CHAPTER 8 – SPECIAL EQUIPMENT

ARTICLE 6.0

ELECTRICAL SIGNS AND OUTLINE LIGHTING

6.0.1 General

6.0.1.1 Scope. This article covers the installation of conductors, equipment, and field wiring for electric signs, retrofit kits and outline lighting, regardless of voltage. All installations and equipment using neon tubing, such as signs, decorative elements, skeleton tubing, or art forms, are covered by this article

6.0.1.2 Definitions

LED Sign Illumination System. A complete lighting system for use in signs and outline lighting consisting of light-emitting diode (LED) light sources, power supplies, wire, and connectors to complete the installation.

Neon Tubing. Electric-discharge luminous tubing, including cold cathode luminous tubing, that is manufactured into shapes to illuminate signs, form letters, parts of letters, skeleton tubing, outline lighting, other decorative elements, or art forms and filled with various inert gases.

6.0.1.2 Definitions

Photovoltaic (PV) Powered Sign. A complete sign powered by solar energy consisting of all components and subassemblies for installation either as an off-grid stand-alone, on-grid interactive, or non-grid interactive system.

Section Sign. A sign or outline lighting system, shipped as subassemblies that requires field-installed wiring between the subassemblies to complete the overall sign. The subassemblies are either physically joined to form a single sign unit or are installed as separate remote parts of an overall sign.

6.0.1.2 Definitions

Sign Body. A portion of a sign that may provide protection from the weather but is not an electrical enclosure.

Skeleton Tubing. Neon tubing that is itself the sign or outline lighting and is not attached to an enclosure or sign body

6.0.1.3 Listing

Fixed, mobile, or portable electric signs, section signs, outline lighting, photovoltaic (PV) Powered signs, and retrofit kits, regardless of voltage, shall be list ed, provided with installation instructions, and installed in conformance with that listing.

(A) Field-Installed Skeleton Tubing. Field-installed skeleton tubing shall not be required to be listed where installed in conformance with this Code.

(B) Outline Lighting. Outline lighting shall not be required to be listed as a system when it consists of listed luminaires wired in accordance with Chapter 3.

6.0.1.4 Markings

(A) Signs and Outline Lighting Systems. Signs and outline lighting systems shall be listed, marked with the manufacturer's name, trademark, or other means of identification, and input voltage and current rating.

(B) Signs with a Retrofitted Illumination System

(1) The retrofitted sign shall be marked that the illumination system has been replaced.

(2) The marking shall include the kit providers and installer's name, logo, or unique identifier.

(3) Signs equipped with tubular light-emitting diode lamps powered by the existing sign sockets shall include a label alerting the service personnel that the sign has been modified.

6.0.1.4 Markings

(C) Signs with lamp-holders for Incandescent Lamps. Signs and outline lighting systems with lamp-holders for incandescent lamps shall be marked to indicate the maximum allowable lamp wattage per lamp-holder. The markings shall be permanently installed, in letters at least 6 mm high, and shall be located where visible during re-lamping.

(D) Visibility. The markings required in 6.0.1.4(A) and listing labels shall not be required to be visible after installation but shall be permanently applied in a location visible during servicing.

6.0.1.4 Markings

(E) Durability. Marking labels shall be permanent, durable and, when in wet locations, shall be weatherproof

(F) Installation Instructions. All signs, outline lighting, skeleton tubing systems, and retrofit kits shall be marked to indicate that field wiring and installation instructions are required.

Exception: Portable, cord-connected signs are not required to be marked.

6.0.1.5 Branch Circuits

(A) Required Branch Circuit. commercial building and each commercial occupancy accessible to pedestrians shall be provided with at least one outlet in an accessible location at each entrance to each tenant space for sign or outline lighting system use. The outlet(s) shall be supplied by a branch circuit rated at least 20 amperes that supplies no other load. Service hallways or corridors shall not be considered accessible to pedestrians.

(B) Rating. Branch circuits that supply signs shall be rated in accordance with 6.0.1.5(B)(1) or (B)(2) and shall be considered to be continuous loads for the purposes of calculations.

(B) Rating

(1) Neon Signs. Branch circuits that supply neon tubing installations shall not be rated in excess of 30 amperes.

(2) All Other Signs. Branch circuits that supply all other signs and outline lighting systems shall be rated not to exceed 20 amperes.

6.0.1.5 Branch Circuits

(C) Wiring Methods. Wiring methods used to supply signs shall comply with 6.0.1.5(C)(1), (C)(2), and (C) (3).

(1) Supply. The wiring method used to supply signs and outline lighting systems shall terminate within a sign, an outline lighting system enclosure, a suitable box, or a conduit body.

(2) Enclosures as Pull Boxes. Signs and transformer enclosures shall be permitted to be used as pull or junction boxes for conductors supplying other adjacent signs, outline lighting systems, or floodlights that are part of a sign and shall be permitted to contain both branch and secondary circuit conductors.

(3) Metal or Nonmetallic Poles. Metal or nonmetallic poles used to support signs shall be permitted to enclose supply conductors, provided the poles and conductors are installed in accordance with a pre-discussed topic in Chapter 4.

6.0.1.6 Disconnects

Each sign and outline lighting system, feeder conductor(s), or branch circuit(s) supplying a sign, outline lighting system, or skeleton tubing shall be controlled by an externally operable switch or circuit breaker that opens all ungrounded conductors and controls no other load. The itch or circuit breaker shall open all ungrounded conductors simultaneously on multi-wire wire branch circuits in accordance with a certain topic in Chapter 2. Signs and outline lighting systems located within fountains shall have the disconnect located in accordance with 6.80.1.12.

(A) Location

The disconnecting means shall be permitted to be located in accordance with:

(1) At Point of Entry to a Sign. The disconnect shall be located at the point the feeder circuit or branch circuit(s) supplying a sign or outline lighting system enters a sign enclosure, a sign body, or a pole in accordance with 6.0.1.5(C)(3). The disconnect shall open all ungrounded conductors where it enters the enclosure of the sign or pole.

(2) Within Sight of the Sign. The disconnecting lighting means shall be within sight of the sign or outline lighting system that it controls.

(A) Location

(3) Within Sight of the Controller. The following I shall apply for signs or outline lighting systems operated by electronic or electromechanical controllers located external to the sign or outline lighting system:

(1) The disconnecting means shall be located within sight of the controller or in the same enclosure with the controller.

(2) The disconnecting means shall disconnect the sign or outline lighting system and the controller from all ungrounded supply conductors.

(3) The disconnecting means shall be designed such that no pole can be operated independently and shall be lockable in accordance with a certain topic in Chapter 1.

(B) Control Switch Rating

Switches, flashers, and similar devices controlling transformers and electronic power supplies shall be rated for controlling inductive loads or have a current rating not less than twice the current rating of the transformer or the electronic power supply.

6.0.1.7 Grounding and Bonding

Grounding

Equipment Grounding. Metal equipment of signs, outline lighting, and skeleton tubing systems shall be grounded by connection to the equipment grounding conductor of the supply branch circuit(s) or feeder using the types of equipment grounding conductors specified in a certain topic in Chapter 2.

Exception: Portable cord-connected signs shall not be required to be connected to the equipment grounding conductor where protected by a system of double insulation or its equivalent. Double insulated equipment shall be distinctively marked.

(A) Grounding

(2) Size of Equipment Grounding Conductor. The equipment grounding conductor size shall be in accordance with a previous article based on the rating of the overcurrent device protecting the branch circuit or feeder conductors supplying the sign or equipment.

(3) Connections. Equipment grounding conductor connections shall be made in accordance with a certain topic back in Chapter 2 and in a method specified in it.

(A) Grounding

(4) Auxiliary Grounding Electrode. Auxiliary grounding electrode(s) shall be permitted for electric signs and outline lighting systems covered by this article and shall meet the requirements of a subtopic in Chapter 2.

(5) Metal Building Parts. Metal parts of a building shall not be permitted as a. secondary return conductor or an equipment grounding conductor.

(B) Bonding

(1) Bonding of Metal Parts. Metal parts and equipment of signs and outline lighting systems shall be bonded together and to the associated transformer or power-supply equipment grounding conductor of the branch circuit or feeder supplying the sign or outline lighting system and shall meet the requirements of a previous topic in Chapter 2.

(2) Bonding Connections. Bonding connections shall be made in accordance with a pre-discussed topic.

6.0.1.8 Enclosures

(A) Strength. Enclosures shall have ample structural strength and rigidity.

(B) Material. Sign and outline lighting system enclosures shall be constructed of metal or shall be listed.

(C) Minimum Thickness of Enclosure Metal. Sheet copper or aluminum shall be at least 0.51 mm thick. Sheet steel shall be at least 0.41 mm thick.

(D) Protection of Metal. Metal parts of equipment shall be protected from corrosion.

6.0.1.9 Location

(A) Vehicles. Sign or outline lighting system equipment shall be at least 4300 mm above areas accessible to vehicles unless protected from physical damage.

(B) Pedestrians. Neon tubing, other than listed, dry-location, portable signs, readily accessible to Pedestrians shall be protected from physical damage.

(C) Adjacent to Combustible Materials. Signs and outline lighting systems shall be installed so that adjacent combustible materials are not subjected to temperatures in excess of 90°C.

6.0.1.9 Location

(D) Wet Location. Signs and outline lighting system equipment for wet location use, other than listed watertight type, shall be weatherproof and have drain holes, as necessary, in accordance with the following:

(1) Drain holes shall not be larger than 13 mm or smaller than 6 mm.

(2) Every low point or isolated section of the equipment shall have at least one drain hole.

(3) Drain holes shall be positioned such that there will be no external obstructions.

6.0.1.10 Portable or Mobile Signs

(A) Support. Portable or mobile signs shall be adequately supported and readily movable without the use of tools.

(B) Attachment Plug. An attachment plug shall be provided for each portable or mobile sign.

(C) Dry Location. Portable or mobile signs in dry locations shall meet the requirements.

(D) Wet or Damp Location. Portable or mobile signs in wet or damp locations shall comply with the following slides.

(C) Wet or Damp Location

(1) Cords. All cords shall be junior hard-service or hard-service types as designated in a table in Chapter 4 and have an equipment grounding conductor.

(2) Ground-Fault Circuit Interrupter. The manufacturer of portable or mobile signs shall provide listed ground-fault circuit-interrupter protection for personnel. The ground-fault circuit interrupter shall be an integral part of the attachment plug or shall be located in the power-supply cord within 300 mm of the attachment plug.

6.0.1.12 Field-Installed Secondary Wiring

Field-installed secondary circuit wiring for electric signs, retrofit kits, outline lighting systems, skeleton tubing, and photovoltaic (PV) sign system shall be in accordance with their installation instructions and the following:

(A) 1000 Volts or Less. Neon and second wiring of 1000 volts or less shall comply with 6.0.2.2.

(B) Over 1000 Volts. Neon secondary circuit wiring of over 1000 volts shall comply with 6.0.2.3

6.0.1.21 Ballasts, Transformers, Electronic Power supplies, and Class 2 Power Sources

(A) Accessibility. Ballasts, transformers, electronic power supplies, and Class 2 power sources shall be located where accessible and shall be securely fastened in place.

(B) Location. Ballasts, transformers, electronic power supplies, and Class 2 power sources shall be installed as near to the lamps or neon tubing as practicable to keep the secondary conductors as short as possible.

(C) Wet Location. Ballasts, transformers, electronic power supplies, and Class 2 power sources used in wet locations shall be of the weatherproof type or be of the outdoor type and protected from the weather by placement in a sign body or separate enclosure.

6.0.1.21 Ballasts, Transformers, Electronic Power supplies, and Class 2 Power Sources

(D) Working Space. A working space at least 900 mm high / 900 mm wide x 900 mm deep shall be provided at each ballast transformer, electronic power supply, and Class 2 power source or at its enclosure where not installed in a sign.

(E) Attic and Soffit Locations. Ballasts, transformers, electronic power supplies, and Class 2 power sources Shall be permitted to be located in attics and soffits, provided there is an access door at least 900 mm x 562.5 mm and a passageway of at least 900 mm high x 600 mm wide with a suitable permanent walkway at least 300 each min wide extending from the point of entry to each component.

6.0.1.22 Ballasts

(A) Type. Ballasts shall be identified for the use and shall be listed.

(B) Thermal Protection. Ballasts shall be thermally protected.

6.0.1.23 Transformers and Electronic Power Supplies.

(A) Type. Transformers and electronic power supplies shall be identified for the use and shall be listed.

(B) Secondary-Circuit Ground-Fault Protection. Transformers and electronic power supplies other than the following shall have secondary-circuit ground-fault protection:

6.0.1.22 Ballasts

(1) Transformers with isolated ungrounded secondaries and with a maximum open circuit voltage of 7500 volts or less.

(2) Transformers with integral porcelain or glass secondary housing for the neon tubing and requiring no field wiring of the secondary circuit.

(C) Voltage. Secondary-circuit voltage shall not exceed 15,000 volts, nominal, under any load condition. The voltage to ground of any output terminals of the secondary circuit shall not exceed 7500 volts, under any load condition.

(D) Rating. Transformers and electronic power supplies shall have a secondary-circuit current rating of not more than 300 mA.

6.0.1.22 Ballasts

(E) Secondary Connections. Secondary circuit outputs shall not be connected in parallel or in series.

(F) Marking. Transformers and electronic power supplies that are equipped with secondary-circuit ground-fault protection shall be so marked.

6.0.2 Field-Installed Skeleton Tubing

(a) Wiring Method. Conductors shall be installed using any wiring method included in Chapter 3 suitable for the conditions.

(b) Insulation and Size. Conductors shall be insulated, listed for the purpose, and not smaller than 0.75 mm^2 (1.0 mm dia.).

(c) Number of Conductors in Raceway. The number of conductors in a raceway shall be in accordance with Table 1 of Chapter 9.

(d) Installation. Conductors shall be installed not to be subjected to physical damage.

(e) Protection of Leads. Bushings shall be used to protect wires passing through an opening in metal. 6.0.2.3 Neon Secondary Circuit Conductors, Over 1 000 Volts, Nominal.

6.0.2.12 Neon Tubing

(A) Design. The length and design of the tubing shall not cause a continuous overcurrent beyond the design loading of the transformer or electronic power supply.

(B) Support. Tubing shall be supported by listed tube sup- ports. The neon tubing shall be supported within 150 mm from the electrode connection.

(C) Spacing. A spacing of not less than 6 mm shall be maintained between the tubing and the nearest surface, other than its support.

(D) Protection. Field-installed skeleton tubing shall not be subject to physical damage. Where the tubing is readily accessible to other than qualified persons, field-installed skeleton tubing shall be provided with suitable guards or protected by other approved means.

6.0.2.13 Electrode Connections

(A) Points of Transition. Where the high-voltage secondary circuit conductors emerge from the wiring methods specified in 6.0.2.3(A), they shall be enclosed in a listed assembly.

(B) Accessibility. Terminals of the electrode shall not be accessible to unqualified persons.

(C) Electrode Connections. Connections shall be made by use of a connection device, twisting of the wires together, or use of an electrode receptacle. Connections shall be electrically and mechanically secure and shall be in an enclosure listed for the purpose.

(D) Support. Neon secondary conductor(s) shall be supported not more than 150 mm from the electrode connection to the tubing.

6.0.2.13 Electrode Connections

(E) Receptacles. Electrode receptacles shall be listed.

(F) Bushings. Where electrodes penetrate an enclosure, bushings listed for the purpose shall be used unless receptacles are provided.

(G) Wet Locations. A listed cap shall be used to close the opening between neon tubing and a receptacle where the receptacle penetrates a building. Where a bushing or neon tubing penetrates a building, the opening between neon tubing and the bushing shall be sealed.

(H) Electrode Enclosures. Electrode enclosures shall be listed.

CHAPTER 6 – SPECIAL EQUIPMENT

ARTICLE 6.4

MANUFACTURED SYSTEM WIRING

SCOPE AND DEFINITIONS

6.4.1.1 Scope. The provisions of this article apply to field-installed wiring using offsite manufactured subassemblies for branch circuits, remote-control circuits, signaling circuits, and communications circuit in accessible areas.

6.4.1.2 Definition.

Manufactured Wiring System. A system containing component parts that are assembled in the process of manufacture and cannot be inspected at the building site without damage or destruction to the assembly and used for the connection of luminaires, utilization equipment, continuous plug-in type busways, and other devices.

Listing and Installation

6.4.1.6 Listing Requirements. Manufactured wiring systems and associated components shall be listed.

FPN: ANSI/CIL 183, Standard for Manufacturing Wiring Systems, is a safety standard for manufactured wiring systems.

6.4.1.7 Installation. Manufactured wiring systems shall be secured and supported in accordance with the applicable cable or conduit article for the cable or conduit type employed

Uses Permitted and Non-permitted

6.4.1.10 Uses Permitted. Manufactured wiring systems shall be permitted in accessible and dry locations and in ducts, plenums, and other air-handling spaces where listed for this application and installed in accordance with a pre-discussed topic in Chapter 3.

6.4.1.12 Uses Not Permitted. Manufactured wiring system types shall not be permitted where limited by e applicable article in Chapter 3 for the wiring method used in its construction.

Office Furnishing

OFFICE FURNISHING

- Cubicle panels, partitions, study carrels, workstations, desks, shelving systems, and storage units that may be mechanically and electrically interconnected to form an office furnishing system.

OFFICE FURNISHING

- Wiring systems shall be identified as suitable for providing power for lighting accessories and utilization equipment used within office furnishings. A wired partition shall not extend from floor to ceiling
- All conductors and connections shall be contained within wiring channels of metal or other material identified as suitable for the conditions of use. Wiring channels shall be free of projections or other conditions that might damage conductor insulation.

Office Furnishing Interconnections

- The electrical connection shall be flexible assembly identified for office furnishing or shall be permitted to be installed using flexible cord, provided that all the following conditions are met:

Office Furnishing Interconnections

1. The cord is extra-hard usage type with **3.5** $\boldsymbol{mm^2}$ or larger conductors, with an insulated equipment grounding conductor.

