiring of lighting and remote control systems,

(3) One-line diagram(s) of entire installation with voltage indicated,

(4) Computations on size of wires, busbar, transformer, fuses, switches and breaker, and

(5) Class of insulation or insulators.

1.3.3.2 Outdoor Substation. Outdoor substation plans shall show same items as indoor substation except that in lieu of walls and roof, details of fence and supporting steel structure shall be shown in accordance with the latest edition of the Philippine Electrical Code, Part 2.

ARTICLE 1.10 — REQUIREMENTS FOR ELECTRICAL INSTALLATIONS

1.10.1 General

1.10.1.1 Scope. This article covers general requirements for the examination and approval, installation and use, access to and spaces about electrical conductors and equipment; enclosures intended for personnel entry; and tunnel installations.

1.10.1.2 Approval. The conductors and equipment required or permitted by this Code shall be acceptable only if approved.

FPN: See 1.0.1.7, Examination of Equipment for Safety, and 1.10.1.3, Examination, Identification, Installation, and Use of Equipment. See definitions of Approved, Identified, Labeled, and Listed.

1.10.1.3 Examination, Identification, Installation, Use, and Listing (Product Certification) of Equipment.

(A) Examination. In judging equipment, considerations such as the following shall be evaluated:

(1) Suitability for installation and use in conformity with the provisions of this *Code*

FPN No. 1: Equipment may be new, reconditioned, refurbished, or remanufactured.

FPN No. 2: Suitability of equipment use may be identified by a description marked on or provided with a product to identify the suitability of the product for a specific purpose, environment, or application. Suitability of equipment may be evidenced by listing or labeling.

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

(3) Wire-bending and connection space

(4) Electrical insulation

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

(6) Arcing effects

(7) Classification by type, size, voltage, current capacity, and specific use

(8) Other factors that contribute to the practical safeguarding of persons using or likely to come in contact with the equipment

(B) Installation and Use. Listed or labeled equipment shall be installed and used in accordance with any instructions included in the listing or labeling.

(C) Listing. Product testing, evaluation, and listing (product certification) shall be performed by recognized qualified electrical testing laboratories and shall be in accordance with applicable product standards recognized as achieving equivalent and effective safety for equipment installed to comply with this *Code*.

FPN: The Occupational Safety and Health Administration (OSHA) recognizes qualified electrical testing laboratories that perform evaluations, testing, and certification of certain products to ensure that they meet the requirements of both the construction and general industry OSHA electrical standards. If the listing (product certification) is done under a qualified electrical testing laboratory program, this listing mark signifies that the tested and certified product complies with the requirements of one or more appropriate product safety test standards.

1.10.1.4 Voltages. Throughout this Code, the voltage considered shall be that at which the circuit operates. The voltage rating of electrical equipment shall not be less than the nominal voltage of a circuit to which it is connected.

1.10.1.5 Conductors. Conductors normally used to carry current shall be of copper or aluminum unless otherwise provided in this Code. Where the conductor material is not specified, the sizes given in this Code shall apply to copper conductors. Where other materials are used, the size shall be changed accordingly.

FPN: For copper-clad aluminum conductors, see 3.10.1.15.

1.10.1.6 Conductor Sizes. Conductor sizes are expressed in metric system (SI).

1.10.1.7 Wiring Integrity. Completed wiring installations shall be free from short circuits and from grounds other than as required or permitted in Article 2.50.

1.10.1.8 Wiring Methods. Only wiring methods recognized as suitable are included in this Code. The recognized methods of wiring shall be permitted to be installed in any type of building or occupancy, except as otherwise provided in this *Code*.

1.10.1.9 Interrupting Rating. Equipment intended to interrupt current at fault levels shall have an interrupting rating sufficient for the nominal circuit voltage at least equal to the current that is available at the line terminals of the equipment.

Equipment intended to interrupt current at other than fault levels shall have an interrupting rating at nominal circuit voltage at least equal to the current that must be interrupted.

1.10.1.10 Circuit Impedance, Short-Circuit Current Ratings, and Other Characteristics. The overcurrent protective devices, the total impedance, the equipment short-circuit current ratings, and other characteristics of the circuit to be protected shall be selected and coordinated to permit the circuit protective devices used to clear a fault to do so without extensive damage

to the electrical equipment of the circuit. This fault shall be assumed to be either between two or more of the circuit conductors or between any circuit conductor and the equipment grounding conductor(s) permitted in 2.50.6.9. Listed equipment applied in accordance with their listing shall be considered to meet the requirements of this section.

1.10.1.11 Deteriorating Agents. Unless identified for use in the operating environment, no conductors or equipment shall be located in damp or wet locations; where exposed to gases, fumes, vapors, liquids, or other agents that have a deteriorating effect on the conductors or equipment; or where exposed to excessive temperatures.

FPN No. 1: See 3.0.1.6 for protection against corrosion.

FPN No. 2: Some cleaning and lubricating compounds can cause severe deterioration of many plastic materials used for insulating and structural applications in equipment.

Equipment identified only as "dry locations," "Type 1," or "indoor use only" shall be protected against permanent damage from the weather during building construction.

FPN No. 3: See Table 1.10.2.3 for appropriate enclosure-type designations.

FPN No. 4: Minimum flood provisions are provided in NFPA 5000-2015 *Building Construction and Safety Code*, the *International Building Code (IBC)*, and the *International Residential Code for One- and Two-Family Dwellings (IRC)*.

1.10.1.12 Listed and Labeled When Not Required. Electrical equipment, materials and services shall not be required to be Listed and/or Labeled when local or international product and services standards do not require listing and/or labeling

1.10.1.13 Mechanical Execution of Work. Electrical equipment shall be installed in a neat and workmanlike manner.

FPN: Accepted industry practices are described in ANSI/ NECA 1-2015, Standard for Good Workmanship in Electrical Contracting, and other ANSI-approved installation standards.

(A) Unused Openings. Unused openings, other than those intended for the operation of equipment, those intended for mounting purposes, or those permitted as part of the design for listed equipment, shall be closed to afford protection substantially equivalent to the wall of the equipment. Where metallic plugs or plates are used with nonmetallic enclosures, they shall be recessed at least 6 mm from the outer surface of the enclosure.

(B) Integrity of Electrical Equipment and Connections. Internal parts of electrical equipment, including busbars, wiring terminals, insulators, and other surfaces, shall not be damaged or contaminated by foreign materials such as paint, plaster, cleaners, abrasives, or corrosive residues. There shall be no damaged parts that may adversely affect safe operation or mechanical strength of the equipment such as parts that are broken; bent; cut; or deteriorated by corrosion, chemical action, or overheating.

1.10.1.14 Mounting and Cooling of Equipment.

(A) Mounting. 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 used.

(B) Cooling. Electrical equipment that depends on the natural circulation of air and convection principles for cooling of exposed surfaces shall be installed so that room airflow over such surfaces is not prevented by walls or by adjacent installed equipment. For equipment designed for floor mounting, clearance between top surfaces and adjacent surfaces shall be provided to dissipate rising warm air.

Electrical equipment provided with ventilating openings shall be installed so that walls or other obstructions do not prevent the free circulation of air through the equipment.

1.10.1.15 Electrical Connections. Because of different characteristics of dissimilar metals, devices such as pressure terminal or pressure splicing connectors and soldering lugs shall be identified for the material of the conductor and shall be properly installed and used. Conductors of dissimilar metals shall not be intermixed in a terminal or splicing connector where physical contact occurs between dissimilar conductors (such as copper and aluminum, copper and copper-clad aluminum, or aluminum and copper-clad aluminum), unless the device is identified for the purpose and conditions of use. Materials such as solder, fluxes, inhibitors, and compounds, where employed, shall be suitable for the use and shall be of a type that will not adversely affect the conductors, installation, or equipment.

Connectors and terminals for conductors more finely stranded than Class B and Class C stranding as shown in Chapter 10, Table 10.1.1.10, shall be identified for the specific conductor class or classes.

(A) Terminals. Connection of conductors to terminal parts shall ensure a thoroughly good connection without damaging the conductors and shall be made by means of pressure connectors (including set-screw type), solder lugs, or splices to flexible leads. Connection by means of wire-binding screws or studs and nuts that have upturned lugs or the equivalent shall be permitted for 5.5 mm^2 (2.6 mm dia.) or smaller conductors.

Terminals for more than one conductor and terminals used to connect aluminum shall be so identified.

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

Wire connectors or splicing means installed on conductors for direct burial shall be listed for such use.

(C) Temperature Limitations. The temperature rating associated with the ampacity of a conductor shall be selected and coordinated so as not to exceed the lowest temperature rating of any connected termination, conductor, or device. Conductors with temperature ratings higher than specified for terminations shall be permitted to be used for ampacity adjustment, correction, or both.

(1) **Equipment Provisions**. The determination of termination provisions of equipment shall be based on 1.10.1.14(C)(1)a or (C)(1)b. Unless the equipment is listed and marked otherwise, conductor ampacities used in determining equipment termination provisions shall be based on Table 3.10.2.6 as appropriately modified by 3.10.2.6(B)(6).

a. Termination provisions of equipment for circuits rated 100 amperes or less, or marked for 2.0 mm^2 (1.6 mm dia.) through 38 mm^2 conductors, shall be used only for one of the following:

1. Conductors rated 60°C

2. Conductors with higher temperature ratings, provided the ampacity of such conductors is determined based on the 60°C ampacity of the conductor size used.

3. Conductors with higher temperature ratings if the equipment is listed and identified for use with such conductors.

4. For motors marked with design letters B, C, or D, conductors having an insulation rating of 75°C or higher shall be permitted to be used, provided the ampacity of such conductors does not exceed the 75°C ampacity.

b. Termination provisions of equipment for circuits rated over 100 amperes, or marked for conductors larger than 38 mm^2, shall be used only for one of the following:

1. Conductors rated 75°C

2. Conductors with higher temperature ratings, provided the ampacity of such conductors does not exceed the 75°C ampacity of the conductor size used, or up to their ampacity if the equipment is listed and identified for use with such conductors

(2) **Separate Connector Provisions.** Separately installed pressure connectors shall be used with conductors at the ampacities not exceeding the ampacity at the listed and identified temperature rating of the connector.

FPN: With respect to 1.10.1.14(C)(1) and (C)(2), equipment markings or listing information may additionally restrict the sizing and temperature ratings of connected conductors.

(D) Installation. Where a tightening torque is indicated as a numeric value on equipment or in installation instructions provided by the manufacturer, a calibrated torque tool shall be used to achieve the indicated torque value, unless the equipment manufacturer has provided installation instructions for an alternative method of achieving the required torque.

1.10.1.16 High-Leg Marking. On a 4-wire, delta-connected system where the midpoint of one phase winding is grounded, only the conductor or busbar having the higher phase voltage to ground shall be durably and permanently marked by an outer finish that is orange in color or by other effective means. Such identification shall be placed at each point on the system where a connection is made if the grounded conductor is also present.

1.10.1.17 Arc-Flash Hazard Warning.

(A) General. Electrical equipment, such as switchboards, switchgear, panelboards, industrial control panels, meter socket enclosures, and motor control centers, that is in other than dwelling units, is likely to require examination, adjustment, servicing, or maintenance while energized, shall be field or factory marked to warn qualified persons of potential electric arc flash hazards. The marking shall meet the requirements in 1.10.1.21(B) and shall be located so as to be clearly visible to qualified persons before examination, adjustment, servicing, or maintenance of the equipment.

(B) Service Equipment. In other than dwelling units, in addition to the requirements in (A), a permanent label shall be field or factory applied to service equipment rated 1200 amps or more. The label shall meet the requirements of 1.10.1.21(B) and contain the following information:

(1) Nominal system voltage

(2) Available fault current at the service overcurrent protective devices

(3) The clearing time of service overcurrent protective devices based on the available fault current at the service equipment

(4) The date the label was applied

Exception: Service equipment labeling shall not be required if an arc flash label is applied in accordance with acceptable industry practice.

FPN No. 1: *NFPA 70E* -2015, *Standard for Electrical Safety in the Workplace*, provides guidance, such as determining severity of potential exposure, planning safe work practices, arc flash labeling, and selecting personal protective equipment.

FPN No. 2: ANSI Z535.4-2011, *Product Safety Signs and Labels*, provides guidelines for the design of safety signs and labels for application to products.

FPN No. 3: Acceptable industry practices for equipment labeling are described in *NFPA 70E* -2015 *Standard for Electrical Safety in the Workplace*. This standard provides specific criteria for developing arc-flash labels for equipment that provides nominal system voltage, incident energy levels, arc-flash boundaries, minimum required levels of personal protective equipment, and so forth.

1.10.1.18 Arcing Parts. Parts of electric equipment that in ordinary operation produce arcs, sparks, flames, or molten metal shall be enclosed or separated and isolated from all combustible material.

FPN: For hazardous (classified) locations, see Articles 5.0 through 5.17. For motors, see 4.30.1.14.

1.10.1.19 Light and Power from Railway Conductors. Circuits for lighting and power shall not be connected to any system that contains trolley wires with a ground return.

Exception: Such circuit connections shall be permitted in car houses, power houses, or passenger and freight stations operated in connection with electric railways.

1.10.1.21 Marking.

(A) Equipment Markings.

(1) **General.** The manufacturer's name, trademark, or other descriptive marking by which the organization responsible for the product can be identified shall be placed on all electrical equipment. Other markings that indicate voltage, current, wattage, or other ratings shall be provided as specified elsewhere in this Code. The marking or label shall be of sufficient durability to withstand the environment involved.

(2) **Reconditioned Equipment.** Reconditioned equipment shall be marked with the name, trademark, or other descriptive marking by which the organization responsible for reconditioning the electrical equipment can be identified, along with the date of the reconditioning.

Reconditioned equipment shall be identified as "reconditioned" and approval of the reconditioned equipment shall not be based solely on the equipment's original listing.

Exception: In industrial occupancies, where conditions of maintenance and supervision ensure that only qualified persons service the equipment, the markings indicated in 1.10.1.21(A)(2) shall not be required.

FPN: Industry standards are available for application of reconditioned and refurbished equipment. Normal servicing of equipment that remains within a facility should not be considered reconditioning or refurbishing.

(B) Field-Applied Hazard Markings. Where caution, warning, or danger signs or labels are required by this Code, the labels shall meet the following requirements:

(1) The marking shall warn of the hazards using effective words, colors, symbols or any combination thereof.

FPN: ANSI Z535.4-2011, Product Safety Signs and Labels, provides guidelines for suitable font sizes, words, colors, symbols, and location requirements for labels.

(2) The label shall be permanently affixed to the equipment or wiring method and shall not be hand written.

Exception to (2): Portions of labels or markings that are variable, or that could be subject to changes, shall be permitted to be hand written and shall be legible.

(3) The label shall be of sufficient durability to withstand the environment involved.

FPN: ANSI Z535.4-2011, Product Safety Signs and Labels, provides guidelines for the design and durability of safety signs and labels for application to electrical equipment.

1.10.1.22 Identification of Disconnecting Means.

(A) General. Each disconnecting means shall be legibly marked to indicate its purpose unless located and arranged so the purpose is evident. The marking shall be of sufficient durability to withstand the environment involved.

(B) Engineered Series Combination Systems. Equipment enclosures for circuit breakers or fuses applied in compliance with series combination ratings selected under engineering supervision in accordance with 2.40.7.7(A) shall be legibly marked in the field as directed by the engineer to indicate the equipment has been applied with a series combination rating. The marking shall meet the requirements in 1.10.1.21(B) and shall be readily visible and state the following:

CAUTION

SERIES COMBINATION SYSTEM RATED ____ AMPERES IDENTIFIED REPLACEMENT COMPONENTS REQUIRED

(C) Tested Series Combination Systems. Equipment enclosures for circuit breakers or fuses applied in compliance with the series combination ratings marked on the equipment by the manufacturer in accordance with 2.40.7.7(B) shall be legibly marked in the field to indicate the equipment has been applied with a series combination rating. The marking shall meet the requirements in 1.10.1.21(B) and shall be readily visible and state the following:

CAUTION — SERIES COMBINATION SYSTEM RATED AMPERES. IDENTIFIED REPLACEMENT COMPONENTS REQUIRED.

FPN: See IEEE 3004.5-2014 *Recommended Practice for the Application of Low-Voltage Circuit Breakers in Industrial and Commercial Power Systems*, for further information on series tested systems.

1.10.1.23 Current Transformers. Unused current transformers associated with potentially energized circuits shall be short-circuited.

1.10.1.24 Available Fault Current.

(A) Field Marking. Service equipment at other than dwelling units shall be legibly marked in the field with the maximum available fault current. The field marking(s) shall include the date the fault-current calculation was performed and be of sufficient durability to withstand the environment involved. The calculation shall be documented and made available to those authorized to design, install, inspect, maintain, or operate the system.

FPN: The available fault-current marking(s) addressed in 1.10.1.24 is related to required short-circuit current ratings of equipment. NFPA 70E-2015, Standard for Electrical Safety in the Workplace, provides assistance in determining the severity of potential exposure, planning safe work practices, and selecting personal protective equipment.

(B) Modifications. When modifications to the electrical installation occur that affect the maximum available fault current at the service, the maximum available fault current shall be verified or recalculated as necessary to ensure the service equipment ratings are sufficient for the maximum available fault current at the line terminals of the equipment. The required field marking(s) in 1.10.1.24(A) shall be adjusted to reflect the new level of maximum available fault current.

Exception: The field marking requirements in 1.10.1.24(A) and 1.10.1.24(B) shall not be required in industrial installations where conditions of maintenance and supervision ensure that only qualified persons service the equipment.

1.10.1.25 Lockable Disconnecting Means. If a disconnecting means is required to be lockable open elsewhere in this Code, it shall be capable of being locked in the open position. The provisions for locking shall remain in place with or without the lock installed.

Exception: Locking provisions for a cord-and-plug connection shall not be required to remain in place without the lock installed.

1.10.2 1000 Volts, Nominal, or Less

1.10.2.1 Spaces About Electrical Equipment. Sufficient access and working space shall be provided and maintained about all electric equipment to permit ready and safe operation and maintenance of such equipment.

(A) Working Space. Working space for equipment operating at 1000 volts, nominal, or less to ground and likely to require examination, adjustment, servicing, or maintenance while energized shall comply with the dimensions of 1.10.2.1(A)(1), (A)(2), and (A)(3) or as required or permitted elsewhere in this Code.

(1) Depth of Working Space. The depth of the working space in the direction of live parts shall not be less than that specified in Table 1.10.2.1(A) (1) unless the requirements of 1.10.2.1(A)(1)a, (A)(1)b, or (A)(1)c are met. Distances shall be measured from the exposed live parts or from the (3) Height of Working Space. The work space shall be clear and extend from the grade, floor, or platform to the height required by 1.10.2.1(E). Within the height requirements of this section, other equipment that is associated with the electrical installation and is located above or below the electrical equipment shall be permitted to extend not more than 150 mm beyond the front of the electrical equipment.

a. *Dead-Front Assemblies.* Working space shall not be required in the back or sides of assemblies, such as dead-front switchboards, switchgear, or motor control centers, where all connections and all renewable or adjustable parts, such as fuses or switches, are accessible from locations other than the back or sides. Where rear access is required to work on nonelectrical parts on the back of enclosed equipment, a minimum horizontal working space of 750 mm shall be provided.

b. *Low Voltage.* Smaller working spaces shall be permitted where all exposed live parts operate at not greater than 30 volts rms, 42 volts peak, or 60 volts dc.

c. *Existing Buildings.* In existing buildings where electrical equipment is being replaced, Condition 2 working clearance shall be permitted between dead-front switchboards, switchgear, panelboards, or motor control centers located across the aisle from each other where conditions of maintenance and supervision ensure that written procedures have been adopted to prohibit equipment on both sides of the aisle from being open at the same time and licensed electrical practitioner or qualified person under the supervision of a licensed electrical practitioner who are authorized will service the installation.

(2) Width of Working Space. The width of the working space in front of the electric equipment shall be the width of the equipment or 750 mm, whichever is greater. In all cases, the work space shall permit at least a 90 degree opening of equipment doors or hinged panels.

(3) Height of Working Space. The work space shall be clear and extend from the grade, floor, or platform to the height required by 1.10.2.1(E). Within the height requirements of this section, other equipment that is associated with the electrical installation and is located above or below the electrical equipment shall be permitted to extend not more than 150 mm beyond the front of the electrical equipment.

Exception No. 1: In existing dwelling units, service equipment or panelboards that do not exceed 200 amperes shall be permitted in spaces where the height of the working space is less than 2000 mm.

Exception No. 2: Meters that are installed in meter sockets shall be permitted to extend beyond the other equipment. The meter socket shall be required to follow the rules of this section.

Exception No. 3: On battery systems mounted on open racks, the top clearance shall comply with 4.80.1.10(D).

Table 1.10.2.1(A)(1) Working Spaces

Nominal Voltage to Ground	Minimum Clear Distance (mm)		
	Condition 1	Condition 2	Condition 3
0 - 150	900	900	900
151 - 600	900	1000	1200
601- 1000	900	1200	1500

Note: Where the conditions are as follows:

Condition 1 — Exposed live parts on one side of the working space and no live or grounded parts on the other side of the working space, or exposed live parts on both sides of the working space that are effectively guarded by insulating materials.

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

Condition 3 — Exposed live parts on both sides of the working space.

(4) Limited Access. Where equipment operating at 1000 volts, nominal, or less to ground and likely to require examination, adjustment, servicing, or maintenance while energized is required by installation instructions or function to be located in a space with limited access, all of the following shall apply:

(a) Where equipment is installed above a lay-in ceiling, there shall be an opening not smaller than 559 mm × 559 mm, or in a crawl space, there shall be an accessible opening not smaller than 559 mm × 762 mm.

(b) The width of the working space shall be the width of the equipment enclosure or a minimum of 762 mm, whichever is greater.

(c) sAll enclosure doors or hinged panels shall be capable of opening a minimum of 90 degrees.

(d) The space in front of the enclosure shall comply with the depth requirements of Table 1.10.2.1(A)(1). The maximum height of the working space shall be the height necessary to install the equipment in the limited space. A horizontal ceiling structural member or access panel shall be permitted in this space.

(5) Separation from High-Voltage Equipment. Where switches, cutouts, or other equipment operating at 1000 volts, nominal, or less are installed in a vault, room, or enclosure where there are exposed live parts or exposed wiring operating over 1000 volts, nominal, the high-voltage equipment shall be effectively separated from the space occupied by the low-voltage equipment by a suitable partition, fence, or screen.

(B) Clear Spaces. Working space required by this section shall not be used for storage. When normally enclosed live parts are exposed for inspection or servicing, the working space, if in a passageway or general open space, shall be suitably guarded.

(C) Entrance to Working Space.

(1) **Minimum Required.** At least one entrance of sufficient area shall be provided to give access to working space about electrical equipment.

(2) **Large Equipment.** For equipment rated 1200 amperes or more that contains overcurrent devices, switching devices, or control devices, there shall be one entrance to the required working space not less than 600 mm wide and 2000 mm high at each end of the working space. Where the entrance has a personnel door(s), the

door(s) shall open in the direction of egress and be equipped with panic bars, pressure plates, or other devices that are normally latched but open under simple pressure.

A single entrance to the required working space shall be permitted where either of the conditions in 1.10.2.1(C)(2)a or (C)(2)b is met.

a. *Unobstructed Exit.* Where the location permits a continuous and unobstructed way of exit travel, a single entrance to the working space shall be permitted.

b. *Extra Working Space.* Where the depth of the working space is twice that required by 1.10.2.1(A)(1), a single entrance shall be permitted. It shall be located so that the distance from the equipment to the nearest edge of the entrance is not less than the minimum clear distance specified in Table 1.10.2.1(A)(1) for equipment operating at that voltage and in that condition.

(3) **Personnel Doors.** Where equipment rated 800 A or more that contains overcurrent devices, switching devices, or control devices is installed and there is a personnel door(s) intended for entrance to and egress from the working space less than 7600 mm from the nearest edge of the working space, the door(s) shall open in the direction of egress and be equipped with listed panic hardware.

(D) Illumination. Illumination shall be provided for all working spaces about service equipment, switchboards, switchgears, panelboards, or motor control centers installed indoors. Additional lighting outlets shall not be required where the work space is illuminated by an adjacent light source or as permitted by 2.10.3.21(A)(1), Exception No. 1, for switched receptacles.

(E) Dedicated Equipment Space. All switchboards, switchgear, panelboards, distribution boards, and motor control centers shall be located in dedicated spaces and protected from damage.

Exception: Control equipment that by its very nature or because of other rules of the Code must be adjacent to or within sight of its operating machinery shall be permitted in those locations.

(1) **Indoor.** Indoor installations shall comply with 1.10.2.1(F)(1)a through (F)(1)d.

a. Dedicated Electrical Space. The space equal to the width and depth of the equipment and extending from the floor to a height of 1800 mm above the equipment or to the structural ceiling, whichever is lower, shall be dedicated to the electrical installation. No piping, ducts, leak protection apparatus, or other equipment foreign to the electrical installation shall be located in this zone.

Exception: Suspended ceilings with removable panels shall be permitted within the 1 800 mm zone.

b. Foreign Systems. The area above the dedicated space required by 1.10.2.1(f)(1)a shall be permitted to contain foreign systems, provided protection is installed to avoid damage to the electrical equipment from condensation, leaks, or breaks in such foreign systems.

c. Sprinkler Protection. Sprinkler protection shall be permitted for the dedicated space where the piping complies with this section.

d. Suspended Ceilings. A dropped, suspended, or similar ceiling that does not add strength to the building structure shall not be considered a structural ceiling.

(2) **Outdoor.** Outdoor installation shall comply with 1.10.1.26(E)(2)(a) and (b).

a. *Installation Requirements.* Outdoor electrical equipment shall be the following:

(1) Installed in identified enclosures

(2) Protected from accidental contact by unauthorized personnel or by vehicular traffic

(3) Protected from accidental spillage or leakage from piping systems.

b. *Work Space.* The working clearance space shall include the zone described in 1.10.2.1(A). No architectural appurtenance or other equipment shall be located in this zone.

