

Chapter 7: Special Occupancies

Hazardous (Classified) Locations, Classes I, II, and III, Division 1 and 2

Scope

Covers the requirements for electrical and electronic equipment and wiring for all voltages in Class I, Division 1 and 2; Class II, Division 1 and 2; and Class III, Division 1 and 2 locations where fire or explosion hazards may exist due to flammable gases, flammable liquid-produced vapors, combustible liquid-produced vapors, combustible dusts, or ignitable fibers/flyings.

Classifications of Locations

A. General. Locations shall be classified depending on the properties of the flammable gas, flammable liquid-produced vapors, combustible liquid-produced vapors, combustible dusts, or fibers/flying that could be present

B. Class I Locations. Are those in which flammable gases, flammable liquid-produced vapors, or combustible liquid-produced vapors are or may be present in the air in quantities sufficient to produced explosive or ignitable mixtures.

Classifications of Locations

B. Class I Locations

1. Class I, Division 1

1. In which ignitable concentrations of flammable gases, flammable liquid-produced vapors, or combustible liquid vapors can exist under normal operating conditions,
2. In which ignitable concentrations of such flammable gases, flammable liquid-produced vapors, or combustible liquids above their flash points may exist frequently because of repair or maintenance operations or because of leakage,
3. In which breakdown or faulty operation of equipment or processes might release ignitable concentrations of flammable gases, flammable liquid-produced vapors, or combustible liquid-produced vapors and might also cause simultaneous failure of electrical equipment in such a way as to directly cause the electrical equipment to become a source of ignition.

Classifications of Locations

1. Class I, Division 2

1. The liquids, vapors, or gases will normally be confined within closed containers or closed systems from which they can escape only in case of accidental rupture or breakdown of such containers or systems or in case of abnormal operation of equipment,
2. Flammable liquid-produced vapors or combustible liquid-produced vapors are normally prevented by positive mechanical ventilation and which might become hazardous through failure or abnormal operation of the ventilating equipment,
3. Flammable gases, flammable liquid-produced vapors, or combustible liquid-produced vapors above their flash point might occasionally be communicated unless such communication is prevented by adequate positive-pressure ventilation from a source of clean air and effective safeguards against ventilation failure are provided.

C. Class II Locations. Are those that are hazardous because of the presence of combustible dust.

1. Class II, Division 1

- 1.** In which combustible dust is in the air under normal operating conditions in quantities sufficient to produce explosive or ignitable mixtures, or
- 2.** Where mechanical failure or abnormal operation of machinery or equipment might cause such explosive or ignitable mixtures to produced,
- 3.** In which Group E combustible dusts may be presents in quantities sufficient to be hazardous.

2. Class II, Division 2

1. In which combustible dust due to abnormal operations may be present in the air in quantities sufficient to produced explosive or ignitable mixtures, or
2. Where combustible dust accumulations are present but are normally insufficient to interfere with the normal operation of electrical equipment or other apparatus, but could as a result of infrequent malfunctioning of handling or processing equipment become suspended in the air, or
3. In which combustible dust accumulations on, in, or in the vicinity of the electrical equipment could be sufficient to interfere with the safe dissipation of heat from electrical equipment, or could be ignitable by abnormal operation or failure electrical equipment.

Classifications of Locations

D. Class III Locations. Are those that are hazardous because of the presence of easily ignitable fibers or where materials producing combustible flyings are handled, manufactured, or used, but in which such fibers/flyings are not likely to be in suspension in the air in quantities sufficient to produce ignitable mixtures.

1. Class III, Division 1. a location in which easily ignitable fibers/fittings are handled, manufactured, or used.

2. Class III, Division 2. a location which is easily ignitable fibers/flyings are stored or handled other than in the process of manufacture.

Material Groups. For purposes of testing, approval, and area classification, various air mixtures shall be grouped.