1. The office furnishings are mechanically contiguous.

1. The cord is not longer than necessary for maximum positioning of the office furnishing but is in no case to exceed **600 mm**.

Office Furnishing Interconnections

4. The cord is terminated at an attachment plug-and-cord connector with strain relief.

Lighting Accessories

A) **Support.** A means for secure attachment or support shall b provided

B) **Connection.** Where cord and plug connection is provided.

C) **Receptacle Outlet.** Receptacles shall not be permitted in lighting accessories.

Fixed-Type office Furnishings

Office furnishings that are fixed (secured to building surfaces) shall be permanently connected to the building electrical system by one of the wiring methods of chapter 3.

Freestanding-Type Office Furnishings

- Office furnishings of the freestanding type (not fixed) shall be permitted to be connected to the building electrical system by one of the wiring methods of chapter 3.

- Individual office furnishings of the free- standing type, or groups of individual office furnishings that are electrically contiguous, and do not exceed **9,000 mm** when assembled, permitted to be connected building electrical system by a single flexible cord and plug.

Freestanding-Type Office Furnishings Cord and Plug-Connected

A) Flexible Power-Supply Cord-extra hard type (3.5 mm^2 or larger conductor) w/ Insulated equipment grounding conductor not exceed 600mm in length.

B) Receptacle Supplying Power-shall not be located not more than 300 mm from the office furnishing.

Freestanding-Type Office Furnishings Cord and Plug-Connected

A)Flexible Power-Supply Cord-extra hard type (3.5 mm^2 or larger conductor) w/ Insulated equipment grounding conductor not exceed 600mm in length.

B)Receptacle Supplying Power-shall not be located not more than 300 mm from the office furnishing.

C) Receptacle, maximum-shall not contain more than thirteen (13) 15-amperes, 125-volt and/or 250-volts receptacles.

D) Multi-wire Circuits, Not Permitted. An Individual office furnishing or group shall not contain multi-wire circuits.

ARTICLE 6.10

CRANES AND HOISTS

Cranes and Hoists

Festoon Cable- Single and multiple-conductor cable intended for use and installation in accordance with Article 6.10 where flexibility is required

Special Requirements for particular Locations

A) hazardous(Classified) Locations –all equipment that operated in a hazardous (classified) location shall conform to Article 5.0

1. Class I Locations – hazardous because of the presence of flammable gases or vapors (Article 5.1)
2. Class II Locations – hazardous because of combustible dust (Article 5.2)
3. Class III Locations – hazardous because of presence of easily ignitable fibers or flyings (Article 5.3)

Special Requirements for particular Locations

B) **Combustible Materials**- crane, hoist, or monorail hoist operates over readily combustible material

C) **Electrolytic Cell Lines**- Sec. 6.68.1.32

Conductor shall be enclosed in raceways or be Type AC cable with insulated grounding conductor. Type MC cable, or Type MI cable unless otherwise permitted or required in 6.10.2.1

Wiring Method

A) Contact Conductor- shall not be required to be enclosed in raceways.

B) Exposed Conductor –Short lengths of exposed conductors at resistors, collectors, and other equipment shall not be required to be enclosed in raceways.

C) Flexible Connections to Motors and Similar Equipment- flexible stranded conductors shall be used.

D) Pushbutton Station Multiconductor Cable–shall be supported in some satisfactory manner that protects the electrical conductors against strain

Wiring Method

E) Flexibility to Moving Parts – flexibility is required for power or control to moving parts.

1. Suitable strain relief and protection from physical damage is provided
2. In Class I, Division 2 locations, the cord is approved for extra-hard usage

Raceway or Cable Terminal Fittings

Conductor leaving raceways or cables shall comply with either A or B.

A) Separately Bushed Hole – used wherever a change is made from a raceway or cable to exposed wiring. A fitting used for this purpose shall not contain taps or splices and shall not be used at luminaire outlets.

Raceway or Cable Terminal Fittings

B) Bushing in Lieu of a Box – Bushing shall be used in lieu of a box at the end of a rigid metal conduit where the raceway terminates at unenclosed controls or similar equipment.

Types of Conductors

Conductors shall comply with Table 3.10.3.1(A) unless otherwise permitted in 6..10.2.3(A) through (D)

Rating and Size of Conductors

A) **Ampacity** – allowable ampacities of conductors shall be as shown in Table .10.2.4(A)

B) **Secondary Resistor Conductors** – separate from the controller, minimum size of conductor between controller and resistor shall be calculated by multiplying the motor secondary current appropriate factor from Table 6.10.2.4

Rating and Size of Conductors

C) Minimum Size – Conductors external to motors and controls shall be not smaller than **1.25mm2** unless otherwise permitted in (1) or (2)

1)**0.75mm2** (1.00mm dia.) wire in multi-conductor cord shall be permitted for control circuits not exceeding 7 amperes.

2) Wire not smaller than **0.50 mm2** for electronic circuits

Rating and Size of Conductors

D) Contact Conductors – Contact Wires shall have an ampacity not less than that required by Table 6.10.2.4(A) for 75C wire, and in no case shall they be smaller than as shown in Table 6.10.2.4(D).

E) Calculation of Motor Load

1) Single Motor – for one motor. 100 percent of motor nameplate full-load ampere rating shall be used

Table 6.10.2.4(B)
Secondary Conductor Rating factors

Time in Seconds		Ampacity of Wire in Percent of Full-Load Secondary Current
ON	OFF	
5	75	35
10	70	45
15	75	55
15	45	65
15	30	75
15	15	85
Continuous Duty		110

Table 6.10.2.4(D)
Minimum Contact Conductor Size Based on Distance Between Supports

Minimum Size of Wire (mm2)	Maximum Distance Between End Strain Insulators or Clamp-Type Intermediate Supports
14	9000 mm or less
22	18000 mm or less
30	Over 18000

Article 6.20

ELEVATORS, DUMPWAITERS, ESCALATORS, MOVING WALKS, PLATFORM LIFTS AND STAIRWAY CHAIRLIFT

6.20.1 GENERAL

- 6.20.1.1 Scope

This article covers the installation of electrical equipment and wiring used in connection with elevators, dumbwaiters, escalators, moving walks, platform lifts, and stairway chairlifts.

6. 20.1.2 Definitions

- **Controller, Operation.** The electrical device for that part of the control system that initiates the starting, stopping and direction of motion in response to a signal from an operating device.
- **Machine Room (for elevator, dumbwaiters).** A space inside or outside the hoist way, intended to be accessed with or without full bodily entry, that contains elevator or dumbwaiter mechanical equipment and electrical equipment used directly in connection with the elevator or dumbwaiter.
- **Operating Device.** Devices used to activate the operation controller,
- **Signal Equipment.** Includes audible and visual equipment.

6.20.1.3 Voltage Limitations.

(A)**Power Circuits.** Branch circuit to door operator controllers and door motors and branch circuits and feeders to motor controllers, driving machine motors, machine brakes and motor generator sets shall not have a circuit voltage in excess of 1000V.

(B) **Lighting Circuits.** Shall comply with the requirement of Article 4.0

(C) **Heating and Air-Conditioning Circuits.** Branch circuit of the these equipment located on the elevator car shall not have a circuit voltage in excess of 1000V.

6.20.1.4 Live Parts Enclosed.

All live parts of electrical apparatus in the hoist ways, at the landing, in or on the cars, in the well ways or in the runways and machinery spaces shall be enclosed to protect against accidental contact.

6.20.1.5 Working Clearances.

Working spaces shall be provided about controllers, disconnecting means, and other electrical equipment in accordance with 1.10.2.1(A).

6.20.2 CONDUCTORS

6.20.2.1 Insulation of Conductors.

The insulation of conductors shall comply with 6.20.2.1(a) through (d).

(a) Hoistway Door Interlocking Wiring. The conductors to the hoist way door interlocks from the hoist way riser shall be one of the following:

1. flame retardant and suitable for temperature of not less than 200◦C, Conductors shall be type SF or equivalent.

2. Physically protecting using an approved method, such that the conductor assembly is flame retardant and suitable for a temperature of not less than 200◦C.

6.20.2.4 Feeder Demand Factor.

Feeder conductors of less than required by 6.20.2.3 shall be permitted, subject to the requirement of Table 6.20.2.4

Number of Elevators in a Single Feeder	Demand Factor
1	*1.00*
2	*0.95*
3	*0.90*
4	*0.85*
5	*0.82*
6	*0.79*
7	*0.77*
8	*0.75*
9	*0.73*
10 or more	*0.72*

Platform lifts and Stairway Chairlift Raceways.

1. **Wiring Methods.** Flexible metal conduit, liquid-tight flexible metal conduit, or liquid-tight flexible nonmetallic conduit shall be permitted in escalator and moving walk well-ways. Flexible metal conduit or liquid-tight flexible conduit of 10 mm raceway size shall be permitted in lengths not in excess of **1800mm**.
2. **Class 2 Circuit Cables.** Cables used in Class 2 power limited circuits shall be permitted to be installed within escalators and moving walkways, provided the cables are supported and protected from physical damage and are of a jacketed and flame retardant type.

6.20.3.2 Branch Circuit for car Lighting, Receptacle, Ventilation, Heating and Air Conditioning.

(a) **Car light source**. A separate branch circuit shall supply the car light, receptacle and auxiliary lighting power source and ventilation on each elevator car. The overcurrent protecting device shall be located in the elevator machine room.

(b) **Air conditioning and Heating source.** Separate branch circuit shall supply the air conditioning and heating unit on each elevator cars. The overcurrent protecting device shall be located in the elevator machine room.

6.20.3.4 Branch Circuit for Hoist ways Pit Lighting and Receptacles.

(a) **Separate branch Circuit.** Shall supply the hoist way pit lighting and receptacle.

(b) **Lighting switch.** Shall be located as to be readily accessible from pit access door.

(c) **Duplex Receptacle.** At lest one 125V or 250V, single phase, 15 or 20 A duplex receptacle shall be provided in the hoist way pit.

6.20.3.5 Branch Circuit for Other Utilization Equipment.

(a) **Additional Branch Circuits.** Shall supply utilization equipment not identified in 6.20.3.2, 6.20.3.3, 6.20.3.4. It shall be restricted to that equipment identified in 6.20.1.1.

(b) **Overcurrent devices.** Protecting the branch circuit shall be located in the elevator machinery and control rooms or spaces.

6.20.7 OVERCURRENT PROTECTION

6.20.7.1 Overcurrent Protection. Shall be provided in accordance with 6.20.7.1 (a) through (d).

(a) **Operating devices and control and signaling circuits.** Shall be protected against overcurrent in accordance with the requirement of 7.25.2.3 and 7.25.2.5.

(b) **Overload protection for motors.**

(c) **Motor feeder short-circuit and ground-fault protection.** Shall be as required in Part 4.30.5.

(d) **Motor Branch-Circuit Short-Circuit and Ground-fault protection.** shall be as required in Part 4.30.4

6.20.8 MACHINE ROOM, CONTROL ROOM, MACHINERY SPACES AND CONTROL SPACES

- **6.20.8.1 Guarding Equipment**. Shall be installed in a room or space set aside for that purpose unless otherwise permitted in 6.20.8.1 (a) or (b). The room or space shall be secured against unauthorized access.

(a) **Motor Controllers.** Shall be permitted outside the spaces herein specified.

(b) **Driving Machines**. Shall be permitted outside the spaces herein specified.

Article 6.25

ELECTRIC VEHICLE CHARGING SYSTEM

6.25.1 GENERAL

- 6.25.1.1 **Scope.** This article covers the electrical conductors and equipment external to an electric vehicle that connect an electric vehicle to a supply of electricity by conductive, inductive or wireless power transfer.

6.25.1.2 Definitions.

- **Cable management system.** An apparatus designed to control and organize the output cable to the electric vehicle.
- **Charger power converter.** Used to convert energy from the power grid to high frequency output for wireless power transfer.
- **Electric Vehicle.** An automotive0type vehicle for on road use, powered by an electric motor that draws current from an rechargeable storage battery, fuel cell, photovoltaic array or other source of electric current.
- **Electric Vehicle Connector.** A device that establishes an electrical connection to the electric vehicle for the purpose of power transfer and information exchange.

6.25.1.2 Definitions.

- **Personal Protection System.** Devices and constructional feature that when used together provide protection against electric shock of personnel.
- **Plug-in Hybrid Electric Vehicle (PHEV).** Intended for on-road use with the ability to store and use off-vehicle electrical energy in rechargeable energy storage system.
- **Portable (as applied to EVSE).** Intended for indoor or outdoor use that can be carried from charging location to charging location and is designed to be transported in the vehicle when not in use.
- **Power Supply Cord.** An assembly consisting of attachment plug and length of flexible cord that connect the electric vehicle supply equipment to a receptacle.

6.25.3 INSTALLATION

- **6.25.3.1 Electric Vehicle Branch Circuit.** Each outlet installed for the purpose of charging electric vehicle shall be supplied by an individual branch circuit.
- **6.25.3.2 Overcurrent Protection.** For feeders and branch circuit supplying equipment shall be sized for continuous duty and shall have a rating of not less than 125% of the maximum load of the equipment.
- **6.25.3.3 Rating.** The equipment shall have sufficient rating to supply to load served, electric vehicle charging load shall be considered to be continuous loads for the purpose of this article.

6.25.3.7 Loss of Primary Source. Shall be provided such that energy cannot be back fed through the electric vehicle and the supply equipment to the premises wiring system unless permitted by 6.25.3.9.

6.25.3.8 Multiple Feeder or Branch Circuit. Where equipment is identified for the application, more than one feeder or branch circuit shall be permitted to supply equipment.

6.25.4 Wireless Power Transfer Equipment

- **6.25.4.1 Grounding**. The primary pad base plate shall be a non-ferrous metal and shall be grounded unless the listed WPTE employs a double-insulation system.
- **6.25.4.2 Construction.**

(a) Type. The charger power converter shall comply with 6.25.4.2(c).

(b) Installation. If the charger power converter is not integral to the primary pad, it shall be mounted at a height of not less than 450 mm above the floor level for indoor locations or 600 mm above grade level for outdoor locations. Shall be mounted in one of the following forms:

Pedestal	**Building or structure**
Wall or pole	**Raised concrete pad**

ARTICLE 6.26

ELECTRIFIED TRUCK PARKING SPACES

Ryan Anthony N. Cahucom

6.26.1.1 SCOPE

The provision of this article covers the electrical conductors and equipment external to the truck or transport refrigerated unit that connects trucks or transport refrigerated units to a supply electricity, and the installation of equipment and devices related to electrical installations within an electrified truck parking spaces.

6.26.1.2 DEFINITIONS

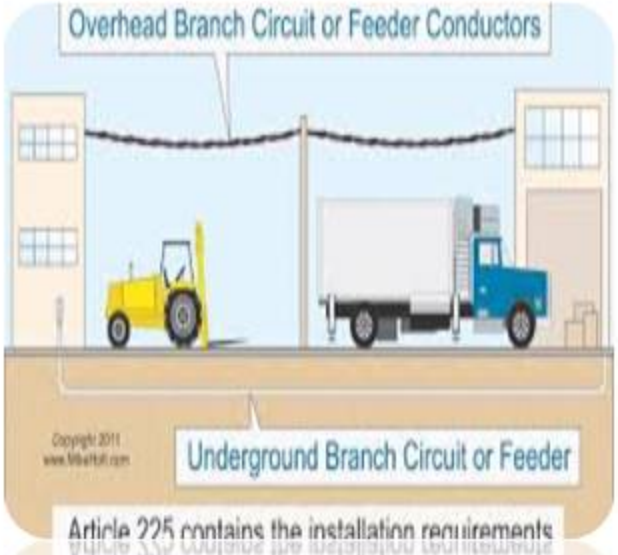
Cable Management System

- An apparatus designed to control and organize unused lengths of cable at electrified truck parking space

Cord Connector

- Inserting it into a truck flanged surface inlet, establishes an electrical connection to the truck.
- It is part of the truck coupler

Disconnecting Means, Parking Space



- Consist of a circuit breaker, switch and fuses, and their accessories, located near the point of entrance of supply conductors in an electrified truck parking space and intended to constitute the means of cutoff for the supply to that truck.

Electrified Truck Parking Space

- A truck parking space that has been provided with an electrical system that allows truck operators to connect their vehicles while stopped and to use off-board power sources.

FPN:

An electrified truck parking space also includes dedicated parking areas for heavy-duty trucks at travel plazas, warehouses, shipper and consignee yards, depot facilities, and boarder crossings.

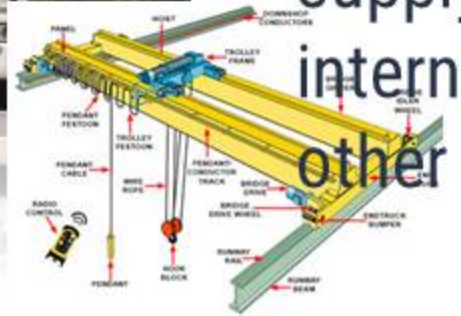
FPN:

It does not include the shoulders of highway ramps and access roads, camping and recreational vehicle sites or other areas where ac power is provided solely.

Electrified Truck Parking Space Wiring System

- All of the electrical wiring, equipment, and appurtenances related to electrical installations within an electrified truck parking space.

Overhead Gantry



- Structure consisting of horizontal framework, supported by vertical columns spanning above electrified parking spaces, that supports equipment and appliances for the purpose of supplying electrical, HVAC, internet, communications, and other services to the spaces.

Separable Power Supply Cable Assembly

- A flexible cable, including ungrounded, grounded, and equipment grounding conductors, provided with a cord connector, an attachment plug, or devices installed for the purpose of delivering energy from the source of electrical supply to the truck.

Transport Refrigerated Unit (TRU)

- A trailer or container with integrated cooling or heating, or both, used for the purpose of maintaining the desired environment of temperature-sensitive goods.

Truck

- A motor vehicle designed for the transportation of goods, services, and equipment

Truck Coupler

A truck flanged surface inlet and mating cord connector.