Exception: Structural overhangs or roof extensions shall be permitted in this zone.

c. *Dedicated Equipment Space.* The space equal to the width and depth of the equipment, and extending from grade to a height of 1800 mm above the equipment, shall be dedicated to the electrical installation. No piping or other equipment foreign to the electrical installation shall be located in this zone.

(F) Locked Electrical Equipment Rooms or Enclosures. Electrical equipment rooms or enclosures housing electrical apparatus that are controlled by a lock(s) shall be considered accessible to qualified persons.

1.10.2.2 Guarding of Live Parts.

(A) Live Parts Guarded Against Accidental Contact. 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 enclosures or by any of the following means:

(1) By location in a room, vault, or similar enclosure that is accessible only to licensed electrical practitioner or qualified person under the supervision of a licensed electrical practitioner.

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

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

(4) By elevation above the floor or other working surface as shown in 1.10.2.2(A)(4)(a) or (b) below:

a. A minimum of 2500 mm for 50 volts to 300 volts between ungrounded conductors

b. A minimum of 2600 mm for 301 volts to 600 volts between ungrounded conductors.

c. A minimum of 2620 mm for 601 volts to 1000 volts between ungrounded conductors.

(B) Prevent Physical Damage. In locations where electric equipment is likely to be exposed to physical damage, enclosures or guards shall be so arranged and of such strength as to prevent such damage.

(C) Warning Signs. Entrances to rooms and other guarded locations that contain exposed live parts shall be marked with conspicuous warning signs forbidding unqualified persons to enter. The marking shall meet the requirements in 1.10.1.21(B)

FPN: For motors, see 4.30.12.2 and 4.30.12.3. For over 1000 volts, see 1.10.3.5.

1.10.2.3 Enclosure Types. Enclosures (other than surrounding fences or walls covered in 1.10.3.2) of switchboards, switchgear, panelboards, industrial control panels, motor control centers, meter sockets, enclosed switches, transfer switches, power outlets, circuit breakers, adjustable-speed drive systems, pullout switches, portable power distribution equipment, termination boxes, general-purpose transformers, fire pump controllers, fire pump motors, and motor controllers, rated not over 1000 volts nominal and intended for such locations, shall be marked with an enclosure-type number as shown in Table 1.10.2.3.

Table 1.10.2.3 shall be used for selecting these enclosures for use in specific locations other than hazardous (classified) locations. The enclosures are not intended to protect against conditions such as condensation, icing, corrosion, or contamination that may occur within the enclosure or enter via the conduit or unsealed openings

1.10.3 Over 1000 Volts, Nominal

1.10.3.1 General. Conductors and equipment used on circuits over 1000 volts, nominal, shall comply with Part 1.10.1 and with 1.10.3.1 through 1.10.3.12, which supplement or modify Part 1.10.1. In no case shall the provisions of this part apply to equipment on the supply side of the service point.

1.10.3.2 Enclosure for Electrical Installations. Electrical installations in a vault, room, or closet or in an area surrounded by a wall, screen, or fence, access to which is controlled by a lock(s) or other approved means, shall be considered to be accessible to licensed electrical practitioner or qualified person under the supervision of a licensed electrical practitioner only. 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.

For installations other than equipment as described in 1.10.3.2(D), a wall, screen, or fence shall be used to enclose an outdoor electrical installation to deter access by persons who are not qualified. A fence shall not be less than 2100 mm in height or a combination of 1800 mm or more of fence fabric and a 300 mm or more extension utilizing three or more strands of barbed wire or equivalent. The distance from the fence to live parts shall be not less than given in Table 1.10.3.2.

FPN: See Article 4.50 for construction requirements for transformer vaults.

(A) Electrical Vaults. Where an electrical vault is required or specified for conductors and equipment 1.10.3.2(A)(1) to (A)(5) shall apply.

(1) **Walls and Roof.** The walls and roof shall be constructed of materials that have adequate structural strength for the conditions, with a minimum fire rating of 3 hours. For the purpose of this section, studs and wallboard construction shall not be permitted.

(2) **Floors.** The floors of vaults in contact with the

earth shall be of concrete that is not less than 100 mm thick, but where the vault is constructed with a vacant space or other stories below it, the floor shall have adequate structural strength for the load imposed on it and a minimum fire resistance of 3 hours.

(3) **Doors.** Each doorway leading into a vault from the building interior shall be provided with a tight-fitting door that has a minimum fire rating of 3 hours. It shall be permitted to have such a door for an exterior wall opening where conditions warrant.

Exception to (1), (2), and (3): Where the vault is protected with automatic sprinkler, water spray, carbon dioxide, or halon, construction with a 1-hour rating shall be permitted.

Table 1.10.3.2 Minimum Distance from Fence to Live Parts

Nominal Voltage	Minimum Distance to Live Parts (m)
1001 - 13,799	3.05
13,800 - 230,000	4.57
Over 230,000	5.49

Note: For clearances of conductors for specific system voltages and typical BIL ratings, see ANSI/IEEE C2-2012, National Electrical Safety Code.

(4) **Locks.** Doors shall be equipped with locks, and doors shall be kept locked, with access allowed only to qualified persons. Personnel doors shall swing out and be equipped with panic bars, pressure plates, or other devices that are normally latched but that open under simple pressure.

Table 1.10.2.3 Enclosure Selection

Provides a Degree of Protection Against the following Environmental Conditions	For Outdoor Use									
	Enlosure Type Number									
	3	3R	3S	3X	3RX	3SX	4	4X	6	6P
Incidental contact with the enclosed equipment	X	X	X	X	X	X	X	X	X	X
Rain	X	X	X	X	X	X	X	X	X	X
Windblown dust	X	-	X	X	-	X	X	X	X	X
Hosedown	-	-	-	-	-	-	X	X	X	X
Corrosive agents	-	-	-	X	X	X	-	X	-	X
Temporary submersion	-	-	-	-	-	-	-	-	X	X
Prolonged submersion	-	-	-	-	-	-	-	-	-	X
Provides a Degree of Protection Against the following Environmental Conditions	**For Indoor Use**									
	Enlosure Type Number									
	1	2	4	4X	5	6	6P	12	12K	13
Incidental contact with the enclosed equipment	X	X	X	X	X	X	X	X	X	X
Falling dirt	X	X	X	X	X	X	X	X	X	X
Falling liquids and light splashing	-	X	X	X	X	X	X	X	X	X
Circulating dust, lint, fibers, and flyings	-	-	X	X	-	X	X	X	X	X
Settling airborne dust, lint, fibers, and flyings	-	-	X	X	X	X	X	X	X	X
Hosedown amd splashing water	-	-	X	X	-	X	X	-	-	-
Oil and coolant seepage	-	-	-	-	-	-	-	X	X	X
Oil and coolant spraying and splashing	-	-	-	-	-	-	-	-	-	X
Corrosive agents	-	-	-	X	-	-	X	-	-	-
Temporary submersion	-	-	-	-	-	X	X	-	-	-
Prolonged submersion	-	-	-	-	-	-	X	-	-	-

FPN No. 1: The term raintight is typically used in conjunction with Enclosure Types 3, 3S, 3SX, 3X, 4, 4X, 6, and 6P. The term rainproof is typically used in conjunction with Enclosure Types 3R and 3RX. The term watertight is typically used in conjunction with Enclosure Types 4, 4X, 6, and 6P. The term driptight is typically used in conjunction with Enclosure Types 2, 5, 12, 12K, and 13. The term dusttight is typically used in conjunction with Enclosure Types 3, 3S, 3SX, 3X, 5, 12, 12K, and 13.

FPN No. 2: Ingress protection (IP) ratings may be found in ANSI/IEC 60529, Degrees of Protection Provided by Enclosures. IP ratings are not a substitute for Enclosure Type ratings.

(5) **Transformers.** Where a transformer is installed in a vault as required by Article 4.50, the vault shall be constructed in accordance with the requirements of Part 4.50.3.

FPN No. 1: For additional information, see ANSI/ASTM E119-2015a, Method for Fire Tests of Building Construction and Materials, and NFPA 80-2016, Standard for Fire Doors and Other Opening Protectives.

FPN No. 2: A typical 3-hour construction is 150 mm thick reinforced concrete.

(B) Indoor Installations.

(1) **In Places Accessible to Unqualified Persons.** Indoor electrical installations that are accessible to unqualified persons shall be made with metal-enclosed equipment. Switchgear, transformers, pull boxes, connection boxes, and other similar associated equipment shall be marked with appropriate caution signs. Openings in ventilated dry-type transformers or similar openings in other equipment shall be designed so that foreign objects inserted through these openings are deflected from energized parts.

(2) **In Places Accessible to Licensed Electrical Practitioner or Qualified Person Under the Supervision of a Licensed Electrical Practitioner Only.** Indoor electrical installations considered accessible only to licensed electrical practitioner or qualified person under the supervision of a licensed electrical practitioner in accordance with this section shall comply with 1.10.3.5, 1.10.3.7, and 4.90.2.4.

(C) Outdoor Installations.

(1) **In Places Accessible to Unqualified Persons.** Outdoor electrical installations that are open to unqualified persons shall comply with Parts 2.25.1, 2.25.2, and 2.25.3.

FPN: For clearances of conductors for system voltages over 600 volts, nominal, see ANSI C2-2002, National Electrical Safety Code, or the Philippine Electrical Code Part 2, 2008.

(2) **In Places Accessible to Licensed electrical practitioner or qualified person under the supervision of a licensed electrical practitioner Only.** Outdoor electrical installations that have exposed live parts shall be accessible to licensed electrical practitioner or qualified person under the supervision of a licensed electrical practitioner only in accordance with the first paragraph of this section and shall comply with 1.10.3.5, 1.10.3.7, and 4.90.2.4.

(D) Enclosed Equipment Accessible to Unqualified Persons. Ventilating or similar openings in equipment shall be designed such that foreign objects inserted through these openings are deflected from energized parts. Where exposed to physical damage from vehicular traffic, suitable guards shall be provided. Equipment located outdoors and accessible unqualified persons shall be designed such that exposed nuts or bolts cannot be readily removed, permitting access to live parts. Where equipment is accessible to unqualified persons and the bottom of the enclosure is less than 2 400 mm above the floor or grade level, the enclosure door or hinged cover shall be kept locked. Doors and covers of enclosures used solely as pull boxes, splice boxes, or junction boxes shall be locked, bolted, or screwed on. Underground box covers that weigh over 45.4 kg shall be considered as meeting this requirement.

1.10.3.3 Work Space About Equipment. Sufficient space shall be provided and maintained about electric equipment to permit ready and safe operation and maintenance of such equipment. Where energized parts are exposed, the minimum clear work space shall not be less than 2000 mm high (measured vertically from the floor or platform) or less than 900 mm wide (measured parallel to the equipment). The depth shall be as required in 1.10.3.5(a). In all cases, the work space shall permit at least a 90 degree opening of doors or hinged panels.

1.10.3.4 Entrance and Access to Work Space.

(A) Entrance. At least one entrance not less than 600 mm wide and 2000 mm high shall be provided to give access to the working space about electric equipment. Where the entrance has a personnel door(s), the door(s) shall open in the direction of egress and be equipped with panic bars, pressure plates, or other devices that are normally latched but open under simple pressure.

(1) **Large Equipment.** On switchgear and control panels exceeding 1800 mm in width, there shall be one entrance at each end of the equipment. A single entrance to the required working space shall be permitted where either of the conditions in 1.10.3.4(A)(1)a or (A)(1)b is met.

a. *Unobstructed Exit.* Where the location permits a continuous and unobstructed way of exit travel, a single entrance to the working space shall be permitted.

b. *Extra Working Space.* Where the depth of the working space is twice that required by 1.10.3.5(A), a single entrance shall be permitted. It shall be located so that the distance from the equipment to the nearest

edge of the entrance is not less than the minimum clear distance specified in Table 1.10.3.5(A) for equipment operating at that voltage and in that condition.

(2) **Guarding.** Where bare energized parts at any voltage or insulated energized parts above 1000 volts, nominal, are located adjacent to such entrance, they shall be suitably guarded.

(3) **Personnel Doors**. Where there is a personnel door(s) intended for entrance to and egress from the working space less than 7600 mm from the nearest edge of the working space, the door(s) shall open in the direction of egress and be equipped with listed panic hardware.

(B) Access. Permanent ladders or stairways shall be provided to give safe access to the working space around electric equipment installed on platforms, balconies, or mezzanine floors or in attic or roof rooms or spaces.

1.10.3.5 Work Space and Guarding.

(A) Working Space. Except as elsewhere required or permitted in this Code, the minimum clear working space in the direction of access to live parts of electrical equipment shall not be less than specified in Table 1.10.3.5(A). Distances shall be measured from the live parts, if such are exposed, or from the enclosure front or opening if such are enclosed.

Exception: Working space shall not be required in back of equipment such as switchgear or control assemblies where there are no renewable or adjustable parts (such as fuses or switches) on the back and where all connections are accessible from locations other than the back. Where rear access is required to work on de-energized parts on the back of enclosed equipment, a minimum working space of 750 mm horizontally shall be provided.

(B) Separation from Low-Voltage Equipment. Where switches, cutouts, or other equipment operating at 1000 volts, nominal, or less are installed in a vault, room, or enclosure where there are exposed live parts or exposed wiring operating at over 1000 volts, nominal, the high-voltage equipment shall be effectively separated from the space occupied by the low-voltage equipment by a suitable partition, fence, or screen.

Exception: Switches or other equipment operating at 1000 volts, nominal, or less and serving only equipment within the high-voltage vault, room, or enclosure shall be permitted to be installed in the high-voltage vault, room or enclosure without a partition, fence, or screen if accessible to licensed electrical practitioner or qualified person under the supervision of a licensed electrical practitioner only.

(C) Locked Rooms or Enclosures. The entrance to all buildings, vaults, rooms, or enclosures containing exposed live parts or exposed conductors operating at over 1000 volts, nominal, shall be kept locked unless such entrances are under the observation of a licensed electrical practitioner or qualified person under the supervision of a licensed electrical practitioner at all times.

Where the voltage exceeds 1000 volts, nominal, permanent and conspicuous warning signs shall be provided, reading as follows:

DANGER — HIGH VOLTAGE — KEEP OUT

(D) Illumination. Illumination shall be provided for all working spaces about electrical equipment. Control by automatic means only shall be permitted. The lighting outlets shall be arranged so that persons changing lamps or making repairs on the lighting system are not endangered by live parts or other equipment.

The points of control shall be located so that persons are not likely to come in contact with any live part or moving part of the equipment while turning on the lights.

(E) Elevation of Unguarded Live Parts. Unguarded live parts above working space shall be maintained at elevations not less than required by Table 1.10.3.5(E).

Table 1.10.3.5(A) Minimum Depth of Clear Working Space at Electrical Equipment

Nominal Voltage to Ground	Minimum Clear Distance (mm)		
	Condition 1	Condition 2	Condition 3
1001 - 2500 V	900	1200	1500
2501 - 9000 V	1200	1500	1800
9001 - 25000 V	1500	1800	2800
25001V - 75kV	1800	2500	3000
Above 75 kV	2500	3000	3700

Note: Where the conditions are as follows:

1. Condition 1 — Exposed live parts on one side of the working space and no live or grounded parts on the other side of the working space, or exposed live parts on both sides of the working space that are effectively guarded by insulating materials.
2. Condition 2 — Exposed live parts on one side of the working space and grounded parts on the other side of the working space. Concrete, brick, or tile walls shall be considered as grounded.
3. Condition 3 — Exposed live parts on both sides of the working space.

(F) Protection of Service Equipment, Switchgear, and Industrial Control Assemblies. Pipes or ducts foreign to the electrical installation and requiring periodic maintenance or whose malfunction would endanger the operation of the electrical system shall not be located in the vicinity of the service equipment, metal-enclosed power switchgear, or industrial control assemblies. Protection shall be provided where necessary to avoid damage from condensation leaks and breaks in such foreign systems. Piping and other facilities shall not be considered foreign if provided for fire protection of the electrical installation.

1.10.3.7 Circuit Conductors. Circuit conductors shall be permitted to be installed in raceways; in cable trays; as metal-clad cable, as bare wire, cable, and busbars; or as Type MV cables or conductors as provided in 3.0.2.7, 3.0.2.9, 3.0.2.10, and 3.0.2.20. Bare live conductors shall conform with 4.90.2.4.

Insulators, together with their mounting and conductor attachments, where used as supports for wires, single-conductor cables, or busbars, shall be capable of safely withstanding the maximum magnetic forces that would prevail when two or more conductors of a circuit were subjected to short-circuit current.

Exposed runs of insulated wires and cables that have 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.

1.10.3.11 Temperature Limitations at Terminations. Conductors shall be permitted to be terminated based on the 90°C temperature rating and ampacity as given in Table 3.10.2.50(C)(67) through Table 3.10.2.50(C)(86), unless otherwise identified.

1.10.3.12 Inspections and Tests

(A) Pre-energization and Operating Tests. Where required elsewhere in this *Code*, the complete electrical system design, including settings for protective, switching, and control circuits, shall be prepared in advance and made available on request to the Office of the Building Official/EE (OBO/EE) and shall be tested when first installed on-site.

Table 1.10.3.5(E) Elevation of Unguarded Live Parts Above Working Space

Nominal Voltage Between Phases	Elevation (m)
1001 - 7500 V	3.05
7501 - 35000 V	4.57
Over 35 kV	Add 9.5 mm per kV above 35 kV

(B) Test Report. A test report covering the results of the tests required in 1.10.3.12(A) shall be available to the Office of the Building Official/EE (OBO/EE) prior to energization and made available to those authorized to install, operate, test, and maintain the system.

1.10.4 Tunnel Installations over 1000 Volts, Nominal

1.10.4.1 General.

(A) Covered. The provisions of this part shall apply to the installation and use of high-voltage power distribution and utilization equipment that is portable, mobile, or both, such as substations, trailers, cars, mobile shovels, draglines, hoists, drills, dredges, compressors, pumps, conveyors, underground excavators, and the like.

(B) Other Articles. The requirements of this part shall be additional to, or amendatory of, those prescribed in Articles 1.0 through 4.90 of this Code. Special attention shall be paid to Article 2.50.

(C) Protection Against Physical Damage. Conductors and cables in tunnels shall be located above the tunnel floor and so placed or guarded to protect them from physical damage.

1.10.4.2 Overcurrent Protection. Motor-operated equipment shall be protected from overcurrent in accordance with Parts 4.30.3, 4.30.4, and 4.30.5. Transformers shall be protected from overcurrent in accordance with 4.50.1.3.

1.10.4.3 Conductors. High-voltage conductors in tunnels shall be installed in metal conduit or other metal raceway, Type MC cable, or other approved multiconductor cable. Multiconductor portable cable shall be permitted to supply mobile equipment.

1.10.4.4 Bonding and Equipment Grounding Conductors.

(A) Grounded and Bonded. All non–current-carrying metal parts of electric equipment and all metal raceways and cable sheaths shall be effectively grounded and bonded to all metal pipes and rails at the portal and at intervals not exceeding 300 m throughout the tunnel.

(B) Equipment Grounding Conductors. An equipment grounding conductor shall be run with circuit conductors inside the metal raceway or inside the multiconductor cable jacket. The equipment grounding conductor shall be permitted to be insulated or bare.

1.10.4.5 Transformers, Switches, and Electrical Equipment. All transformers, switches, motor controllers, motors, rectifiers, and other equipment installed below ground shall be protected from physical damage by location or guarding.

1.10.4.6 Energized Parts. Bare terminals of transformers, switches, motor controllers, and other equipment shall be enclosed to prevent accidental contact with energized parts.

1.10.4.7 Ventilation System Controls. Electrical controls for the ventilation system shall be arranged so that the airflow can be reversed.

1.10.4.8 Disconnecting Means. A switch or circuit breaker that simultaneously opens all ungrounded conductors of the circuit shall be installed within sight of each transformer or motor location for disconnecting the transformer or motor. The switch or circuit breaker for a transformer shall have an ampere rating not less than the ampacity of the transformer supply conductors. The switch or circuit breaker for a motor shall comply with the applicable requirements of Article 4.30.

1.10.4.9 Enclosures. Enclosures for use in tunnels shall be dripproof, weatherproof, or submersible as required by the environmental conditions. Switch or contactor enclosures shall not be used as junction boxes or as raceways for conductors feeding through or tapping off to other switches, unless the enclosures comply with 3.12.1.8.

1.10.5 Manholes and Other Electric Enclosures Intended for Personnel Entry

1.10.5.1 General. Electric enclosures intended for personnel entry and specifically fabricated for this purpose shall be of sufficient size to provide safe work space about electric equipment with live parts that is likely to require examination, adjustment, servicing, or maintenance while energized. Such enclosures shall have sufficient size to permit ready installation or withdrawal of the conductors employed without damage to the conductors or to their insulation. They shall comply with the provisions of this part.

Exception: Where electric enclosures covered by 1.10.5 are part of an industrial wiring system operating under conditions of maintenance and supervision that ensure that only licensed electrical practitioner or qualified person under the supervision of a licensed electrical practitioner monitor and supervise the system, they shall be permitted to be designed and installed in accordance with appropriate engineering practice. If required by the Office of the Building Official/EE, design documentation shall be provided.

1.10.5.2 Strength. Manholes, vaults, and their means of access shall be designed under qualified engineering supervision and shall withstand all loads likely to be imposed on the structures.

FPN: See ANSI C2-2007, National Electrical Safety Code, or the Philippine Electrical Code Part 2, 2008 for additional information on the loading that can be expected to bear on underground enclosures.

1.10.5.3 Cabling Work Space. A clear work space not less than 900 mm wide shall be provided where cables are located on both sides, and not less than 750 mm where cables are only on one side. The vertical headroom shall not be less than 1800 mm unless the opening is within 300 mm, measured horizontally, of the adjacent interior side wall of the enclosure.

Exception: A manhole containing only one or more of the following shall be permitted to have one of the horizontal work space dimensions reduced to 600 mm where the other horizontal clear work space is increased so the sum of the two dimensions is not less than 1800 mm:

(1) Optical fiber cables as covered in Article 7.70

(2) Power-limited fire alarm circuits supplied in accordance with 7.60.3.1(A)

(3) Class 2 or Class 3 remote-control and signaling circuits, or both, supplied in accordance with 7.25.3.1.

1.10.5.4 Equipment Work Space. Where electric equipment with live parts that is likely to require examination, adjustment, servicing, or maintenance while energized is installed in a manhole, vault, or other enclosure designed for personnel access, the work space and associated requirements in 1.10.2.1 shall be met for installations operating at 1000 volts or less. Where the installation is over 1000 volts, the work space and associated requirements in 1.10.3.5 shall be met. A manhole access cover that weighs over 45 kg shall be considered as meeting the requirements of 1.10.3.5(C).

1.10.5.5 Bending Space for Conductors. Bending space for conductors operating at 600 volts or below shall be provided in accordance with the requirements of 3.14.2.14. Conductors operating over 1000 volts shall be provided with bending space in accordance with 3.14.4.2(A) and 3.14.4.2(B), as applicable. All conductors shall be cabled, racked up, or arranged in an approved manner that provides ready and safe access for persons to enter for installation and maintenance.

Exception: Where 3.14.4.2(B) applies, each row or column of ducts on one wall of the enclosure shall be calculated individually, and the single row or column that provides the maximum distance shall be used.

1.10.5.6 Access to Manholes.

(A) Dimensions. Rectangular access openings shall not be less than 650 mm × 550 mm. Round access openings in a manhole shall not be less than 650 mm in diameter.

Exception: A manhole that has a fixed ladder that does not obstruct the opening or that contains only one or more of the following shall be permitted to reduce the minimum cover diameter to 600 mm:

(1) Optical fiber cables as covered in Article 7.70

(2) Power-limited fire alarm circuits supplied in accordance with 7.60.3.1

(3) Class 2 or Class 3 remote-control and signaling circuits, or both, supplied in accordance with 7.25.3.1

(B) Obstructions. Manhole openings shall be free of protrusions that could injure personnel or prevent ready egress.

(C) Location. Manhole openings for personnel shall be located where they are not directly above electric equipment or conductors in the enclosure. Where this is not practicable, either a protective barrier or a fixed ladder shall be provided.

(D) Covers. Covers shall be over 45 kg or otherwise designed to require the use of tools to open. They shall be designed or restrained so they cannot fall into the manhole or protrude sufficiently to contact electrical conductors or equipment within the manhole.

(E) Marking. Manhole covers shall have an identifying mark or logo that prominently indicates their function, such as "electric."

1.10.5.7 Access to Vaults and Tunnels.

(A) Location. Access openings for personnel shall be located where they are not directly above electric equipment or conductors in the enclosure. Other openings shall be permitted over equipment to facilitate installation, maintenance, or replacement of equipment.

(B) Locks. In addition to compliance with the requirements of 1.10.3.5, if applicable, access openings for personnel shall be arranged such that a person on the inside can exit when the access door is locked from the outside, or in the case of normally locking by padlock, the locking arrangement shall be such that the padlock can be closed on the locking system to prevent locking from the outside.

1.10.5.8 Ventilation. Where manholes, tunnels, and vaults have communicating openings into enclosed areas used by the public, ventilation to open air shall be provided wherever practicable.

1.10.5.9 Guarding. Where conductors or equipment, or both, could be contacted by objects falling or being pushed through a ventilating grating, both conductors and live parts shall be protected in accordance with the requirements of 1.10.2.2(A)(2) or 1.10.3.2(B)(1), depending on the voltage.

1.10.5.10 Fixed Ladders. Fixed ladders shall be corrosion resistant.

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Chapter 2. Wiring and Protection

ARTICLE 2.0 – USE AND IDENTIFICATION OF GROUNDED CONDUCTORS

2.0.1.1 Scope. This article provides requirements for the following:

(1) Identification of terminals

(2) Grounded conductors in premises wiring systems

(3) Identification of grounded conductors

FPN: See Article 1.1 for definitions of *Grounded Conductor, Equipment Grounding Conductor,* and *Grounding Electrode Conductor.*

2.0.1.2 General. Grounded conductors shall comply with 2.0.1.2(A) and (B).

(A)Insulation. The grounded conductor, if insulated, shall have insulation that is (1) suitable, other than color, for any ungrounded conductor of the same circuit for systems of 1000 volts or less, or impedance grounded neutral systems of over 1000 volts, or (2) rated not less than 600 volts for solidly grounded neutral systems of over 1000 volts as described in 2.50.10.5(A).