**Class I Group
Classifications**

Group A. Acetylene

Group B. Hydrogen

Group C. Ethylene

Group D. Propane

Class I Group Classifications

Group E. Zirconium, Thorium,
and Uranium Dusts

Group F. Carbonaceous
dusts

Group G. Flour, grain, wood,
plastic, and chemicals

Protection Techniques

- A. Explosionproof Equipment**
- B. Dust Ignitionproof**
- C. Dusttight**
- D. Purged and Pressurized**
- E. Intrinsic Safety**
- F. Nonincendive Circuit**
- G. Nonincendive Equipment**
- H. Nonincendive Component**

I. Oil Immersion

J. Hermetically Sealed

K. Combustible Gas Detection System

- 1. Inadequate Ventilation**
- 2. Interior of a Building**
- 3. Interior of a Control Panel**

L. Other Protection Techniques

Equipment

A. Suitability

1. Equipment listing or labeling
2. Evidence of equipment evaluation from a qualified testing laboratory or inspection agency concerned with product evaluation

B. Approval for Class and Properties

1. Equipment shall be identified not only for the class of location but also for the explosive, combustible, or ignitable properties of the specific gas, vapor, dust, or fiber/flyings that will be present.
2. Equipment that has been identified for a Division 1 location shall be permitted in a Division 2 location of the same class, group, and temperature class and shall comply with (a) or (b) as applicable

B. Approval for Class and Properties

3. General-purpose equipment or equipment in general-purpose enclosures shall be permitted to be installed in Division 2 locations if the equipment does not constitute a source of ignition under normal operating procedure.
4. Equipment that depends on a single compression seal, diaphragm, or tube to prevent flammable or combustible fluids from entering the equipment shall be identified for a Class 1, Division 2 location even if installed in an unclassified location.

B. Approval for Class and Properties

5. Unless otherwise specified, normal operating conditions for motors shall be assumed to be rated full-load steady conditions.
6. Where flammable gases, flammable liquid-produced vapors, combustible liquid-produced vapors, or combustible dusts are or may be present at the same time, the simultaneous presence of both shall be considered when determining the safe operating temperature of the electrical equipment.

Marking. Equipment shall be marked to show the environment for which it has been evaluated.

1. Class
2. Division
3. Material Classification Group
4. Equipment Temperature
5. Ambient Temperature Range
6. Special Allowances


Table 5.0.1.8(C) Classification of Maximum Surface Temperature

Maximum Temperature °C	Temperature Class (T Code)
450	T1
300	T2
280	T2A
260	T2B
230	T2C
215	T2D
200	T3
180	T3A
165	T3B
160	T3C
135	T4
120	T4A
100	T5
85	T6

D. Temperature


Class I Temperature. Shall not exceed the autoignition temperature of the specific gas or vapor to be encountered.

Class II Temperature. Shall be less than the ignition temperature of the specific dust to be encountered. For organic dusts that may dehydrate or carbonize, the temperature marking shall not exceed the lower of either the ignition temperature or 165 degree Celsius.



E. Threading. The supply connection entry thread form shall be made wrenchtight to prevent sparking when fault current flows through the conduit system, and to ensure the explosion-proof integrity of the conduit system where applicable.

1. Equipment Provided with Threaded Entries for NPT-Threaded Conduit or Fittings
2. Equipment Provided With Threaded Entries for Metric-Threaded Fittings
3. Unused Openings



F. Optical Fiber Cables. An optical fiber cable, with or without current-carrying conductors, shall be installed to address the associated fire hazard and sealed to address the associated explosion hazard.

Specific Occupancies. Cover garages, aircraft hangars, motor fuel dispensing facilities, bulk storage plants, spray application, dipping and coating processes, and health care facilities.

Class I Location

Scope

Covers the requirements for electrical and electronic equipment and wiring for voltages Class I, Division 1 and 2 locations where fire or explosion hazards may exist due to flammable gases or vapors or flammable liquids.

Wiring Methods: Class I Division 1

General

a. Threaded rigid metal conduit or threaded steel intermediate metal conduit.

Exception: Type PVC conduit, Type RTRC conduit, and Type HDPE conduit shall be permitted where encased in a concrete envelope a minimum of 50 mm thick and provided with not less than 600 mm of cover measured from the top of the conduit to grade.

b. Type MI cable shall be installed and supported in a manner to avoid tensile stress at the termination fittings.

c. Type MC-HL cable listed for use in Class I, Zone 1 or Division 1 locations

d. Type ITC-HL cable listed for use in Class I, Zone 1 or Division 1 locations

e. Optical fiber cable Types OFNP, OFCP, OFNR, OFCR, OFNG, OFCG, OFN, and OFC shall be permitted to be installed in raceways.