Truck Flanged Surface Inlet

- The device on the truck into which the connector is inserted to provide electric energy and other services. This device is part of the truck coupler.

6.26.1.3 OTHER ARTICLES

Wherever the requirements of other articles of this *Code* and Article 6.26 differ, the req. of Article 6.26 ***shall*** apply. Unless electrified truck parking space wiring systems are supported in such a manner that they cannot be used in 5.11.1.3 or 5.14.1.3, they shall comply with 6.26.1.3(A) and (B) in addition to the requirements of this article.

(A) VEHICLE REPAIR AND STORAGE FACILITIES

- Electrified truck parking space electrical wiring systems located at facilities for the repair or storage of self-propelled vehicles that use volatile flammable liquids or power ***shall*** comply with Article 5.11.

(B) MOTOR FUEL DISPENSING STATIONS

- Electrified truck parking space electrical wiring systems located at or serving motor fuel dispensing stations ***shall*** comply with Article 5.14.

FPN: For additional information, see NFPA 88A-2015, *Standard for Parking Structures*, and NFPA 30A-2015, *Code for Motor Fuel Dispensing Facilities and Repair Garages*.

6.26.1.4 GENERAL REQUIREMENTS

(A) NOT COVERED

- The provisions of this article ***shall not*** apply to that portion of other equipment in residential, commercial, or industrial facilities that requires electric power used to load or unload cargo, operate conveyors, and for other equipment used on the site or truck.

(B) DISTRIBUTION SYSTEM VOLTAGES

- Unless other voltages are specified, the nominal ac system voltages of 115, 115/230, 208Y/120, 230, 400Y/230, or 460Y/265 ***shall*** be used to supply equipment covered by this article

(C) CONNECTION TO WIRING SYSTEM

- The provisions of this article ***shall*** apply to the electric truck parking space supply equipment intended for connection to a wiring system as defined in 6.26.1.4 (B).

6.26.2 ELECTRIFIED TRUCK PARKING SPACE ELECTRICAL WIRING SYSTEM

6.26.2.1 BRANCH CIRCUITS

- Electrified truck parking space single-phase branch circuits *shall* be derived from a 208Y/120-volt, 400Y/230-volt, 3-phase, 4-wire system or a 230-volt, single-phase, 2-wire system.

Exception:

A 115-volt distribution system *shall* be permitted to supply existing electrified truck parking spaces.

6.26.2.2 FEEDER AND SERVICE LOAD CALCULATIONS

(A)Parking Space Load

- The calculated laod of a feeder or service ***shall not*** be less than the sum of the loads on the branch circuits.

(B)Demand Factors

- Demand factor ***shall*** be a minimum of 70% permitted for calculating load for service and feeders.

(C)Two or More ETPS

- Is in location that serves two or more ETPS, the equipment for each space ***shall*** comply with 6.26.2.2(A), and the calculated load shall be calculated on the basis of each parking space

(D) Conductor Rating

- Truck space branch-circuit supplied loads ***shall*** be considered to be continuous.

6.26.3 ELECTRIFIED TRUCK PARKING SPACE SUPPLY EQUIPMENT

6.26.3.1 WIRING METHODS AND MATERIALS

(A) Electrified Truck Parking Space Supply Equipment Type. The electrified truck parking space supply equipment ***shall*** be provided in one of the following forms:

(1) Pedestal

(2) Overhead Gantry

(3) Raised concrete pad

6.26.3.1 WIRING METHODS AND MATERIALS

(B) Mounting Height.

- Post, pedestal, and raised concrete pad types of ETPS supply equipment ***shall not*** be less than ***600 mm*** aboveground based on seasonal from historical records.

6.26.3.1 WIRING METHODS AND MATERIALS

(C) Access to Working Space

- All electrified truck parking space supply equipment ***shall*** be accessible by an unobstructed entrance or passageway not less than **600 mm wide** and not less than **200 mm high**.

6.26.3.2 OVERHEAD GANTRY OR CABLE MANAGEMENT SYSTEM

(A) Cable Management

- Electrified truck parking space equipment from either overhead gantry or cable management system *shall* utilize a permanently attached power supply cable in electrified truck parking space supply equipment.

6.26.3.2 OVERHEAD GANTRY OR CABLE MANAGEMENT SYSTEM

- Other cable types and assemblies listed as being suitable for the purpose including **optional hybrid communications, signal,** and **composite optical fiber cables,** ***shall*** be permitted.

6.26.3.2 OVERHEAD GANTRY OR CABLE MANAGEMENT SYSTEM

(B) Strain Relief

- Means to prevent strain from being transmitted to the wiring terminals ***shall*** be provided.

- Permanently attached power supply cables ***shall*** be provided with a means to de-energized the cable conductors and power service delivery device upon exposure to strain.

6.26.3.3 ELECTRIFIED TRUCK PARKING SPACE SUPPLY EQUIPMENT CONNECTION

(A) General

- Each truck *shall* be supplied from electrified truck parking space supply equipment through suitable extra-hard service cables or cords.

6.26.3.4 SEPARABLE POWER-SUPPLY CABLE ASSEMBLY

(A) Rating(s).

(1) 20-Amperes Power Supply Cable Assembly. Equipment with a 20-amperes, 125-volt or 250-volt receptacle, in accordance with 6.26.3.3(B)(1), ***shall*** use a listed **20-amperes** power-supply cable assembly.

6.26.3.4 SEPARABLE POWER-SUPPLY CABLE ASSEMBLY

(2) 30-Amperes Power-Supply Cable Assembly. Equipment with a 30-ampere, 208Y/120-volt or 125/250-volt receptacle, in accordance with 6.26.3.3(B)(2), ***shall*** use a listed 30-ampere main power-supply cable assembly.

6.26.3.4 SEPARABLE POWER-SUPPLY CABLE ASSEMBLY

(B) Power-Supply Cord.

(1) Conductors. The cord *shall* be a listed type with three or four conductors, for single-phase connection, one conductor of which shall be identified in accordance with 4.0.2.4.

6.26.3.4 SEPARABLE POWER-SUPPLY CABLE ASSEMBLY

(2) Cord. Extra-hard usage flexible cords and cables rated not less than **90°C, 600V**; listed for both wet locations and sunlight resistance; and having an outer jacket rated to be resistant to temperature extremes, oil, gasoline, ozone, and chemicals ***shall*** be permitted.

6.26.3.4 SEPARABLE POWER-SUPPLY CABLE ASSEMBLY

(3) Cord Overall Length. The exposed cord length shall be measured from the face of the attachment plug to the point of entrance to the truck.

- The overall length of the cable ***shall NOT*** exceed **7,500 mm** unless equipped with a cable management system that is listed as suitable for the purpose.

6.26.3.4 SEPARABLE POWER-SUPPLY CABLE ASSEMBLY

(4) Attachment Plug. Shall be listed by itself or as part of a cord set, for the purpose and ***shall*** be molded to or installed on the flexible cord so that it is secured tightly to the cord.

(a) Connection to a 20-Ampere Receptacle

(b) Connection to a 30-Ampere Receptacle

6.26.3.4 SEPARABLE POWER-SUPPLY CABLE ASSEMBLY

(5) Cord Connector.

-The cord connector for a separable power-supply cable assembly, as specified in 6.26.3.4(A)(1), ***shall*** be a 2-pole,3-wire grounding type rated 20 amperes, 125 volts 0r 250 volt.

6.26.3.5 LOSS OF A PRIMARY POWER

- Means shall be provided such that, upon loss of voltage from the utility, energy cannot be back-fed through the truck and the truck supply equipment to the electrified truck parking space wiring system unless permitted by 6.26.3.6.

6.26.4 TRANSPORT REFRIGERATED UNITS (TRUs)

6.26.4.1 TRANSPORT REFIGERATED UNITS

- Electrified truck parking spaces intended to supply TRUs ***shall*** include an individual branch circuit and receptacle for operation of the heating/refrigerating units.
  - **(A) Branch Circuits**
  - **(B) Electrified Truck Parking Space Supply Equipment**

6.26.4.2 DISCONNECTING MEANS AND RECEPTACLE

(A) Disconnecting Means and Receptacles

(B) Location

(C) Receptacles. Every electrified truck parking space intended to provide an electrical supply for transport refrigerated units ***shall*** be equipped with one of the following:

(1) A 30-A, 400Y/230-V or 460Y/265, 3-phase, 3-pole, 4-wire receptacle

(2)A 60-A, 208-V, 3-phase, 3-pole, 4-wire receptacle

(3)A 20-A, 1000-V, 3-phase, 3-pole, 4-wire receptacle, pin and sleeve type

6.26.4.3 SEPARABLE POWER SUPPLY CABLE ASSEMBLY

- *Shall* be one of the types and ratings specified in 6.26.4.3(A), (B), & (C). Cords with adapters and pig tail ends, extension cords, and similar items shall not be used.
  - **(A) Rating(s)**
  - **(B) Cord Assemblies**
  - **(C) Attachment Plugs and Cord Connectors**

ARTICLE 6.30

ELECTRIC WELDERS

6.30.1 GENERAL

SCOPE

Apparatus for electric arc welding, resistance welding, plasma cutting, and other that is connected to an electric supply system.

LISTING

All welding and cutting power equipment under the scope of this article shall be listed

6.30.2.1 AMPACITY OF SUPPLY CONDUCTORS

- The ampacity of conductors for arc welders ***shall*** be in accordance with chapter 6.

  - **(A) Individual Welders**
  - **(B) Group of Welders**

Table 6.30.2.1(A) Duty Cycle Multiplication Factors for Arc Welders

Duty Cycle	Multiplier for Arc Welders	
	Nonmotor Generator	Motor Generator
100	1.0	1.0
90	0.95	0.96
80	0.89	0.91
70	0.84	0.86
60	0.78	0.81
50	0.71	0.75
40	0.63	0.69
30	0.55	0.62
20 or less	0.45	0.55

6.30.3 RESISTANCE WELDERS

Ampacity of Supply Conductors.

- The ampacity of the supply conductors for resistance welders necessary to limit the voltage drop to a value permissible for the satisfactory performance of the welder is usually greater than that required to prevent over heating.

FPN: Explanation of Terms

(1) ***Rated Primary Current.*** *The rated KVA multiplied by 1000 and divided by the rated primary voltage given on the nameplate.*

(2) ***Actual Primary Current.*** Current drawn from the supply circuit during each welder operation.

(3) ***Duty Cycle.*** percentage of the time during which the welder is loaded

ARTICLE 6.40


AUDIO SIGNAL PROCESSING,
AMPLIFICATION,
AND REPRODUCTION
EQUIPMENT

6.40.1.2 DEFINITIONS

Abandoned Audio Distribution Cable

- Installed audio distribution cable that is not permitted at equipment and not identified for future use with a tag.

Audio Amplifier or Pre-Amplifier

- Electronic equipment that increases the current or voltage, or both.

Audio Autotransformer

- A transformer with a single winding and multiple taps intended for use with an amplifier loudspeaker signal output.

Audio Signal Processing Equipment

- Electrically operated equipment that produces an acoustic signal within the range of normal human hearing.

Audio System

- The totality of all equipment and interconnecting wiring used to fabricate an audio signal processing, amplification, and reproduction system.

Audio Transformer

- A transformer with two or more electrically insolated windings and multiple taps intended for use with an amplifier loudspeaker signal output.

Equipment Rack

- A *framework* for the support, enclosure, or both, of equipment; can be portable or stationary.

Loudspeaker

- Equipment that converts an ac electric signal into an acoustic signal.

Maximum Output Power

- The maximum power delivered by an amplifier into its rated load as determined under specified test conditions.

Mixer

- Equipment used to combine and level match a multiplicity of electronic signals, such as from microphones, electronic instruments, and recorded audio.

Portable Equipment

- Equipment fed with portable cords or cables intended to be moved from one place to another.

Rated Output Power

- The amplifier manufacturer's stated or marked output power capability into its rated load.

Technical Power System

- An electrical distribution system with equipment grounding conductor isolated form the premises grounding conductor.

Temporary Equipment

- Portable wiring and equipment intended for use with events of a transient nature where all equipment is presumed to be removed at the conclusion of the event.

(A) Wiring to and Between Audio Equipment.

Power Wiring. Wiring and equipment from source of power to and between devices connected to the premises wiring systems ***shall*** comply with the requirements of Chapter 1, except modified by this article.

(1) Separately Derived Power Systems

(2) Other Wiring

(B) Auxiliary Power Supply Wiring

- Equipment that has a separate input for an auxiliary power supply ***shall*** be wired in compliance with Article 7.25.

(C) Output Wiring and Listing of Amplifiers

- Amplifiers with output circuits carrying audio program signals ***shall*** be permitted to employ Class 1, 2 or 3 wiring.

(D) Used of Audio Transformers and Autotransformers.

- Audio transformers and autotransformers ***shall*** be used only for audio signals in a manner so as not to exceed the manufacturer's stated input or output voltage, impedance, or power limitations.

6.40.3.4 ENVIRONMENTAL PROTECTION OF EQUIPMENT

- Portable equipment not listed for outdoor use ***shall*** be permitted only where appropriate protection of such equipment from adverse weather conditions is provided to prevent risk of fire or electric shock.

6.40.3.5 PROTECTION OF WIRING

- Where accessible to the public, flexible cords and cables laid or run on the ground or on the floor ***shall*** be covered with approved nonconductive mats.
- Cables and mats ***shall*** be arranged so as not to present a tripping hazard.

ARTICLE 6.46- MODULAR DATA CENTERS

Modular Data Centers

Scope. This article covers modular data center.

FPN No. 1: modular data center include the information technology equipment (ITE) and support equipment, electrical supply and distribution, wiring and protection, working space, grounding, HVAC, and the like, that are located in an equipment enclosures.

FPN No.2: For further information, see NFPA 75-2017, Standard for the protection of information technology equipment, which covers the requirements for the protection of information technology equipment and system in an information technology equipment room.

Modular Data Center(MDC)

Prefabricated units, rated 1000 volts or less, consisting an outer enclosure housing multiple racks or cabinets of information technology equipment (ITE) and various support equipment, such as electrical service and distribution equipment, HVAC systems, and the like.

(A) Spread of Fire or Products of Combustion.

Section 3.0.1.21, 7.70.1.26, 8.0.1.26, and 8.20.1.26 shall apply to penetrations of fire-resistant room boundary, if provided.

(B) Wiring and Cabling in other Spaces Used for Environmental Air (Plenums).

"The following sections and tables shall apply to wiring and cabling in spaces used for environmental air(plenums) within a modular d center space:

(1) Wiring methods: 3.0.1.22(C)(1)

(2) Class 2, Class 3, and PLTC cables: 7.25.3.15(C) ar 7.25.3.34

(3) Fire alarm systems: 7.60.2.13(B)(2), 7.60.3.15(C) and Table 7.60.3.34

(4) Optical Fiber Cables: 7.70.5.4(C) and table 7.70.5.45(a)

(5) Communication Circuits: 8.0.5.4(C) and Table 8.0.5.45(a),(b), and(c)

(6) CATV and radio distribution systems:8.20.5.4(C) and Table 8.20.5.45(a)

(C) Grounding

Grounding and bonding of MDC shall comply with article 2.50. The non-current carrying conductive members of optical fiber cables in an MDC shall be grounded in accordance with 7.70.5.5. Grounding and bonding of communications protectors, cables shields, and non-current carrying metallic members of cable shall comply with Part 8.0.4.

(D) Electrical Classification of Data Circuits

Section 7.25.3.1(A)(4) shall apply to the electrical classification of listed information technology equipment signaling circuits. Section 7.25.3.19(D)(1) and 8.0.5.24(A)(1)(b) shall apply to the electrical classification of class 2 and class 3 circuits in the same cable with communication circuits.

(E) Fire Alarm Equipment

Parts article 7.60.1, 7.60.2 and 7.60.3 shall aplly to fire alarm systems, cables and equipment installed in a MDC, where provided. Only fire alarm cables listed in accordance with Part 7.60.4 and listed fire alarm equipment shall be permitted to be installed ina n MDC.

(F) Cable Routing Assemblies and Communications, Wires, Cables, Raceways, and Equipment.

Parts 8.0.1, 8.0.2, 8.0.3, 8.0.4, and 8.0.5 shall apply to cable routing assemblies and communications wires, cables, raceways, and equipment installed in an MDC. Only communications wires and cables listed in accordance with 8.0.6.10, cable routing assemblies and communications raceways listed in accordance with 8.0.6.13 and communications equipment listed in accordance with 8.0.6.1 shall be permitted to be installed in an MDC.

(G) Community Antenna Television and Radio Distribution Systems Cables and Equipment

-Parts 8.20.1, 8.20.2, 8.20.3, 8.20.4, and 8.20.5 shall apply to community antenna television and radio distribution systems equipment installed in an MDC. Only community antenna television and radio distributions cables listed in accordance with 8.20.6.1 and listed CATV equipment shall be permitted to be installed in an MDC.

(H) **Storage Batteries** . Installation of batteries shall comply with article 4.80.

(I) **Surge-Protective Devices(SPDs)**.Where provided, surge protective devices shall be listed and labeled and installed in accordance with Article 2.85.

(J) Lighting. Lighting shall be installed in accordance with Article 4.10

(K) Power Distribution and Wiring Protection. Power Distribution and wiring protection within an MDC shall comply with Article 2.10 for branch circuits.

(L) Wiring Methods and Materials

(1) Unless modified elsewhere in this Article, wiring methods and materials for power distribution shall comply with chapter 3.

(2) The following wiring methods shall not be permitted

a. Integrated Gas Spacer Cable: Type (IGS) Article 3.26
b. Concealed knob-and-tube wiring (Article 3.94)
c. Messenger-supported wiring (Article 3.96)

(L) Wiring Methods and Materials

d. Open wiring on insulators (Article 3.98)

e. Outdoor overhead conductors over **600 volts** (Article **3.99**)

(3) Wiring in areas under a raised floor that are constructed and used for ventilation as discribed in **6.45.1.5(E)** shall be permitted to use the wiring methods in **6.45.1.5(E)** if the conditions of **6.45.1.4** are met.