(B) Continuity. The continuity of a grounded conductor shall not depend on a connection to a metallic enclosure, raceway, or cable armor.

FPN: See 3.0.1.13(B) for the continuity of grounded conductors used in multiwire branch circuits.

2.0.1.3 Connection to Grounded System. Premises wiring shall not be electrically connected to a supply system unless the latter contains, for any grounded conductor of the interior system, a corresponding conductor that is grounded. For the purpose of this section, *electrically connected* shall mean connected so as to be capable of carrying current, as distinguished from connection through electromagnetic induction.

Exception: Listed utility-interactive inverters identified for use in distributed resource generation systems such as photovoltaic and fuel cell power systems shall be permitted to be connected to premises wiring without a grounded conductor where the connected premises wiring or utility system includes a grounded conductor.

2.0.1.4 Neutral Conductors. Neutral conductors shall be installed in accordance with 2.0.1.4(A) and (B).

(A) Installation. Neutral conductors shall not be used for more than one branch circuit, for more than one multiwire branch circuit, or for more than one set of ungrounded feeder conductors unless specifically permitted elsewhere in this *Code.*

(B) Multiple Circuits. Where more than one neutral conductor associated with different circuits is in an enclosure, grounded circuit conductors of each circuit shall be identified or grouped to correspond with the ungrounded circuit conductor(s) by wire markers, cable ties, or similar means in at least one location within the enclosure.

Exception No. 1: The requirement for grouping or identifying shall not apply if the branch-circuit or feeder conductors enter from a cable or a raceway unique to the circuit that makes the grouping obvious.

Exception No. 2: The requirement for grouping or identifying shall not apply where branch-circuit conductors pass though a box or conduit body without a loop as described in 3.14.2.2(B)(1) or without a splice or termination.

2.0.1.6 Means of Identifying Grounded Conductors.

(A) Sizes 14 mm² or Smaller. An insulated grounded conductor of 14 mm² or smaller shall be identified by one of the following means:

(1) A continuous white outer finish.

(2) A continuous gray outer finish.

(3) Three continuous white or gray stripes along the conductor's entire length on other than green insulation.

(4) Wires that have their outer covering finished to show a white or gray color but have colored tracer threads in the braid identifying the source of manufacture shall be considered as meeting the provisions of this section.

(5) The grounded conductor of a mineral-insulated, metal-sheathed cable (Type MI) shall be identified at the time of installation by distinctive marking at its terminations.

(6) A single-conductor, sunlight-resistant, outdoor-rated cable used as a grounded conductor in photovoltaic power systems, as permitted by 6.90.4.1, shall be identified at the time of installation by distinctive white marking at all terminations.

(7) Fixture wire shall comply with the requirements for grounded conductor identification as specified in 4.2.1.8.

(8) For aerial cable, the identification shall be as above, or by means of a ridge located on the exterior of the cable so as to identify it.

(B) Sizes 22 mm² or Larger. An insulated grounded conductor 22 mm² or larger shall be identified by one of the following means:

(1) A continuous white outer finish.

(2) A continuous gray outer finish.

(3) Three continuous white or gray stripes along the conductor's entire length on other than green insulation.

(4) At the time of installation, by a distinctive white or gray marking at its terminations. This marking shall encircle the conductor or insulation.

(C) Flexible Cords. An insulated conductor that is intended for use as a grounded conductor, where contained within a flexible cord, shall be identified by a white or gray outer finish or by methods permitted by 4.0.2.3.

(D) Grounded Conductors of Different Systems. Where grounded conductors of different systems are installed in the same raceway, cable, box, auxiliary gutter, or other type of enclosure, each grounded conductor shall be identified by system. Identification that distinguishes each system grounded conductor shall be permitted by one of the following means:

(1) One system grounded conductor shall have an outer covering conforming to 2.0.1.6(A) or (B).

(2) The grounded conductor(s) of other systems shall have a different outer covering conforming to 2.0.1.6(A) or 2.0.1.6(B) or by an outer covering of white or gray with a readily distinguishable colored stripe other than green running along the insulation.

(3) Other and different means of identification allowed by 2.0.1.6(A) or (B) shall distinguish each system grounded conductor.

The means of identification shall be documented in a manner that is readily available or shall be permanently posted where the conductors of different systems originate.

(E) Grounded Conductors of Multiconductor Cables. The insulated grounded conductors in a multiconductor cable shall be identified by a continuous white or gray outer finish or by three continuous white or gray stripes on other than green insulation along its entire length. Multiconductor flat cable 22 mm² or larger shall be permitted to employ an external ridge on the grounded conductor.

Exception No. 1: Where the conditions of maintenance and supervision ensure that only qualified persons service the installation, grounded conductors in multiconductor cables shall be permitted to be permanently identified at their terminations at the time of installation by a distinctive white marking or other equally effective means.

Exception No. 2: The grounded conductor of a multiconductor varnished-cloth-insulated cable shall be permitted to be identified at its terminations at the time of installation by a distinctive white marking or other equally effective means.

FPN: The color gray may have been used in the past as an ungrounded conductor. Care should be taken when working on existing systems.

2.0.1.7 Use of Insulation of a White or Gray Color or with Three Continuous White or Gray Stripes.

(A) General. The following shall be used only for the grounded circuit conductor, unless otherwise permitted in 2.0.1.7(B) and (C):

(1) A conductor with continuous white or gray covering

(2) A conductor with three continuous white or gray stripes on other than green insulation

(3) A marking of white or gray color at the termination

(B) Circuits of Less Than 50 Volts. A conductor with white or gray color insulation or three continuous white stripes or having a marking of white or gray at the termination for circuits of less than 50 volts shall be required to be grounded only as required by 2.50.2.1(A).

(C) Circuits of 50 Volts or More. The use of insulation that is white or gray or that has three continuous white or gray stripes for other than a grounded conductor for circuits of 50 volts or more shall be permitted only as in (1) and (2).

(1) If part of a cable assembly that has the insulation permanently reidentified to indicate its use as an ungrounded conductor by marking tape, painting, or other effective means at its termination and at each location where the conductor is visible and accessible. Identification shall encircle the insulation and shall be a color other than white, gray, or green. If used for single-pole, 3-way or 4-way switch loops, the reidentified conductor with white or gray insulation or three continuous white or gray stripes shall be used only for the supply to the switch, but not as a return conductor from the switch to the outlet.

(2) A flexible cord having one conductor identified by a white or gray outer finish or three continuous white or gray stripes, or by any other means

permitted by 4.0.2.3, that is used for connecting an appliance or equipment permitted by 400.7. This shall apply to flexible cords connected to outlets whether or not the outlet is supplied by a circuit that has a grounded conductor.

FPN: The color gray may have been used in the past as an ungrounded conductor. Care should be taken when working on existing systems.

2.0.1.9 Means of Identification of Terminals. The identification of terminals to which a grounded conductor is to be connected shall be substantially white in color. The identification of other terminals shall be of a readily distinguishable different color.

Exception: Where the conditions of maintenance and supervision ensure that only qualified persons service the installations, terminals for grounded conductors shall be permitted to be permanently identified at the time of installation by a distinctive white marking or other equally effective means.

2.0.1.10 Identification of Terminals.

(A) Device Terminals. All devices, excluding panelboards, 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, unless the electrical connection of the terminal intended to be connected to the grounded conductor is clearly evident.

Exception: Terminal identification shall not be required for devices that have a normal current rating of over 30 amperes, other than polarized attachment plugs and polarized receptacles for attachment plugs as required in 2.0.1.10(B).

(B) Receptacles, Plugs, and Connectors. Receptacles, polarized attachment plugs, and cord connectors for plugs and polarized plugs shall have the terminal intended for connection to the grounded conductor identified as follows:

(1) Identification shall be by a metal or metal coating that is substantially white in color or by the word *white* or the letter *W* located adjacent to the identified terminal.

(2) If the terminal is not visible, the conductor entrance hole for the connection shall be colored white or marked with the word *white* or the letter *W*.

FPN: See 2.50.6.17 for identification of wiring device equipment grounding conductor terminals.

(C) Screw Shells. For devices with screw shells, the terminal for the grounded conductor shall be the one connected to the screw shell.

(D) Screw Shell Devices with Leads. For screw shell devices with attached leads, the conductor attached to the screw shell shall have a white or gray finish. The outer finish of the other conductor shall be of a solid color that will not be confused with the white or gray finish used to identify the grounded conductor.

FPN: The color gray may have been used in the past as an ungrounded conductor. Care should be taken when working on existing systems.

(E) Appliances. Appliances that have a single-pole switch or a single-pole overcurrent device in the line or any line-connected screw shell lampholders, and that are to be connected by (1) a permanent wiring method or (2) field-installed attachment plugs and cords with three or more wires (including the equipment grounding conductor), shall have means to identify the terminal for the grounded circuit conductor (if any).

2.0.1.11 Polarity of Connections. No grounded conductor shall be attached to any terminal or lead so as to reverse the designated polarity.

ARTICLE 2.10 – BRANCH CIRCUITS

2.10.1 General Provisions

2.10.1.1 Scope. This article provides the general requirements for branch circuits.

2.10.1.3 Other Articles for Specific-Purpose Branch Circuits. Table 2.10.1.3 lists references for specific equipment and applications not located in Chapters 5, 6, and 7 that amend or supplement the provisions of this article.

Table 2.10.1.3 Specific-Purpose Branch Circuit

Equipment	Article	Section
Air-conditioning and refrigerating equipment		4.40.1.6, 4.40.4.1, 4.40.4.2
Busways		3.68.2.8
Central heating equipment other than fixed electric space-heating equipment		4.22.2.3
Fixed electric heating equipment for pipelines and vessels		4.27.1.4
Fixed electric space-heating equipment		4.24.1.3
Infrared lamp industrial heating equipment		4.22.4.9, 4.24.1.3
Motors, motor circuits, and controllers	4.30	
Switchboards and panelboards		4.8.4.3

2.10.1.4 Multiwire Branch Circuits.

(A) General. Branch circuits recognized by this article shall be permitted as multiwire circuits. A multiwire circuit shall be permitted to be considered as multiple circuits. All conductors of a multiwire branch circuit shall originate from the same panelboard or similar distribution equipment.

FPN No. 1: A 3-phase, 4-wire, wyeconnected power system used to supply power to nonlinear loads may necessitate that the power system design allow for the possibility of high harmonic currents on the neutral conductor.

FPN No. 2: See 3.0.1.13(B) for continuity of grounded conductors on multiwire circuits.

(B) Disconnecting Means. Each multiwire branch circuit shall be provided with a means that will simultaneously disconnect all ungrounded conductors at the point where the branch circuit originates.

FPN: See 2.40.1.15(B) for information on the use of single-pole circuit breakers as the disconnecting means.

(C) Line-to-Neutral Loads. Multiwire branch circuits shall supply only line-to-neutral loads.

Exception No. 1: A multiwire branch circuit that supplies only one utilization equipment.

Exception No. 2: Where all ungrounded conductors of the multiwire branch circuit are opened simultaneously by the branch-circuit overcurrent device.

(D) Grouping. The ungrounded and grounded circuit conductors of each multiwire branch circuit shall be grouped in accordance with 2.0.1.4(B).

2.10.1.5 Identification for Branch Circuits.

(A) Grounded Conductor. The grounded conductor of a branch circuit shall be identified in accordance with 2.0.1.6.

(B) Equipment Grounding Conductor. The equipment grounding conductor shall be identified in accordance with 2.50.6.10.

(C) Identification of Ungrounded Conductors. Ungrounded conductors shall be identified in accordance with 2.10.1.5(C)(1) or (2), as applicable.

(1) Branch Circuits Supplied from More Than One Nominal Voltage System. Where the premises wiring system has branch circuits supplied from more than one nominal voltage system, each ungrounded conductor of a branch circuit shall be identified by phase or line and system at all termination, connection, and splice points in compliance with 2.10.1.5(C)(1)(a) and (b).

(a) Means of Identification. The means of identification shall be permitted to be by separate color coding, marking tape, tagging, or other approved means.

(b) Posting of Identification Means. The method utilized for conductors originating within each branch-circuit panelboard or similar branch-circuit distribution equipment shall be documented in a manner that is readily available or shall be permanently posted at each branch-circuit panel-board or similar branch-circuit distribution equipment. The label shall be of sufficient durability to withstand the environment involved and shall not be handwritten.

Exception: In existing installations where a voltage system(s) already exists and a different voltage system is being added, it shall be permissible to mark only the new system voltage. Existing unidentified systems shall not be required to be identified at each termination, connection, and splice point in compliance with 2.10.1.5(C)(1)(a) and (b). Labeling shall be required at each voltage system distribution equipment to identify that only one voltage system has been marked for a new system(s). The new system label(s) shall include the words "other unidentified systems exist on the premises."

(2) Branch Circuits Supplied From Direct-Current Systems. Where a branch circuit is supplied from a dc system operating at more than60 volts, each ungrounded conductor of 22 mm^2 or larger shall be identified by polarity at all termination, connection, and splice points by marking tape, tagging, or other approved means; each ungrounded conductor of 14 mm^2 or smaller shall be identified by polarity at all termination, connection, and splice points in compliance with 2.10.1.5(C)(2)(a) and (b). The identification methods utilized for conductors originating within each branch circuit panelboard or similar branch-circuit distribution equipment shall be documented in a manner that is readily available or shall be permanently posted at each branch circuit panelboard or similar branch-circuit distribution equipment.

(a) *Positive Polarity, Sizes 14 mm^2 or Smaller.* Where the positive polarity of a dc system does not serve as the connection point for the grounded conductor, each positive ungrounded conductor shall be identified by one of the following means:

(1) A continuous red outer finish

(2) A continuous red stripe durably marked along the conductor's entire length on insulation of a color other than green, white, gray, or black

(3) Imprinted plus signs (+) or the word POSITIVE or POS durably marked on insulation of a color other than green, white, gray, or black, and repeated at intervals not exceeding 610 mm in accordance with 3.10.3.17(B)

(4) An approved permanent marking means such as sleeving or shrink-tubing that is suitable for the conductor size, at all termination, connection, and splice points, with imprinted plus signs (+) or the word POSITIVE or POS durably marked on insulation of a color other than green, white, gray, or black

(b) *Negative Polarity, Sizes 14 mm² or Smaller.* Where the negative polarity of a dc system does not serve as the connection point for the grounded conductor, each negative ungrounded conductor shall be identified by one of the following means:

(1) A continuous black outer finish

(2) A continuous black stripe durably marked along the conductor's entire length on insulation of a color other than green, white, gray, or red

(3) Imprinted minus signs (-) or the word NEGATIVE or NEG durably marked on insulation of a color other than green, white, gray, or red, and repeated at intervals not exceeding 610 mm in accordance with 3.10.3.17(B)

(4) An approved permanent marking means such as sleeving or shrink-tubing that is suitable for the conductor size, at all termination, connection, and splice points, with imprinted plus signs (-) or the word NEGATIVE or NEG durably marked on insulation of a color other than green, white, gray, or black

2.10.1.6 Branch-Circuit Voltage Limitations. The nominal voltage of branch circuits shall not exceed the values permitted by 2.10.1.6(A) through (E).

(A) Occupancy Limitation. In dwelling units and guest rooms or guest suites of hotels, motels, and similar occupancies, the voltage shall not exceed 230 volts, nominal, between conductors that supply the terminals of the following:

(1) Luminaires

(2) Cord-and-plug-connected loads 2760 volt-amperes, nominal, or less or less than 1/2 hp

(B) 230 Volts Between Conductors. Circuits not exceeding 230 volts, nominal, between conductors shall be permitted to supply the following:

(1) The terminals of lampholders applied within their voltage ratings

(2) Auxiliary equipment of electric-discharge lamps

FPN: See 4.10.12.8 for auxiliary equipment limitations.

(3) Cord-and-plug-connected or permanently connected utilization equipment

(C) 265 Volts to Ground. Circuits exceeding 115 volts, nominal, between conductors and not exceeding 265 volts, nominal, to ground shall be permitted to supply the following:

(1) Listed electric-discharge or listed light-emitting diode-type luminaires

(2) Listed incandescent luminaires, where supplied at 230 volts or less from the output of a stepdown autotransformer that is an integral component of the luminaire and the outer shell terminal is electrically connected to a grounded conductor of the branch circuit

(3) Luminaires equipped with mogul-base screw shell lamp-holders

(4) Lampholders, other than the screw shell type, applied within their voltage ratings

(5) Auxiliary equipment of electric-discharge lamps

Informational Note: See 410.137 for auxiliary equipment limitations

(6) Cord-and-plug-connected or permanently connected utilization equipment

(D) 600 Volts Between Conductors. Circuits exceeding 265 volts, nominal, to ground and not exceeding 600 volts, nominal, between conductors shall be permitted to supply the following:

(1) The auxiliary equipment of electric-discharge lamps mounted in permanently installed luminaires where the luminaires are mounted in accordance with one of the following:

a. Not less than a height of 6 700 mm on poles or similar structures for the illumination of outdoor areas such as highways, roads, bridges, athletic fields, or parking lots

b. Not less than a height of 5500 mm on other structures such as tunnels

FPN: See 4.10.12.8 for auxiliary equipment limitations.

(2) Cord-and-plug-connected or permanently connected utilization equipment other than luminaires

(3) Luminaires powered from direct-current systems where either of the following apply:

a. The luminaire contains a listed, dc-rated ballast that provides isolation between the dc power source and the lamp circuit and protection from electric shock when changing lamps.

b. The luminaire contains a listed, dc-rated ballast and has no provision for changing lamps.

Exception No. 1 to (B), (C), and (D): For lampholders of infrared industrial heating appliances as provided in 4.22.2.7.

Exception No. 2 to (B), (C), and (D): For railway properties as described in 1.10.1.19.

(E) Over 600 Volts Between Conductors. Circuits exceeding 600 volts, nominal, between conductors shall be permitted to supply utilization equipment in installations where conditions of maintenance and supervision ensure that only qualified persons service the installation.

2.10.1.7 Multiple Branch Circuits. Where two or more branch circuits supply devices or equipment on the same yoke or mounting strap, a means to simultaneously disconnect the ungrounded supply conductors shall be provided at the point at which the branch circuits originate.

2.10.1.8 Ground-Fault Circuit-Interrupter Protection for Personnel. Ground-fault circuit-interrupter protection for personnel shall be provided as required in 2.10.1.8(A) through (E). The ground-fault circuit-interrupter shall be installed integrated with the receptacle (GFCI receptacle).

In lieu of the GFCI receptacle(s), a branch circuit supplying 15- and 20- ampere receptacles shall be permitted to be protected by a ground-fault circuit breaker.

FPN No. 1: See 2.15.1.9 for ground-fault circuit-interrupter protection for personnel on feeders.

FPN No. 2: See 4.22.1.5(A) for GFCI requirements for appliances.

For the purposes of this section, when determining distance from receptacles the distance shall be measured as the shortest path the cord of an appliance connected to the receptacle would follow without piercing a floor, wall, ceiling, or fixed barrier, or passing through a door, doorway, or window.

(A) Dwelling Units. All 250 and 125-volt, single-phase, 15- and 20-ampere receptacles installed in the locations specified in 2.10.1.8(A)(1) through (10) shall have ground-fault circuit-interrupter protection for personnel.

(1) Bathrooms

(2) Garages, and also accessory buildings that have a floor located at or below grade level not intended as habitable rooms and limited to storage areas, work areas, and areas of similar use

(3) Outdoors

Exception to (3): Receptacles that are not readily accessible and are supplied by a branch circuit dedicated to pipeline and vessel heating equipment shall be permitted to be installed in accordance with 4.27.3.9, as applicable.

(4) Crawl spaces — at or below grade level

(5) Unfinished portions of areas of the basement not intended as habitable rooms.

Exception to (5): A receptacle supplying only a permanently installed fire alarm or burglar alarm system shall not be required to have ground-fault circuit-interrupter protection.

FPN: See 7.60.2.1(B) and 7.60.3.1(B) for power supply requirements for fire alarm systems.

Receptacles installed under the exception to 2.10.1.8(A)(5) shall not be considered as meeting the requirements of 2.10.3.3(G)

(6) Kitchens — where the receptacles are installed to serve the countertop surfaces

(7) Sinks — where receptacles are installed within 1800 mm from the inside edge of the bowl of the sink

(8) Boathouses

(9) Bathtubs or shower stalls — where receptacles are installed within 1800 mm of the outside edge of the bathtub or shower stall

(10) Laundry areas

(B) Other Than Dwelling Units. All single-phase receptacles rated 250 volts to ground or less, 50 amperes or less and three-phase receptacles rated 250 volts to ground or less, 100 amperes or less installed in the following locations shall have ground-fault circuit-

interrupter protection for personnel.

(1) Bathrooms

(2) Kitchens

(3) Rooftops

Exception: Receptacles on rooftops shall not be required to be readily accessible other than from the rooftop.

(4) Outdoors

Exception to (4): In industrial establishments only, where the conditions of maintenance and supervision ensure that only qualified personnel are involved, an assured equipment grounding conductor program as specified in 5.90.1.6(B)(2) shall be permitted for only those receptacle outlets used to supply equipment that would create a greater hazard if power is interrupted or having a design that is not compatible with GFCI protection.

(5) Sinks — where receptacles are installed within 1800 mm from the inside edge of the bowl of the sink

Exception No. 1 to (5): In industrial laboratories, receptacles used to supply equipment where removal of power would introduce a greater hazard shall be permitted to be installed without GFCI protection.

Exception No. 2 to (5): For receptacles located in patient bed locations of general care (Category 2) or critical care (Category 1) spaces of health care facilities other than those covered under 2.10.1.8(B)(1), GFCI protection shall not be required.

(6) Indoor wet locations

(7) Locker rooms with associated showering facilities

(8) Garages, service bays, and similar areas other than vehicle exhibition halls and showrooms

(9) Crawl spaces — at or below grade level

(10) Unfinished portions or areas of the basement not intended as habitable rooms

(C) Boat Hoists. GFCI protection shall be provided for outlets not exceeding 230 or 115 volts that supply boat hoists installed in dwelling unit locations.

(D) Kitchen Dishwasher Branch Circuit. GFCI protection shall be provided for outlets that supply dishwashers installed in dwelling unit locations.

(E) Crawl Space Lighting Outlets. GFCI protection shall be provided for lighting outlets not exceeding 230 or 115 volts installed in crawl spaces.

2.10.1.9 Circuits Derived from Autotransformers. Branch circuits shall not be derived from autotransformers unless the circuit supplied has a grounded conductor that is electrically connected to a grounded conductor of the system supplying the autotransformer.

Exception No. 1: An autotransformer shall be permitted without the connection to a grounded conductor where transforming from a nominal 208 volts to a nominal 240-volt supply or similarly from 240 volts to 208 volts.

Exception No. 2: In industrial occupancies, where conditions of maintenance and supervision ensure that only qualified persons service the installation, autotransformers shall be permitted to supply nominal 600-volt loads from nominal 460-volt systems, and 460-volt loads from nominal 600-volt systems, without the connection to a similar grounded conductor.

2.10.1.10 Ungrounded Conductors Tapped from Grounded Systems. Two-wire dc circuits and ac circuits of two or more ungrounded conductors shall be permitted to be tapped from the ungrounded conductors of circuits that have a grounded neutral conductor. Switching devices in each tapped circuit shall have a pole in each ungrounded conductor. All poles of multipole switching devices shall manually switch together where such switching devices also serve as a disconnecting means as required by the following:

(1) 4.10.8.4 for double-pole switched lampholders

(2) 4.10.9.2(B) for electric-discharge lamp auxiliary equipment switching devices

(3) 4.22.3.2(B) for an appliance

(4) 4.24.3.2 for a fixed electric space-heating unit

(5) 4.30.7.5 for a motor controller

(6) 4.30.9.3 for a motor

2.10.1.11 Branch Circuits Required. Branch circuits for lighting and for appliances, including motor-operated appliances, shall be provided to supply the loads calculated in accordance with 2.20.2.1. In addition, branch circuits shall be provided for specific loads not covered by 2.20.2.1 where required elsewhere in this *Code* and for dwelling unit loads as specified in 2.10.1.11(C).

(A) Number of Branch Circuits. The minimum number of branch circuits shall be determined from the total calculated load and the size or rating of the circuits used. In all installations, the number of circuits shall be sufficient to supply the load served. In no case shall the load on any circuit exceed the maximum specified by 2.20.2.9.

(B) Load Evenly Proportioned Among Branch Circuits. Where the load is calculated on the basis of volt-amperes per square meter, the wiring system up to and including the branch-circuit panelboard(s) shall be provided to serve not less than the calculated load. This load shall be evenly proportioned among multioutlet branch circuits within the panelboard(s). Branch-circuit overcurrent devices and circuits shall be required to be installed only to serve the connected load.

(C) Dwelling Units.

(1) Small-Appliance Branch Circuits. In addition to the number of branch circuits required by other parts of this section, one or more 20-ampere small-appliance branch circuits shall be provided for all receptacle outlets specified by 2.10.3.3(B).

(2) Laundry Branch Circuits. In addition to the number of branch circuits required by other parts of this section, at least one additional 20-ampere branch circuit shall be provided to supply the laundry receptacle outlet(s) required by 2.10.3.3(F). This circuit shall have no other outlets.

(3) Bathroom Branch Circuits. In addition to the number of branch circuits required by other parts of this section, at least one 230-volt, 20-ampere branch circuit shall be provided to supply a bathroom receptacle outlet(s). Such circuits shall have no other outlets.

Exception: Where the 20-ampere circuit supplies a single bathroom, outlets for other equipment within the same bathroom shall be permitted to be supplied in accordance with 2.10.2.6(A)(1) and (A)(2).

(4) Garage Branch Circuits. In addition to the number of branch circuits required by other parts of this section, at least one 230- or 115-volt, 20-ampere branch circuit shall be installed to supply receptacle outlets in attached garages and in detached garages with electric power. This circuit shall have no other outlets.