2. Flexible Connection.

Where necessary to employ flexible connections

1. Flexible fittings
2. Flexible cord
3. Type TC-ER-HL cable

3. Boxes and Fittings.

For entry into enclosures required to be explosionproof.

Wiring Methods: Class I Division 2

1. General

1. Type RMC and Type IMC with listed threadless fittings
2. Enclosed gasketed busways and enclosed gasketed wireways
3. Type PLTC and Type PLTC-ER cable
4. Type ITC and Type ITC-ER cable
5. Type MC, MV, TC, or TC-ER cable
6. RTRC, factory elbows, and associated fittings
7. Optical fiber cable Types OFNP, OFCP, OFNR, OFCR, OFNG, OFCG, OFN, and OFC shall be permitted to be installed in cable trays.
8. Cable bus

2. Flexible Connections

1. Flexible metal fittings
2. Flexible metal conduit with listed fittings
3. Interlocked armor Type MC cable with listed fittings
4. Liquidtight flexible metal conduit with listed fittings
5. Liquidtight flexible nonmetallic conduit with listed fittings
6. Flexible cord
7. Type EO, Type ETP, or Type ETT

3. Nonincendive Field Wiring

1. In separate cables
2. In multiconductor cables where the conductors of each circuits are within a grounded metal shield
3. In multiconductor cables or raceways, where the conductors of each circuit have insulation with a minimum thickness of 0.25 mm

4. Boxes and Fittings. Shall not be required to be explosionproof except as required by 5.1.3.6 (B)(2), 5.1.3.16 (B)(1), and 5.1.3.51 (B)(1).

Sealing and Drainage: Conduit Seals, Class I, Division 1

1. Entering Enclosures

- The enclosure contains apparatus, such as switches, circuit breakers, fuses, relays, or resistors, that may produce arcs, sparks, or temperatures that exceed 80 percent of the autoignition temperature of the gas or vapor involved in normal operation.
- The entry is metric designator 53 (trade size 2) or larger, and the enclosure contains terminals, splices, or taps.

2. Pressurized Enclosures.

Conduit seals shall be installed within 450 mm of the enclosure in each conduit entry into a pressurized enclosure where the conduit is not pressurized as part of the protection system.

Sealing and Drainage: Conduit Seals, Class I, Division 1

3. Two or More Explosionproof Enclosures. Require conduit seals are connected by nipples or runs of conduit not more than 900 mm long. A single conduit seal in each nipple connection or run of conduit shall be considered sufficient if the seal is located not more than 450 mm from either enclosure.

4. Class I, Division 1 Boundary. The conduit run between the conduit seal and the point at which the conduit leaves the Division 1 location shall contain no union, coupling, box, or other fitting except for a listed explosionproof reducer installed at the conduit seal.

Sealing and Drainage: Conduit Seals, Class I, Division 2

1. Entering Enclosures. For connections to enclosures that are required to be explosionproof, a conduit seal shall be provided in accordance with Conduit Seals, Class I, Division 1, Entering Enclosures (1) and Two or More Explosionproof Enclosures.

2. Class I, Division 2 Boundary. Rigid metal conduit or threaded steel intermediate metal conduit shall be used between the sealing fitting and the point at which the conduit leaves the Division 2 location, and a threaded connection shall be used at the sealing fitting.

Sealing and Drainage: Conduit Seals, Class I, Division 1 and 2

1. Fittings. Sealing fittings shall be listed for use with one or more specific compounds and shall be accessible.

2. Compound. The compound shall provide a seal to minimize the passage of gas and/or vapor through sealing fitting and shall not be affected by the surrounding atmosphere or liquids.

3. Thickness of Compounds. In no case shall the thickness of the compound be less than 16 mm.

4. Splices and Taps

5. Assemblies

6. Conductor or Optical Fiber Fill

Sealing and Drainage: Cable Seals, Class I, Division 1

1. At Terminations. Cables shall be sealed with sealing fittings that comply with (C)Class I, Division 1 and 2 at all terminations.