(4) Installation of wiring for remote-control, signaling, and power-limited circuits shall comply with part **7.25.3**

(L) Wiring Methhods and Materials

(5) Installation of optical fiber cables shall comply with part **7.70.5**

(6)Alternative wiring methods as permitted by **Article 6.45** shall be permitted for MDCs, provided that all of the conditions of **6.45.1.4** are met.

(M) Service Equipment

The service equipment and their arrangement and installation shall permit the installation of the service entrance conductors in accordance with Article 2.30. Service equipment shall be listed and labeled and marked as being suitable for use as service equipment

(N)Disconnecting means

An approved means shall be provided to disconnect power to all electronic equipment in MDC in accordance with 6.45.

6.46.1.5 Nameplate Data. A permanent nameplate shall be attached to each equipment enclosures of an MDC and shall be plainly visible after installation. The nameplate shall include the information in 6.46.1.5(1) through (6), as applicable:

(1) Supply vooltage, number of phases, frequency, and full-load current.The full-load current shown on the nameplate shall not less than the sum of the full-load currents required for all the motors and other equipment that maybe in operation at the same time under normal conditions of use.

(2) for MDCs powered by a separate service, the short-circuit current rating of the service equipment provided as part of the MDC.

(3) For MDCs powered by a separate sevice, if the required serrvice as determined by parts 2.20.3 and 2.20.4 is less than the rating of the service panel used, the required service shall be included on the nameplate.

(4)Electrical diagram number(s) or the number of the index to the electrical drawings

(5)For MDC equipment enclosures that are not powered by separate service, feeder, or branch circuit, a reference to the powering equipment .

(6) Manufacturer's name or trademark

6.46.1.6 Supply Connductors and Overcurrent

A. Size

The size of the supply conductor shall be such as to have an ampacity not less than 125 percent of the full-load current rating.

FPN No. 1: See the 0-2000-volt ampacity tables of Article 3.10 for ampacity of conductors rated 600 V and below

FPN No.2: See 4.30.2.2(E)for duty cycle requirements.

B. Overcurrent Protection

Where overcurrent protection for supply conductors is furnished as part of the MDC, overcurrent protection for each supply circuit shall comply with 6.46.1.6(B)(1) through (B)(1)

(B)Over-current protection

(1) Service equipment – Over-current Protection.
Service conductors shall be provided with over-current protection in accordance with 2.30.7.1 through 2.30.7.6.

(2) Taps and Feeders .Where over-current protection for supply conductors is furnished as part of the MDC as permitted by 2.40.2.2, the over-current protection shall comply with the following:

a. The overcurrent protection shall consist of a single breaker or a set of fuses.

b. The MDC shall marked"OVERCURRENT PROTECTION PROVIDED AT MDC SUPPLY TERMINALS"

C. The Supply conductors shall be considered either as feeders or as taps and be provided with overcurrent protection complying with 2.40.2.2

6.46.1.7 Short-Circuit Current Rating

(A) Service Equipment. The service equipment of an MDC that connects directly to a service shall have a shortcircuit current rating not less than the available fault current of the service.

(B) MDCs Connected to branch circuits and feeders.

Modular data centers that connects to a branch circuit or a feeder circuit shall have a short-circuit current rating not less than the available fault current of the branch circuit or feeder.

(C) MDCs powered from separate MDC system enclosures.

Modular data center equipment enclosures, powered from a separate MDC system enclosure that is part of the specific MDC system shall have short circuit current rating coordinated with the powering module in accordance with 1.10.1.10.

6.46.1.8 field wiring compartment.

A field wiring compartment in which service or feeder connecyions are to be made shall be readily accessible and comply with 6.46.1.8(1) through (3) as follows

(1)Permit the connection of the supply wires after the MDC is installed

(2) Permit to connevtion to be introduced and readily connected

(3) Be located so that the connections may be readily inspected after MDC is installed

6.46.1.9 Flexible power cords and cables for connecting equipment enclosures of an MDC System.

(A)Uses Permitted. Flexible power cords and cables shall be permitted to be used for connections between equipment enclosures of an MDC system were not subject to physical damage.

(B) Uses not permitted. Flexible power cords and cables shall not be used for connection to external sources of power.

(C) Listing. Where flexible power cords or cables are used, they shall be listed as suitable for extra hard usage. Where used outdoors, flexible power cords and cables shall also be listed as suitable for wet locations and shall be sunlight resistant.

(D) Single - Conductor cable. Single- conductor power cable shall be permitted to be used only in sizes 30 mm^2 or larger.

6.46.2.1 Electrical supply and distribution.

Equipment used for electrical supply distribution in an MDC, including fittings, devices, luminaires, apparatus, machinery, and the like, shall comply with parts 1.10.1 and 1.10.2

6.46.2 Equipment

6.46.2.2 Distribution transformers.

(A) Utility-Owned Transformers. Utility-Owned distribution transformers shall not be Permitted in an MDC.

(B) Non-Utility-Owned premises transformers. Shall be of the dry type or the type field with a noncombustible dielectric medium.

(C) Power transformers. Only dry type transformers shall be permitted to be installed in the MDC equipment enclosure such transformer shall be installed in accordance with the requirement of article 4.50

6.46.2.3 Receptacles.

- At least one 125-vOlt AC or 250-volt AC,15-or 20-ampere-rated duplex convenience outlet shall be provided in each work area of the MDC to facilitate the powering of test and measurement equipment that may be required during routine maintenance and servicing without having to route flexible power cords through or across doorways or around line-ups of equipment or the like

6.46.3.1 General Illumination.

Illumination shall be provided for all workspaces and areas that are used for exit access and exit discharge.

6.46.3.2 Emergency Lighting.

Areas that are used for exit access and exit discharge shall be provided with emergency lighting.

6.46.3.3 Emergency Lighting Circuits.

- No appliances or lamps, other than those specified as required for emergency used, shall be supplied by emergency lighting circuits. Branch circuits supplying emergency lighting shall be installed to provide service from storage batteries, generator sets, UPS, separate service, fuel cells, or unit equipment.

6.46.4 Workspace

6.46.4.1 General.

Space about electrical equipment shall comply with 1.10.2.1.

6.46.4.2 Entrance to and Egress from Working Space.

For equipment over 1800 mm wide or deep, there shall be one entrance to and egress from the required working space not less than 610 mm wide and 2000 mm high at each end of the working space

6.46.4.2 Entrance to and egress from working space

(A) Unobstructed egress.

Where the location permits a continuous and unobstructed way of egress 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 (1), a single entrance shall be permitted.

6.46.4.3 WORKING SPACE FOR ITE

(A) Low-voltage circuits.

The working space about ITE where any live parts that may be exposed during routine servicing operate at not greater than 30 volts rms, 42 volts, or 60 volts DC shall not be required to comply with the work space requirement of 6.46.4.2

(B) Other circuits.

Any areas of ITE that requires servicing of parts that are greater than 30 volts rms, 42 volts peak, or 60 volts DC shall comply with the workspace requirement of 6.46.4.2

6.46.4.4 Work areas and working space about batteries.

- Working space about battery system shall comply with 1.10.2.1. working space shall be measured from the edges of the battery racks, cabinets, or trays

6.46.4.5 WORK SPACE FOR ROUTINE SERVICES AND MAINTENANCE

- Work space shall be provided to facilitate routine services and maintenance (those tasks involving of operations that can be accomplished by employees and where extensive disassembly of equipment is not required). Routine servicing and maintenance shall be able to perform without exposing the worker to a risk of electric shock or personal injury.

ARTICLE 6.47-SENSITIVE ELECTRONIC EQUIPMENT

Scope.

This article covers the installation and wiring of separately derived systems operating at 120 volts line-to-line and 60 volts to ground for sensitive electronic equipment

General.

Used of a separately derived 120-volts single-phase 3-wire system with 60 volts on each of two ungrounded conductors to an equipment grounding conductors shall be permitted for the purpose of reducing objectionable noise in sensitive electronic equipment locations

ARTICLE 6.47-SENSITIVE ELECTRONIC EQUIPMENT

- Wiring methods.

(A)Panel boards and Overcurrent Protection.

Used of standard single-phase panel boards and distribution equipment with a higher voltage rating shall be permitted. The system shall be clearly marked on the face of the panel or on the inside of the panel doors.

(B) Junction boxes.

All junction box covers shall be clearly marked to indicate the distribution panel and the system voltage

ARTICLE 6.47 SENSITIVE ELECTRONIC EQUIPMENT

- Wiring methods

(C) Conductors identification.

All feeders and branch circuit conductors installed under the section shall be identified as to system at all splices and terminations by color , marking, tagging or equal effective means.

(D) Voltage drop.

the voltage drop on any branch circuit shall not exceed 1.5 percent. The combined voltage drop of feeder and branch-circuit conductors shall not exceed to 2.5 percent.

ARTICLE 6.47 SENSITIVE ELECTRONIC EQUIPMENT

- **Three-phase systems.**
  - Where three-phase power is supplied, a separately derived 6-phase “wye” system with 60 volts to ground installed under this article shall be configured as three separately derived 120-volt single-phase systems having a combined total no more than 6 disconnects

ARTICLE 6.47 SENSITIVE ELECTRONIC EQUIPMENT

Receptacle.

- (1) All 15- and 20- ampere receptacles shall be GFCI protected
- (2) All receptacle outlet strips, adapters, receptacle covers, and faceplates shall be marked with the ff. words or equivalent:

WARNING-TECHNICAL POWER

DO NOT CONNECT TO LIGHTING EQUIPMENT.

For electronic equipment use only.

60/120 V.1 ac

GFCI protected

ARTICLE 6.47 SENSITIVE ELECTRONIC EQUIPMENT

Receptacle.

(3) A 125-volt or 250-volt, single-phase,15- or 20-ampere-rated receptacle having one of its current-carrying poles connected to a grounded circuit conductor shall be located within 1800 mm of all permanently installed 15- or 20-ampere-rated 60/120-volt technical power system receptacles.

(4) All 125-volt or 250-volt receptacle used for 60/120-volt technical power shall have unique configurations and be identified for us with this class of system.

ARTICLE 6.47 SENSITIVE ELECTRONIC EQUIPMENT

- Lighting Equipment.
  - Lighting equipment installed under this Article for the purpose of reducing electrical noise originating from lighting equipment shall meet the conditions of 6.47.1.8(A) through (C).

ARTICLE 6.50- PIPE ORGANS

Scope.

- This Article covers those electrical circuits and parts of electrically operated pipe organs that are employed for the control of the keyboards and of the sound apparatus, typically organ pipes

ARTICLE 6.50- PIPE ORGANS

Definitions.

Electronic Organs.

A musical instrument that imitates the sound of the pipe organ by producing sound electronically.

Pipe Organ.

A musical instrument that produces sound by driving pressurized air (called wind) through pipes selected via keyboard.

Sounding Apparatus.

The sound-producing part of a pipe organ, including, but not limited to, pipes, chimes, bells , the pressurized air(wind)-producing equipment (blower), associated controls, and power equipment.

ARTICLE 6.50- PIPE ORGANS

- Grounding or Double Institution of the DC Power Supply.
- (1) The DC power supply shall be double insulated.
- (2) The metallic case of the dc power supply shall be bonded to the input equipment grounding conductor.

ARTICLE 6.50- PIPE ORGANS

- Conductors
- (A) Size.
  - The minimum conductor size shall be not less than 0.08 mm^2 for electronic signal circuits and not less than 0.13 mm^2 for electromagnetic valve supply and the like. The minimum conductor size of a main common return conductor in the electromagnetic supply shall not be less than 2.0 mm^2.

ARTICLE 6.50- PIPE ORGANS

- Conductors
- (B) Insulation.
  - Conductors shall have thermoplastic or thermosetting insulation

(C)Conductors to be Cabled.

Except for the common return conductor and conductors inside the organ proper, the organ sections and the organ console conductors shall be cabled.

ARTICLE 6.50- PIPE ORGANS

- Insulation of Conductors.
  - Cables shall be securely fastened in place and shall be permitted to be attached directly to the organ structure without insulating supports. Control equipment and bus bars connecting common-return conductors shall be permitted to be attached to the organ structure without insulation supports.

ARTICLE 6.50- PIPE ORGANS

- Overcurrent Protection.
  - Circuits shall be so arranged that 0.50 mm^2 through 0.08mm^2 conductors shall be protected by an overcurrent device rated at not more than 6 amperes. Other conductor sizes shall be protected in accordance with their ampacity. A common return conductor shall not require overcurrent protection.

ARTICLE 6.60-X-RAY EQUIPMENT

Scope

This Article covers all x-ray equipment operating at any frequency or voltage for industrial or other nonmedical or non dental use.

Definitions.

Long-time Rating. A rating based on an operating interval or five minutes or longer.

Mobile. X-ray equipment mounted on a permanent base with wheels and/or casters for moving while completely assembled

ARTICLE 6.60-X-RAY EQUIPMENT

Definitions.

Momentary Rating. A rating based on a operating interval that does not exceed 5 sec.

Portable. X-ray equipment designed to be hand-carried.

Transportable. X-ray equipment that is to be installed in a vehicle or that may be readily disassembled for transport in a vehicle.

ARTICLE 6.60-X-RAY EQUIPMENT

Connection and supply circuit.

Fixed and stationary equipment.

Fixed and stationary x-ray equipment shall be connected by means of a wiring method meeting the general requirement of this code.

6.60.2 CONTROL

Fixed and stationary equipment.

(A)Separate control device.

A separate control device, in addition to the disconnecting means, shall be incorporated in the x-ray control supply or in the primary circuit to the high-voltage transformer.

(B)Protective Device.

A protective device, which shall be permitted to be incorporated in to the separate control device, shall be provide to control the load resulting from failures in the high-voltage circuit.

6.60.2 CONTROL

- Fixed and stationary equipment.
- (C) Portable and mobile equipment.
  - Portable mobile equipment shall comply with 6.60.2.1, but the manually controlled device shall be located in or on the equipment.

6.60.2 CONTROL

- Industrial and commercial laboratory equipment.
  - (A) Radiographic and fluoroscopic types.
    - All radiographic-and fluoroscopic-type equipment shall be effectively enclosed or shall have interlocks that de-energize the equipment automatically to prevent ready access to live current-carrying parts.

6.60.2 CONTROL

- (B) Diffraction and Irradiation types.
  - Diffraction and irradiation-type equipment or installations not effectively enclosed or not provided with interlocks to prevent access to un insulated live parts during operation shall be provided with a positive means to indicate when they are energized.

6.60.3 TRANSFORMERS AND CAPACITORS

General.

- Transformers and Capacitors that are part of an X-ray equipment shall not be required to comply with Articles 4.50 and 4.60.s

Capacitors.

- Capacitors shall be mounted within enclosures of insulating materials or grounded metal.

6.60.4 GUARDING AND GROUNDING

- General
- (A) High-Voltage Parts. All high-voltage parts including x-ray tubes shall be mounted within grounded enclosures. Air, oil, gas, or other suitable insulating media shall used to insulate the high voltage from the grounded enclosure.
- (B) Low-voltage cables. Low-voltage cables connecting to oil-filled units that are not completely sealed, such as transformers, condensers, oil coolers, and high-voltage switches, shall have insulation of the oil- resistant type.

6.60.4 GUARDING AND GROUNDING

- Grounding. Non-current-carrying metal parts of x-ray and associated equipment shall be grounded in the manner specified in article 2.50. Portable and mobile equipment shall be provided when an approved grounding-type attachment plug cap.

Article 6.65- Induction and Dielectric Heating Equipment

6.65.1.1 SCOPE

This article covers the construction and installation of dielectric heating, induction heating, induction melting, and induction welding equipment and accessories for industrial and scientific applications. Medical or dental applications, appliances, or line frequency pipeline and vessel heating are not covered in this article.

FPN: See Part 4.27.5 for line frequency induction heating of pipeline and vessels.

6.65.1.2 DEFINITIONS

Applicator- The device used to transfer energy between the output circuit or mass to be heated.

Converting Device- That part of heating equipment that converts input mechanical or electrical energy to the voltage, current and frequency used for heating applicator. A converting device consists of equipment using line frequency, all static multipliers, oscillator-type units using vacuum tubes, inverters using solid-state devices, or motor-generator equipment.

6.65.1.2 DEFINITIONS

Dielectric Heating- Heating of a nominally insulating material due to its own dielectric losses when the material is placed in a varying electric field.

Heating Equipment- As used in this article, any equipment that is used for heating purposes and whose heat is generated by induction or dielectric methods.

Induction Heating, Melting, and Welding- The heating, melting, and welding of a nominally conductive material due to its own I^2R losses when the material is placed in a varying electromagnetic field.

6.65.1.4 Hazardous (Classified) Locations

Heating equipment shall not be installed in hazardous (classified) locations as defined in Article 5.0 unless the equipment and wiring are designed and approved for the hazardous (classified) locations.

6.65.1.5Output Circuit

The output circuit shall include all output components external to the converting device, including contactors, switches, busbars, and other conductors. The current flow from the output circuit to the ground under operating and ground-fault conditions shall be limited to a value that does not cause 50 volts or more to ground to appear on any accessible part of heating equipment and its load. The output circuit shall be permitted to be isolated from the ground.

6.65.1.7 Remote Control

(A) Multiple Control Points- Where multiple control points are for applicator energization, a means shall be provided and interlocked so that the applicator can be energized from only one control point at a time. A means for de-energizing the applicator shall be provided at each control point.

(B) Foot Switches- Switches operated by foot pressure shall be provided with a shield over the contact button to avoid accidental closing of foot switch.

6.65.1.10 Ampacity of Supply Conductors

(A) Nameplate Rating- The ampacity of the conductors supplying one or more pieces of equipment shall be not less than the sum of the nameplate ratings for the largest group of machines capable of simultaneous operation plus 100 percent of the standby currents of the remaining machines.

(B) Motor-Generator Equipment- The ampacity of supply conductors for motor-generator equipment shall be determined in accordance with Part 4.30.2.

6.65.2 Guarding, Grounding and Labeling

6.65.2.2 Enclosures

The converting device (excluding the component interconnections) shall be completely contained within and enclosure(s) of noncombustible material.