Exception: This circuit shall be permitted to supply readily accessible outdoor receptacle outlets.

(5) Single Branch Circuit. For dwelling unit having a floor area not more than 50 m^2 it shall be permitted to have single 20-ampere 2-wire branch-circuit provided that the total load shall not exceed 3680 volt-amperes.

FPN: See Example D1 in Appendix D.

2.10.1.13 Ground-Fault Protection of Equipment. Each branch-circuit disconnect rated 1000 A or more and installed on solidly grounded wye electrical systems of more than 150 volts to ground, but not exceeding 600 volts phase-tophase, shall be provided with ground-fault protection of equipment in accordance with the provisions of 2.30.7.6.

FPN: For buildings that contain health care occupancies, see the requirements of 5.17.2.8.

Exception No. 1: The provisions of this section shall not apply to a disconnecting means for a continuous industrial process where a nonorderly shutdown will introduce additional or increased hazards.

Exception No. 2: The provisions of this section shall not apply if ground-fault protection of equipment is provided on the supply side of the branch circuit and on the load side of any transformer supplying the branch circuit.

2.10.1.17 Guest Rooms and Guest Suites. Guest rooms and guest suites that are provided with permanent provisions for cooking shall have branch circuits installed to meet the rules for dwelling units.

2.10.2 Branch-Circuit Ratings

2.10.2.1 Rating. Branch circuits recognized by this article shall be rated in accordance with the maximum permitted ampere rating or setting of the overcurrent device. The rating for other than individual branch circuits shall be 15, 20, 30, 40, and 50 amperes. Where conductors of higher ampacity are used for any reason, the ampere rating or setting of the specified over-current device shall determine the circuit rating.

Exception: Multioutlet branch circuits greater than 50 amperes shall be permitted to supply nonlighting outlet loads on industrial premises where conditions of maintenance and supervision ensure that only qualified persons service the equipment.

2.10.2.2 Conductors — Minimum Ampacity and Size.

(A) Branch Circuits Not More Than 600 Volts.

FPN No. 1: See 3.10.2.6 for ampacity ratings of conductors.

FPN No. 2: See Part 4.30.2 for minimum rating of motor branch-circuit conductors.

FPN No. 3: See 3.10.2.6(A)(3) for temperature limitation of conductors.

FPN No. 4: Conductors for branch circuits as defined in Article 1.1, sized to prevent a voltage drop exceeding 3 percent at the farthest outlet of power, heating, and lighting loads, or combinations of such loads, and where the maximum total voltage drop on both feeders and branch circuits to the farthest outlet does not exceed 5 percent, provide reasonable efficiency of operation. See FPN No. 2 of 2.15.1.2(A)(1) for voltage drop on feeder conductors.

(1) General. Branch-circuit conductors shall have an ampacity not less than the maximum load to be served. Conductors shall be sized to carry not less than the larger of 2.10.2.2(A)(1)(a) or (b).

(a) Where a branch circuit supplies continuous loads or any combination of continuous and noncontinuous loads, the minimum branch-circuit conductor size shall have an allowable ampacity not less than the noncontinuous load plus 125 percent of the continuous load.

(b) The minimum branch-circuit conductor size shall have an allowable ampacity not less than the maximum load to be served after the application of any adjustment or correction factors.

Exception: If the assembly, including the overcurrent devices protecting the branch circuit(s), is listed for operation at 100 percent of its rating, the allowable ampacity of the branch-circuit conductors shall be permitted to be not less than the sum of the continuous load plus the noncontinuous load.

(2) Branch Circuits with More than One Receptacle. Conductors of branch circuits supplying more than one receptacle for cord-and-plug-connected portable loads shall have an ampacity of not less than the rating of the branch circuit.

(3) Household Ranges and Cooking Appliances. Branch-circuit conductors supplying household ranges, wall-mounted ovens, counter-mounted cooking units, and other household cooking appliances shall have an ampacity not less than the rating of the branch circuit and not less than the maximum load to be served. For ranges of 8¾ kW or more rating, the minimum branch-circuit rating shall be 40 amperes.

Exception No. 1: Conductors tapped from a 50-ampere branch circuit supplying electric ranges, wall-mounted electric ovens, and counter-mounted electric cooking units shall have an ampacity of not less than 20 amperes and shall be sufficient for the load to be served. These tap conductors include any conductors that are a part of the leads supplied with the appliance that are smaller than the branch-circuit conductors. The taps shall not be longer than necessary for servicing the appliance.

Exception No. 2: The neutral conductor of a 3-wire branch circuit supplying a household electric range, a wall-mounted oven, or a counter-mounted cooking unit shall be permitted to be smaller than the ungrounded conductors where the maximum demand of a range of 8¾-kW or more rating has been calculated according to Column C of Table 2.20.3.16, but such conductor shall have an ampacity of not less than 70 percent of the branch-circuit rating and shall not be smaller than 5.5 mm² (2.6 mm dia.).

(4) Other Loads. Branch-circuit conductors that supply loads other than those specified in 2.10.1.3 and other than cooking appliances as covered in 2.10.2.2(A)(3) shall have an ampacity sufficient for the loads served and shall not be smaller than 2.0 mm² (1.6 mm dia.).

Exception No. 1: Tap conductors shall have an ampacity sufficient for the load served. In addition, they shall have an ampacity of not less than 15 for circuits rated less than 40 amperes and not less than 20 for circuits rated at 40 or 50 amperes and only where these tap conductors supply any of the following loads:

(a) Individual lampholders or luminaires with taps extending not longer than 450 mm beyond any portion of the lampholder or luminaire.

(b) A luminaire having tap conductors as provided in 4.10.10.8.

(c) Individual outlets, other than receptacle outlets, with taps not over 450 mm long.

(d) Infrared lamp industrial heating appliances.

Exception No. 2: Fixture wires and flexible cords shall be permitted to be smaller than 2.0 mm² (1.6 mm dia.) as permitted by 2.40.1.5.

(B) Branch Circuits Over 600 Volts. The ampacity of conductors shall be in accordance with 3.10.2.6 and 3.10.2.51, as applicable. Branch-circuit conductors over 600 volts shall be sized in accordance with 2.10.2.2(B)(1) or (B)(2).

(1) General. The ampacity of branch-circuit conductors shall not be less than 125 percent of the designed potential load of utilization equipment that will be operated simultaneously.

(2) Supervised Installations. For supervised installations, branch-circuit conductor sizing shall be permitted to be determined by qualified persons under engineering supervision. Supervised installations are defined as those portions of a facility where both of the following conditions are met:

(1) Conditions of design and installation are provided under engineering supervision.

(2) Qualified persons with documented training and experience in over 600-volt systems provide maintenance, monitoring, and servicing of the system.

2.10.2.3 Overcurrent Protection. Branch-circuit conductors and equipment shall be protected by overcurrent protective devices that have a rating or setting that complies with 2.10.2.3(A) through (D).

(A) Continuous and Noncontinuous Loads. Where a branch circuit supplies continuous loads or any combination of continuous and noncontinuous loads, the rating of the overcurrent device shall not be less than the noncontinuous load plus 125 percent of the continuous load.

Exception: Where the assembly, including the overcurrent devices protecting the branch circuit(s), is listed for operation at 100 percent of its rating, the ampere rating of the overcurrent device shall be permitted to be not less than the sum of the continuous load plus the noncontinuous load.

(B) Conductor Protection. Conductors shall be protected in accordance with 2.40.1.4. Flexible cords and fixture wires shall be protected in accordance with 2.40.1.5.

(C) Equipment. The rating or setting of the overcurrent protective device shall not exceed that specified in the applicable articles referenced in Table 2.40.1.3 for equipment.

(D) Outlet Devices. The rating or setting shall not exceed that specified in 2.10.2.4 for outlet devices.

2.10.2.4 Outlet Devices. Outlet devices shall have an ampere rating that is not less than the load to be served and shall comply with 2.10.2.4(A) and (B).

(A) Lampholders. Where connected to a branch circuit having a rating in excess of 20 amperes, lampholders shall be of the heavy-duty type. A heavy-duty lampholder shall have a rating of not less than 660 watts if of the admedium type, or not less than 750 watts if of any other type.

(B) Receptacles.

(1) Single Receptacle on an Individual Branch Circuit. A single receptacle installed on an individual branch circuit shall have an ampere rating not less than that of the branch circuit.

Exception No. 1: A receptacle installed in accordance with 4.30.7.1(B).

Exception No. 2: A receptacle installed exclusively for the use of a cord-and-plug-connected arc welder shall be permitted to have an ampere rating not less than the minimum branch-circuit conductor ampacity determined by 6.30.2.1(A) for arc welders.

FPN: See the definition of *receptacle* in Article 1.1.

(2) Total Cord-and-Plug-Connected Load. Where connected to a branch circuit supplying two or more receptacles or outlets, a receptacle shall not supply a total cordand-plug-connected load in excess of the maximum specified in Table 2.10.2.4(B)(2).

(3) Receptacle Ratings. Where connected to a branch circuit supplying two or more receptacles or outlets, receptacle ratings shall conform to the values listed in Table 2.10.2.4(B)(3), or, where rated higher than 50 amperes, the receptacle rating shall not be less than the branch-circuit rating.

Exception No. 1: Receptacles installed exclusively for the use of one or more cord-and plug-connected arc welders shall be permitted to have ampere ratings not less than the minimum branch-circuit conductor ampacity determined by 6.30.2.1(A) or (B) for arc welders.

Exception No. 2: The ampere rating of a receptacle installed for electric discharge lighting shall be permitted to be based on 4.10.6.15(C).

(4) Range Receptacle Rating. The ampere rating of a range receptacle shall be permitted to be based on a single range demand load as specified in Table 2.20.3.16.

2.10.2.5 Permissible Loads, Individual Branch Circuits. An individual branch circuit shall be permitted to supply any load for which it is rated, but in no case shall the load exceed the branch-circuit ampere rating.

Table 2.10.2.4(B)(2) Maximum Cord-and-Plug-Connected Load to Receptacle

Circuit Rating (Amperes)	Receptacle Rating (Amperes)	Maximum Load (Amperes)
15 or 20	15	12
20	20	16
30	30	24

Table 2.10.2.4(B)(3) Receptacle Ratings for Various Size Circuits

Circuit Rating (Amperes)	Receptacle Rating (Amperes)
15	Not over 15
20	15 or 20
30	30
40	40 or 50
50	50

2.10.2.6 Permissible Loads, Multiple-Outlet Branch Circuits. In no case shall the load exceed the branch-circuit ampere rating. A branch circuit supplying two or more outlets or receptacles shall supply only the loads specified according to its size as specified in 2.10.2.6(A) through (D) and as summarized in 2.10.2.7 and Table 2.10.2.7.

(A) 15- and 20-Ampere Branch Circuits. A 15- or 20-ampere branch circuit shall be permitted to supply lighting units or other utilization equipment, or a combination of both, and shall comply with 2.10.2.6(A)(1) and (A)(2).

Exception: The small-appliance branch circuits, laundry branch circuits, and bathroom branch circuits required in a dwelling unit(s) by 2.10.1.11(C)(1), (C)(2), and (C)(3) shall supply only the receptacle outlets specified in that section.

(1) Cord-and-Plug-Connected Equipment Not Fastened in Place. The rating of any one cord-and-plug-connected utilization equipment not fastened in place shall not exceed 80 percent of the branch-circuit ampere rating.

(2) Utilization Equipment Fastened in Place. The total rating of utilization equipment fastened in place, other than luminaires, shall not exceed 50 percent of the branch-circuit ampere rating where lighting units, cord-and-plug connected utilization equipment not fastened in place, or both, are also supplied.

(B) 30-Ampere Branch Circuits. A 30-ampere branch circuit shall be permitted to supply fixed lighting units with heavy-duty lampholders in other than a dwelling unit(s) or utilization equipment in any occupancy. A rating of any one cord-and-plug-connected utilization equipment shall not exceed 80 percent of the branch-circuit ampere rating.

(C) 40- and 50-Ampere Branch Circuits. A 40- or 50-ampere branch circuit shall be permitted to supply cooking appliances that are fastened in place in any occupancy. In other than dwelling units, such circuits shall be permitted to supply fixed lighting units with heavy-duty lampholders, infrared heating units, or other utilization equipment.

(D) Branch Circuits Larger Than 50 Amperes. Branch circuits larger than 50 amperes shall supply only nonlighting outlet loads.

2.10.2.7 Branch-Circuit Requirements — Summary. The requirements for circuits that have two or more outlets or receptacles, other than the receptacle circuits of 2.10.1.11(C)(1), (C)(2), and (C)(3), are summarized in Table 2.10.2.7. This table provides only a summary of minimum requirements. See 2.10.2.2, 2.10.2.3, and 2.10.2.4 for the specific requirements applying to branch circuits.

2.10.2.8 Branch Circuits in Buildings and Site Development with More Than One Occupancy.

(A) Dwelling Unit Branch Circuits. Branch circuits in each dwelling unit shall supply only loads within that dwelling unit or loads associated only with that dwelling unit.

(B) Common Area Branch Circuits. Branch circuits installed for the purpose of lighting, central alarm, signal, communications, or other purposes for public or common areas of a two-family dwelling, a multifamily dwelling, or a multi-occupancy building or a site development with group of single detached buildings shall not be supplied from equipment that supplies an

Table 2.10.2.7 Summary of Branch-Circuit Requirements

Circuit Rating	15 A	20 A	30 A	40 A	50 A
Conductors (min. size):					
Circuit Wires[1]	2.0 (1.6)	3.5 (2.0)	5.5 (2.6)	8.0 (3.2)	14
Taps[1]	2.0 (1.6)	2.0 (1.6)	2.0 (1.6)	3.5 (2.0)	3.5 (2.0)
Fixture wires and cords - see 2.40.1.5					
Overcurrent Protection	**15 A**	**20 A**	**30 A**	**40 A**	**50 A**
Outlet devices:					
Lampholders permitted	Any type	Any type	Heavy duty	Heavy duty	Heavy duty
Receptacle rating[2]	15 max. A	15 or 20 A	30 A	40 or 50 A	50 A
Maximum Load	**15 A**	**20 A**	**30 A**	**40 A**	**50 A**
Permissible load	See 2.10.2.6(A)	See 2.10.2.6(A)	See 2.10.2.6(B)	See 2.10.2.6(C)	See 2.10.2.6(C)

[1]These wires sizes are for 60 °C insulated copper conductors - mm² (mm dia.).

[2]For receptacle rating of cord-connected electric-discharge luminaires, see 4.10.6.15

individual dwelling unit or tenant space. This branch circuit shall be permitted only owned and managed by one person or entity or under single management.

2.10.3 Required Outlets

2.10.3.1 General. Receptacle outlets shall be installed as specified in 2.10.3.3 through 2.10.3.15.

(A) Cord Pendants. A cord connector that is supplied by a permanently connected cord pendant shall be considered a receptacle outlet.

(B) Cord Connections. A receptacle outlet shall be installed wherever flexible cords with attachment plugs are used. Where flexible cords are permitted to be permanently connected, receptacles shall be permitted to be omitted for such cords.

(C) Appliance Receptacle Outlets. Appliance receptacle outlets installed in a dwelling unit for specific appliances, such as laundry equipment, shall be installed within 1800 mm of the intended location of the appliance.

2.10.3.3 Dwelling Unit Receptacle Outlets. This section provides requirements for 250- and 125-volt, 15- and 20-ampere receptacle outlets. The receptacles required by this section shall be in addition to any receptacle that is:

(1) Part of a luminaire or appliance, or

(2) Controlled by a wall switch in accordance with 2.10.3.21(A)(1), Exception No. 1, or

(3) Located within cabinets or cupboards, or

(4) Located more than 1700 mm above the floor

Permanently installed electric baseboard heaters equipped with factory-installed receptacle outlets or outlets provided as a separate assembly by the manufacturer shall be permitted as the required outlet or outlets for the wall space utilized by such permanently installed heaters. Such receptacle outlets shall not be connected to the heater circuits.

FPN: Listed baseboard heaters include instructions that may not permit their installation below receptacle outlets.

(A) General Provisions. In every kitchen, family room, dining room, living room, parlor, library, den, sunroom, bedroom, recreation room, or similar room or area of dwelling units, receptacle outlets shall be installed in accordance with the general provisions specified in 2.10.3.3(A)(1) through (A)(4).

(1) Spacing. Receptacles shall be installed such that no point measured horizontally along the floor line of any wall space is more than 1800 mm from a receptacle outlet.

(2) Wall Space. As used in this section, a wall space shall include the following:

(1) Any space 600 mm or more in width (including space measured around corners) and unbroken along the floor line by doorways and similar openings, fireplaces, and fixed cabinets that do not have countertops or similar work surfaces

(2) The space occupied by fixed panels in exterior walls, excluding sliding panels

(3) The space afforded by fixed room dividers, such as freestanding bar-type counters or railings

(3) Floor Receptacles. Receptacle outlets in or on floors shall not be counted as part of the required number of receptacle outlets unless located within 450 mm of the wall.

(4) Countertop and Similar Work Surface Receptacle Outlets. Receptacles installed for countertop and similar work surfaces as specified in 2.10.3.3(C) shall not be considered as the receptacle outlets required by 2.10.3.3(A).

(B) Small Appliances.

(1) Receptacle Outlets Served. In the kitchen, pantry, breakfast room, dining room, or similar area of a dwelling unit, the one or more 20-ampere small-appliance branch circuits required by 2.10.1.11(C)(1) shall serve all wall and floor receptacle outlets covered by 2.10.3.3(A), all countertop outlets covered by 2.10.3.3(C), and receptacle outlets for refrigeration equipment.

Exception No. 1: In addition to the required receptacles specified by 2.10.3.3, switched receptacles supplied from a general-purpose branch circuit as defined in 2.10.3.21(A)(1), Exception No. 1, shall be permitted.

Exception No. 2: In addition to the receptacles specified by 2.10.3.3, a receptacle outlet to serve a specific appliance shall be permitted to be supplied from an individual branch circuit rated 15 amperes or greater.

(2) No Other Outlets. The one or more small-appliance branch circuits specified in 2.10.3.3(B)(1) shall have no other outlets.

Exception No. 1: A receptacle installed solely for the electrical supply to and support of an electric clock in any of the rooms specified in 2.10.3.3(B)(1).

Exception No. 2: Receptacles installed to provide power for supplemental equipment and lighting on gas-fired ranges, ovens, or counter-mounted cooking units.

(3) Kitchen Receptacle Requirements. Receptacles installed in a kitchen to serve countertop surfaces shall be supplied by at least one small-appliance branch circuits, which shall also be permitted to supply receptacle outlets in the same kitchen and in other rooms specified in 2.10.3.3(B)(1). Additional small-appliance branch circuits shall be permitted to supply receptacle outlets in the kitchen and other rooms specified in 2.10.3.3(B)(1). No small-appliance branch circuit shall serve more than one kitchen.

(C) Countertops and Work Surfaces. In kitchens, pantries, breakfast rooms, dining rooms, and similar areas of dwelling units, receptacle outlets for countertop and work surface shall be installed in accordance with 2.10.3.3(C)(1) through (C)(5).

(1) Wall Countertop and Work Surface. A receptacle outlet shall be installed at each wall countertop and work surface that is 300 mm or wider. Receptacle outlets shall be installed so that no point along the wall line is more than 600 mm measured horizontally from a receptacle outlet in that space.

Exception: Receptacle outlets shall not be required on a wall directly behind a range, counter-mounted cooking unit, or sink in the installation described in Figure 2.10.3.3(C)(1).

(2) Island Countertop Spaces. At least one receptacle shall be installed at each island countertop space with a long dimension of 600 mm or greater and a short dimension of 300 mm or greater.

(3) Peninsular Countertop Spaces. At least one receptacle outlet shall be installed at each peninsular countertop long dimension space with a long dimension of 600 mm or greater and a short dimension of 300 mm or greater. A peninsular countertop is measured from the connected perpendicular wall.

(4) Separate Spaces. Countertop spaces separated by rangetops, refrigerators, or sinks shall be considered as separate countertop spaces in applying the requirements of 2.10.3.3(C)(1). If a range, counter-mounted cooking unit, or sink is installed in an island or peninsular countertop and the depth of the countertop behind the range, counter-mounted cooking unit, or sink is less than 300 mm, the range, counter-mounted cooking unit, or sink shall be considered to divide the countertop space into two separate countertop spaces. Each separate countertop space shall comply with the applicable requirements in 2.10.3.3(C).

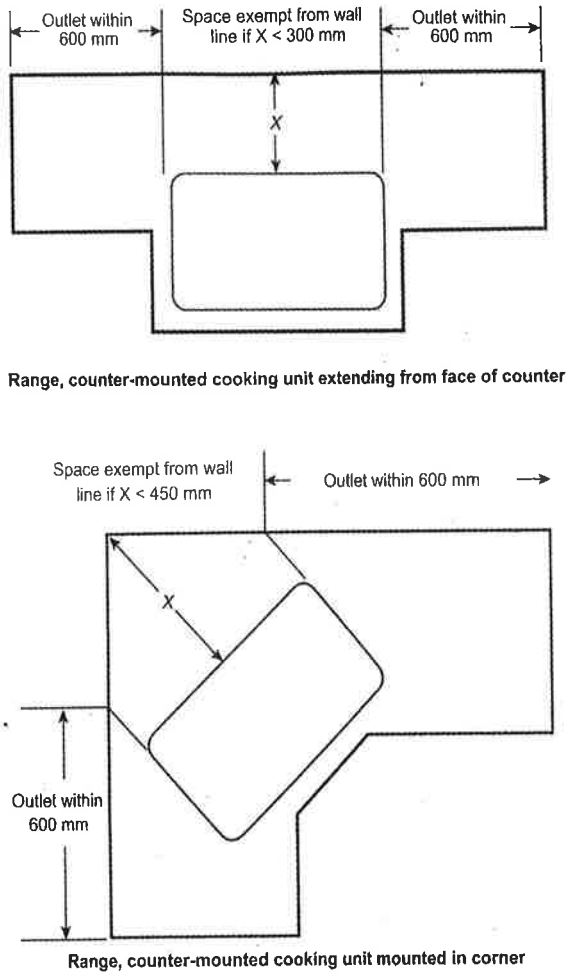

Figure 2.10.3.3(C)(1) Determination of Area Behind a Range, Counter-Mounted Cooking Unit, or Sink

(5) Receptacle Outlet Location. Receptacle outlets shall be located on or above, but not more than 500 mm above, the countertop or work surface. Receptacle outlet assemblies listed for use in countertops or work surfaces shall be permitted to be installed in countertops or work surfaces. Receptacle outlets rendered not readily accessible by appliances fastened in place, appliance garages, sinks, or rangetops as covered in 2.10.3.3(C)(1), Exception, or appliances occupying dedicated space shall not be considered as these required outlets.

FPN: See 4.6.1.5(E) and 4.6.1.5(G) for requirements for installation of receptacles in countertops and 4.6.1.5(F) and 4.6.1.5(G) for requirements for installation of receptacles in work surfaces.

Exception to (5): To comply with the following conditions (1) and (2), receptacle outlets shall be permitted to be mounted not more than 300 mm below the countertop or work surface. Receptacles mounted below a countertop

or work surface in accordance with this exception shall not be located where the countertop or work surface extends more than 150 mm beyond its support base.

(1) Construction for the physically impaired

(2) On island and peninsular countertops where the countertop is flat across its entire surface (no backsplashes, dividers, etc.) and there are no means to mount a receptacle within 500 mm above the countertop, such as an overhead cabinet

(D) Bathrooms. At least one receptacle outlet shall be installed in bathrooms within 900 mm of the outside edge of each basin. The receptacle outlet shall be located on a wall or partition that is adjacent to the basin or basin countertop, located on the countertop, or installed on the side or face of the basin cabinet. In no case shall the receptacle be located more than 300 mm below the top of the basin or basin countertop. Receptacle outlet assemblies listed for use in countertops shall be permitted to be installed in the countertop.

FPN: See 4.6.1.5(E) and 4.6.1.5(G) for requirements for installation of receptacles in countertops.

(E) Outdoor Outlets. Outdoor receptacle outlets shall be installed in accordance with 2.10.3.3(E)(1) through (E)(3).

FPN: See 2.10.1.8(A)(3).

(1) One-Family and Two-Family Dwellings. For a one-family dwelling and each unit of a two-family dwelling that is at grade level, at least one receptacle outlet readily accessible from grade and not more than 2000 mm above grade level shall be installed at the front and back of the dwelling.

(2) Multifamily Dwellings. For each dwelling unit of a multifamily dwelling where the dwelling unit is located at grade level and provided with individual exterior entran ce/egress, at least one receptacle outlet readily accessible from grade and not more than 2000 mm above grade level shall be installed.

(3) Balconies, Decks, and Porches. Balconies, decks, and porches that are attached to the dwelling unit and are accessible from inside the dwelling unit shall have at least one receptacle outlet accessible from the balcony, deck, or porch. The receptacle outlet shall not be located more than 2000 mm above the balcony, deck, or porch walking surface.

(F) Laundry Areas. In dwelling units, at least one receptacle outlet shall be installed in areas designated for the installation of laundry equipment.

Exception No. 1: A receptacle for laundry equipment shall not be required in a dwelling unit of a multifamily building where laundry facilities are provided on the premises for use by all building occupants.

Exception No. 2: A receptacle for laundry equipment shall not be required in other than one-family dwellings where laundry facilities are not to be installed or permitted.

(G) Basements, Garages, and Accessory Buildings. For one- and two- family dwelling, at least one receptacle outlet shall be installed in the areas specified in 2.10.3.3(G)(1) through (3).

These receptacles shall be in addition to receptacles required for specific equipment.

(1) Garages. In each attached garage and in each detached garage with electric power. The branch circuit supplying this receptacle(s) shall not supply outlets outside of the garage. At least one receptacle outlet shall be installed in each vehicle bay and not more than 1700 mm above the floor.

(2) Accessory Buildings. In each accessory building with electric power.

(3) Basements. In each separate unfinished portion of a basement.