Exception: Shielded cables and twisted pair cables shall require the removal of the shielding material provided the termination is sealed.

2. Cables Capable of Transmitting Gases or Vapors

Exception: Multiconductor cables with a gas/vaportight continuous sheath capable of transmitting gases or vapors through the cable core shall be permitted.

3. Cables Incapable of Transmitting Gases or Vapors. Each multiconductor cable installed in conduit shall be considered as a single conductor if the cable is incapable of transmitting gases or vapors through the cable core.

Sealing and Drainage: Cable Seals, Class I, Division 2

Exception: Cables with an unbroken gas/vaportight continuous sheath shall be permitted to pass through a Division 2 location without seals.

1. Terminations. Cables entering enclosures that are required to be explosionproof shall be sealed at the point of entrance.

2. Cables That Do Not Transmit Gases or Vapors. Cables that have a gas/vaportight continuous sheath and do not transmit gases or vapors through the cable core in excess of the quantity permitted for seal fittings shall not be required to be sealed.

Sealing and Drainage: Cable Seals, Class I, Division 2

3. Cables Capable of transmitting Gases or Vapors. Cables with a gas/vaportight continuous sheath capable transmitting gases or vapors through the cable core shall not be required to be sealed.

4. Cables Without Gas/Vaportight Sheath. Cables that do not have a gas/vaportight continuous sheath shall be sealed at the boundary of the Division 2 and unclassified location.

Sealing and Drainage: Drainage

1. Control Equipment.

Where there is a probability that liquid or other condensed vapor may be trapped within enclosures for control equipment.

2. Motors and Generators.

Where liquid or condensed vapor may accumulate within motors or generators, joints and conduit systems shall be arranged to minimize the entrance of the liquid.

Grounding and Bonding, Class I, Division 1 and 2.

A. Bonding. The locknut-bushing and double-locknut types of contacts shall not be depended on for bonding purposes, but bonding jumpers with proper fittings or other approved means of bonding shall be used.

B. Types of Equipment Grounding Conductors. Flexible metal conduit and liquidtight flexible metal conduit shall include an equipment bonding jumper of the wire type.

Surge Protections

A. Class I, Division 1.

Surge arresters, surge-protective devices, and capacitor shall be installed in enclosures. Surge-protective capacitors shall be of a type designed for specific duty.

B. Class I, Division 2.

Surge arresters and surge-protective devices shall be nonarcing, such as metal-oxide varistor (MOV) sealed type. Surge-protective capacitors shall be of a type designed for specific duty. Enclosures shall be permitted to be of the general-purpose type.

Transformers and Capacitors

Class I, Division 1

1. Containing Liquid That Will Burn

- There shall be no door or other communicating opening between the vault and Division 1 location.
- Ample ventilation shall be provided for the continuous removal of flammable gases or vapors
- Vent openings or ducts shall lead to a safe location outside of buildings
- Vent ducts and openings shall be of sufficient area to relieve explosion pressure within the vault, and all portions of vent ducts within the building shall be reinforced concrete construction.

2. Not Containing Liquid That Will Burn

Class I, Division 2. In Class I, Division 2 locations, transformers shall comply with 4.50.2.1 through 4.50.2.7, and capacitors shall comply with 4.60.1.2 through 4.60.2.5.

Meters, Instrument, and Relays

A. Class I, Division 1

Meters, instruments, and relays, including kilowatt-hour meters, instrument transformers, resistors, rectifiers, and thermionic tubes, shall be provided with enclosures.

B. Class I, Division 2

1. General-Purpose Assemblies
2. Contacts
3. Resistors and Similar Equipment
4. Without Make-or-Break Contacts
5. Fuses
6. Connections

Switches, Circuit Breakers, Motor Controllers, Fuses

A. Class I, Division 1.

Switches, circuit breakers, motor controllers, and fuses, including pushbuttons, relays, and similar devices, shall be provided with enclosures.

B. Class I, Division 2

1. Type Required

2. Isolating Switches

3. Fuses

4. Fuses Internal to Luminaires.

Listed cartridge fuses shall be permitted as supplementary protection within luminaires.

Utilization Equipment

Class I, Division 1

All utilization equipment shall be identified for Class I, Division 1 locations.