6.65.2.3 Control Panels

All control panels shall be of dead-front construction.

6.65.2.4 Access to Internal Equipment

Access doors or detachable access panels shall be employed for internal access to heating equipment. Access doors to internal compartments containing equipment employing voltages from 150 volts or 1000 volts ac or dc shall be capable of being locked closed or shall be interlocked to prevent the supply circuit from being energized while the door(s) is open. The provision for locking or adding a lock to the access door shall be installed on or at the access door and shall remain in place with or without the lock installed.

6.65.2.5 Warning Labels or Signs

Warning labels or signs that read “DANGER --- HIGH VOLTAGE --- KEEP OUT” shall be attached to the equipment and shall plainly visible where persons might come in contact with energized parts when doors are open or closed or when panels are removed from compartments containing over 150 volts ac or dc. The warning sign(s) or label(s) shall comply with 1.10.1.21(B).

6.65.2.7 Dielectric Heating Applicator Shielding

Protective cages or adequate shielding shall be used to guard dielectric heating applicator. Interlock switches shall be used on all hinged doors, sliding panels, or other easy means of access to the applicator. All interlock switches shall be connected in such manner as to remove all power from the applicator when any one of the access doors or panels is open.

6.65.2.8 Grounding and Bonding

Bonding to the equipment grounding conductor or inter-unit bonding, or both, shall be used wherever required for circuit operation, and for limiting to a safe value radio frequency voltages between all exposed non-current-carrying parts of the equipment and earth ground, between all equipment parts and surrounding objects, and between such subject and earth ground. Such connection to the equipment grounding conductor and bonding shall be installed in accordance with Part 2.50.2 and 2.50.5.

FPN: Under certain conditions, contact between object being heated and the applicator results in an unsafe condition, such as eruption of heated materials. Grounding of the object being heated and ground detection can be used to prevent this unsafe condition.

6.65.2.9 Marking

Each heating equipment shall be provided with a nameplate giving the manufacturer's name model identification and the following input data: line voltage, frequency, number of phases, maximum current, full-load kilovolt-amperes (kVA), and full-load power factor. Additional data shall be permitted.

Article 6.68- Electrolytic Cells

6.68.1.1 Scope

This article applies to the installation of the electric components and accessory equipment of electrolytic cells, electrolytic cell line, and the process power supply for the production of aluminum, cadmium chlorine, copper, fluorine, hydrogen peroxide, magnesium, sodium, sodium chlorate, and zinc.

Not covered by this article are cells used as a source of electric energy and for electroplating processes and cells used for the production of hydrogen.

FPN No. 1: In general, any cell line or group cell lines separated as a unit for the production of a particular metal, gas or chemical compound may differ from any other cell line producing the same product.
FPN No. 2: For further information, see IEEE 463-2013, Standard for Electrical Safety Practices in Electrolytic Cell Line Working Zones.

6.68.1.2 DEFINITIONS

Cell Line- An assembly of electrically interconnected electrolytic cell supplied by a source of direct-current power.

Cell Line Attachment and Auxiliary Equipment- As applied to this article, a term that includes, but in not limited to, auxiliary tanks; process piping; ductwork; structural supports; exposed cell line conductors; conduits and other raceway; pumps, positioning equipment, and cell cutout or buy pass electrical devices.

Electrically Connected- A connection capable of carrying current as distinguished from connection through electromagnetic induction.

6.68.1.2 DEFINITIONS

Electrolytic Cell- A tank or vat in which electrochemical reactions are caused by applying electric energy for the purpose of refining or producing usable materials.

Electrolytic Cell Line Working Zone- The space envelope wherein operation or maintenance is normally performed on or in the vicinity of exposed energized surfaces of electrolytic cell lines or their attachments.

6.68.1.3 Other Articles

(A) Lighting, Ventilating, Material Handling- Chapters 1 through 4 shall apply to services, feeders, branch circuits, and apparatus for supplying lighting, ventilating, material handling, and the like that are outside the electrolytic cell in the working zone.

(B) Systems Not Electrically Connected- Those elements of a cell line power-supply system that are not electrically connected to the cell supply system, such as primary winding of a two-winding transformer, motor of a motor-generator set, feeders, branch circuits, disconnecting means, motor controllers, and overload protective equipment, shall comply to all applicable provisions of this Code.

6.68.1.3 Other Articles

Electrolytic Cell Lines- Electrolytic cell lines shall comply with the provisions of Chapter 1 through 4 except as amended in 6.68.1.3(C)(1) through (C)(4).

(1) Conductors- The electrolytic cell line conductors shall not be required to comply with the provisions of Article 1.10, 2.10, 2.15, 2.20, and 2.25. See 6.68.1.11.

(2) Overcurrent Protection- Overcurrent protection of electrolytic cell dc process power circuits shall not be required to comply with the requirements of Article 2.40.

6.68.1.3 Other Articles

Electrolytic Cell Lines- Electrolytic cell lines shall comply with the provisions of Chapter 1 through 4 except as amended in 6.68.1.3(C)(1) through (C)(4).

(3) Grounding- Equipment located or used within the electrolytic cell line working zone or associated with the cell line direct-current power circuits shall not be required to comply with the provisions of Article 2.50.

(4) Working Zones- Electrolytic cells, cell line attachments, and the wiring of auxiliary equipment and devices within the cell line working zone shall not be required to comply with the provisions of Articles 1.10, 2.10, 2.15, 2.20, and 2.25. See 6.68.1.30.

6.68.1.10 Cell Line Working Zone

(A) Area Covered- The space envelope of the cell line working zone shall encompass spaces that meet any of the following conditions:

(1) Is within 2500mm above energized surfaces of electrolytic cell lines or their energized attachment.

(2) Is below energized surfaces of electrolytic cell lines or their energized attachments, provided the headroom is the space beneath is less than 2500mm.

(3) Is within 1000mm horizontally from the energized surfaces of electrolytic cell lines or their energized attachment or from the spaces envelope described in 6.68.1.10(A)(1) or (A)(2).

6.68.1.10 Cell Line Working Zone

(B) Area not covered- The cell line working zone shall not be required to extend through or beyond walls, roofs, floors, partitions, barriers, or the like.

6.68.1.11 Direct-Current Cell Line Process Power Supply

(A) Not Grounded- The direct-current cell line process power-supply conductors shall not be required to be grounded.

(B) Metal Enclosures Grounded- All metal enclosures of power-supply apparatus for the direct-current cell line process operating with a power-supply over 50 volts shall be grounded by either of the following means:

(1) Through protective relaying equipment

(2) By a minimum 60mm^2 copper grounding conductor or a conductor of equal or greater conductance.

(C) Grounding Requirements- The grounding connections required by 6.68.1.11(B) shall be installed in accordance with 2.50.1.8, 2.50.1.10, 2.50.1.12, 2.50.3.19, and 2.50.3.21.

6.68.1.12 Cell Line Conductor

(A) Insulation of Material- Cell line conductor shall either bare, covered or insulated and of copper, aluminum, copper-clad aluminum, steel, or other suitable material.

(B) Size- Cell line conductor shall be of such cross-sectional area that the temperature rise under maximum load conditions and at maximum ambient shall not exceed the safe operating temperature of the conductor insulation or the material of the copper supports.

(C) Connection- Cell line conductors shall be joined by bolted, welded, clamped, or compression connection.

6.68.1.13 Disconnecting Means

(A) More Than One Process Power Supply- Where more than one direct-current cell line process power supply serves the same cell line, a disconnecting means shall be provided on the cell line circuit side of each power supply to disconnect it from the cell line circuit.

(B) Removable Links or Conductors- Removable links or conductors shall be permitted to be used as disconnecting means.

6.68.1.14 Shunting Means

(A) Partial or Total Shunting- Partial or total shunting of cell line circuit current around one or more cells shall be permitted.

(B) Shunting of One or More Cells- The conductors, switches, or combination of conductors and switches used for shunting one or more cells shall comply with the applicable requirements of 6.68.1.12.

6.68.1.15 Grounding

For equipment, apparatus, and structural components that are required to be grounded by provisions of Article 6.68, the provisions of the Article 2.50 shall apply, except a water pipe electrode shall not be required to be used. Any electrode or combination of electrodes described in 2.50.3.3 shall be permitted.

6.68.1.20 Portable Electrical Equipment

(A) Portable Electrical Equipment Not to Be Grounded- The frames and enclosures of portable electrical equipment used within the cell working zone shall be grounded

Exception No. 1: Where the cell line voltage does not exceed 200 volts dc, these frames and enclosures shall be permitted to be grounded.

Exception No. 2: These frames and enclosures shall be permitted to be grounded where guarded.

6.68.1.20 Portable Electrical Equipment

(B) Isolating Transformer- Electrically powered, handheld, cord-connected portable equipment with underground frames or enclosures used within the cell line working zone shall be connected to receptacle circuits that have only grounded conductors such as a branch circuit supplied by an isolating transformer with an underground secondary.

(C) Marking- Underground portable electrical equipment shall be distinctively marked and shall employ plugs and receptacles of a configuration that prevents connection of this equipment to grounding receptacle and that prevents inadvertent interchange of ungrounded and grounded portable electrical equipment.

6.68.1.21 Power-Supply Circuits and Receptacles for Portable Electrical Equipment

(A) Isolated Circuits- Circuits supplying power to underground receptacles for hand-held, cord-connected equipment shall be electrically isolated and isolating transformer shall supply power to this circuit. Primaries of the transformer shall operate not more than 1000 volts between conductors and provided with proper over-current protection. The secondary voltage of such transformer shall not exceed 300 volts between conductors and all circuits supplied by the secondary shall be ungrounded and have proper overcurrent protection on each conductor.

6.68.1.21 Power-Supply Circuits and Receptacles for Portable Electrical Equipment

(B) Non-interchangeability- Receptacles and their mating plugs for ungrounded equipment shall not have provision for a grounding conductor and shall be of a configuration that prevents their use for equipment required to be grounded.

(C) Marking- Receptacles on circuits supplied by isolating transformer with an underground secondary shall be a distinctive configuration, shall be distinctively marked, and shall not be used in any other location in the plant.

6.68.1.30 Fixed and Portable Equipment

(A) Electrical Equipment Not Required To Be Grounded- Alternating-current system supplying fixed and portable electrical equipment within the cell line working zone shall not be required to be grounded.

(B) Exposed Conductive Surfaces Not Required To Be Grounded- Exposed conductive surface such as electrical equipment housings, cabinets, boxes, motors, raceways, and the like, that are within the cell working zone shall be required to be grounded.

6.68.1.30 Fixed and Portable Equipment

(C) Wiring Methods- Auxiliary electrical equipment such as motors, transducers, sensors, control devices, and alarms, mounted on an electrolytic cell or other energized surface, shall be connected to premises wiring system by any of the following means:

(1) Multiconductor hard usage cord

(2) Wire or cable in suitable raceways or metal or nonmetallic cable trays.

6.68.1.30 Fixed and Portable Equipment

(D) Circuit Protection- Circuit protection shall not be required for the control and instrumentation that are totally within the cell line working zone.

(E) Bonding- Bonding of fixed electrical equipment to the energized conductive surfaces of the cell line, its attachments, or auxiliaries shall be permitted. Where fixed electrical equipment is mounted on an energized conductive surface, it shall be bonded to that surface.

6.68.1.31 Auxiliary Nonelectric Connections

Auxiliary nonelectric connections, such as air hoses, water hoses, and the like, to an electrolytic cell, its attachments, or auxiliary equipment shall not have continuous conductive reinforcing wire, armor, braids, and the like. Hoses shall be of nonconductive material.

6.68.1.32 Cranes and Hoists

(A) Conductive Surfaces To Be Insulated From The Ground- The portion of an overhead crane or hoist that contacts an energized electrolytic cell or energized attachments shall be insulated from the ground.

(B) Hazardous Electrical Conditions- Hazardous electrical conditions shall employ one or more of the following systems:

(1) Isolated and ungrounded control circuit in accordance with 6.68.1.21(A)

(2) Nonconductive rope operator

Article 6.69- Electroplating

6.69.1.1 Scope

The provisions of this article apply to the installation of the electric components and the accessory equipment that supply the power and controls for electroplating, anodizing, electropolishing, and electro-stripping. For the purpose of this article, the term *electroplating* shall be used to identify any or all of the these processes.

6.69.1.5 Branch Circuit Conductors

Branch-circuit conductors supplying one or more units of equipment shall have an ampacity of not less than **125 percent** of the total connected load. The ampacity for busbars shall be in accordance with 3.66.2.14

6.69.1.6 Wiring Methods

Conductors connecting to the electrolytic tank equipment to the conversion equipment shall be in accordance with 6.69.6(A) and (B).

(A) Systems Not Exceeding 60 Volts DC- Insulated conductors shall be permitted to be run without insulated support, provided they are protected from physical damage. Bare copper and aluminum conductors shall be permitted where supported on insulators

(B) Systems Exceeding 60 Volts DC- Insulated conductors shall be permitted to be run on insulated supports. Bare copper or aluminum conductors shall be permitted where supported on insulators and guarded against accidental contact taps in accordance with 1.10.2.2.

6.69.1.7 Warning Signs

Warning signs shall be posted to indicate the presence of bare conductors. The warning sing(s) or label(s) shall comply with 1.10.1.21.(B)

6.69.1.8 Disconnecting Means

(A) More Than One Power Supply- Where more than one power supply serves the same dc system, a disconnecting means shall be provided on the dc side of each power supply.

(B) Removable Links or Conductors- Removable links or conductors shall be permitted to be used as disconnecting means.

6.69.1.9 Overcurrent Protection

Direct-current conductors shall be protected from overcurrent by one or more of the following:

(1) Fuses or circuit breakers

(2) A current-sensing device that operates a disconnecting means

(3) Other approved means

Article 6.70- Industrial Machinery

6.70.1.2 Definition

Industrial Machinery (Machine)- A power-driven machine, not portable by hand while working, that is used to process material by cutting; forming; pressure; electrical, thermal, or optical techniques; lamination; or a combination of these processes. It can include associate equipment used to transfer material or tooling, including fixtures, to assemble/disassemble, to inspect or test, or to package.

6.70.1.3 Machine Nameplate Data

(A) Permanent Nameplate- A permanent nameplate shall be attached to the control equipment enclosure or machine and shall be plainly visible after installation. The nameplate shall include the following information:

(1) Supply voltage, number of phases, frequency, and full-load current.

(2) Maximum ampere rating of the of the short-circuit and ground-fault protective device.

(3) Ampere rating of largest motor, from the motor nameplate

6.70.1.3 Machine Nameplate Data

(4) Short-circuit current rating of the machine industrial control panel based on one of the following:

a. Short-circuit current rating of a listed and labeled machine control enclosure or assembly

b. Short-circuit current rating established utilizing an approved method

6.70.1.3 Machine Nameplate Data

(5) Electrical diagram(s) or the number of the index to the electrical drawings

The full-load current shown on the nameplate shall not be less than the sum of the full-load currents required for all the motors and other equipment that may be in operation at the same time under normal conditions of use.

6.70.1.3 Machine Nameplate Data

(B) Overcurrent Protection- Where the overcurrent protection is provided in accordance with 6.70.1.4(C), the machine shall be marked “overcurrent protection provided at the machine supply terminals.”

6.70.1.4 Supply Conductors and Overcurrent Protection

(A) Size- The size of the supply conductor shall be such as to have an ampacity not less than 125 percent of the full-load current rating of all the resistance heating loads plus 125 percent of the full-load current rating of the highest rated motor plus the sum of the full-load current ratings of all other connected motors and apparatus, based on their duty cycle, that may be in operation at the same time.

6.70.1.4 Supply Conductors and Overcurrent Protection

(B) Disconnecting Means- A machine shall be considered as an individual unit and therefore shall be provided with disconnecting means. The disconnecting means shall be permitted to be supplied by branch circuits protected by either fuses or circuit breakers. The disconnecting means shall be required to incorporate overcurrent protection.

6.70.1.4 Supply Conductors and Overcurrent Protection

(C) Overcurrent Protection- The rating or setting of the overcurrent protective device shall not be greater than the sum of the largest rating or setting of the branch-circuit short-circuit and ground-fault protective device with the machine, plus 125 percent of the full-load current rating.

(C) Overcurrent Protection

Exception: Where one or more instantaneous trip circuit breakers or motor short-circuit protectors are used for motor branch circuit and ground-fault protection, for determining the maximum rating of the protective device shall follow the provision: For the of the calculation, each instantaneous trip circuit breaker or motor short-circuit protector shall be assumed to have a rating not exceeding the maximum percentage of the motor full-load current permitted by Table 4.30.4.2.

6.70.1.5 Short-Circuit Current Rating

(1) Industrial machinery shall not be installed where the available short-circuit current rating as marked in accordance with 6.70.1.3(A)(4).

(2) Industrial machinery shall be legibly marked in the field with the maximum available short-circuit current. The field marking(s) shall include the date the short-circuit current calculation was performed and the sufficient durability to withstand the environment involved.

ARTICLE 6.75
ELECTRICALLY DRIVEN OR CONTROLLED IRRIGATION MACHINES

6.75.1.2Definitions

- **Center Pivot Irrigation Machine-** A multi motored irrigation machine that revolves around a central pivot and employs alignment switches or similar devices to control individual motors.
- **Collector Rings-** an assembly of slip rings for transferring electric energy from a stationary to a rotating member.

6.75.1.2Definitions

- **Irrigation Machine-** An electrically driven or controlled machine, with one or more motors, not hand-portable, and used primarily to transport and distribute water for agricultural purposes.

6.75.1.4 Irrigation cable

- **Construction.** The cable used to interconnect enclosures on the structure of an irrigation machine shall be an assembly of stranded, insulated conductors with nonhygroscopic and non wicking filler in a core of moisture- and flame-resistant non metallic material overlaid with a metallic covering and jacketed with a moisture-,corrosion, and sunlight- resistant nonmetallic material.