(H) Hallways. In dwelling units, hallways of 3000 mm or more in length shall have at least one receptacle outlet.

As used in this subsection, the hallway length shall be considered the length along the centerline of the hallway without passing through a doorway.

(I) Foyers. Foyers that are not part of a hallway in accordance with 2.10.3.3(H) and that have an area that is greater than 5.6 m^2 shall have a receptacle(s) located in each wall space 900 mm or more in width. Doorways, door-side windows that extend to the floor, and similar openings shall not be considered wall space.

2.10.3.11 Guest Rooms, Guest Suites, Dormitories, and Similar Occupancies.

(A) General. Guest rooms or guest suites in hotels, motels, sleeping rooms in dormitories, and similar occupancies shall have receptacle outlets installed in accordance with 2.10.3.3(A) and (D). Guest rooms or guest suites provided with permanent provisions for cooking shall have receptacle outlets installed in accordance with all of the applicable rules in 2.10.3.3.

(B) Receptacle Placement. In applying the provisions of 2.10.3.3(A), the total number of receptacle outlets shall not be less than the minimum number that would

comply with the provisions of that section. These receptacle outlets shall be permitted to be located conveniently for permanent furniture layout. At least two receptacle outlets shall be readily accessible. Where receptacles are installed behind the bed, the receptacle shall be located to prevent the bed from contacting any attachment plug that may be installed or the receptacle shall be provided with a suitable guard.

2.10.3.13 Show Windows. At least one 250 or 125-volt, single-phase, 15- or 20-ampere-rated receptacle outlet shall be installed within 450 mm of the top of a show window for each 3700 linear mm or major fraction thereof of show window area measured horizontally at its maximum width.

2.10.3.14 Heating, Air-Conditioning, and Refrigeration Equipment Outlet. A 250- or 125-volt, single-phase, 15- or 20-ampere-rated receptacle outlet shall be installed at an accessible location for the servicing of heating, air-conditioning, and refrigeration equipment. The receptacle shall be located on the same level and within 7500 mm of the heating, air-conditioning, and refrigeration equipment. The receptacle outlet shall not be connected to the load side of the equipment disconnecting means.

FPN: See 2.10.1.8 for ground-fault circuit-interrupter requirements.

Exception: A receptacle outlet shall not be required at one- and two- family dwellings for the service of evaporative coolers.

2.10.3.15 Electrical Service Areas. At least one 250- or 125-volt, single-phase, 15- or 20-ampere-rated receptacle outlet shall be installed in an accessible location within 7500 mm of the indoor within 15 m of the electrical service equipment. The required receptacle outlet shall be located within the same room or area as the service equipment.

Exception No. 1: The receptacle outlet shall not be required to be installed in one-and two-family dwellings.

Exception No. 2: Where the service voltage is greater than 115 volts to ground, a receptacle outlet shall not be required for services dedicated to equipment covered in Articles 6.75 and 6.82.

2.10.3.21 Lighting Outlets Required. Lighting outlets shall be installed where specified in 2.10.3.21(A), (B), and (C).

(A) Dwelling Units. In dwelling units, lighting outlets shall be installed in accordance with 2.10.3.21(A)(1), (A)(2), and (A)(3).

(1) Habitable Rooms. At least one wall switch–controlled lighting outlet shall be installed in every habitable room, kitchen and bathroom.

Exception No. 1: In other than kitchens and bathrooms, one or more receptacles controlled by a wall switch shall be permitted in lieu of lighting outlets.

Exception No. 2: Lighting outlets shall be permitted to be controlled by occupancy sensors that are (1) in addition to wall switches or (2) located at a customary wall switch location and equipped with a manual override that will allow the sensor to function as a wall switch.

(2) Additional Locations. Additional lighting outlets shall be installed in accordance with the following.

(a) At least one wall switch–controlled lighting outlet shall be installed in hallways, stairways, attached garages, and detached garages with electric power.

(b) For dwelling units, attached garages, and detached garages with electric power, at least one wall switch– controlled lighting outlet shall be installed to provide illumination on the exterior side of outdoor entrances or exits with grade level access. A vehicle door in a garage shall not be considered as an outdoor entrance or exit.

(c) Where one or more lighting outlet(s) are installed for interior stairways, there shall be a wall switch at each floor level, and landing level that includes an entryway, to control the lighting outlet(s) where the stairway between floor levels has six risers or more.

Exception to (A)(2)(a), (A)(2)(b), and (A)(2)(c): In hallways, in stairways, and at outdoor entrances, remote, central, or automatic control of lighting shall be permitted.

(d) Lighting outlets controlled in accordance with 2.10.3.21(A)(2)(c) shall not be controlled by use of dimmer switches unless they provide the full range of dimming control at each location.

(3) Storage or Equipment Spaces. For attics, underfloor spaces, utility rooms, and basements, at least one lighting outlet containing a switch or controlled by a wall switch shall be installed where these spaces are used for storage or contain equipment requiring servicing. At least one point of control shall be at the usual point of entry to these spaces. The lighting outlet shall be provided at or near the equipment requiring servicing.

(B) Guest Rooms or Guest Suites. In hotels, motels, or similar occupancies, guest rooms or guest suites shall have at least one wall switch–controlled lighting outlet installed in every habitable room and bathroom.

Exception No. 1: In other than bathrooms and kitchens where provided, one or more receptacles controlled by a wall switch shall be permitted in lieu of lighting outlets.

Exception No. 2: Lighting outlets shall be permitted to be controlled by occupancy sensors that are (1) in addition to wall switches or (2) located at a customary wall switch location and equipped with a manual override that allows the sensor to function as a wall switch.

(C) All Occupancies. For attics and underfloor spaces, utility rooms, and basements, at least one lighting outlet containing a switch or controlled by a wall switch shall be installed where these spaces are used for storage or contain equipment requiring servicing. At least one point of control shall be at the usual point of entry to these spaces. The lighting outlet shall be provided at or near the equipment requiring servicing.

2.10.3.22 Meeting Rooms.

(A) General. Each meeting room of not more than 93 m^2 in other than dwelling units shall have outlets for nonlocking-type, 250 or 125-volt, 15- or 20-ampere receptacles. The outlets shall be installed in accordance with 2.10.3.22(B). Where a room or space is provided with movable partition(s), each room size shall be determined with the partition in the position that results in the smallest size meeting room.

FPN No. 1: For the purposes of this section, meeting rooms are typically designed or intended for the gathering of seated occupants for such purposes as conferences, deliberations, or similar purposes, where portable electronic equipment such as computers, projectors, or similar equipment is likely to be used.

FPN No. 2: Examples of rooms that are not meeting rooms include auditoriums, schoolrooms, and coffee shops.

(B) Receptacle Outlets Required. The total number of receptacle outlets, including floor outlets and receptacle outlets in fixed furniture, shall not be less than as determined in (1) and (2). These receptacle outlets shall be permitted to be located as determined by the designer or building owner.

(1) **Receptacle Outlets in Fixed Walls.** Receptacle outlets shall be installed in accordance with 2.10.3.3(A)(1) through (A)(4).

(2) **Floor Receptacle Outlets.** A meeting room that is at least 3700 mm wide and that has a floor area of at least 20 m^2 shall have at least one receptacle outlet located in the floor at a distance not less than 1800 mm from any fixed wall for each 20 m^2 or major portion of floor space.

FPN No. 1: See Section 3.14.2.13(B) for floor boxes used for receptacles located in the floor.

FPN No. 2: See Article 5.18 for assembly occupancies designed for 100 or more persons.

ARTICLE 2.15 – FEEDERS

2.15.1.1 Scope. This article covers the installation requirements, overcurrent protection requirements, minimum size, and ampacity of conductors for feeders.

Exception: Feeders for electrolytic cells as covered in 6.68.1.3(C)(1) and (C)(4).

2.15.1.2 Minimum Rating and Size.

(A) Feeders Not More Than 600 Volts.

(1) **General.** Feeder conductors shall have an ampacity not less than required to supply the load as calculated in Parts 2.20.3, 2.20.4, and 2.20.5. Conductors shall be sized to carry not less than the larger of 2.15.1.2(A)(1)(a) or (b).

(a) Where a feeder supplies continuous loads or any combination of continuous and noncontinuous loads, the minimum feeder conductor size shall have an allowable ampacity not less than the noncontinuous load plus 125 percent of the continuous load.

Exception No. 1: If the assembly, including the overcurrent devices protecting the feeder(s), is listed for operation at 100 percent of its rating, the allowable ampacity of the feeder conductors shall be permitted to be not less than the sum of the continuous load plus the noncontinuous load.

Exception No. 2: Where a portion of a feeder is connected at both its supply and load ends to separately installed pressure connections as covered in 1.10.1.14(C)(2), it shall be permitted to have an allowable ampacity not less than the sum of the continuous load plus the noncontinuous load. No portion of a feeder installed under the provisions of this exception shall extend into an enclosure containing either the feeder supply or the feeder load terminations, as covered in 1.10.1.14(C)(1).

Exception No. 3: Grounded conductors that are not connected to an overcurrent device shall be permitted to be sized at 100 percent of the continuous and noncontinuous load.

(b) The minimum feeder conductor size shall have an allowable ampacity not less than the maximum load to be served after the application of any adjustment or correction factors.

FPN No. 1: See Examples D7, D8, and D10 in Appendix D.

FPN No. 2: Conductors for feeders, as defined in Article 1.1, sized to prevent a voltage drop exceeding 3 percent at the farthest outlet of power, heating, and lighting loads, or combinations of such loads, and where the maximum total voltage drop on both feeders and branch circuits to the farthest outlet does not exceed 5 percent, will provide reasonable efficiency of operation.

FPN No. 3: See 2.10.2.2(A), FPN No. 4, for voltage drop for branch circuits.

(2) Grounded Conductor. The size of the feeder circuit grounded conductor shall not be smaller than that required by 2.50.6.13, except that 2.50.6.13(F) shall not apply where grounded conductors are run in parallel.

Additional minimum sizes shall be as specified in 2.15.1.2(A)(3) under the conditions stipulated.

(3) Ampacity Relative to Service Conductors. The feeder conductor ampacity shall not be less than that of the service conductors where the feeder conductors carry the total load supplied by service conductors with an ampacity of 55 amperes or less.

(B) Feeders over 600 Volts. The ampacity of conductors shall be in accordance with 3.10.2.6 and 3.10.2.51 as applicable. Where installed, the size of the feeder-circuit grounded conductor shall not be smaller than that required by 2.50.6.13, except that 2.50.6.13(F) shall not apply where grounded conductors are run in parallel. Feeder conductors over 600 volts shall be sized in accordance with 2.15.1.2(B)(1), (B)(2), or (B)(3).

(1) Feeders Supplying Transformers. The ampacity of feeder conductors shall not be less than the sum of the nameplate ratings of the transformers supplied when only transformers are supplied.

(2) Feeders Supplying Transformers and Utilization Equipment. The ampacity of feeders supplying a combination of transformers and utilization equipment shall not be less than the sum of the nameplate ratings of the transformers and 125 percent of the designed potential load of the utilization equipment that will be operated simultaneously.

(3) Supervised Installations. For supervised installations, feeder conductor sizing shall be permitted to be determined by qualified persons under engineering supervision. Supervised installations are defined as those portions of a facility where all of the following conditions are met:

(1) Conditions of design and installation are provided under engineering supervision.

(2) Qualified persons with documented training and experience in over 600-volt systems provide maintenance, monitoring, and servicing of the system.

2.15.1.3 Overcurrent Protection. Feeders shall be protected against overcurrent in accordance with the provisions of Part 2.40.1. Where a feeder supplies continuous loads or any combination of continuous and noncontinuous loads, the rating of the overcurrent device shall not be less than the noncontinuous load plus 125 percent of the continuous load.

Exception No. 1: Where the assembly, including the over-current devices protecting the feeder(s), is listed for operation at 100 percent of its rating, the ampere rating of the overcurrent device shall be permitted to be not less than the sum of the continuous load plus the noncontinuous load.

Exception No. 2: Overcurrent protection for feeders between 600 to 1000 volts shall comply with Parts 2.40.1 through 2.40.7. Feeders over 1000 volts, nominal, shall comply with Part 2.40.9.

2.15.1.4 Feeders with Common Neutral Conductor.

(A) Feeders with Common Neutral. Up to three sets of 3-wire feeders or two sets of 4-wire or 5-wire feeders shall be permitted to utilize a common neutral.

(B) In Metal Raceway or Enclosure. Where installed in a metal raceway or other metal enclosure, all conductors of all feeders using a common neutral conductor shall be enclosed within the same raceway or other enclosure as required in 3.0.1.20.

2.15.1.5 Diagrams of Feeders. If required by the Office of the Building Official/EE, a diagram showing feeder details shall be provided prior to the installation of the feeders. Such a diagram shall show the area in square meter of the building or other structure supplied by each feeder, the total calculated load before applying demand factors, the demand factors used, the calculated load after applying demand factors, and the size and type of conductors to be used.

2.15.1.6 Feeder Equipment Grounding Conductor. Where a feeder supplies branch circuits in which equipment grounding conductors are required, the feeder shall include or provide an equipment grounding conductor in accordance with the provisions of 2.50.7.5, to which the equipment grounding conductors of the branch circuits shall be connected. Where the feeder supplies a separate building or structure, the requirements of 2.50.2.13(B) shall apply.

2.15.1.7 Ungrounded Conductors Tapped from Grounded Systems. Two-wire dc circuits and ac circuits of two or more ungrounded conductors shall be permitted to be tapped from the ungrounded conductors of circuits having a grounded neutral conductor. Switching devices in each tapped circuit shall have a pole in each ungrounded conductor.

2.15.1.9 Ground-Fault Circuit-Interrupter Protection for Personnel. Feeders supplying 15- and 20-ampere receptacle branch circuits shall be permitted to be protected by a ground-fault circuit interrupter installed in a readily accessible location in lieu of the provisions for such interrupters as specified in 2.10.1.8 and 5.90.1.6(A).

2.15.1.10 Ground-Fault Protection of Equipment. Each feeder disconnect rated 1000 amperes or more and installed on solidly grounded wye electrical systems of more than 150 volts to ground, but not exceeding 600 volts phase-to-phase, shall be provided with ground-fault protection of equipment in accordance with the provisions of 2.30.7.6.

FPN: For buildings that contain health care occupancies, see the requirements of 5.17.2.8.

Exception No. 1: The provisions of this section shall not apply to a disconnecting means for a continuous industrial process where a nonorderly shutdown will introduce additional or increased hazards.

Exception No. 2: The provisions of this section shall not apply if ground-fault protection of equipment is provided on the supply side of the feeder and on the load side of any transformer supplying the feeder.

2.15.1.11 Circuits Derived from Autotransformers. Feeders shall not be derived from autotransformers unless the system supplied has a grounded conductor that is electrically connected to a grounded conductor of the system supplying the autotransformer.

Exception No. 1: An autotransformer shall be permitted without the connection to a grounded conductor where transforming from a nominal 208 volts to a nominal 240-volt supply or similarly from 240 volts to 208 volts.

Exception No. 2: In industrial occupancies, where conditions of maintenance and supervision ensure that only qualified persons service the installation, autotransformers shall be permitted to supply nominal 600-volt loads from nominal 460-volt systems, and 460-volt loads from nominal 600-volt systems, without the connection to a similar grounded conductor.

2.15.1.12 Identification for Feeders.

(A) Grounded Conductor. The grounded conductor of a feeder, if insulated, shall be identified in accordance with 2.0.1.6.

(B) Equipment Grounding Conductor. The equipment grounding conductor shall be identified in accordance with 2.50.6.10.

(C) Identification of Ungrounded Conductors. Ungrounded conductors shall be identified in accordance with 2.15.1.12(C)(1) or (C)(2), as applicable.

(1) Feeders Supplied from More Than One Nominal Voltage System. Where the premises wiring system has feeders supplied from more than one nominal voltage system, each ungrounded conductor of a feeder shall be identified by phase or line and system at all termination, connection, and splice points in compliance with 2.15.1.12(C)(1)(a) and (b).

(a) Means of Identification. The means of identification shall be permitted to be by separate color coding, marking tape, tagging, or other approved means.

(b) Posting of Identification Means. The method utilized for conductors originating within each feeder panel-board or similar feeder distribution equipment shall be documented in a manner that is readily available or shall be permanently posted at each feeder panelboard or similar feeder distribution equipment.

(2) Feeders Supplied from Direct-Current Systems. Where a feeder is supplied from a dc system operating at more than 60 volts, each ungrounded conductor of 22 mm^2 or larger shall be identified by polarity at all termination, connection, and splice points by marking tape, tagging, or other approved means; each ungrounded conductor of 14 mm^2 or smaller shall be identified by polarity at all termination, connection, and splice points in compliance with 2.15.1.12(C)(2)(a) and (b). The identification methods utilized for conductors originating within each feeder panelboard or similar feeder distribution equipment shall be documented in a manner that is readily available or shall be permanently posted at each feeder panelboard or similar feeder distribution equipment.

(a) Positive Polarity, Sizes 14 mm^2 or Smaller. Where the positive polarity of a dc system does not serve as the connection for the

grounded conductor, each positive ungrounded conductor shall be identified by one of the following means:

(1) A continuous red outer finish

(2) A continuous red stripe durably marked along the conductor's entire length on insulation of a color other than green, white, gray, or black

(3) Imprinted plus signs (+) or the word POSITIVE or POS durably marked on insulation of a color other than green, white, gray, or black, and repeated at intervals not exceeding 610 mm in accordance with 3.10.3.17(B)

(4) An approved,permanent marking means such as sleeving or shrink-tubing that is suitable for the conductor size, at all termination, connection, and splice points, with imprinted plus signs (+) or the word POSITIVE or POS durably marked on insulation of a color other than green, white, gray, or black

(b) Negative Polarity, Sizes 14 mm² or Smaller. Where the negative polarity of a dc system does not serve as the connection for the grounded conductor, each negative ungrounded conductor shall be identified by one of the following means:

(1) A continuous black outer finish

(2) A continuous black stripe durably marked along the conductor's entire length on insulation of a color other than green, white, gray, or red

(3) Imprinted minus signs (–) or the word NEGATIVE or NEG durably marked on insulation of a color other than green, white, gray, or red, and repeated at intervals not exceeding 610 mm in accordance with 3.10.3.17(B)

(4) An approved permanent marking means such as sleeving or shrink-tubing that is suitable for the conductor size, at all termination, connection, and splice points, with imprinted minus signs (–) or the word NEGATIVE or NEG durably marked on insulation of a color other than green, white, gray, or red

ARTICLE 2.20 – BRANCH-CIRCUIT, FEEDER, AND SERVICE CALCULATIONS

2.20.1 General

2.20.1.1 Scope. This article provides requirements for calculating branch-circuit, feeder, and service loads. Part 2.20.1 provides general requirements for calculation methods. Part 2.20.2 provides calculation methods for branch-circuit loads. Parts 2.20.3 and 2.20.4 provide calculation methods for feeder and service loads. Part 2.20.5 provides calculation methods for farm loads.

FPN No. 1: See examples in Appendix D.

FPN No. 2: See Figure 2.20.1.1 for information on the organization of Article 2.20.

2.20.1.3 Other Articles for Specific-Purpose Calculations. Table 2.20.1.3 shall provide references for specific-purpose calculation requirements not located in Chapters 5, 6, or 7 that amend or supplement the requirements of this article.

2.20.1.5 Calculations.

(A) Voltages. Unless other voltages are specified, for purposes of calculating branch-circuit and feeder loads, nominal system voltages of 115, 115/230, 208Y/120, 230, 380, 400Y/230, 460Y/265, 460, 660Y/380, and 660 volts shall be used.

(B) Fractions of an Ampere. Calculations shall be permitted to be rounded to the nearest whole ampere, with decimal fractions smaller than 0.5 dropped.

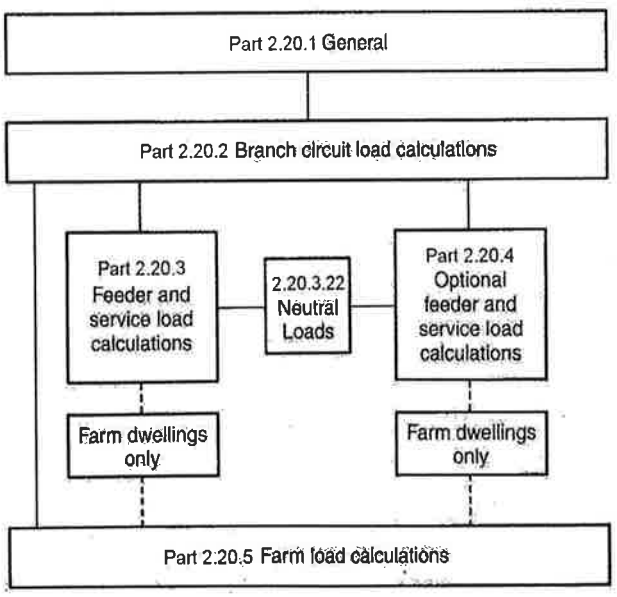

Figure 2.20.1.1 Branch-Circuit, Feeder, and Service Load Calculation Methods.

Table 2.20.1.3 Specific-Purpose Calculation References

Calculation	Article	Section (or Part)
Air-Conditioning and Refrigerating Equipment, Branch-Circuit Conductor Sizing	4.4	4.40.4
Fixed Electric Heating Equipment for Pipelines and Vessels, Branch-Circuit Sizing	4.27	4.27.1.4
Fixed Electric Space Heating Equipment, Branch-Circuit Sizing	4.24	4.24.1.3
Motors, Multimotor and Combination-Load Equipment	4.30	4.30.2.5
Motors, Several Motors or a Motor(s) and Other Load(s)	4.30	4.30.2.4
Over 600 Volt Branch Circuit Calculations	2.10	2.10.2.2
Over 600 Volt Feeder Calculations	2.15	2.15.1.2
Phase Converters, Conductors	4.55	4.55.1.6
Storage-Type Water Heaters	4.22	4.22.2.2

2.20.2 Branch-Circuit Load Calculations

2.20.2.1 General. Branch-circuit loads shall be calculated as shown in 2.20.2.3, 2.20.2.5, and 2.20.2.7.

2.20.2.3 Lighting Load for Specified Occupancies. A unit load of not less than that specified in Table 2.20.2.3 for occupancies specified shall constitute the minimum lighting load. The floor area for each floor shall be calculated from the outside dimensions of the building, dwelling unit, or other area involved. For dwelling units, the calculated floor area shall not include open porches, garages, or unused or unfinished spaces not adaptable for future use.

FPN: The unit values are based on minimum load conditions and 100 percent power factor and may not provide sufficient capacity for the installation contemplated.

Exception: Where the building is designed and constructed to comply with an energy code adopted by the local authority the lighting load shall be permitted to be calculated at the values specified in the energy code where the following conditions are met.

(1) *A power monitoring system is installed that will provide continuous information regarding the total general lighting load of the building.*

(2) *The power monitoring system will be set with alarm values to alert the building owner or manager if the lighting load exceeds the values set by the energy code.*

(3) *The demand factors specified in 2.20.3.3 are not applied to the general lighting load.*

Exception No. 2: Where a building is designed and constructed to comply with an energy code adopted by the local authority and specifying an overall lighting density of less than 13.5 volt-amperes/13.5 m², the unit lighting loads in Table 2.20.2.3 for office and bank areas within the building shall be permitted to be reduced by 11 volt-amperes/11 m².

2.20.2.5 Other Loads — All Occupancies. In all occupancies, the minimum load for each outlet for general-use receptacles and outlets not used for general illumination shall not be less than that calculated in 2.20.2.5(A) through (L), the loads shown being based on nominal branch-circuit voltages.

Exception: The loads of outlets serving switchboards and switching frames in telephone exchanges shall be waived from the calculations.

Table 2.20.2.3 General Lighting Loads by Occupancy

Type of Occuppancy	Unit Load Volt - amperes/ m²
Armories and auditoriums	8
Banks	28[b]
Barber shops and beauty parlors	24
Churches	8
Clubs	16
Court rooms	16
Dwelling units[a]	24
Garages — commercial (storage)	4
Hospitals	16
Hotels and motels, including apartment houses without provision for cooking by tenants[a]	16
Industrial commercial (loft) buildings	16
Lodge rooms	12
Office buildings	28[b]
Restaurants	16
Schools	24
Stores	24
Warehouses (storage)	2
In any of the preceding occupancies except one-family dwellings and individual dwelling units of two-family and multifamily dwellings:	
Assembly halls and auditoriums	8
Halls, corridors, closets, stairways	4
Storage spaces	2

[a]See 2.20.2.5(J).
[b]See 2.20.2.5(K).

(A) Specific Appliances or Loads. An outlet for a specific appliance or other load not covered in 2.20.2.5(B) through (L) shall be calculated based on the ampere rating of the appliance or load served.

(B) Electric Dryers and Electric Cooking Appliances in Dwellings and Household Cooking Appliances Used in Instructional Programs. Load calculations shall be permitted as specified in 2.20.3.15 for electric dryers and in 2.20.3.16 for electric ranges and other cooking appliances.

(C) Motor Outlets. Loads for motor outlets shall be calculated in accordance with the requirements in 4.30.2.2, 4.30.2.4, and 4.40.1.6.

(D) Luminaires. An outlet supplying luminaire(s) shall be calculated based on the maximum volt-ampere rating of the equipment and lamps for which the luminaire(s) is rated.

(E) Heavy-Duty Lampholders. Outlets for heavy-duty lampholders shall be calculated at a minimum of 600 volt-amperes.

(F) Sign and Outline Lighting. Sign and outline lighting outlets shall be calculated at a minimum of 1200 volt-amperes for each required branch circuit specified in 6.0.1.5(A).

(G) Show Windows. Show windows shall be calculated in accordance with either of the following:

(1) The unit load per outlet as required in other provisions of this section

(2) At 200 volt-amperes per linear 300 mm of show window

(H) Fixed Multioutlet Assemblies. Fixed multioutlet assemblies used in other than dwelling units or the guest rooms or guest suites of hotels or motels shall be calculated in accordance with (H)(1) or (H)(2). For the purposes of this section, the calculation shall be permitted to be based on the portion that contains receptacle outlets.