B. Class I, Division 2

1. Heaters
2. Motors
3. Switches, Circuit Breakers, and Fuses

Flexible Cords, Class I, Division 1 and 2

A. Permitted Uses

1. The flexible cord shall be attached to the utilization equipment with a cord connector listed for the protection technique of the equipment wiring compartment.
2. The flexible cord is protected by location or by a suitable guard from damage.
3. The extension of the flexible cord within a suitable raceway between the wet-pit and the power source shall be permitted.
4. For electric mixers intended for travel into and out of open-type mixing tanks or vats.
5. For temporary portable assemblies consisting of receptacles, switches, and other devices that are not considered portable utilization equipment but are individually listed for the location.

Flexible Cords, Class I, Division 1 and 2

B. Installation

1. Be of a type listed for extra-hard usage
2. Contain, in addition to the conductors of the circuit, an equipment grounding conductor complying with 4.0.2.4
3. Be supported by clamps or by other suitable means in such a manner that there is no tension on the terminal connections.
4. Boxes, fittings, or enclosures are required to be explosionproof, the cord shall be terminated with a cord connector or attachment plug listed for the location.
5. Be of continuous length. Cords shall be of continuous length from the power source to the temporary portable assembly and from the temporary portable assembly to the utilization equipment.

Signaling, Alarm, Remote-Control, and Communications Systems

A. Class I, Division 1. All apparatus and equipment of signaling, alarm, remote-control, and communication systems, regardless of voltage, shall be identified for Class I, Division 1 location.

B. Class I, Division 2

1. Contacts

1. Immersed in oil
2. Enclosed within a chamber hermetically sealed against the entrance of gases or vapors
3. In nonincendive circuits
4. Part of a listed nonincendive component

2. Resistors and Similar Equipment

3. Protectors. Enclosures shall be provided for lightning protective devices and for fuses.

4. Wiring and Sealing

Class II Locations

Scope

Article 5.2 Covers the requirements for electrical and electronic equipment and wiring for all voltages in class II, division 1 and 2 locations where fire or explosion hazards may exist due to combustible dust.

Explosionproof Equipment. Explosionproof equipment and wiring shall not be required and shall not be acceptable in class II locations unless also identified for such locations.


Zone Equipment. Equipment listed and for zone twenty locations shall be permitted in class II division, 1 locations for same dust atmosphere; and with a suitable temperature class.

Wiring methods

General. In class II division 1 locations, the wiring method from 1 through 5 shall be permitted

- Threaded rigid metal conduit, or threaded steel intermediate metal conduit.
- Type MI cable with termination fittings listed for the location.

- In industrial establishments with limited public access, where the conditions of maintenance and supervision ensure that only qualified persons service installation, Type MC-HL cable, listed for use in class II division 1 locations, with gas/vaportight continuous corrugated metallic sheath, an overall jacket of suitable polymeric material, a separate equipment grounding conductors in accordance with 2.50.6.13 and provided with termination fittings listed for the locations, shall be permitted.
- Optical fiber cable types OFNP, OFCP, OFNR, OFCR, OFNG, OFCG, OFN, and OFC shall be permitted to be installed in raceways in accordance with 5.2.2.1 (A) optical fiber cables shall be sealed in accordance with 5.2.2.6.



In industrial establishment with restricted public access, where the conditions of maintenance and supervisions ensure that only qualified person service installation, listed that type ITC-HL cable with a gas/vaportight continuous corrugated metallic sheath and overall jacket of suitable polymeric materials, and terminated with fittings listed for the application , and installed in accordance with provisions of article 7.27.

2. Flexible Connections

- Dusttight flexible connectors
- Liquidtight flexible metal conduit with listed fittings
- Liquidtight flexible nonmetallic conduit with listed fittings
- Interlocked armor type MC cable having and overall jacket of suitable polymeric material and provided with termination fittings listed for class II, division 1 locations
- Flexible cord listed for extra-hard usage and terminated with listed dusttight cords connectors. Where flexible cord are used, shall comply with 5.2.3.41
- For evaluator used, identified elevator cable of type EO,ETP or ETT, shown under the “use” column in table 400.4 for “hazardous (classified) locations” and terminated with listed dusttight fittings.