6.75.1.4 Irrigation cable

- The core insulating material thickness shall not be less tan 0.76mm, and the metallic overlay thickness shall be not less than 0.20mm. The jacketing material thickness shall be not less than 1.27mm.
- A composite of Power, Control, Grounding conductors in the cable shall be permitted.
- **Alternate Wiring Methods.** Installation of other listed cables complying with the construction requirements of 6.75.1.4(A) shall be permitted.

6.75.1.4 Irrigation cable

- **Supports.** Irrigation cable shall be secured by straps, hangers, or similar fittings identified for the purpose and so installed as not to damage the cable. Cable shall be supported at intervals not exceeding 1200mm.
- **Fittings.** Fittings shall be used at all points where irrigation cable terminates. The fittings shall be designed for use with the cable and shall be suitable for the conditions of service.

6.75.1.11 Collector Rings

- **A. Transmitting Current for Power Purposes.** Collector rings shall have a current rating not less than 125 percent of the full-load current of the largest device served plus the full-load current of all other devices served, or as determined from 6.75.1.7(A) or 6.75.2.2(A).
- **B. Control and Signal Purposes.** Collector rings for control and signal purposes shall have a current rating not less than 125 percent of the full-load current of the largest device served plus the full-load current of all other devices served.

6.75.1.11 Collector Rings

- **C. Grounding.** The collector ring used for grounding shall have a current rating not less than that sized in accordance with 6.75.1.11(A).
- **D. Protection.** Collector rings shall be protected from the expected environment and from accidental contact by means of suitable enclosure.

6.75.1.12 Grounding. The following equipment shall be grounded:

- 1. All electrical equipment on the irrigation machine.
- 2. All electrical equipment associated with the irrigation machine.
- 3. Metal junction boxes and enclosures.
- 4. Control panels or control equipment that supplies or controls electrical equipment to the irrigation machine.
- Exception: Grounding shall not be required on machines where all of the following provisions are met

6.75.1.12 Grounding. The following equipment shall be grounded:

- 1.The machine is electrically controlled but not electrically driven.
- 2. The control voltage is 30 volts or less.
- 3. The control or signal circuits are current limited as specified in Tables 10.1.1.11(A) and 10.1.1.11(B).

6.75.1.15 Lightning Protection.

- If an irrigation machine has a stationary point, a grounding electrode system in accordance with Part 2.50.3 shall be connected to the machine at the stationary point for lightning protection.

6.75.1.16 Energy from More than One Source.

- Equipment within an enclosure receiving electric energy from more than one source shall not be required to have a disconnecting means for the additional source provided that its voltage is 30 volts or less and it meets the requirements of Part 7.25.3

6.75.2 Center Pivot Irrigation Machines

- **6.75.2.1 General.** Intended to cover additional special requirements that are peculiar to center pivot irrigation machines.
- **6.75.2 .2 Equivalent Current Ratings.** To establish ratings of controllers , disconnecting means, conductors, and the like, for the inherent intermittent duty of center pivot irrigation machines.

6.75.2 Center Pivot Irrigation Machines

- **a. Continuous-Current Rating.** The selection of branch-circuit conductors and branch-circuit devices shall be equal to 125 percent of the motor nameplate full-load current rating of the largest motor plus 60 percent of the sum of the motor nameplate.
- **b. Locked-Rotor Current.** Equivalent locked-rotor current rating shall be equal to numerical sum of two times the locked-rotor current of the largest motor plus 80 percent of the sum of the motor nameplate full-load current ratings of all remaining circuit.

ARTICLE 6.80 – SWIMMING POOLS, FOUNTAINS, AND SIMILAR INSATALLATIONS

6.80.1.1 Scope.

- Construction and installation of electrical wiring , and equipment in or adjacent to, all swimming , wading, therapeutic, and decorative pools, whether permanently installed or storable, and to metallic auxiliary equipment.

6.80.1.2 Definitions. Cord- and-Plug-Connected Lighting Assembly.

- Intended for installation in wall of a spa, hot tub, or storable pool and a cord-and-plug-connected transformer.
- **Dry-Niche Luminaire.** Intended for installation in the floor or wall of a pool, that is sealed against the entry of water.
- **Fixed (as applied to equipment).** Equipment that is fastened or otherwise secured at a specific location.
- **Forming Shell.** Designed to support a wet-niche luminaire assembly and intended for mounting in a pool or fountain structure.

6.80.1.2 Definitions. Cord- and-Plug-Connected Lighting Assembly.

- **Fountain.** Fountains, ornamental pools, display pools, and reflection pools. Does not include drinking fountains.
- **Hydro-massage Bathtub.** Equipped with a recirculating piping system, pump, and associated equipment. Designed so it can accept, circulate, and discharge water upon each use.
- **Low Voltage Contact Limit.** A voltage not exceeding the following values:
- 15 volts (RMS) for sinusoidal ac
- 21.2 volts peak for non-sinusoidal ac

6.80.1.2 Definitions. Cord- and-Plug-Connected Lighting Assembly.

- 30 volts for continuous dc
- 12.4 volts peak for dc that is interrupted at a rate of 10 to 200 Hz.
- **Maximum Water Level.** Highest level that water can reach before it spills out.
- **No-Niche Luminaire.** Intended for installation above or below the water without a niche.
- **Packaged Spa or Hot Tub Equipment Assembly.** A factory-fabricated unit consisting of water-circulating, heating, and

6.80.1.2 Definitions. Cord- and-Plug-Connected Lighting Assembly.

- control equipment mounted on a common base.
- **Packaged Therapeutic Tub or Hydrotherapeutic Tank Equipment Assembly.** Factory-fabricated unit consisting of water circulating , heating, and control equipment mounted on a common base, intended to operate a therapeutic tub or hydrotherapeutic tank.
- **Permanently Installed Decorative Fountains and Reflection Pools.** Constructed in the ground, or in a building. Primarily constructed for their aesthetic value.

6.80.1.2 Definitions. Cord- and-Plug-Connected Lighting Assembly.

- **Permanently Installed Swimming, Wading, Immersion, Therapeutic Pools.** Those are constructed in the ground or partially in the ground, and all others capable of holding water in a depth greater then 1000mm.
- **Pool.** Manufactured or field-constructed equipment designed to contain water on a permanent or semi-permanent basis.
- **Pool Cover, Electrically Operated.** Motor-driven equipment designed to cover and uncover the water surface.

6.80.1.2 Definitions. Cord- and-Plug-Connected Lighting Assembly.

- **Portable (as applied to equipment).** Equipment that is actually moved or can easily be moved from one place to another in normal use.
- **Self-Contained Spa or Hot Tub.** Factory-fabricated unit consisting of a therapeutic tub or hydrotherapeutic tank with all water-circulating, heating, and control equipment integral to the unit.
- **Spa or Hot Tub.** A hydro-massage pool, or tub for recreational or therapeutic use, designed for immersion of users, and usually

6.80.1.2 Definitions. Cord- and-Plug-Connected Lighting Assembly.

- having filter, heater, and motor-driven blower. Installed indoors or outdoors, on the ground or supporting structure.
- **Stationary (as applied to equipment).** Equipment that is not moved from one place to another.
- **Storable Swimming, Wading, or Immersion Pools; or Storable/ Portable Spas and Hot tubs.** Constructed on or above the ground and are capable of holding water to a maximum depth of 1000 mm, with nonmetallic, molded polymeric walls or inflatable fabric walls regardless dimension.

6.80.1.2 Definitions. Cord- and-Plug-Connected Lighting Assembly.

- **Through-Wall Lighting Assembly.** A lighting assembly intended for installation above grade, on or through the wall of a pool, consisting of two interconnected groups of components separated by the pool wall
- **Wet-Niche Luminaire.** A luminaire intended for installation in a forming shell mounted in a pool or fountain structure where the luminaire will be completely surrounded by water.

6.80.1.4 Approval of Equipment.

- All electrical equipment installed in the water, walls, or decks of pools, fountains, and similar installations shall comply with the provisions of this article. Equipment and products shall be listed.

6.80.1.8 Cord-and-Plug-Connected Equipment.

- Fixed or stationary equipment, other than underwater luminaires, for a permanently installed pool shall be permitted to be connected with a flexible cord and plug to facilitate the removal or discontinuous for maintenance or repair.
- **A. Length.** For other than storable pools, the flexible cord shall not exceed 900mm in the length.
- **B. Equipment Grounding.** The flexible cord shall have a copper equipment grounding conductor sized in accordance with 2.50.6.13 but not smaller than 3.5mm^2.

6.80.1.8 Cord-and-Plug-Connected Equipment.

- **C. Construction.** The equipment grounding conductors shall be connected to a fixed metal part of assembly

6.80.1.9 Overhead Conductor Clearances.

- Overhead conductors shall meet the clearance requirements in this section. Where a minimum clearance from the water level is given, the measurement shall be taken from the maximum water level of the specified body of water.
- **A. Power.** With respect to service-drop conductors overhead service conductors, and open overhead wiring.
- **B. Communication Systems.** Communications radio and television coaxial cables within the scope of Articles 8.0 through 8.20 shall be permitted at a height of not less than 3000mm above swimming and wading pools.

6.80.2 Permanently Installed Pools

- **6.80.2.1 General.** Electrical installations at permanently installed pools shall comply with the provisions of Parts 6.80.1 and 6.80.2.
- **6.80.2.2 Motors.**
- **(A) Wiring Methods.** A pool motor shall comply with (A)(1) unless modified for specific circumstances by (A)(2), (A)(3),(A)(4), or (A)(5).

6.80.2 Permanently Installed Pools

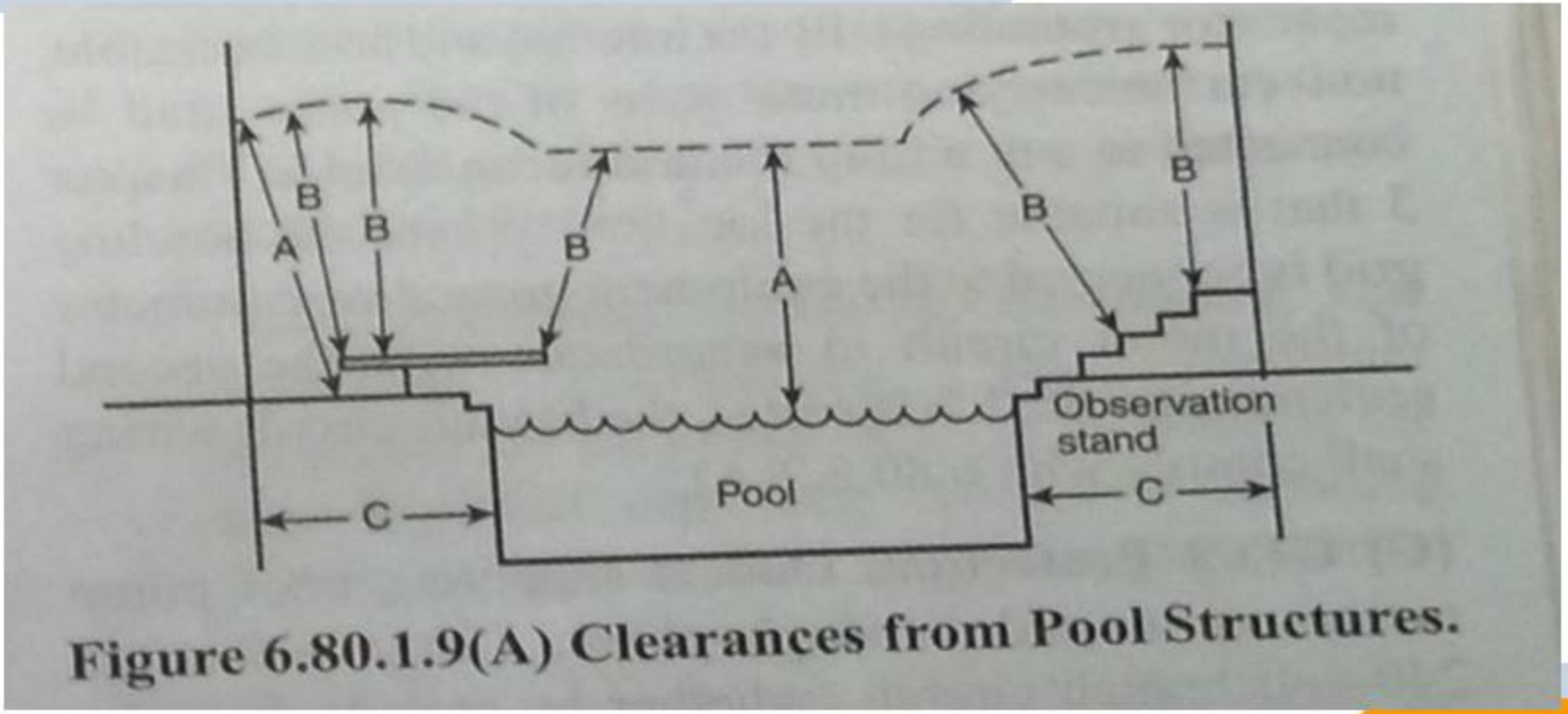


Figure 6.80.1.9(A) Clearances from Pool Structures.

6.80.2 Permanently Installed Pools

- **(1) General.** Wiring methods installed in the corrosive environment described in 6.80.1.14 shall comply with 6.80.1.14(B) or shall be type MC cable listed for that location.

- **(2) Flexible Connections.** Necessary to employ flexible connections at or adjacent to the motor, liquidtight flexible metal or liquidtight flexible nonmetallic conduit with approved fittings shall be permitted.

6.80.2 Permanently Installed Pools

- **(3) Cord-and-Plug Connections.** For Pool-associated motors, the flexible cord shall not exceed **900 mm** in length, shall include a copper equipment grounding conductor sized in accordance with 2.50.6.13 but not smaller than **3.5 mm2**.
- **(B) Double Insulated Pool Pumps.** a listed cord-and plug-connected pool pump incorporating an approved system of double insulation that provides a means for grounding only the internal and non-accessible, The bonding grid is connected to the equipment grounding conductor of the motor circuit.

6.80.2 Permanently Installed Pools

- **(C) GFCI Protection.** Outlets supplying pool pump motors connected to a single-phase, 120-volt through 240-volt branch circuits, whether by receptacle or by direct connection.

6.80.2.3 Lighting, Receptacles, and Equipment.

- **(A) Receptacles.**
- **(1) Required Receptacle, Location.** Where a permanently installed pool is installed, no fewer than one 125-volt or 250 volt, 15 0r 20 ampere receptacle on a general-purpose branch circuit shall be located not less than 1800mm from, and not more than 6000mm from, the inside wall of the pool.

6.80.2.3 Lighting, Receptacles, and Equipment.

- **2. Circulation and Sanitation System, Location.** Receptacles that provide power for water-pump motors or for other loads directly related to the circulation and sanitation system shall be located at least 1800 mm from the inside walls of the pool.
- **3. Other Receptacles, Location.** Other receptacles shall be not less than 1800 mm from the inside walls of a pool.
- **4. GFCI Protection.** All 15- and 20-ampere, single phase, 125-volt and/or 250-volt receptacles located within 6000 mm of the inside walls of a pool

6.80.2.3 Lighting, Receptacles, and Equipment.

- **5. Measurements.** Determining the dimensions in this section addressing receptacle spacing's the distance to be measured shall be the shortest path the supply cord of an appliance connected to the receptacle.

6.80.2.3 Lighting, Receptacles, and Equipment.

- **(B) Luminaires, Lighting Outlets, and Suspended (Paddle) Fans.**
- **(1) New Outdoor Installation Clearances.** Installed above the pool or the area extending 1500 mm horizontally from the inside walls of the pool shall be installed at a height not less than 3700 mm above the maximum water level of the pool.
- **(2) Indoor Clearances.** If the branch circuit supplying the equipment is protected by a ground fault circuit interrupter, the following equipment shall be permitted at a height not less than 2300 mm above the maximum pool water level:

6.80.2.3 Lighting, Receptacles, and Equipment.

- **a.** Totally enclosed luminaires
- **b.** Ceiling-suspended (paddle) fans identified for use beneath ceiling structures such as provided on porches or patios.

6.80.2.3 Lighting, Receptacles, and Equipment.

- **(3) Existing Installations.** Luminaires and lighting outlets located less than **1500 mm** measured horizontally from the inside walls of pool shall be not less than 1500 mm above the surface of the maximum water level.
- **(4) GFCI Protection in Adjacent Areas.** Luminaires, lighting outlets, and ceiling-suspended (paddle) fans installed in the area extending between **1500 mm and 3000 mm** horizontally from the inside walls of a pool shall be protected by a ground-fault circuit interrupter .

6.80.2.3 Lighting, Receptacles, and Equipment.

- **(5) Cord-and-Plug-Connected Luminaires.** Comply with the requirements of 6.80.1.7 where installed within **4900 mm** of any point on the water surface measured radially.
- **(6) Low-Voltage Luminaires.** Not requiring grounding, not exceeding the low voltage contact limit, and supplied by listed transformers or power supplies that comply with 6.80.2.4 (A)(2).

6.80.2.3 Lighting, Receptacles, and Equipment.

- **(7) Low-Voltage Gas-Fired Luminaires, Decorative Fireplaces, Fire Pits, and Similar Equipment.** Do not require grounding, and are supplied by listed transformers or power supplies that comply with 6.80.2.4(A)(2) with outputs that do not exceed the low-voltage contact limit shall be permitted to be located less than 1500 mm from the inside walls of the pool.

6.80.2.3 Lighting, Receptacles, and Equipment.

- **(C) Switching Devices.** Located at least **1500 mm** horizontally from the inside walls of a pool unless separated from the pool by a solid fence, wall, or other permanent barrier.

- **(D) Other Outlets.** Not less than **3000 mm** from the inside walls of the pool. Measurements shall be determined in accordance with 6.80.2.3(A)(5).

6.80.2.4 Underwater Luminaires.

- **(A) General.**
- **1. Luminaire Design, Normal Operation.** The design of an underwater luminaire supplied from a branch circuit either directly or by way of a transformer or power supply, properly installed without a ground-fault circuit interrupter.
- **2. Transformers and Power Supplies.** Incorporate either a transformer of the isolated winding type, with an undergrounded secondary that has a grounded metal barrier between the primary and secondary windings.