(1) Where appliances are unlikely to be used simultaneously, each 1500 mm or fraction thereof of each separate and continuous length shall be considered as one outlet of not less than 180 volt-amperes.

(2) Where appliances are likely to be used simultaneously, each 300 mm or fraction thereof shall be considered as an outlet of not less than 180 volt-amperes.

(I) Receptacle Outlets. Except as covered in 2.20.2.5(J) and (K), receptacle outlets shall be calculated at not less than 180 volt-amperes for each single or for each multiple receptacle on one yoke. A single piece of equipment consisting of a multiple receptacle comprised of four or more receptacles shall be calculated at not less than 90 volt-amperes per receptacle. This provision shall not be applicable to the receptacle outlets specified in 2.10.1.11(C)(1) and (C)(2).

(J) Dwelling Occupancies. In one-family, two-family, and multifamily dwellings and in guest rooms or guest suites of hotels and motels, the outlets specified in (J)(1), (J)(2), and (J)(3) are included in the general lighting load calculations of 2.20.2.3. No additional load calculations shall be required for such outlets.

(1) All general-use receptacle outlets of 20-ampere rating or less, including receptacles connected to the circuits in 2.10.1.11(C)(3)

(2) The receptacle outlets specified in 2.10.3.3(E) and (G)

(3) The lighting outlets specified in 2.10.3.21(A) and (B)

(K) Banks and Office Buildings. In banks or office buildings, the receptacle loads shall be calculated to be the larger of (1) or (2):

(1) The calculated load from 2.20.2.5(I)

(2) 11 volt-amperes/m^2

(L) Other Outlets. Other outlets not covered in 2.20.2.5(A) through (K) shall be calculated based on 180 volt-amperes per outlet.

2.20.2.7 Loads for Additions to Existing Installations.

(A) Dwelling Units. Loads added to an existing dwelling unit(s) shall comply with the following as applicable:

(1) Loads for structural additions to an existing dwelling unit or for a previously unwired portion of an existing dwelling unit, either of which exceeds 46.5 m^2, shall be calculated in accordance with 2.20.2.3 and 2.20.2.5.

(2) Loads for new circuits or extended circuits in previously wired dwelling units shall be calculated in accordance with either 2.20.2.3 or 2.20.2.5, as applicable.

(B) Other Than Dwelling Units. Loads for new circuits or extended circuits in other than dwelling units shall be calculated in accordance with either 2.20.2.3 or 2.20.2.5, as applicable.

2.20.2.9 Maximum Loads. The total load shall not exceed the rating of the branch circuit, and it shall not exceed the maximum loads specified in 2.20.2.9(A) through (C) under the conditions specified therein.

(A) Motor-Operated and Combination Loads. Where a circuit supplies only motor-operated loads, Article 4.30 shall apply. Where a circuit supplies only air-conditioning equipment, refrigerating equipment, or both, Article 4.40 shall apply. For circuits supplying loads consisting of motor-operated utilization equipment that is fastened in place and has a motor larger than ⅛ hp in combination with other loads, the total calculated load shall be based on 125 percent of the largest motor load plus the sum of the other loads.

(B) Inductive and LED Lighting Loads. For circuits supplying lighting units that have ballasts, transformers, autotransformers, or LED drivers, the calculated load shall be based on the total ampere ratings of such units and not on the total watts of the lamps.

(C) Range Loads. It shall be permissible to apply demand factors for range loads in accordance with Table 2.20.3.16, including Note 4.

2.20.3 Feeder and Service Load Calculations

2.20.3.1 General. The calculated load of a feeder or service shall not be less than the sum of the loads on the branch circuits supplied, as determined by Part 2.20.2, after any applicable demand factors permitted by Part 2.20.3 or 2.20.4 or required by Part 2.20.5 have been applied.

FPN: See Examples D1 to D10 in Appendix D. See 2.20.2.9(B) for the maximum load in amperes permitted for lighting units operating at less than 100 percent power factor.

2.20.3.3 General Lighting. The demand factors specified in Table 2.20.3.3 shall apply to that portion of the total branch-circuit load calculated for general illumination. They shall not be applied in determining the number of branch circuits for general illumination.

2.20.3.4 Show-Window and Track Lighting.

(A) Show Windows. For show-window lighting, a load of not less than 660 volt-amperes/linear meter shall be included for a show window, measured horizontally along its base.

FPN: See 2.20.2.5(G) for branch circuits supplying show windows.

(B) Track Lighting. For track lighting in other than dwelling units or guest rooms or guest suites of hotels or motels, an additional load of 150 volt-amperes shall be included for every 600 mm of lighting track or fraction thereof. Where multicircuit track is installed, the load shall be considered to be divided equally between the track circuits.

Table 2.20.3.3 Lighting Load Demand Factors

Type of Occupancy	Portion of Lighting Load to Which Demand Factor Applies (Volt-Amperes)	Demand Factor (Percent)
Dwelling units	First 3,000 at	100
	From 3,001 to 120,000 at	35
	Remainder over 120,000 at	25
Hospitals*	First 50,000 or less at	40
	Remainder over 50,000 at	20
Hotels and motels, including apartment houses without provision for cooking by tenants*	First 20,000 or less at	50
	From 20,001 to 100,000 at	40
	Remainder over 100,000 at	30
Warehouses (storage)	First 12,500 or less at	100
	Remainder over 12,500 at	50
All others	Total volt-amperes	100

*The demand factors of this table shall not apply to the calculated load of feeders or services supplying areas in hospitals, hotels and motels where the entire lighting is likely to be used at one time, as in operating rooms, ballrooms, or dining rooms.

Exception: If the track lighting is supplied through a device that limits the current to the track, the load shall be permitted to be calculated based on the rating of the device used to limit the current.

2.20.3.5 Receptacle Loads — Other Than Dwelling Units. Receptacle loads calculated in accordance with 2.20.2.5(H) and (I) shall be permitted to be made subject to the demand factors given in Table 2.20.3.3 or Table 2.20.3.5.

2.20.3.11 Motors. Motor loads shall be calculated in accordance with 4.30.2.4, 4.30.2.5, and with 4.40.1.6 for hermetic refrigerant motor compressors.

2.20.3.12 Fixed Electric Space Heating. Fixed electric space-heating loads shall be calculated at 100 percent of the total connected load. However, in no case shall a feeder or service load current rating be less than the rating of the largest branch circuit supplied.

Table 2.20.3.5 Demand Factors for Non-Dwelling Receptacle Loads

Portion of Receptacle Load to Which Demand Factor Applies (Volt-Amperes)	Demand Factor (%)
First 10 kVA or less at	100
Remainder over 10 kVA at	50

Exception: Where reduced loading of the conductors results from units operating on duty-cycle, intermittently, or from all units not operating at the same time can be supported by load computations, the feeder and service conductors are permitted to have an ampacity less than 100 percent, provided the conductors have an ampacity for the load so determined.

2.20.3.13 Small-Appliance and Laundry Loads — Dwelling Unit.

(A) Small-Appliance Circuit Load. In each dwelling unit, the load shall be calculated at 1500 volt-amperes for each 2-wire small-appliance branch circuit as covered by 2.10.1.11(C)(1). Where the load is subdivided through two or more feeders, the calculated load for each shall include not less than 1500 volt-amperes for each 2-wire small-appliance branch circuit. These loads shall be permitted to be included with the general lighting load and subjected to the demand factors provided in Table 2.20.3.3.

Exception: The individual branch circuit permitted by 2.10.3.3(B)(1), Exception No. 2, shall be permitted to be excluded from the calculation required by 2.20.3.13.

(B) Laundry Circuit Load. A load of not less than 1500 volt-amperes shall be included for each 2-wire laundry branch circuit installed as covered by 2.10.1.11(C)(2). This load shall be permitted to be included with the general lighting load and subjected to the demand factors provided in Table 2.20.3.3.

2.20.3.14 Appliance Load — Dwelling Unit(s). It shall be permissible to apply a demand factor of 75 percent to the nameplate rating load of four or more appliances fastened in place, other than electric ranges, clothes dryers, space-heating equipment, or air-conditioning equipment, that are served by the same feeder or service in a one-family, two-family, or multifamily dwelling.

2.20.3.15 Electric Clothes Dryers — Dwelling Unit(s). The load for household electric clothes dryers in a dwelling unit(s) shall be either 5000 watts (volt-amperes) or the nameplate rating, whichever is larger, for each dryer served. The use of the demand factors in Table 2.20.3.15 shall be permitted. Where two or more single-phase dryers are supplied by a 3-phase, 4-wire feeder or service, the total load shall be calculated on the basis of twice the maximum number connected between any two phases. Kilovolt-amperes (kVA) shall be considered equivalent to kilowatts (kW) for loads calculated in this section.

Table 2.20.3.15 Demand Factors for Household Electric Clothes Dryers

Number of Dryers	Demand Factor (%)
1–4	100
5	85
6	75
7	65
8	60
9	55
10	50
11	47
12–23	% = 47 – (number of dryers - 11)
24–42	% = 35 – [0.5 × (number of dryers - 23)]
43 and over	75%

2.20.3.16 Electric Cooking Appliances in Dwelling Units and Household Cooking Appliances Used in Instructional Programs. The load for household electric ranges, wall-mounted ovens, counter-mounted cooking units, and other household cooking appliances individually rated in excess of 1¾ kW shall be permitted to be calculated in accordance with Table 2.20.3.16. Kilovolt-amperes (kVA) shall be considered equivalent to kilowatts (kW) for loads calculated under this section.

Where two or more single-phase ranges are supplied by a 3-phase, 4-wire feeder or service, the total load shall be calculated on the basis of twice the maximum number connected between any two phases.

FPN No. 1: See the examples in Appendix D.

FPN No. 2: See Table 2.20.3.17 for commercial cooking equipment.

2.20.3.17 Kitchen Equipment — Other Than Dwelling Unit(s). It shall be permissible to calculate the load for commercial electric cooking equipment, dishwasher booster heaters, water heaters, and other kitchen equipment in accordance with Table 2.20.3.17. These demand factors shall be applied to all equipment that has either thermostatic control or intermittent use as kitchen equipment. These demand factors shall not apply to space-heating, ventilating, or air-conditioning equipment.

However, in no case shall the feeder or service calculated load be less than the sum of the largest two kitchen equipment loads.

2.20.3.21 Noncoincident Loads. Where it is unlikely that two or more noncoincident loads will be in use simultaneously, it shall be permissible to use only the largest load(s) that will be used at one time for calculating the total load of a feeder or service.

Table 2.20.3.16 Demand Factors and Loads for Household Electric Ranges, Wall-Mounted Ovens, Counter-Mounted Cooking Units, and Other Household Cooking Appliances over 1¾ kW Rating (Column C to be used in all cases except as otherwise permitted in Note 3.)

Number of Appliances	Demand Factor (%) (See Notes)		Column C Maximum Demand (kW) (See Notes) (Not over 12 kW Rating)
	Column A (Less than 3 1/2 kW Rating)	Column B (3 1/2 kW through 8 3/4 Rating)	
1	80	80	8
2	75	65	11
3	70	55	14
4	66	50	17
5	62	45	20
6	59	43	21
7	56	40	22
8	53	36	23
9	51	35	24
10	49	34	25
11	47	32	26
12	45	32	27
13	43	32	28
14	41	32	29
15	40	32	30
16	39	28	31
17	38	28	32
18	37	28	33
19	36	28	34
20	35	28	35
21	34	26	36
22	33	26	37
23	32	26	38
24	31	26	39
25	30	26	40
26 - 30	30	24	15 kW + 1 kW for each range
31 - 40	30	22	
41 - 50	30	20	25 kW + 3/4 kW for each range
51 - 60	30	18	
61 and over	30	16	

Notes:

1.Over 12 kW through 27 kW ranges all of same rating. For ranges individually rated more than 12 kW but not more than 27 kW, the maximum demand in Column C shall be increased 5 percent for each additional kilowatt of rating or major fraction thereof by which the rating of individual ranges exceeds 12 kW.

2.Over 8¾ kW through 27 kW ranges of unequal ratings. For ranges individually rated more than 8 ¾ 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. Then the maximum demand in Column C shall be increased 5 percent for each kilowatt or major fraction thereof by which this average value exceeds 12 kW.

3.Over 1¾ kW through 8¾ kW. In lieu of the method provided in Column C, it shall be permissible to add the nameplate ratings of all household cooking appliances rated more than 1¾ kW but not more than 8¾ kW and multiply the sum by the demand factors specified in Column A or Column B for the given number of appliances. Where the rating of cooking appliances falls under both Column A and Column B, the demand factors for each column shall be applied to the appliances for that column, and the results added together.

4.Branch-Circuit Load. It shall be permissible to calculate the branch-circuit load for one range in accordance with Table 2.20.3.16. 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 two wall-mounted ovens, all supplied from a single branch circuit and located in the same room, shall be calculated by adding the nameplate rating of the individual appliances and treating this total as equivalent to one range.

5.This table shall also apply to household cooking appliances rated over 1¾ kW and used in instructional programs.

Table 2.20.3.17 Demand Factors for Kitchen Equipment - Other than Dwelling Units

Number of Units of Equipment	Demand Factor (%)
1	100
2	100
3	90
4	80
5	70
6 and over	65

2.20.3.22 Feeder or Service Neutral Load.

(A) Basic Calculation. The feeder or service neutral load shall be the maximum unbalance of the load determined by this article. The maximum unbalanced load shall be the maximum net calculated load between the neutral conductor and any one ungrounded conductor.

Exception: For 3-wire, 2-phase or 5-wire, 2-phase systems, the maximum unbalanced load shall be the maximum net calculated load between the neutral conductor and any one ungrounded conductor multiplied by 140 percent.

(B) Permitted Reductions. A service or feeder supplying the following loads shall be permitted to have an additional demand factor of 70 percent applied to the amount in 2.20.3.22(B)(1) or portion of the amount in 2.20.3.22(B)(2) determined by the following basic calculations:

(1) A feeder or service supplying household electric ranges, wall-mounted ovens, counter-mounted cooking units, and electric dryers, where the maximum unbalanced load has been determined in accordance with Table 2.20.3.16 for ranges and Table 2.20.3.15 for dryers

(2) That portion of the unbalanced load in excess of 200 amperes where the feeder or service is supplied from a 3-wire dc or single-phase ac system; or a 4-wire, 3-phase system; or a 3-wire, 2-phase system; or a 5-wire, 2-phase system

FPN: See Examples D6 to D8 in Appendix D.

(C) Prohibited Reductions. There shall be no reduction of the neutral or grounded conductor capacity applied to the amount in 2.20.3.22(C)(1), or portion of the amount in (C)(2), from that determined by the basic calculation:

(1) Any portion of a 3-wire circuit consisting of 2 ungrounded conductors and the neutral conductor of a 4-wire, 3-phase, wye-connected system

(2) That portion consisting of nonlinear loads supplied from a 4-wire, wye-connected, 3-phase system

FPN: A 3-phase, 4-wire, wye-connected power system used to supply power to nonlinear loads may necessitate that the power system design allow for the possibility of high harmonic neutral conductor currents.

2.20.3.23 Dwelling Unit—More than 150 Square Metres Floor Area. For a dwelling unit having a floor area more than 150 square metres, the feeder and service loads shall be computed with 100 percent demand factor on the airconditioning load and the lighting load. The cooking load shall be computed in accordance with Section 2.20.3.16. Other load shall be permitted to be computed with 40 percent demand factor.

2.20.4 Optional Feeder and Service Load Calculations

2.20.4.1 General. Optional feeder and service load calculations shall be permitted in accordance with Part 2.20.4.

2.20.4.3 Dwelling Unit.

(A) Feeder and Service Load. This section applies to a dwelling unit having the total connected load served by a single 230-volt set of 2-wire service, or 115/230-volt or 208Y/120-volt set of 3-wire service or feeder conductors with an ampacity of 100 or greater. It shall be permissible to calculate the feeder and service loads in accordance with this section instead of the method specified in Part III of this article. The calculated load shall be the result of adding the loads from 2.20.4.3(B) and (C). Feeder and service-entrance conductors whose calculated load is determined by this optional calculation shall be permitted to have the neutral load determined by 2.20.3.22.

(B) General Loads. The general calculated load shall be not less than 100 percent of the first 10 kVA plus 40 percent of the remainder of the following loads:

(1) 24 volt-amperes/m^2 for general lighting and general-use receptacles. The floor area for each floor shall be calculated from the outside dimensions of the dwelling unit. The calculated floor area shall not include open porches, garages, or unused or unfinished spaces not adaptable for future use.

(2) 1500 volt-amperes for each 2-wire, 20-ampere small-appliance branch circuit and each laundry branch circuit covered in 2.10.1.11(C)(1) and (C)(2).

(3) The nameplate rating of the following:

a. All appliances that are fastened in place, permanently connected, or located to be on a specific circuit

b. Ranges, wall-mounted ovens, counter-mounted cooking units

c. Clothes dryers that are not connected to the laundry branch circuit specified in item (2)

d. Water heaters

(4) The nameplate ampere or kVA rating of all permanently connected motors not included in item (3).

(C) Heating and Air-Conditioning Load. The largest of the following six selections (load in kVA) shall be included:

(1) 100 percent of the nameplate rating(s) of the air conditioning and cooling.

(2) 100 percent of the nameplate rating(s) of the heat pump when the heat pump is used without any supplemental electric heating.

(3) 100 percent of the nameplate rating(s) of the heat pump compressor and 65 percent of the supplemental electric heating for central electric space-heating systems. If the heat pump compressor is prevented from operating at the same time as the supplementary heat, it does not need to be added to the supplementary heat for the total central space heating load.

(4) 65 percent of the nameplate rating(s) of electric space heating if less than four separately controlled units.

(5) 40 percent of the nameplate rating(s) of electric space heating if four or more separately controlled units.

(6) 100 percent of the nameplate ratings of electric thermal storage and other heating systems where the usual load is expected to be continuous at the full nameplate value. Systems qualifying under this selection shall not be calculated under any other selection in 2.20.4.3(C).

2.20.4.4 Existing Dwelling Unit. This section shall be permitted to be used to determine if the existing service or feeder is of sufficient capacity to serve additional loads. Where the dwelling unit is served by a 230-volt, 2-wire service, or 115/230-volt or 208Y/120-volt, 3-wire service, it shall be permissible to calculate the total load in accordance with 2.20.4.4(A) or (B).

(A) Where Additional Air-Conditioning Equipment or Electric Space-Heating Equipment Is Not to Be Installed. The following percentages shall be used for existing and additional new loads.

Load (kVA)	Percent of Load
First 8 kVA of load at	100
Remainder of load at	40

Load calculations shall include the following:

(1) General lighting and general-use receptacles at 24 voltamperes/m^2 as determined by 2.20.2.3

(2) 1500 volt-amperes for each 2-wire, 20-ampere small-appliance branch circuit and each laundry branch circuit covered in 2.10.1.11(C)(1) and (C)(2)

(3) The nameplate rating of the following:

a. All appliances that are fastened in place, permanently connected, or located to be on a specific circuit

b. Ranges, wall-mounted ovens, counter-mounted cooking units

c. Clothes dryers that are not connected to the laundry branch circuit specified in item (2)

d. Water heaters

(B) Where Additional Air-Conditioning Equipment or Electric Space-Heating Equipment Is to Be Installed. The following percentages shall be used for existing and additional new loads. The larger connected load of air-conditioning or space-heating, but not both, shall be used.

Load	% of Load
Air-conditioning equipment	100
Central electric space heating	100
Less than four separately controlled space-heating units	100
First 8 kVA of all other loads	100
Remainder of all other loads	40

Other loads shall include the following:

(1) General lighting and general-use receptacles at 24 voltamperes/m^2 as determined by 2.20.2.3

(2) 1500 volt-amperes for each 2-wire, 20-ampere small-appliance branch circuit and each laundry branch circuit covered in 2.10.1.11(C)(1) and (C)(2)

(3) The nameplate rating of the following:

a. All appliances that are fastened in place, permanently connected, or located to be on a specific circuit

b. Ranges, wall-mounted ovens, counter-mounted cooking units

c. Clothes dryers that are not connected to the laundry branch circuit specified in item (2)

d. Water heaters

2.20.4.5 Multifamily Dwelling.

(A) Feeder or Service Load. It shall be permissible to calculate the load of a feeder or service that supplies three or more dwelling units of a multifamily dwelling in accordance with Table 2.20.4.5 instead of Part 2.20.3 if all the following conditions are met:

(1) No dwelling unit is supplied by more than one feeder.

(2) Each dwelling unit is equipped with electric cooking equipment.

Exception: When the calculated load for multifamily dwellings without electric cooking in Part 2.20.3 exceeds that calculated under Part 2.20.4 for the identical load plus electric cooking (based on 8 kW per unit), the lesser of the two loads shall be permitted to be used.

(3) Each dwelling unit is equipped with either electric space heating or air conditioning, or both. Feeders and service conductors whose calculated load is determined by this optional calculation shall be permitted to have the neutral load determined by 2.20.3.22.

(B) House Loads. House loads shall be calculated in accordance with Part 2.20.3 of this article and shall be in addition to the dwelling unit loads calculated in accordance with Table 2.20.4.5.

(C) Calculated Loads. The calculated load to which the demand factors of Table 2.20.4.5 apply shall include the following:

(1) 24 volt-amperes/m^2 for general lighting and general-use receptacles

(2) 1500 volt-amperes for each 2-wire, 20-ampere small-appliance branch circuit and each laundry branch circuit covered in 2.10.1.11(C)(1) and (C)(2)

(3) The nameplate rating of the following:

a. All appliances that are fastened in place, permanently connected, or located to be on a specific circuit

b. Ranges, wall-mounted ovens, counter-mounted cooking units

c. Clothes dryers that are not connected to the laundry branch circuit specified in item (2)

d. Water heaters

(4) The nameplate ampere or kVA rating of all permanently connected motors not included in item (3)

(5) The larger of the air-conditioning load or the fixed electric space-heating load

2.20.4.6 Two Dwelling Units. Where two dwelling units are supplied by a single feeder and the calculated load under Part III of this article exceeds that for three identical units calculated under 2.20.4.5, the lesser of the two loads shall be permitted to be used.

2.20.4.7 Schools. The calculation of a feeder or service load for schools shall be permitted in accordance with Table 2.20.4.7 in lieu of Part 2.20.3 where equipped with electric space heating, air conditioning, or both. The connected load to which the demand factors of Table 220.86 apply shall include all of the interior and exterior lighting, power, water heating, cooking, other loads, and the larger of the air-conditioning load or space-heating load within the building or structure.

Feeders and service conductors whose calculated load is determined by this optional calculation shall be permitted to have the neutral load determined by 2.20.3.22. Where the building or structure load is calculated by this optional method, feeders within the

Table 2.20.4.5 Optional Calculations — Demand Factors for Three or More Multifamily Dwelling Units

Number of Dwelling Units	Demand Factor (%)
3 - 5	45
6 - 7	44
8 - 10	43
11	42
12 - 13	41
14 - 15	40
16 - 17	39
18 - 20	38
21	37
22 -23	36
24 -25	35
26 - 27	34
28 - 30	33
31	32
32 - 33	31
34 - 36	30
37 - 38	29
39 - 42	28
43 - 45	27
46 - 50	26
51 - 55	25
56 - 61	24
62 and over	23

building or structure shall have ampacity as permitted in Part 2.20.3; however, the ampacity of an individual feeder shall not be required to be larger than the ampacity for the entire building.

This section shall not apply to portable classroom buildings.

Table 2.20.4.7 Optional Method — Demand Factors for Feeders and Service Conductors for Schools

Connected Load	Demand Factor (%)
First 24 VA/m² Plus,	100
Over 24 through 180 VA/ m² Plus	75
Remainder over180 VA/m²	25

2.20.4.8 Determining Existing Loads. The calculation of a feeder or service load for existing installations shall be permitted to use actual maximum demand to determine the existing load under all of the following conditions:

(1) The maximum demand data is available for a 1-year period.

Exception: If the maximum demand data for a 1-year period is not available, the calculated load shall be permitted to be based on the maximum demand (the highest average kilowatts reached and maintained for a 15-minute interval) continuously recorded over a minimum 30-day period using a recording ammeter or power meter connected to the highest loaded phase of the feeder or service, based on the initial loading at the start of the recording. The recording shall reflect the maximum demand of the feeder or service by being taken when the building or space is occupied and shall include by measurement or calculation the larger of the heating or cooling equipment load, and other loads that may be periodic in nature due to seasonal or similar conditions.

(2) The maximum demand at 125 percent plus the new load does not exceed the ampacity of the feeder or rating of the service.

(3) The feeder has overcurrent protection in accordance with 2.40.1.4, and the service has overload protection in accordance with 2.30.7.1.

2.20.4.9 New Restaurants. Calculation of a service or feeder load, where the feeder serves the total load, for a new restaurant shall be permitted in accordance with Table 2.20.4.9 in lieu of Part 2.20.3.

The overload protection of the service conductors shall be in accordance with 2.30.7.1 and 2.40.1.4.

Feeder conductors shall not be required to be of greater ampacity than the service conductors.

Service or feeder conductors whose calculated load is determined by this optional calculation shall be permitted to have the neutral load determined by 2.20.3.22.

2.20.5 Farm Load Calculations

2.20.5.1 General. Farm loads shall be calculated in accordance with Part 2.20.5.

2.20.5.3 Farm Loads — Buildings and Other Loads.

(A) Dwelling Unit. The feeder or service load of a farm dwelling unit shall be calculated in accordance with the provisions for dwellings in Part 2.20.3 or 2.20.4. Where the dwelling has electric heat and the farm has electric grain-drying systems, Part 2.20.4 of this article shall not be used to calculate the dwelling load where the dwelling and farm loads are supplied by a common service.

(B) Other Than Dwelling Unit. Where a feeder or service supplies a farm building or other load having two or more separate branch circuits, the load for feeders, service conductors, and service equipment shall be calculated in accordance with demand factors not less than indicated in Table 2.20.5.3.