6.80.2.4 Underwater Luminaires.

- **3. GFCI Protection, Lamping Relamping, and Servicing.** Installed in the branch circuit supplying luminaires operating at voltages greater than the low-voltage contact limit.
- **4. Voltage Limitation.** No luminaires shall be installed for operation on supply circuits over 150 volts between conductors.
- **5. Location, Wall-Mounted Luminaires.** Installed with the top of the luminaire lens not less than **450 mm** below the normal water level of the pool.

6.80.2.4 Underwater Luminaires.

- **6. Bottom-Mounted Luminaires.** Facing upward shall comply with either (1) or (2):
- **a.** Have lens guarded to prevent contact by any person.
- **b.** Listed for use without a guard.

- **7. Dependence on Submersion.** For safe operation shall be inherently protected against the hazards of overheating when not submerged.

6.80.2.4 Underwater Luminaires.

- **8. Compliance.** Obtained by the use of a listed underwater luminaire and by installation of a listed ground-fault circuit interrupter in the branch circuit or a listed transformer or power supply.

6.80.2.4 Underwater Luminaires.

(B) Wet-Niche Luminaires.

1. Forming Shells. Installed for the mounting of all wet-niche underwater luminaires and shall be equipped with provisions for conduit entries. Used with nonmetallic conduit systems, other than those that are part of a listed low-voltage lighting system not requiring grounding, shall include provisions for terminating an **8.0 mm2** copper conductor.

2. Wiring Extending Directly to the Forming Shell. Installed from the forming shell to a junction box or other enclosure conforming to the requirements in 6.80.2.5.

6.80.2.4 Underwater Luminaires.

a. Metal Conduit. Shall be approved and shall be of brass or other approved corrosion-resistant metal.

b. *Non-metallic Conduit.* An 8.0 mm2 insulated solid or stranded copper bonding jumper shall be installed in this conduit unless a listed low-voltage lighting system not requiring grounding is used. The bonding jumper shall be terminated in the forming shell, junction box or transformer enclosure.

6.80.2.4 Underwater Luminaires.

- **3. Equipment Grounding Provisions for Cords.** Other than listed low-voltages lighting systems not requiring grounding wet niche luminaires that are supplied by a flexible cord or cable shall have all exposed non-current carrying metal parts grounded by an insulated copper equipment grounding conductor that is an integral part of the cord or cable.
- **4. Luminaire Grounding terminations.** The end of the flexible-cord jacket and the flexible-cord conductor terminations within a luminaire shall be covered with, or encapsulated in, a suitable potting compound to prevent the entry of water into the luminaire through the cord or its conductors.

6.80.2.4 Underwater Luminaires.

- **C. Dry-Niche Luminaires.**
- **1. Construction.** A dry-niche luminaire shall have provision for drainage of water. Other than listed low voltage luminaires not requiring grounding, a dry-niche luminaire shall have means for accommodating one equipment grounding conductor for each conduit entry.
- **2. Junction Box.** A junction box shall not be required but, if used, shall not be required to be elevated.
- **D. No-Niche Luminaires.** A no-niche luminaire shall meet the construction requirements of 6.80.2.4(B)(3) and be installed in accordance with the requirements of 6.80.2.4(B)

6.80.2.4 Underwater Luminaires.

- **E. Through-Wall Lighting Assembly.** A through-wall lighting assembly shall be equipped with a threaded entry or hub, or a nonmetallic hub, for the purpose of accommodating the termination of the supply conduit.
- **F. Branch-Circuit Wiring.**
- **1. Wiring Methods.** Where branch-circuit wiring on the supply side of enclosures and junction boxes connected to conduits run to underwater luminaires are installed in corrosive environments.
- **2. Equipment Grounding**. Other than listed low-voltage luminaires not requiring grounding, all through-wall lighting assemblies, wet-niche, dry-niche, or no-niche luminaires shall be connected to an insulated copper equipment grounding conductor installed with the circuit conductors.

6.80.2.5 Junction Boxes and Electrical Enclosures for Transformers or Ground Fault Circuit Interrupters.

- **A. Junction Boxes.** A junction box connected to a conduit that extends directly to a forming shell or mounting bracket of a no-niche luminaire shall meet the requirements of this section.
- **1. Construction.** The junction box shall be listed, labeled and identified as a swimming pool junction box.
- **2.Installation.** Where the luminaire operates over the low voltage contact limit.
- **a. Vertical spacing.** The junction box shall be located not less than 100mm, measured from the inside of the bottom of the box, above the ground level, or pool deck, or not less than 200mm above the maximum pool water level.

6.80.2.5 Junction Boxes and Electrical Enclosures for Transformers or Ground Fault Circuit Interrupters.

- **b. Horizontal Spacing.** The junction box shall be located not less than 1200mm from the inside wall of the pool.
  - **c. Flush Deck Box.** If used on a lighting system operating at the low voltage contact limit or less, a flush deck box shall be permitted if both of the following are met:
- **1.** An approved potting compound is used to fill the box to prevent the entrance of moisture.
- **2.** The flush deck box is located not less than 1200m from the inside wall of the pool.

6.80.2.5 Junction Boxes and Electrical Enclosures for Transformers or Ground-Fault Circuit Interrupters.

- **B. Other Enclosures.** An enclosure for a transformer, ground-fault circuit interrupter, or a similar device connected to a conduit that extends directly to a forming shell or mounting bracket of a no-niche luminaire.
- **C. Protection.** Junction boxes and enclosures mounted above the grade of the finished walkaway around the pool shall not be located in the walkway unless afforded additional protection.
- **D. Grounding Terminals.** Junction boxes, transformer and power-supply enclosures, and ground-fault circuit-interrupter enclosures connected to a conduit that extends directly to a forming shell or mounting bracket of a no-niche luminaire.

6.80.2.5 Junction Boxes and Electrical Enclosures for Transformers or Ground-Fault Circuit Interrupters.

- **E. Strain Relief**. The termination of a flexible cord of an underwater luminaire within a junction box, transformer or power-supply enclosure, ground-fault circuit interrupter.
- **F. Grounding**. The equipment grounding conductor terminals of a junction box, transformer enclosure, or other enclosure in the supply circuit to a wet-niche or no-niche luminaire.

6.80.2.8 Specialized Pool Equipment.

- **A. Underwater Audio Equipment.** All underwater audio equipment shall be identified.
- **1. speakers**. Each speaker shall be mounted in an approved metal forming shell, the front of which is enclosed by a captive metal screen, or equivalent, that is bonded to, and secured to, the forming shell by a positive locking device that ensures a low-resistance contact and requires a to to open for installation
- **2. Wiring Methods**. Rigid metal conduit of brass or other identified corrosion-resistant metal, liquid tight flexible nonmetallic conduit shall extend from the forming shell to a listed junction box.

6.80.2.8 Specialized Pool Equipment.

- **3.Forming Shell and Metal Screen**. The forming shell and metal screen shall be of brass or other approved corrosion-resistant metal.
- **B. Electrically Operated Pool Covers.**
- **1.Motors and Controllers.** The electric motors, controllers, and wiring shall be located not less than 1500 mm from the inside wall of the pool unless separated from the inside wall of the pool unless separated from the pool by a wall, cover, or other permanent barrier.
- **2. Protection.** The electric motor and controller shall be connected to a branch circuit protected by a ground-fault circuit interrupter.

6.80.2.8 Specialized Pool Equipment.

- **C. Deck Area Heating**. The provision of this section shall apply to all pool deck areas, including a covered pool, where electrically operated comfort heating units are installed within 6000mm of the inside wall of the pool.
- **1. Unit Heaters**. It shall be rigidly mounted to the structure and shall be of the totally enclosed or guarded type. Unit heaters shall not be mounted over the pool or within the area extending 1500 mm horizontally from the inside walls of a pool.
- **2.Permanently Wired Radiant Heaters**. Radiant electric heaters shall be suitably guarded and securely fastened to their mounting device. Heaters shall not be installed over a pool or within the area extending 1500 mm horizontally from the inside walls of the pool and shall be mounted at least 3700mm vertically

6.80.2.8 Specialized Pool Equipment.

- **3.Radiant Heating Cables Not Permitted.** Radiant heating cables embedded in or below the deck shall not be permitted.
- **6.80.2.9 Gas –Fired Water Heater**. Circuits serving gas-fired swimming pool and spa water heaters operating at voltages above the low-voltage contact limit shall be provided with ground –fault circuit-interrupter protection for personnel.

6.80.3 Storable Pools, Storable Spas, and Storable Hot Tubs

- **6.80.3.1 General**. Electrical installation at storable pools, storable spas, or storable hot tubs shall comply with the provisions of Parts 6.80.10and 6.80.3
- **6.80.3.2 Pumps**. A cord connected pool filter pump shall incorporate an approved system of double insulation or its equivalent and shall be provided with means for grounding only the internal and non-accessible non-current carrying metal parts of the appliance.
- **6.80.3.3 Ground fault Circuit Interrupters Required**. All electrical equipment, including power-supply cords, used with storable pools shall be protected by ground-fault circuit interrupters.

6.80.3 Storable Pools, Storable Spas, and Storable Hot Tubs

- **6.80.3.4 Luminaires**. An underwater luminaire, if installed, shall be installed in or on the wall of the storable pool, storable spa, or storable hot tub. It shall comply with either 6.80.3.4(A) or (B).
- **A. Within the Low Voltage Contact Limit.** A luminaire shall be part of a cord- and plug connected lighting assembly. This assembly shall be listed as an assembly for purpose and have the following construction features:
- **1**. No exposed metal parts
- **2**.A luminaire lamp that is suitable for use at the supplied voltage
- **3**. An impact-resistant polymeric lens, luminaire body, and transformer enclosure

6.80.4 Spas and Hot tubs

- **6.80.4.1 General**. Electrical installations at spas and hot tubs shall comply with the provisions of Parts 6.80.1 and 6.80.4
- **6.80.4.2 Emergency Switch for Spas and Hot Tubs**. A clearly labeled emergency shutoff or control switch for the purpose of stopping the motors that provide power to the recirculation system and jet system shall be installed at a point readily accessible to the users and not less than 1500 mm away, adjacent to, and within sight of the spa or hot tub.
- **6.80.4.3 Outdoor Installations**. A spa or hot tub installed outdoors shall comply with the provisions of Parts 6.80.1 and 6.80.2, except as permitted in 6.80.4.3(A) and (B), that would otherwise apply to pools installed outdoors.

6.80.4 Spas and Hot tubs

- **A. Flexible Connections**. Listed packaged spa or hot tub equipment assemblies or self-contained spas or hot tubs utilizing a factory-install or assembled control panel or panel board shall be permitted to use flexible connections as covered in 6.80.4.3(A)(1) and (A)(2).
- **1. Flexible Conduit**. Liquidtight flexible metal conduit or liquidtight flexible non metallic conduit shall be permitted.
- **2. Cord-and-Plug Connections**. Cord-and-plug connections with a cord not longer than 4600mm shall be permitted where protected by a ground-fault circuit interrupter.

6.80.7 Hydromassage Bathtubs

- **6.82.1.1 Scope**. This article applies to the installations of electrical wiring for and equipment in and adjacent to natural or artificially made bodies of water.
- **6.82.1.2 Definitions**
- **Artificially Made Bodies of Water.** Bodies of water that have been constructed or modified to fit some decorative or commercial purpose
- **Electrical Datum Plane** The. In land areas subject to tidal fluctuation, the electrical datum plane is a horizontal plane 600mm above the highest tide level for the area

6.80.7 Hydromassage Bathtubs

- **Equipotential Plane**. An area where wire mesh or other conductive elements are on, embedded in, or placed under the walk surface with in 75 mm, bonded to all metal structures.
- **Natural Bodies of Water.** Bodies of water such as lakes, streams, ponds rivers.
- **Shoreline**. The farthest extent of standing water under the applicable conditions that determine the electrical datum plane.
- **6.82.2 Installation**
- **6.82.2.1 Electrical Equipment and Transformers.** including their enclosures, shall be specifically approved for the intended location.

ARTICLE 6.85 INTEGRATED ELECTRICAL SYSTEMS

6.85.1 General

- **6.82.1.1 Scope**. This article covers integrated electrical systems, other than unit equipment, in which orderly shutdown is necessary to ensure safe operation.
- **6.82.2 Application of Other Articles**. These articles sections in Table 6.85.1.3 apply to particular cases of installation of conductors and equipment where there are orderly shutdown requirements that are in addition to those of this article or are modifications of them.

6.85.1 General

- **6.85.2.1 Location of Overcurrent Devices on or on Premises**. Location of overcurrent devices that are critical to integrated electrical systems shall be permitted to be accessible.
- **6.85.2.3 Direct-Current System Grounding**. Two wire dc circuits shall be permitted to be ungrounded.
- **6.85.2.5 Ungrounded Control Circuits**. Where operational continuity is required, control circuits of 150 volts or less from separately derived systems shall be permitted to be ungrounded

6.23 Solar Photovoltaic (PV) Systems

6.24 Large-Scale Photovoltaic (PV) Electric Power Production Facility

6.25 Fuel Cells System

6.26 Wind Electric System

6.23

Solar Photovoltaic (PV) Systems

- **Scope.** This article applies to solar PV systems, other than those covered by article 6.91, including the array circuit(s), inverter(s), and controller(s) for such systems.

DEFINITION OF TERMS

- **AC Photovoltaic Module.** a complete, environmentally protected unit consisting of solar cells, optic, inverter, and other components, exclusive of tracker, designed to generate ac power when exposed to sunlight.
- **Array.** a mechanically integrated assembly of module(s) or panel(s) with a support structure and foundation, tracker, and other components, as required, to form a dc or ac power-production unit.
- **Bipolar Photovoltaic Array.** a dc PV array that has two outputs, each having opposite polarity to a common reference point or center tap.

DEFINITION OF TERMS

- **DC to DC Converter.** a device installed in a PV source circuit or PV output circuit that can provide an output dc voltage and current at a higher or lower value than the input dc voltage or current.
- **DC Combiner.** a device used in the PV source or PV output circuits to combine two or more dc circuit inputs and provide one dc circuit output.
- **Diversion Charge Controller.** equipment that regulates the charging process of a battery by diverting power from energy storage to dc or ac loads or to an interconnected utility service.

DEFINITION OF TERMS

- **Functional Grounded PV System.** a PV system that has an electrical reference to ground that is not solidly grounded.
- **Generating Capacity.** the sum of parallel-connected inverter maximum continuous output power at 40°C in kilowatts.
- **Interactive System.** a PV system that operates in parallel with and may deliver power to an electrical production and distribution network.
- **Module.** a complete, environmentally protected unit consisting of solar cells optics, and other components, exclusive of tracker, designed to generate dc power when exposed to sunlight.

DEFINITION OF TERMS

- **Inverter.** equipment that is used to change voltage level or waveform, or both, of electrical energy. Commonly, an inverter [also known as power conditioning unit (PCU) or power conversion system (PCS)] is a device that changes dc input to an ac output.
- **Panel.** a collection of modules mechanically fastened together, wired, and designed to provide a field-installable unit.
- **Solar Cell.** the basic PV device that generates electricity when exposed to light.
- **Subarray.** an electrical subset of a PV array.

GENERAL REQUIEMENTS

- **PV Systems** – shall be permitted to supply a building or other structure in addition to any other electrical supply system(s).
- **Equipment** – intended for use in PV systems shall be listed or field labeled for the PV application.
  - ✓ inverters
  - ✓ motor generators
  - ✓ PV modules
  - ✓ AC modules
  - ✓ DC combiners
  - ✓ DC to DC converters
  - ✓ charge controllers
- **Locations not Permitted -** PV system equipment and disconnecting means shall not be installed in bathrooms.

ALTERNATING-CURRENT MODULES

- **Photovoltaic Source Circuits –** the requirements of Article pertaining to PV source circuits shall not apply to ac modules. The PV source circuit conductors and inverters shall be considered as internal wiring of ac module.
- **Inverter Output Circuit –** the output of an ac module shall be considered an inverter output circuit.

CIRCUIT REQUIREMENTS

- **Maximum Voltage –** the maximum voltage of PV system dc circuits shall be the highest voltage between any two conductors or any conductor and ground.
  - PV system dc circuits on or in one- and two- family dwellings shall be permitted to have a maximum voltage of 600 volts or less.
  - PV system dc circuits on or in other types of buildings shall be permitted to have a maximum voltage of 1000 volts or less.

" the maximum voltage shall be used to determine the voltage rating of conductors, cables, disconnects, overcurrent devices, and other equipment."

CIRCUIT SIZING AND CURRENT

- **Calculation of Maximum Circuit Current –** the maximum current for the specific circuit shall be calculated in accordance with:
  - *Photovoltaic source circuit current*
  - *Photovoltaic output circuit current*
  - *Inverter output circuit current*
  - *Stand-alone inverter input circuit current*
  - *DC-to-DC converter source circuit output current*
  - *DC-to-DC converter output circuit current*

OVERCURRENT PROTECTION

- **Circuits and Equipment –** PV system dc circuit and inverter output conductors and equipment shall be protected against overcurrent. Overcurrent protective devices shall not be required for circuits with sufficient ampacity for the highest available current.
- **Overcurrent Device Ratings –** overcurrent devices used in PV system dc circuits shall be listed for use in PV systems.
- **PV Source and Output Circuits –** a single overcurrent protective device, where required, shall be permitted to protect the PV modules and conductors of each source circuit or the conductors of each output circuit.
- **Power Transformer –** overcurrent protection for a transformer with a source(s) on each side shall be provided in accordance with 4.50.1.3 by considering first one side of the transformer, then the other side of the transformer, as the primary.

ARC-FAULT CIRCUIT PROTECTION

- PV systems operating at 80 volts dc or greater between any two conductors shall be protected by a listed PV arc-fault circuit interrupter or other system components listed to provide equivalent protection.
- The system shall detect and interrupt arcing faults resulting from a failure in the intended continuity of a conductor, connection, module, or other circuit component in the PV system dc circuit.