2.20.5.4 Farm Loads — Total. Where supplied by a common service, the total load of the farm for service conductors and service equipment shall be calculated

Table 2.20.4.9 Optional Method — Permitted Load Calculations for Service and Feeder Conductors for New Restaurants

Total Connected Load (kVA)	All Electric Restaurant Calculated Loads (kVA)	Not all Electric Restaurant Calculated Loads (kVA)
0 - 200	80%	100%
201 - 325	10% (amount over 200) + 160	50% (amount over 200) + 200
326 - 800	50% (amount over 325) + 172.5	45% (amount over 325) + 262.5
Over 800	50% (amount over 800) + 410	30% (amount over 800) + 476.3

Note: Add all electrical loads, including both heating and cooling loads. Select the one demand factor that applies from the table, then multiply the total connceted load by this single demand factor

in accordance with the farm dwelling unit load and demand factors specified in Table 2.20.5.4. Where there is equipment in two or more farm equipment buildings or for loads having the same function, such loads shall be calculated in accordance with Table 2.20.5.3 and shall be permitted to be combined as a single load in Table 2.20.5.3 for calculating the total load.

Table 2.20.5.3 Method for Calculating Farm Loads for Other Than Dwelling Unit

Ampere Load at 230 Volts Maximum	Demand Factor (Percent)
Loads expected to operate simultaneously, but not less than 125 percent full-load current of the largest motor and not less than the first 60 amperes of load	100
Next 60 amperes of all other loads	50
Remainder of other load	25

Table 2.20.5.4 Method for Calculating Total Farm Load

Individual Loads Calculated in Accordance with Table 2.20.5.3	Demand Factor (Percent)
Largest load	100
Second largest load	75
Third largest load	65
Remaining loads	50

Note: To this total load, add the load of the farm dwelling unit calculated in accordance with Parts 2.20.3 or 2.20.4.

ARTICLE 2.25 – OUTSIDE BRANCH CIRCUITS AND FEEDERS

2.25.1 General

2.25.1.1 Scope. This article covers requirements for outside branch circuits and feeders run on or between buildings, structures, or poles on the premises; and electrical equipment and wiring for the supply of utilization equipment that is located on or attached to the outside of buildings, structures, or poles.

FPN: For additional information on wiring over 1 000 volts, see ANSI/IEEE C2-2012, *National Electrical Safety Code.*

2.25.1.3 Other Articles. Application of other articles, including additional requirements to specific cases of equipment and conductors, is shown in Table 2.25.1.3.

2.25.1.4 Conductor Covering. Where within 3 000 mm of any building or structure other than supporting poles or towers, open individual (aerial) overhead conductors shall be insulated for the nominal voltage. The insulation of conductors in cables or raceways, except Type MI cable, shall be of thermoset or thermoplastic type and, in wet locations, shall comply with 3.10.2.1(C). The insulation of conductors for festoon lighting shall be of the rubber-covered or thermoplastic type.

Exception: Equipment grounding conductors and grounded circuit conductors shall be permitted to be bare or covered as specifically permitted elsewhere in this Code.

2.25.1.5 Size of Conductors 600 Volts, Nominal, or Less. The ampacity of outdoor branch-circuit and feeder conductors shall be in accordance with 3.10.2.6 based on loads as determined under 2.20.2.1 and Part 2.20.3.

Table 2.25.1.3 Other Articles

Equipment/Conductors	Article
Branch circuits	2.10
Class 1, Class 2, and Class 3 remote-control, signaling, and power-limited circuits	7.25
Communications circuits	8.0
Community antenna television and radio distribution systems	8.20
Conductors for general wiring	3.10
Electrically driven or controlled irrigation machines	6.75
Electric signs and outline lighting	6.0
Feeders	2.15
Fire alarm systems	7.60
Floating buildings	5.53
Grounding	2.50
Hazardous (classified) locations	5.0
Hazardous (classified) locations — specific	5.10
Marinas and boatyards	5.55
Messenger supported wiring	3.96
Mobile homes, manufactured homes, and mobile home parks	5.50
Open wiring on insulators	3.98
Over 1000 volts, general	4.90
Overcurrent protection	2.40
Radio and television equipment	8.10
Services	2.30
Solar photovoltaic systems	6.90
Swimming pools, fountains, and similar installations	6.80
Use and identification of grounded conductors	2.0

2.25.1.6 Conductor Size and Support.

(A) Overhead Spans. Open individual conductors shall not be smaller than the following:

(1) For 1 000 volts, nominal, or less, 5.5 mm² (2.6 mm dia.) copper or 8.0 mm² (3.2 mm dia.) aluminum for spans up to 15 m in length, and 8.0 mm² (3.2 mm dia.) copper or 14 mm² aluminum for a longer span unless supported by a messenger wire (2) For over 1 000 volts, nominal, 14 mm² copper or 22 mm² aluminum where open individual conductors, and 8.0 mm² (3.2 mm dia.) copper or 14 mm² aluminum where in cable

(B) Festoon Lighting. Overhead conductors for festoon lighting shall not be smaller than 3.5 mm² (2.0 mm dia.) unless the conductors are supported by messenger wires. In all spans exceeding 12 m, the conductors shall be supported by messenger wire. The messenger wire shall be supported by strain insulators. Conductors or messenger wires shall not be attached to any fire escape, downspout, or plumbing equipment.

2.25.1.7 Lighting Equipment Installed Outdoors.

(A) General. For the supply of lighting equipment installed outdoors, the branch circuits shall comply with Article 2.10 and 2.25.1.7(B) through (D).

(B) Common Neutral. The ampacity of the neutral conductor shall not be less than the maximum net calculated load current between the neutral conductor and all ungrounded conductors connected to any one phase of the circuit.

(C) 265 Volts to Ground. Circuits exceeding 115 volts, nominal, between conductors and not exceeding 265 volts, nominal, to ground shall be permitted to supply luminaires for illumination of outdoor areas of industrial establishments, office buildings, schools, stores, and other commercial or public buildings.

(D) 1000 Volts Between Conductors. Circuits exceeding 265 volts, nominal, to ground and not exceeding 1000 volts, nominal, between conductors shall be permitted to supply the auxiliary equipment of electric-discharge lamps in accordance with 2.10.1.6(D)(1).

2.25.1.8 Calculation of Loads 1000 Volts, Nominal, or Less.

(A) Branch Circuits. The load on outdoor branch circuits shall be as determined by 2.20.2.1.

(B) Feeders. The load on outdoor feeders shall be as determined by Part 2.20.3.

2.25.1.10 Wiring on Buildings (or Other Structures). The installation of outside wiring on surfaces of buildings (or other structures) shall be permitted for circuits not over 1000 volts, nominal, as the following:

(1) Auxiliary gutters
(2) Busways
(3) Cable trays
(4) Cablebus
(5) Electrical metallic tubing (EMT)
(6) Flexible metal conduit (FMC)
(7) Intermediate metal conduit (IMC)
(8) Liquidtight flexible metal conduit (LFMC)
(9) Liquidtight flexible nonmetallic conduit (LFNC)
(10) Messenger-supported wiring
(11) Multiconductor cable
(12) Open wiring on insulators
(13) Reinforced thermosetting resin conduit (RTRC)
(14) Rigid metal conduit (RMC)
(15) Rigid polyvinyl chloride conduit (PVC)
(16) Type MC cable
(17) Type MI cable
(18) Type UF cable
(19) Wireways

2.25.1.11 Feeder and Branch-Circuit Conductors Entering, Exiting, or Attached to Buildings or Structures. Feeder and branch-circuit conductors entering or exiting buildings or structures shall be in installed in accordance with the requirements of 2.30.4.13. Overhead branch circuits and feeders attached to buildings or structures shall be installed in accordance with the requirements of 2.30.4.15.

2.25.1.12 Open-Conductor Supports. Open conductors shall be supported on knobs, racks, brackets, or strain insulators, that are made of glass, porcelain, or other approved materials.

2.25.1.14 Open-Conductor Spacings.

(A) 1000 Volts, Nominal, or Less. Conductors of 1000 volts, nominal, or less, shall comply with the spacings provided in Table 2.30.4.12(C).

(B) Over 1000 Volts, Nominal. Conductors of over 1000 volts, nominal, shall comply with the spacings provided in 1.10.3.7 and 4.90.2.4.

(C) Separation from Other Circuits. Open conductors shall be separated from open conductors of other circuits or systems by not less than 100 mm.

(D) Conductors on Poles. Conductors on poles shall have a separation of not less than 300 mm where not placed on racks or brackets. Conductors supported on poles shall provide a horizontal climbing space not less than the following:

(1) Power conductors below communications conductors — 750 mm

(2) Power conductors alone or above communications conductors:

a. 300 volts or less — 600 mm

b. Over 300 volts — 750 mm

(3) Communications conductors below power conductors — same as power conductors

(4) Communications conductors alone — no requirement

2.25.1.15 Supports over Buildings. Supports over a building shall be in accordance with 2.30.2.8.

2.25.1.16 Attachment to Buildings.

(A) Point of Attachment. The point of attachment to a building shall be in accordance with 2.30.2.5.

(B) Means of Attachment. The means of attachment to a building shall be in accordance with 2.30.2.6.

2.25.1.17 Masts as Supports. Only feeder or branch-circuit conductors specified within this section shall be permitted to be attached to the feeder and/or branch-circuit mast. Masts used for the support of final spans of feeders or branch circuits shall be installed in accordance with 2.25.1.17(A) and (B).

(A) Strength. The mast shall have adequate strength or be supported by braces or guys to safely withstand the strain imposed by the overhead feeder or branch-circuit conductors. Hubs intended for use with a conduit serving as a mast for support of feeder or branch-circuit conductors shall be identified for use with a mast.

(B) Attachment. Feeder and/or branch-circuit conductors shall not be attached to a mast where the connection is between a weatherhead or the end of the conduit and a coupling where the coupling is located above the last point of securement to the building or other structure, or where the coupling is located above the building or other structure.

2.25.1.18 Clearance for Overhead Conductors and Cables. Overhead spans of open conductors and open multiconductor cables of not over 1000 volts, nominal, shall have a clearance of not less than the following:

(1) 3000 mm — above finished grade, sidewalks, or from any platform or projection that will permit personal contact where the voltage does not exceed 150 volts to ground and accessible to pedestrians only

(2) 3700 mm — over residential property and driveways, and those commercial areas not subject to truck traffic where the voltage does not exceed 300 volts to ground

(3) 4500 mm — for those areas listed in the 3 700 mm classification where the voltage exceeds 300 volts to ground

(4) 5500 mm — over public streets, alleys, roads, parking areas subject to truck traffic, driveways on other than residential property, and other land traversed by vehicles, such as cultivated, grazing, forest, and orchard

(5) 7500 mm — over track rails of railroads

2.25.1.19 Clearances from Buildings for Conductors of Not over 1 000 Volts, Nominal.

(A) Above Roofs. Overhead spans of open conductors and open multiconductor cables shall have a vertical clearance of not less than 2700 mm above the roof surface. The vertical clearance above the roof level shall be maintained for a distance not less than 900 mm in all directions from the edge of the roof.

Exception No. 1: The area above a roof surface subject to pedestrian or vehicular traffic shall have a vertical clearance from the roof surface in accordance with the clearance requirements of 2.25.1.18.

Exception No. 2: Where the voltage between conductors does not exceed 300, and the roof has a slope of 100 mm in 300 mm or greater, a reduction in clearance to 900 mm shall be permitted.

Exception No. 3: Where the voltage between conductors does not exceed 300, a reduction in clearance above only the overhanging portion of the roof to not less than 450 mm shall be permitted if (1) not more than 1800 mm of the conductors, 1200 mm horizontally, pass above the roof overhang and (2) they are terminated at a through-theroof raceway or approved support.

Exception No. 4: The requirement for maintaining the vertical clearance 900 mm from the edge of the roof shall not apply to the final conductor span where the conductors are attached to the side of a building.

(B) From Nonbuilding or Nonbridge Structures. From signs, chimneys, radio and television antennas, tanks, and other nonbuilding or nonbridge structures, clearances — vertical, diagonal, and horizontal — shall not be less than 900 mm.

(C) Horizontal Clearances. Clearances shall not be less than 900 mm.

(D) Final Spans. Final spans of feeders or branch circuits shall comply with 2.25.1.19(D)(1), (D)(2), and (D)(3).

(1) **Clearance from Windows.** Final spans to the building they supply, or from which they are fed, shall be permitted to be attached to the building, but they shall be kept not less than 900 mm from windows that are designed to be opened, and from doors, porches, balconies, ladders, stairs, fire escapes, or similar locations.

Exception: Conductors run above the top level of a window shall be permitted to be less than the 900-mm requirement.

(2) **Vertical Clearance.** The vertical clearance of final spans above or within 900 mm measured horizontally of platforms, projections, or surfaces that will permit personal contact shall be maintained in accordance with 2.25.1.18.

(3) **Building Openings.** The overhead branch-circuit and feeder conductors shall not be installed beneath openings through which materials may be moved, such as openings in farm and commercial buildings, and shall not be installed where they obstruct entrance to these openings.

(E) Zone for Fire Ladders. Where buildings exceed three stories or 15 m in height, overhead lines shall be arranged, where practicable, so that a clear space (or zone) at least 1800 m wide will be left either adjacent to the buildings or beginning not over 2500 mm from them to facilitate the raising of ladders when necessary for fire fighting.

2.25.1.20 Protection Against Physical Damage. Conductors installed on buildings, structures, or poles shall be protected against physical damage as provided for services in 2.30.4.11.

2.25.1.21 Multiconductor Cables on Exterior Surfaces of Buildings (or Other Structures). Supports for multiconductor cables on exterior surfaces of buildings (or other structures) shall be as provided in 2.30.4.12.

2.25.1.22 Raceways on Exterior Surfaces of Buildings or Other Structures. Raceways on exteriors of buildings or other structures shall be arranged to drain and shall be suitable for use in wet locations.

2.25.1.24 Outdoor Lampholders. Where outdoor lampholders are attached as pendants, the connections to the circuit wires shall be staggered. Where such lampholders have terminals of a type that puncture the insulation and make contact with the conductors, they shall be attached only to conductors of the stranded type.

2.25.1.25 Location of Outdoor Lamps. Locations of lamps for outdoor lighting shall be below all energized conductors, transformers, or other electric utilization equipment, unless either of the following apply:

(1) Clearances or other safeguards are provided for relamping operations.

(2) Equipment is controlled by a disconnecting means that is lockable in accordance with 1.10.1.25.

2.25.1.26 Vegetation as Support. Vegetation such as trees shall not be used for support of overhead conductor spans.

2.25.1.27 Raceway Seal. Where a raceway enters a building or structure from outside, it shall be sealed. Spare or unused raceways shall also be sealed. Sealants shall be identified for use with cable insulation, conductor insulation, bare conductor, shield, or other components.

2.25.2 Buildings or Other Structures Supplied by a Feeder(s) or Branch Circuit(s)

2.25.2.1 Number of Supplies. A building or other structure that is served by a branch circuit or feeder on the load side of a service disconnecting means shall be supplied by only one feeder or branch circuit unless permitted in 2.25.2.1(A) through (E). For the purpose of this section, a multiwire branch circuit shall be considered a single circuit.

Where a branch circuit or feeder originates in these additional buildings or other structures, only one feeder or branch circuit shall be permitted to supply power back to the original building or structure, unless permitted in 2.25.2.1(A) through (E).

(A) Special Conditions. Additional feeders or branch circuits shall be permitted to supply the following:

(1) Fire pumps

(2) Emergency systems

(3) Legally required standby systems

(4) Optional standby systems

(5) Parallel power production systems

(6) Systems designed for connection to multiple sources of supply for the purpose of enhanced reliability

(7) Electric vehicle charging systems listed, labeled, and identified for more than a single branch circuit or feeder

(B) Special Occupancies. Additional feeders or branch circuits shall be permitted for either of the following:

(1) Multiple-occupancy buildings or site developments with group of single detached buildings where there is no space available for supply equipment accessible to all occupants

(2) A single building or other structure sufficiently large to make two or more supplies necessary

(C) Capacity Requirements. Additional feeders or branch circuits shall be permitted where the capacity requirements are in excess of 2000 amperes at a supply voltage of 1000 volts or less.

(D) Different Characteristics. Additional feeders or branch circuits shall be permitted for different voltages, frequencies, or phases or for different uses, such as control of outside lighting from multiple locations.

(E) Documented Switching Procedures. Additional feeders or branch circuits shall be permitted to supply installations under single management where documented safe switching procedures are established and maintained for disconnection.

2.25.2.2 Disconnecting Means. Means shall be provided for disconnecting all ungrounded conductors that supply or pass through the building or structure.

2.25.2.3 Location. The disconnecting means shall be installed either inside or outside of the building or structure served or where the conductors pass through the building or structure. The disconnecting means shall be at a readily accessible location nearest the point of entrance of the conductors. For the purposes of this section, the requirements in 2.30.1.6 shall be utilized.

Exception No. 1: For installations under single management, where documented safe switching procedures are established and maintained for disconnection, and where the installation is monitored by qualified individuals, the disconnecting means shall be permitted to be located elsewhere on the premises.

Exception No. 2: For buildings or other structures qualifying under the provisions of Article 6.85, the disconnecting means shall be permitted to be located elsewhere on the premises.

Exception No. 3: For towers or poles used as lighting standards, the disconnecting means shall be permitted to be located elsewhere on the premises.

Exception No. 4: For poles or similar structures used only for support of signs installed in accordance with Article 6.0, the disconnecting means shall be permitted to be located elsewhere on the premises.

2.25.2.4 Maximum Number of Disconnects.

(A) General. The disconnecting means for each supply permitted by 2.25.2.1 shall consist of not more than six switches or six circuit breakers mounted in a single enclosure, in a group of separate enclosures adjacent to each other, or in or on a switchboard or switchgear. There shall be no more than six disconnects per supply grouped in any one location.

Exception: For the purposes of this section, disconnecting means used solely for the control circuit of the ground-fault protection system, or the control circuit of the power-operated supply disconnecting means, installed as part of the listed equipment, shall not be considered a supply disconnecting means.

(B) Single-Pole Units. Two or three single-pole switches or breakers capable of individual operation shall be permitted on multiwire circuits, one pole for each ungrounded conductor, as one multipole disconnect, provided they are equipped with identified handle ties or a master handle to disconnect all ungrounded conductors with no more than six operations of the hand.

2.25.2.5 Grouping of Disconnects.

(A) General. The two to six disconnects as permitted in 2.25.2.4 shall be grouped adjacent to each other. Each disconnect shall be marked to indicate the load served.

Exception: One of the two to six disconnecting means permitted in 2.25.2.4, where used only for a water pump also intended to provide fire protection, shall be permitted to be located remote from the other disconnecting means.

(B) Additional Disconnecting Means. The one or more additional disconnecting means for fire pumps or for emergency, legally required standby or optional standby system permitted by 2.25.2.1 shall be installed sufficiently remote from the one to six disconnecting means for normal supply to minimize the possibility of simultaneous interruption of supply.

2.25.2.6 Access to Occupants. In a multiple-occupancy building, each occupant shall have access to the occupant's supply disconnecting means.

Exception: In a multiple-occupancy building where electric supply and electrical maintenance are provided by the building management and where these are under continuous building management supervision, the supply disconnecting means supplying more than one occupancy shall be permitted to be accessible to authorized management personnel only.

2.25.2.7 Type of Disconnecting Means. The disconnecting means specified in 2.25.2.2 shall be comprised of a circuit breaker, molded case switch, general-use switch, snap switch, or other approved means. Where applied in accordance with 2.50.2.13(B), Exception No. 1, the disconnecting means shall be suitable for use as service equipment.

2.25.2.8 Identification. Where a building or structure has any combination of feeders, branch circuits, or services passing through it or supplying it, a permanent plaque or directory shall be installed at each feeder and branch-circuit disconnect location denoting all other services, feeders, or branch circuits supplying that building or structure or passing through that building or structure and the area served by each.

Exception No. 1: A plaque or directory shall not be required for large-capacity multibuilding industrial installations under single management, where it is ensured that disconnection can be accomplished by establishing and maintaining safe switching procedures.

Exception No. 2: This identification shall not be required for branch circuits installed from a dwelling unit to a second building or structure.

2.25.2.9 Disconnect Construction. Disconnecting means shall meet the requirements of 2.25.2.9(A) through (D).

(A) Manually or Power Operable. The disconnecting means shall consist of either (1) a manually operable switch or a circuit breaker equipped with a handle or other suitable operating means or (2) a power-operable switch or circuit breaker, provided the switch or circuit breaker can be opened by hand in the event of a power failure.

(B) Simultaneous Opening of Poles. Each building or structure disconnecting means shall simultaneously disconnect all ungrounded supply conductors that it controls from the building or structure wiring system.

(C) Disconnection of Grounded Conductor. Where the building or structure disconnecting means does not disconnect the grounded conductor from the grounded conductors in the building or structure wiring, other means shall be provided for this purpose at the location of the disconnecting means. A terminal or bus to which all grounded conductors can be attached by means of pressure connectors shall be permitted for this purpose.

In a multisection switchboard or switchgear, disconnects for the grounded conductor shall be permitted to be in any section of the switchboard or switchgear, if the switchboard section or switchgear section is marked to indicate a grounded conductor disconnect is contained within the equipment.

(D) Indicating. The building or structure disconnecting means shall plainly indicate whether it is in the open or closed position.

2.25.2.10 Rating of Disconnect. The feeder or branch-circuit disconnecting means shall have a rating of not less than the calculated load to be supplied, determined in accordance with Parts 2.20.1 and 2.20.2 for branch circuits, Part 2.20.3 and 2.20.4 for feeders, or Part 2.20.5 for farm loads. Where the branch circuit or feeder disconnecting means consists of more than one switch or circuit breaker, as permitted by 2.25.2.4, combining the ratings of all the switches or circuit breakers for determining the rating of the disconnecting means shall be permitted. In no case shall the rating be lower than specified in 2.25.2.10(A), (B), (C), or (E).

(A) One-Circuit Installation. For installations to supply only limited loads of a single branch circuit, the branch circuit disconnecting means shall have a rating of not less than 15 amperes.

(B) One-Circuit Installation – Dwelling Unit. For a dwelling unit with a single branch circuit as permitted in Section 2.10.1.11(C)(5), the branch circuit disconnect means shall have a rating of not less than 20 amperes.

(C) Two-Circuit Installations. For installations consisting of not more than two 2-wire branch circuits, the feeder or branch-circuit disconnecting means shall have a rating of not less than 30 amperes.

(D) One-Family Dwelling. For a one-family dwelling, the feeder disconnecting means shall have a rating of not less than 60 amperes, 3-wire.

(E) All Others. For all other installations, the feeder or branch-circuit disconnecting means shall have a rating of not less than 60 amperes.

2.25.2.11 Access to Overcurrent Protective Devices. Where a feeder overcurrent device is not readily accessible, branch-circuit overcurrent devices shall be installed on the load side, shall be mounted in a readily accessible location, and shall be of a lower ampere rating than the feeder over-current device.

2.25.3 Over 1000 Volts.

2.25.3.1 Sizing of Conductors. The sizing of conductors over 1000 volts shall be in accordance with 2.10.2.2(B) for branch circuits and 2.15.1.2(B) for feeders.

2.25.3.2 Isolating Switches. Where oil switches or air, oil, vacuum, or sulfur hexafluoride circuit breakers constitute a building disconnecting means, an isolating switch with visible break contacts and meeting the requirements of 230.204(B), (C), and (D) shall be installed on the supply side of the disconnecting means and all associated equipment.

Exception: The isolating switch shall not be required where the disconnecting means is mounted on removable truck panels or switchgear units that cannot be opened unless the circuit is disconnected and that, when removed from the normal operating position, automatically disconnect the circuit breaker or switch from all energized parts.

2.25.3.3 Disconnecting Means.

(A) Location. A building or structure disconnecting means shall be located in accordance with 2.25.3.3, or, if not readily accessible, it shall be operable by mechanical linkage from a readily accessible point. For multibuilding industrial installations under single management, it shall be electrically operated by a readily accessible, remote-control device in a separate building or structure.

(B) Type. Each building or structure disconnect shall simultaneously disconnect all ungrounded supply conductors it controls and shall have a fault-closing rating not less than the maximum available short-circuit current available at its supply terminals.

Exception: Where the individual disconnecting means consists of fused cutouts, the simultaneous disconnection of all ungrounded supply conductors shall not be required if there is a means to disconnect the load before opening the cutouts. A permanent legible sign shall be installed adjacent to the fused cutouts and shall read DISCONNECT LOAD BEFORE OPENING CUTOUTS.

Where fused switches or separately mounted fuses are installed, the fuse characteristics shall be permitted to contribute to the fault closing rating of the disconnecting means.

(C) Locking. Disconnecting means shall be lockable in accordance with 1.10.1.25.

Exception: Where an individual disconnecting means consists of fused cutouts, a suitable enclosure capable of being locked and sized to contain all cutout fuse holders shall be installed at a convenient location to the fused cutouts.

(D) Indicating. Disconnecting means shall clearly indicate whether they are in the open "off" or closed "on" position.

(E) Uniform Position. Where disconnecting means handles are operated vertically, the "up" position of the handle shall be the "on" position.

Exception: A switching device having more than one "on" position, such as a double throw switch, shall not be required to comply with this requirement.

(F) Identification. Where a building or structure has any combination of feeders, branch circuits, or services passing through or supplying it, a permanent plaque or directory shall be installed at each feeder and branch-circuit disconnect location that denotes all other services, feeders, or branch circuits supplying that building or structure or passing through that building or structure and the area served by each.

2.25.3.7 Inspections and Tests.

(A) Pre-Energization and Operating Tests. The complete electrical system design, including settings for protective, switching, and control circuits, shall be prepared in advance and made available on request to the Office of the Building Official/EE and shall be performance tested when first installed on-site. Each protective, switching, and control circuit shall be adjusted in accordance with the system design and tested by actual operation using current injection or equivalent methods as necessary to ensure that each and every such circuit operates correctly.

(1) **Instrument Transformers.** All instrument transformers shall be tested to verify correct polarity and burden.

(2) **Protective Relays.** Each protective relay shall be demonstrated to operate by injecting current or voltage, or both, at the associated instrument transformer output terminal and observing that the associated switching and signaling functions occur correctly and in proper time and sequence to accomplish the protective function intended.

(3) **Switching Circuits.** Each switching circuit shall be observed to operate the associated equipment being switched.

(4) **Control and Signal Circuits.** Each control or signal circuit shall be observed to perform its proper control function or produce a correct signal output.

(5) **Metering Circuits.** All metering circuits shall be verified to operate correctly from voltage and current sources in a similar manner to protective relay circuits.

(6) **Acceptance Tests.** Complete acceptance tests shall be performed, after the substation installation is completed, on all assemblies, equipment, conductors, and control and protective systems, as applicable, to verify the integrity of all the systems.

(7) **Relays and Metering Utilizing Phase Differences.** All relays and metering that use phase differences for operation shall be verified by measuring phase angles at the relay under actual load conditions after operation commences.

(B) Test Report. A test report covering the results of the tests required in 2.25.3.7(A) shall be delivered to the Office of the Building Official/EE prior to energization.

FPN: For an example of acceptance specifications, see ANSI/NETA ATS-2013, *Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems*, published by the InterNational Electrical Testing Association.

2.25.3.11 Clearances over Roadways, Walkways, Rail, Water, and Open Land.

(A) 22 kV, Nominal, to Ground or Less. The clearances over roadways, walkways, rail, water, and open land for conductors and live parts up to 22 kV, nominal, to ground or less shall be not less than the values shown in Table 2.25.3.11.

(B) Over 22 kV Nominal to Ground. Clearances for the categories shown in Table 2.25.3.11 shall be increased by 10 mm per kV above 22 000 volts.

(C) Special Cases. For special cases, such as where crossings will be made over lakes, rivers, or areas using large vehicles such as mining operations, specific designs shall be engineered considering the special circumstances.

FPN: For additional information, see ANSI/IEEE C2-2012, *National Electrical Safety Code.*

2.25.3.12 Clearances over Buildings and Other Structures.

(A) 22 kV Nominal to Ground or Less. The clearances over buildings and other structures for conductors and live parts up to 22 kV, nominal, to ground or less shall be not less than the values shown in Table 2.25.3.12.

(B) Over 22 kV Nominal to Ground. Clearances for the categories shown in Table 2.25.3.12 shall be increased by 10 mm per kV above 22,000 volts.

FPN: For additional information, see ANSI/IEEE C2-2012, *National Electrical Safety Code.*

Table 2.25.3.11 Clearances over Roadways, Walkways, Rail, Water, and Open Land

Location	Clearance (m)
Open land subject to vehicles, cultivation, or grazing	5.6
Roadways, driveways, parking lots, and alleys	5.6
Walkways	4.1
Rails	8.1
Spaces and ways for pedestrians and restricted traffic	4.4
Water areas not suitable for boating	5.2

Table 2.25.3.12 Clearances over Buildings and Other Structures

Clearance from Conductors or Live Parts from	Horizontal (m)	Vertical (m)
Building walls, projections, and windows	2.3	-
Balconies, catwalks, and similar areas accessible to people	2.3	4.1
Over or under roofs or projections not readily accessible to people	-	3.8
Over roofs accessible to vehicles but not trucks	-	4.1
Over roofs accessible to trucks	-	5.6
Other structures	2.3	-

ARTICLE 2.30 – SERVICES

2.30.1 Generals

2.30.1.1 Scope. This article covers service conductors and equipment for control and protection of services and their installation requirements.

FPN: See Figure 2.30.1.1.

2.30.1.2 Number of Services. A building or other structure or a site development with group of single detached buildings served shall be supplied by only one service unless permitted in 2.30.1.2(A) through (D). For the purpose of 2.30.4.1, Exception No. 2 only, underground sets of conductors, 50 mm² and larger, running to the same location and connected together at their supply end but not connected together at their load end shall be considered to be supplying one service.

(A) Special Conditions. Additional services shall be permitted to supply the following:

(1) Fire pumps

(2) Emergency systems

(3) Legally required standby systems

(4) Optional standby systems

(5) Parallel power production systems

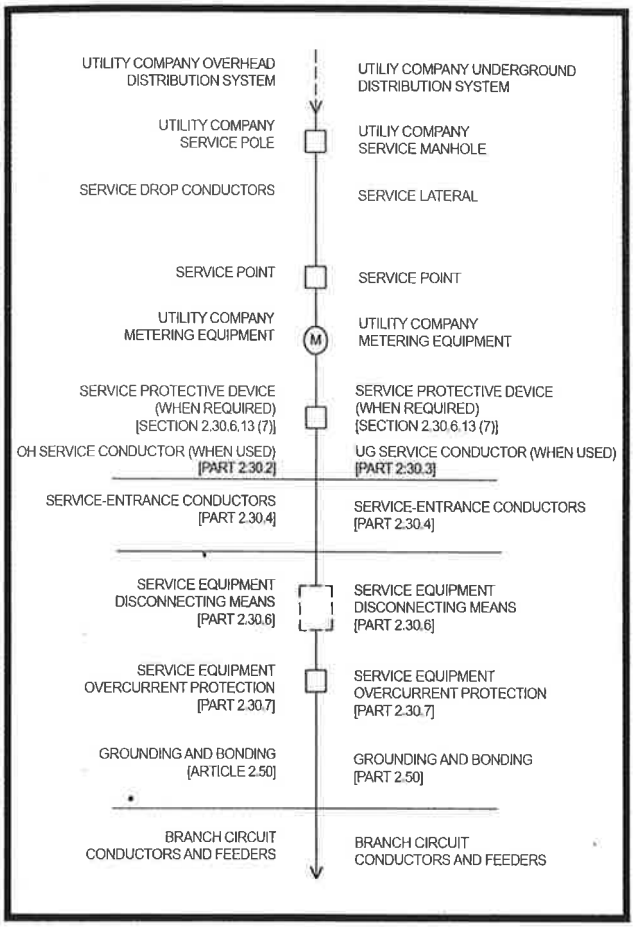

Figure 2.30.1.1 Services.

(6) Systems designed for connection to multiple sources of supply for the purpose of enhanced reliability

(B) Special Occupancies. Additional services shall be permitted for either of the following:

(1) Multiple-occupancy buildings or site developments with group of single detached buildings where there is no available space for service equipment accessible to all occupants

(2) A single building or other structure or a site development with group of single detached buildings sufficiently large to make two or more services necessary

(C) Capacity Requirements. Additional services shall be permitted under any of the following:

(1) Where the capacity requirements are in excess of 2000 amperes at a supply voltage of 1000 volts or less

(2) Where the load requirements of a single-phase installation are greater than the serving agency normally supplies through one service

(D) Different Characteristics. Additional services shall be permitted for different voltages, frequencies, or phases, or for different uses, such as for different rate schedules.

(E) Identification. Where a building or structure is supplied by more than one service, or any combination of branch circuits, feeders, and services, a permanent plaque or directory shall be installed at each service disconnect location denoting all other services, feeders, and branch circuits supplying that building or structure and the area served by each. See 2.25.2.8.

2.30.1.3 One Building or Other Structure Not to Be Supplied Through Another. Service conductors supplying a building or other structure shall not pass through the interior of another building or other structure.

2.30.1.6 Conductors Considered Outside the Building. Conductors shall be considered outside of a building or other structure under any of the following conditions:

(1) Where installed under not less than 50 mm of concrete beneath a building or other structure

(2) Where installed within a building or other structure in a raceway that is encased in concrete or brick not less than 50 mm thick

(3) Where installed in any vault that meets the construction requirements of Part 4.50.3.

(4) Where installed in conduit and under not less than 450 mm of earth beneath a building or other structure

(5) Where installed within rigid metal conduit (Type RMC) or intermediate metal conduit (Type IMC) used to accommodate the clearance requirements in 2.30.2.3 and routed directly through an eave but not a wall of a building.

2.30.1.7 Other Conductors in Raceway or Cable. Conductors other than service conductors shall not be installed in the same service raceway or service cable in which the service conductors are installed.

Exception No. 1: Grounding electrode conductors or supply side bonding jumpers or conductors shall be permitted within service raceways.

Exception No. 2: Load management control conductors having overcurrent protection.

2.30.1.8 Raceway Seal. Where a service raceway enters a building or structure from an underground distribution system, it shall be sealed in accordance with 3.0.1.5(G). Spare or unused raceways shall also be sealed. Sealants shall be identified for use with the cable insulation, shield, or other components.

2.30.1.9 Clearances on Buildings. Service conductors and final spans shall comply with 2.30.1.9(A), (B), and (C).

(A) Clearances. Service conductors installed as open conductors or multiconductor cable without an overall outer jacket shall have a clearance of not less than 900 mm from windows that are designed to be opened, doors, porches, balconies, ladders, stairs, fire escapes, or similar locations.

Exception: Conductors run above the top level of a window shall be permitted to be less than the 900-mm requirement.

(B) Vertical Clearance. The vertical clearance of final spans above, or within 900 mm measured horizontally of, platforms, projections, or surfaces that will permit personal contact shall be maintained in accordance with 2.30.2.3(B).

(C) Building Openings. Overhead service conductors shall not be installed beneath openings through which materials may be moved, such as openings in farm and commercial buildings, and shall not be installed where they obstruct entrance to these building openings.

2.30.1.10 Vegetation as Support. Vegetation such as trees shall not be used for support of overhead service conductors.

2.30.2 Overhead Service Conductors

2.30.2.1 Insulation or Covering. Individual conductors shall be insulated or covered.

Exception: The grounded conductor of a multiconductor cable shall be permitted to be bare.

2.30.2.2 Size and Rating.

(A) General. Conductors shall have sufficient ampacity to carry the current for the load as calculated in accordance with Article 2.20 and shall have adequate mechanical strength.

(B) Minimum Size. The conductors shall not be smaller than 8.0 mm^2 (3.2 mm dia.) copper or 14 mm^2 aluminum or copper-clad aluminum.

Exception: Conductors supplying only limited loads of a single branch circuit — such as small polyphase power, controlled water heaters, and similar loads — shall not be smaller than 3.5 mm^2 (2.0 mm dia.)hard-drawn copper or equivalent.

(C) Grounded Conductors. The grounded conductor shall not be less than the minimum size as required by 2.50.2.5(C).

2.30.2.3 Clearances. Overhead service conductors shall not be readily accessible and shall comply with 2.30.2.3(A) through (E) for services not over 1000 volts, nominal.

(A) Above Roofs. Conductors shall have a vertical clearance of not less than 2500 mm above the roof surface. The vertical clearance above the roof level shall be maintained for a distance of not less than 900 mm in all directions from the edge of the roof.

Exception No. 1: The area above a roof surface subject to pedestrian or vehicular traffic shall have a vertical clearance from the roof surface in accordance with the clearance requirements of 2.30.2.3(B).

Exception No. 2: Where the voltage between conductors does not exceed 300 and the roof has a slope of 100 mm in 300 mm or greater, a reduction in clearance to 900 mm shall be permitted.

Exception No. 3: Where the voltage between conductors does not exceed 300, a reduction in clearance above only the overhanging portion of the roof to not less than 450 mm shall be permitted if (1) not more than 1800 mm of overhead service conductors, 1200 mm horizontally, pass above the roof overhang, and (2) they are terminated at a through-the-roof raceway or approved support.

FPN: See 2.30.2.7 for mast supports.

Exception No. 4: The requirement for maintaining the vertical clearance 900 mm from the edge of the roof shall not apply to the final conductor span where the service drop or overhead service conductors are attached to the side of a building.

Exception No. 5: Where the voltage between conductors does not exceed 300 and the roof area is guarded or isolated, a reduction in clearance to 900 mm shall be permitted.

(B) Vertical Clearance for Overhead Service Conductors. Overhead service conductors, where not in excess of 600 volts, nominal, shall have the following minimum clearance from final grade:

(1) 3000 mm — at the electrical service entrance to buildings, also at the lowest point of the drip loop of the building electrical entrance, and above areas or sidewalks accessible only to pedestrians, measured from final grade or other accessible

surface only for overhead service conductors supported on and cabled together with a grounded bare messenger where the voltage does not exceed 150 volts to ground

(2) 3700 mm — over residential property and driveways, and those commercial areas not subject to truck traffic where the voltage does not exceed 300 volts to ground

(3) 4500 mm — for those areas listed in the 3700-mm classification where the voltage exceeds 300 volts to ground

(4) 5500 mm — over public streets, alleys, roads, parking areas subject to truck traffic, driveways on other than residential property, and other land such as cultivated, grazing, forest, and orchard

(5) 7500 mm over tracks of railroads

(C) Clearance from Building Openings. See 2.30.1.9.

(D) Clearance from Swimming Pools. See 6.80.1.8.

(E) Clearance from Communication Wires and Cables. Clearance from communication wires and cables shall be in accordance with 8.0.2.1(A)(4).

2.30.2.5 Point of Attachment. The point of attachment of the overhead service conductors to a building or other structure shall provide the minimum clearances as specified in 2.30.1.9 and 2.30.2.3. In no case shall this point of attachment be less than 3000 mm above finished grade.

2.30.2.6 Means of Attachment. Multiconductor cables used for overhead service conductors shall be attached to buildings or other structures by fittings identified for use with service conductors. Open conductors shall be attached to fittings identified for use with service conductors or to noncombustible, nonabsorbent insulators securely attached to the building or other structure.

2.30.2.7 Service Masts as Supports. Only power service-drop or overhead service conductors shall be permitted to be attached to a service mast. Service masts used for the support of service-drop or overhead service conductors shall be installed in accordance with 2.30.2.7(A) and (B).

(A) Strength. The service mast shall be of adequate strength or be supported by braces or guys to withstand safely the strain imposed by the service-drop or overhead service conductors. Hubs intended for use with a conduit that serves as a service mast shall be identified for use with service-entrance equipment.

(B) Attachment. Service-drop or overhead service conductors shall not be attached to a service mast between a weatherhead or the end of the conduit and a coupling, where the coupling is located above the last point of securement to the building or other structure or is located above the building or other structure.

2.30.2.8 Supports over Buildings. Service conductors passing over a roof shall be securely supported by substantial structures. For a grounded system, where the substantial structure is metal, it shall be bonded by means of a bonding jumper and listed connector to the grounded overhead service conductor. Where practicable, such supports shall be independent of the building.

2.30.3 Underground Service Conductors

2,30.3.1 Installation.

(A) Insulation. Underground service conductors shall be insulated for the applied voltage.

Exception: A grounded conductor shall be permitted to be uninsulated as follows:

(1) Bare copper used in a raceway

(2) Bare copper for direct burial where bare copper is approved for the soil conditions

(3) Bare copper for direct burial without regard to soil conditions where part of a cable assembly identified for underground use

(4) Aluminum or copper-clad aluminum without individual insulation or covering where part of a cable assembly identified for underground use in a raceway or for direct burial

(B) Wiring Methods. Underground service conductors shall be installed in accordance with the applicable requirements of this Code covering the type of wiring method used and shall be limited to the following methods:

(1) Type RMC conduit

(2) Type IMC conduit

(3) Type NUCC conduit

(4) Type HDPE conduit

(5) Type PVC conduit

(6) Type RTRC conduit

(7) Type IGS cable

(8) Type USE conductors or cables

(9) Type MV or Type MC cable identified for direct burial applications

(10) Type MI cable, where suitably protected against physical damage and corrosive conditions

2.30.3.2 Size and Rating.

(A) General. Underground service conductors shall have sufficient ampacity to carry the current for the load as calculated in accordance with Article 2.20 and shall have adequate mechanical strength.

(B) Minimum Size. The conductors shall not be smaller than 8.0 mm^2 (3.2 mm dia.) copper or 14 mm^2 aluminum or copper-clad aluminum.

Exception: Conductors supplying only limited loads of a single branch circuit — such as small polyphase power, controlled water heaters, and similar loads — shall not be smaller than 3.5 mm^2 (2.0 mm dia.)copper or 5.5 mm^2 (2.6 mm dia.) aluminum or copper-clad aluminum.

(C) Grounded Conductors. The grounded conductor shall not be less than the minimum size required by 2.50.2.3(C).

2.30.3.3 Protection Against Damage. Underground service conductors shall be protected against damage in accordance with 3.0.1.5. Service conductors entering a building or other structure shall be installed in accordance with 2.30.1.6 or protected by a raceway wiring method identified in 2.30.4.4.

2.30.3.4 Spliced Conductors. Service conductors shall be permitted to be spliced or tapped in accordance with 1.10.1.14, 3.0.1.5(E), 3.0.1.13, and 3.0.1.15.

2.30.4 Service-Entrance Conductors

2.30.4.1 Number of Service-Entrance Conductor Sets. Each service drop, set of overhead service conductors, set of underground service conductors, or service lateral shall supply only one set of service-entrance conductors.

Exception No. 1: A building with more than one occupancy or a site development with group of single detached buildings shall be permitted to have one set of service-entrance conductors for each service, as defined in 2.30.1.2, run to each occupancy or each group of occupancies. Service-entrance sets serving a group of occupancies shall be permitted only if owned and managed by one person or entity or under single management. If the number of service disconnect locations for any given classification of service does not exceed six, the requirements of 2.30.1.2(E) shall apply at each location. If the number of service disconnect locations exceeds six for any given supply classification, all service disconnect locations for all supply characteristics, together with any branch circuit or feeder supply sources, if applicable, shall be clearly described using suitable graphics or text, or both, on one or more plaques located in a readily accessible location(s) on the building or structure served and as near as practicable to the point(s) of attachment or entry(ies) for each service drop or service lateral, and for each set of overhead or underground service conductors.

FPN: There may be more than one location of service disconnecting means grouping in multiple-occupancy buildings or a site development with group of single detached buildings.

Exception No. 2: Where two to six service disconnecting means in separate enclosures are grouped adjacent to each other at one location and supply separate loads from one service drop, set of overhead service conductors, set of underground service conductors, or service lateral, one set of service-entrance conductors shall be permitted to supply each or several such service equipment enclosures.

Exception No. 3: A one-family dwelling unit and its accessory structures shall be permitted to have one set of service-entrance conductors run to each from a single service drop, set of overhead service conductors, set of underground service conductors, or service lateral.

Exception No. 4: Two-family dwellings, multifamily dwellings, multiple occupancy buildings and a site development with group of single detached buildings shall be permitted to have one set of service-entrance conductors installed to supply the circuits covered in 2.10.2.8.

Exception No. 5: One set of service-entrance conductors connected to the supply side of the normal service disconnecting means shall be permitted to supply each or several systems covered by 2.30.3.13(5) or 2.30.6.13(6).

2.30.4.2 Insulation of Service-Entrance Conductors. Service-entrance conductors entering or on the exterior of buildings or other structures shall be insulated.

Exception: A grounded conductor shall be permitted to be uninsulated as follows:

(1) Bare copper used in a raceway or part of a service cable assembly

(2) Bare copper for direct burial where bare copper is approved for the soil conditions

(3) Bare copper for direct burial without regard to soil conditions where part of a cable assembly identified for underground use

(4) Aluminum or copper-clad aluminum without individual insulation or covering where part of a

cable assembly or identified for underground use in a raceway, or for direct burial

(5) Bare conductors used in an auxiliary gutter

2.30.4.3 Minimum Size and Rating.

(A) General. Service-entrance conductors shall have an ampacity of not less than the maximum load to be served. Conductors shall be sized to carry not less than the largest of 2.30.4.3(A)(1) or (A)(2). Loads shall be determined in accordance with Part 2.20.3, 2.20.4, or 2.20.5, as applicable. Ampacity shall be determined from 3.10.2.6. The maximum allowable current of busways shall be that value for which the busway has been listed or labeled.

(1) Where the service-entrance conductors supply continuous loads or any combination of noncontinuous and continuous loads, the minimum service-entrance conductor size shall have an allowable ampacity not less than sum of the noncontinuous loads plus 125 percent of continuous loads

Exception No.1: Grounded conductors that are not connected to an overcurrent device shall be permitted to be sized at 100 percent of the sum of the continuous and noncontinuous load.

Exception No. 2: The sum of the noncontinuous load and the continuous load if the service-entrance conductors terminate in an overcurrent device where both the overcurrent device and its assembly are listed for operation at 100 percent of their rating shall be permitted.

(2) The minimum service-entrance conductor size shall have an ampacity not less than the maximum load to be served after the application of any adjustment or correction factors.

(B) Specific Installations. In addition to the requirements of 2.30.4.3(A), the minimum ampacity for ungrounded conductors for specific installations shall not be less than the rating of the service disconnecting means specified in 2.30.6.10(A) through (D).

(C) Grounded Conductors. The grounded conductor shall not be smaller than the minimum size as required by 2.50.2.5(C).

2.30.4.4 Wiring Methods for 1000 Volts, Nominal, or Less. Service-entrance conductors shall be installed in accordance with the applicable requirements of this *Code* covering the type of wiring method used and shall be limited to the following methods:

(1) Open wiring on insulators

(2) Type IGS cable

(3) Rigid metal conduit (RMC)

(4) Intermediate metal conduit (IMC)

(5) Electrical metallic tubing (EMT)

(6) Electrical nonmetallic tubing

(7) Service-entrance cables

(8) Wireways

(9) Busways

(10) Auxiliary gutters

(11) Rigid polyvinyl chloride conduit (PVC)

(12) Cablebus

(13) Type MC cable

(14) Mineral-insulated, metal-sheathed cable, Type MI

(15) Flexible metal conduit (FMC) not over 1 800 mm long or liquidtight flexible metal conduit (LFMC) not over 1 800 mm long between a raceway, or between a raceway and service equipment, with a supply-side bonding jumper routed with the flexible metal conduit (FMC) or the liquidtight flexible metal conduit (LFMC) according to the provisions of 2.50.5.13(A), (B), (C), and (E)

(16) Liquidtight flexible nonmetallic conduit (LFNC)

(17) High density polyethylene conduit (HDPE)

(18) Nonmetallic underground conduit with conductors (NUCC)

(19) Reinforced thermosetting resin conduit (RTRC)

2.30.4.5 Cable Trays. Cable tray systems shall be permitted to support service-entrance conductors. Cable trays used to support service-entrance conductors shall contain only service-entrance conductors and shall be limited to the following methods:

(1) Type SE cable

(2) Type MC cable

(3) Type MI cable

(4) Type IGS cable

(5) Single conductors 50 mm^2 and larger that are listed for use in cable tray

Such cable trays shall be identified with permanently affixed labels with the wording "Service-Entrance Conductors." The labels shall be located so as to be

visible after installation with a spacing not to exceed 3000 mm so that the service-entrance conductors are able to be readily traced through the entire length of the cable tray.

Exception: Conductors, other than service-entrance conductors, shall be permitted to be installed in a cable tray with service-entrance conductors, provided a solid fixed barrier of a material compatible with the cable tray is installed to separate the service-entrance conductors from other conductors installed in the cable tray.

2.30.4.7 Spliced Conductors. Service-entrance conductors shall be permitted to be spliced or tapped in accordance with 1.10.1.14, 3.0.1.5(E), 3.0.1.13, and 3.0.1.15.

2.30.4.11 Protection Against Physical Damage.

(A) Underground Service-Entrance Conductors. Underground service-entrance conductors shall be protected against physical damage in accordance with 3.0.1.5.

(B) All Other Service-Entrance Conductors. All other service-entrance conductors, other than underground service entrance conductors, shall be protected against physical damage as specified in 2.30.4.11(B)(1) or (B)(2).

(1) Service-Entrance Cables. Service-entrance cables, where subject to physical damage, shall be protected by any of the following:

(1) Rigid metal conduit (RMC)

(2) Intermediate metal conduit (IMC)

(3) Schedule 80 PVC conduit

(4) Electrical metallic tubing (EMT)

(5) Reinforced thermosetting resin conduit (RTRC)

(6) Other approved means

(2) Other Than Service-Entrance Cables. Individual open conductors and cables, other than service-entrance cables, shall not be installed within 3000 mm of grade level or where exposed to physical damage.

Exception: Type MI and Type MC cable shall be permitted within 3000 mm of grade level where not exposed to physical damage or where protected in accordance with 3.0.1.5(D).

2.30.4.12 Mounting Supports. Service-entrance cables or individual open service-entrance conductors shall be supported as specified in 2.30.4.12(A), (B), or (C).

(A) Service-Entrance Cables. Service-entrance cables shall be supported by straps or other approved means within 300 mm of every service head, gooseneck, or connection to a raceway or enclosure and at intervals not exceeding 750 mm.

(B) Other Cables. Cables that are not approved for mounting in contact with a building or other structure shall be mounted on insulating supports installed at intervals not exceeding 4 500 mm and in a manner that maintains a clearance of not less than 50 mm from the surface over which they pass.

(C) Individual Open Conductors. Individual open conductors shall be installed in accordance with Table 2.30.4.12(C). Where exposed to the weather, the conductors shall be mounted on insulators or on insulating supports attached to racks, brackets, or other approved means. Where not exposed to the weather, the conductors shall be mounted on glass or porcelain knobs.

2.30.4.13 Individual Conductors Entering Buildings or Other Structures. Where individual open conductors enter a building or other structure, they shall enter through roof bushings or through the wall in an upward slant through individual, noncombustible, nonabsorbent insulating tubes. Drip loops shall be formed on the conductors before they enter the tubes.

2.30.4.14 Raceways to Drain. Where exposed to the weather, raceways enclosing service-entrance conductors shall be listed or approved for use in wet locations and arranged to drain. Where embedded in masonry, raceways shall be arranged to drain.

2.30.4.15 Overhead Service Locations.

(A) Service Head. Service raceways shall be equipped with a service head at the point of connection to service-drop or overhead service conductors. The service head shall be listed for use in wet locations.

(B) Service-Entrance Cables Equipped with Service Head or Gooseneck. Service-entrance cables shall be

Table 2.30.4.12(C) Supports

Maximum Volts	Maximum Distance Between Supports (m)	Minimum Clearance	
		Between Conductors (mm)	From Surface (mm)
1000	2.7	150	50
1000	4.5	300	50
300	1.4	75	50
1000*	1.4*	65*	25*

*Where not exposed to weather.