WIRING METHODS

- **Wiring Systems.** all raceway and cable wiring methods included in this *Code*, other wiring systems and fittings specifically listed for use on PV arrays and wiring as part of a listed system shall be permitted.
- **Component Interconnections.** Fittings and connectors tat are intended to be concealed at the time of on-site assembly, where listed for such use, shall be permitted for onsite interconnection of modules or other array components.
- **Access to Boxes.** Junction, pull and outlet boxes located behind modules or panels shall be so installed that the wiring contained in them can be rendered accessible directly or by displacement of module(s) or panel(s) secured by removable fasteners and connected by a flexible wiring system.

System Grounding

A. **PV System Grounding Configurations .** One or more of the following system grounding configuration shall be employed:

- 2-wire PV arrays with one functional grounded conductors
- Bipolar PV arrays according to 6.90.2.1(C) with a functional ground reference (center tap)
- PV arrays not isolated from the grounded inverter output circuit
- Ungrounded PV arrays
- Solidly grounded PV arrays as permitted in B. Exception

B. **Ground-Fault Protection.** DC PV arrays shall be provided with DC ground-fault protection meeting the requirements of the **ground-fault detection** and **isolating Faulted circuits** to reduce fire hazards.

Exception: PV arrays with not more than two PV source circuits and with all PV system circuits not on or in buildings shall be permitted without ground-fault protection where solidly ground.

- **Array Equipment Grounding Conductors.** For PV modules, equipment grounding conductors smaller than 14 mm^2 shall comply with 2.50.6.11(C).

6.24

Large-Scale Photovoltaic (PV) Electric Power Production Facility

- **Scope.** This article covers the installation of large-scale PV electric power production facilities with a generating capacity not less than 5000 kW, and not under exclusive utility control.

DEFINITION OF TERMS

- **Electric Supply Stations.** Locations containing the generating stations and substations, including their associated generator, storage battery, transformer, and switchgear areas.
- **Generating Capacity.** the sum of the parallel-connected inverter rated maximum continuous output power at 40 ℃ in kilo-watts (kW).
- **Generating Station.** a plant wherein electric energy is produced by conversion by some other form of energy (e.g., chemical, nuclear, solar, wind, mechanical, or hydraulic) by means of suitable apparatus.

SPECIAL REQUIREMENTS FOR LARGE-SCALE PV ELECTRIC SUPPLY STATIONS

- **Electric Supply Stations –** large scale PV electric supply stations shall be accessible only to authorized personnel and comply with the following:
  - Electrical circuits and equipment shall be maintained and operated only by qualified personnel.
  - Access to PV electric supply stations shall be restricted by fencing or other adequate means in accordance with 1.10.3.2. Field-applied hazard markings shall be applied in accordance with 1.10.1.21(B)

SPECIAL REQUIREMENTS FOR LARGE-SCALE PV ELECTRIC SUPPLY STATIONS

- Connection between the PV electric supply station and the system operated by a utility for the transfer of electrical energy shall be through medium- or high-voltage switch gear, substation, switch yard, or similar methods whose sole purpose shall be to safety and effectively interconnect the two systems.
- The electrical loads within the PV electric supply station shall only be used to power auxiliary equipment for the generation of the PV power.
- Large-scale PV electric supply stations shall not be installed on buildings.

EQUIPMENT APPROVAL

- All electrical equipment shall be approved for installation by one of the following:
  - Listing and labeling;
  - Field labeling;
  - Where products complying with 6.91.1.5(1) or (2) are not available, by engineering review validating that the electrical equipment is tested or relevant standards or industry practice

ENGINEERED DESIGN

- Documentation of the electrical portion of the engineered design of the electric supply station shall be stamped and provided upon request of the Office of the Building Official/EE. Additional stamped independent engineering reports detailing compliance of the design with applicable electrical standards and industry practice shall be provided upon request of the Office of the Building Official/EE.

6.25

Fuel Cells System

GENERAL

- **Scope.** This article applies to the installation of fuel cell power systems.

FPN: some fuel systems can be interactive with other electrical power production sources, are stand-alone, or both. Some fuel cells are connected to electric energy storage systems such as batteries. Fuel cell systems can have ac output(s), dc output(s), or both for utilization.

DEFINITION OF TERMS

- **Fuel Cell.** An electrochemical system that consumes fuel to produce electric current. In such cell, the main chemical reaction used for producing electric power is not combustion.
- **Fuel Cells System.** the complete aggregate of equipment used to convert chemical fuel into usable electricity and typically consisting of a reformer, stack, power inverter, and auxiliary equipment.
- **Interactive System.** a fuel cells system that operates in parallel with and may deliver power to an electrical production and distribution network.

INSTALLATION

- **Fuel Cell System –** a fuel cell system shall be permitted to supply a building or other structure in addition to other service(s) of another electricity supply system(s).
- **Identification –** a permanent plaque or directory, denoting all electric power sources on or in the premises, shall be installed at each service equipment location.
- **System Installation –** fuel cells systems including all associated wirings and interconnections shall be installed only by qualified persons.
- **Listing Requirements –** fuel cell system shall be listed or field labeled for its intended application.

CIRCUIT REQUIREMENTS

Circuit Sizing and Current

A. **Nameplate Rated Circuit Current.** The nameplate(s) rated circuit current shall be rated current indicated on the fuel cell nameplate(s).

B. **Conductor Ampacity and Overcurrent Device Rating.** The ampacity of the feeder circuit conductors from the fuel cell systems to the premises wiring system shall not be less than the greater of (1) nameplates rated circuit current or (2) the rating of the fuel cell systems overcurrent protective devices.

OVERCURRENT PROTECTION

- **Circuits and Equipment .** If the fuel cell system is provided with overcurrent protection sufficient to protect the circuit conductors that supply the load, additional circuit overcurrent devices shall not be required. Equipment and conductors connected to more than one electrical source shall be protected.
- **Accessibility.** Overcurrent devices shall be readily accessible.

DISCONNECTING MEANS

- **All conductors.** Means shall be provided to disconnect all current-carrying conductors of a fuel cell system power source from all other conductors in a building or other structure.
- **Switch or Circuit Breakers.** The disconnecting means for ungrounded conductors shall consist of readily accessible, manually operable switches or circuit breakers.

WIRING METHODS

- **Wiring System –** all raceway and cable wiring methods included in Chapter 3 of this *Code* and other wiring systems and fittings specifically intended and identified for use with fuel cell systems shall be permitted. Where wiring devices with integral enclosures are used, sufficient length of cable shall be provided to facilitate replacement.

GROUNDING

- **AC Systems.** Grounding of ac systems shall be in accordance with 2.50.2.1, and with 2.50.2.11 for stand-alone systems.
- **DC Systems.** Grounding of dc systems shall be in accordance with 2.50.8.1.
- **Equipment Grounding Conductor.** A separate grounding conductor shall be installed.
- **Size of Equipment Grounding Conductor.** The equipment grounding conductor shall be sized in accordance with 2.50.6.13.
- **Grounding Electrode System.** Any auxiliary grounding electrodes required by the manufacturer shall be connected to the equipment grounding conductor specified in 2.50.6.9.

MARKING

- **Fuel Cell Power Sources.** A marking specifying the fuel cell system, output voltage, output power rating, and continuous output current rating shall be provided at the disconnecting means for the fuel cell power source at an accessible location on the site.
- **Fuel Shut-off.** The location of the manual fuel shut-off valve shall be marked at the location of primary disconnecting means of the building or circuits supplied.
- **Stored Energy.** A fuel cell system that stores electric energy shall require the following warning sign, or equivalent, at the location of the service disconnecting means of the premises:

WARNING!!!
FUEL CELL POWER SYSTEM CONTAINS
ELECTRICAL ENERGY STORAGE DEVICE

6.26

Wind Electric System

GENERAL

- **Scope.** This article applies to wind (turbine) electric system that consist of one or more wind electric generators and their related alternators, generators, inverters, controllers, and associated equipment.

DEFINITION OF TERMS

- **Diversion Charge Controller**
  - Equipment that regulates the charging process of a battery or other energy storage device by diverting power from energy storage to dc or ac loads, or to an interconnected utility service.
- **Diversion Load**
  - a load connected to a diversion charge controller or diversion load controller, also known as dump load.
- **Nacelle**
  - an enclosure housing the alternator and other parts of a wind turbine.

DEFINITION OF TERMS

- **Tower (as applied to wind electric systems)**
  - A pole or other structure that supports a wind turbine.
- **Wind Turbine**
  - a mechanical device that converts wind energy to electrical energy.
- **Rated Power**
  - the output power of a wind turbine at its rated wind speed.
- **Maximum Voltage**
  - The maximum voltage the wind turbine produces in operation including open circuit conditions.

CIRCUIT REQUIREMENTS

Maximum Voltage.

a) **Wind Turbine Output Circuits.** For wind turbines connected to one- or two-family dwellings, turbine output circuits shall be permitted to have a maximum voltage up to 600 volts. Other installation with the maximum voltage over 1000 volts shall comply with Part 6.94.9.

b) **Direct Current Utilization Circuits.** The voltage of dc utilization circuits shall comply with 2.10.2.6.

c) **Circuits over 150 Volts to Ground.** In one- and two-family dwellings, live parts in circuits over 150 volts to ground shall not be accessible to other than qualified persons when energized.

DISCONNECTING MEANS

- **All conductors.** Means shall be provided to disconnect all current-carrying conductors of a small wind electric power source from all other conductors in a building or other structure.
- **Fuses.** Means shall provide to disconnect the fuse from all sources of supply where the fuse is energized from both directions and is accessible to other than qualified persons.

Equipment Grounding

A. **General.** Exposed non-current-carrying metal parts of towers, turbine nacelles, other equipment, and conductor enclosures shall be grounded and bonded to the premises grounding and bonding system.

B. **Tower Grounding and Bonding.**

1. **Grounding Electrodes and Grounding electrode Conductors.** A wind turbine tower shall be connected to a grounding electrode system.

MARKING

- **Interactive System Point of Interconnection.** All interactive system points of interconnection with other sources shall be marked at an accessible location at the disconnecting means and with the rated ac output current and the nominal operating ac voltage.
- **Power Systems Employing Energy Storage.** Wind electric systems employing energy storage shall be marked with the maximum operating voltage, any equalization voltage, and the polarity of the grounded circuit conductors.

Article 6.95 - Fire pumps

Article 6.95 - Fire pumps

6.95.1.1Scope

FPN: Extracted from NFPA 20-2013, Standard for the Installation of Stationary Pumps for Fire Protection.

A)Covered. *This article cover the installation of the following:*

1.Electric power sources and interconnecting circuits

2.Switching and control equipment dedicated to fire pump drivers

B) **Not Covered.** *This article does not cover the following:*

1.The performance, maintenance, and acceptance testing of the fire pump system, and the internal wiring of the components of the system.

Article 6.95 - Fire pumps

2.The installation of pressure maintenance (jockey or makeup pimps)

FNP: For the installation of pressure maintenance (jockey or makeup) pumps supplied by the fire pump circuit or another source. Article 4.30

3.Transfer equipment upstream of the fire pump transfer switches.

Article 6.95 - Fire pumps

6.95.1.2 Definitions.

Fault-Tolerant External Control Circuits. Those control circuits either entering or leaving the fire pump controller enclosure, which if broken, disconnected, or shorten will not prevent the controller om starting the fire pump from all other internal or external means.

On-Site Power Production Facility. The normal supply of electric power for the site that is expected to be constantly producing power.

On-Site Standby Generator. A facility producing electric power on site as the alternate supply of electric power. It differs from an on-site power production facility, in that it is not constantly producing of power.

Article 6.95 - Fire pumps

6.95.1.3 Power Source(s) for Electric Motor-Driven Fire Pumps. Electric motor-driven fire pumps shall have a reliable source of power.

FPN: See Section 9.3.2 and A.9.3.2 from NFPA 20-2013, *Standard for the installation of stationary pumps for fire Protection, For guidance in the determination of power source.*

(A) Individual Sources. Where reliable, and where capable of carrying indefinitely the sum of the locked-rotor current of the fire pump motor(s) and the pressure maintenance pump motor(s) and the full-load current of the associated fire pump accessory when connected to this power supply.

Article 6.95 - Fire pumps

1.) **Electric Utility Service Connection**

-A fire pump shall be permitted to be supplied by a separate services.

-From a connection located ahead of and not within the same cabinet, enclosure, vertical switchgear section.

2.) **On-Site Power Production Facility**

-A fire pump shall be permitted to be supplied by an on-site power production facility.

3.) **Dedicated Feeder**

- Shall be permitted where it is derived from a services connection.

Article 6.95 - Fire pumps

(B) Multiple Sources:

Individual Source. A combination of two or more of the sources

Individual Source and On-site Standby Generator. One or more of the sources.

(C) Multibuilding Campus-Styles Complexes.

(1) Feeder Sources. Two or more feeders shall be permitted as more than one power source.

(2) Feeder and Alternate Source. shall be permitted as a normal source of power if an alternate source of power independent.

(3) Selective Coordination. shall be selectively coordinated with other supply side overcurrent protective devices.

Article 6.95 - Fire pumps

(D) On-Site Standby Generator as Alternate Source

(1) Capacity. shall have sufficient capacity to allow normal starting and running of the motors driving the fire pumps while supplying all other simultaneously operated load.

(2) Connection. A tap ahead of the generator disconnecting means shall not be required.

(E) Arrangement. All power supplies shall be located and arranged to protect against damage by a fire from within premises and exposing hazards.

(F) Transfer of Power. to the fire pump controller between the individual source and one alternate source shall take place within the pump room.

Article 6.95 - Fire pumps

(1) Power Source Selection. shall be performed by a transfer switch listed for the fire pump service.

(2) Overcurrent Device Section

(G) Phase Converters. Shall not be permitted to be used for fire services.

6.95.14 Continuity of Powers - Circuits that supply electric motor driven fire pumps

(A)Direct Connection
(B) Connection Through Disconnecting Means

Article 6.95 - Fire pumps

(1) Number of Disconnecting Means

(a) General - A single disconnecting means and associated overcurrent protective devices.

(b) ***Feeder Sources***

(c) ***On-Site Standby Generator***

(2) Overcurrent Device Selection

(a) Individual Source

(b) On-Site Standby Generators

Article 6.95 - Fire pumps

(3) Disconnecting Means - All disconnecting devices that are unique to the fire pump load shall comply with items (A) through (E).

(a) *Features and Location*

(b) Disconnect marking

(d) Controller Marking

(e) Supervision

6.95.1.5 Transformers - Where the service or the system voltage is different from the utilization voltage of the fire pump motors, transformers protected by disconnecting means and overcurrent protective devices shall be permitted to be installed between the system supply.

Article 6.95 - Fire pumps

(A) Size - it shall be rated at a minimum of 125 percent of the sum of the fire pump motors and pressure maintenance pumps motor loads. and 100 percent of the associated fire pump accessory equipment supplied by the transformer.

(B) Overcurrent Protection - The primary overcurrent devices shall be selected or set to carry indefinitely the sum of locked-rotor current of the fire pump motors.

(C) Feeder Sources

6.95.1.6 Power Wiring - Power circuit and wiring method shall comply with the following requirements.

Article 6.95 - Fire pumps

(A) Supply Conductors

(1) Services and On-Site Power Production

(2) Feeder

(a) Independent Rout

(b) Associated Fire Pump Load

(c) Protection from Potential Damage

(d) Inside of the a Building

(B) Conductor Size

(1) Fire Pump Motors and Other Equipment

(2) Fire Pump Motors Only

Article 6.95 - Fire pumps

(C) Overload Protection - Power circuits shall not have automatic protection against overload, Branch-circuit and feeder conductors shall be protected against short circuit only.

(D) Pump Wiring - All wiring from the controllers to the pump motors shall be in rigid metal conduit, intermediate metal conduit, electrical metallic tubing etc.

(E) Loads Supplied by Controllers and Transfer Switches

(F) Mechanical Protection - All wiring from engine controllers and batteries shall be protected against physical damage and shall be installed in accordance with the controller and engine manufacturer's instruction.

Article 6.95 - Fire pumps

(G) Ground-Fault Protection of Equipment

(H) Listed Electrical Circuit Protective System to Controller Wiring

(1) A junction box shall be installed ahead of the fire pump controller a minimum of 300 mm beyond the fire-rated wall or floor bounding the fire zone.

(2) Where required by the manufacturer of a listed electrical circuit protective system

(3) Standard wiring between the junction box and the controller shall be permitted.

Article 6.95 - Fire pumps

6.95.1.12 Equipment Location

(A) Controllers and Transfer Switches. Shall be located as close as practicable to, and within sight of, the motors that they control.

(B) Engine-Drive Controllers. Shall be located as close as is practical to, and within sight of, the engines that they control.

(C) Storage Batteries. Shall be supported above the floor, secure against displacement, located where they are not subjected to physical damage, flooding with water, excessive temperature, or excessive vibration.

(D) Energized Equipment. All energized equipment parts shall be located at least 300 mm above the floor level.

Article 6.95 - Fire pumps

(E) Protection Against Pump Water. Shall be located or protected so that they are not damaged by water escaping from pumps or pump connection.

(F) Mounting. Shall be mounted in a substantial manner on noncombustible supporting structures.

6.95.1.14 Control Wiring

(A) Control Circuit failures. External control circuits that extend outside the fire pump room shall be arranged so that failure of any external circuit (open or short circuit) shall not prevent the operation of a pumps from all other internal or external means.

Article 6.95 - Fire pumps

(B) Sensor Functioning. No undervoltage, phase-loss, frequency-sensitive, or other sensors shall be installed that automatically or manually prohibits actuation of the motor contractor.

Exception: A phase loss sensors shall not be permitted only as a part of a listed fire pump controller.

(C) Remote Devices. No remote devices shall be installed that will prevent automatic operation of the transfer switch.

(D) Engine-Drive Control Wiring. All wiring between the controller and the diesel engine shall be stranded and sized to continuously carry the charging.

THANKS!