3.Boxes and Fittings.

Shall be provided with threaded bosses for connection to conduit or cable terminations and shall be dusttight.

(B) Class II, division 2

General. All wiring methods permitted in 5.3.2.1

- Rigid metal conduit, electric metallic tubing , dusttight wireways
- Type MI cable with listed termination fittings.

- Type PLTC and type PLTC-ER cable in accordance the provisions of article 7.25,including the installation in cable tray system. The cable shall be terminated with listed fittings
- Type ITC and type ITC-ER cable permitted in 7.27.1.4 and terminated with listed fittings.
- Type MC, MI, MV, TC,or TC-ER cable installed in ladder, ventilated trough, or ventilated channel cable trays in a single layer, with a space not less than the larger cable diameter between the 2 adjacent cables, shall be the wiring method employed.

- In industrial establishment with restricted public access where the conditions of the maintenance and supervision ensure that only qualified persons service the installation and where metallic conduit does not provide sufficient corrosion resistance, reinforced thermosetting resin conduit or (RTRC) factory elbows, and associated fittings, all marked with suffix -XW, and schedule 80 PVC conduit, factory elbows and associated fittings shall be permitted.
- Optical fiber cable types OFNP, OFCP, OFNR, OFCR, OFNG, OFCG, OFN and OFC shall be permitted to be installed in cable trays or any other raysways in accordance with 5.2.2.1.
- Cablebus

Flexible connections. Where provisions must be made for flexibility 5.2.2.1 (A) (2) shall apply.

Boxes and fittings. All boxes and fittings shall be dusttight.

Nonincendive Field Wiring

- In separate cables,
- In multiconductor cables where the conductors of each circuits with in a grounded metal shield,
- In muticonductor cables or in raceways where the conductor of each circuit have insulation with a minimum thickness of 0.25mm.

Sealing, Class II Division 1 and 2

- A permanent and effective seal
- A horizontal raceway not less than 3 000 mm long
- A vertical raceway not less than 1 500 mm long and extending downward from the dust-ignitionproof enclosure.

A raceway installed in manner equivalent to (2) or (3) that extends only horizontally and downward from the dust-ignitionproof enclosures.

Uninsulated Exposed parts, Class II Divisions 1 and 2

There shall be no uninsulated exposed parts, such as electrical conductors, busses, terminals, or components, that operate more than 30 volts (15 volts in wet locations).

5.2.2.21 Grounding and Bonding, Class II, Divisions 1 and 2

Regardless of the voltage of the electrical system, wiring and equipment shall be grounded as specified in article 2.50 and in accordance with the requirements of 5.2.2.21 (A) and (B).

A. Bonding. The locknut-bushing and double locknut types of contact shall not be depended on for bonding purposes, but bonding jumper with proper fittings or other approved means of bonding shall be used.

B. Types of Equipment Grounding Conductors. Liquidtight flexible metal conduit shall include an equipment bonding jumper of the wire type in compliance with 2.50.5.13.

EXCEPTION:

1. Listed liquidtight flexible metal conduit in 1 800 mm or less in length with fittings listed for grounding is used.
2. Overcurrent protection in the circuit is limited to 10 amperes or less.
3. The load is not power utilization load.

Surge Protection: Class II, Divisions 1 and 2

Surge arrester and surge protective devices installed in a class II, division 1 location shall be in suitable enclosures.

5.2.3.1 Transformer and Capacitors

(A) Class II, Division 1

- Containing Liquid that will burn
- Not containing Liquid that will burn
- Group E- no transistor or capacitor shall be installed

(B) Class II, Division 2

1. Containing Liquid that will burn

2. **Containing Askarel.** Transformer containing askarel and rated in excess of 25 kVA shall be as follows:

- Provided with pressure-relief vents
- Provided with a means for absorbing any gasses generated by arcing inside the case, or the pressure-relief vents shall be connected to a chimney or flue that will carry such gasses outside the building.
- Have an airspace or not less than 150 mm between the transformer cases and any adjacent combustible material.

3. **Dry-type Transformer.** Shall be installed in vaults or shall have their windings and terminal connections enclosed in tight metal housings without ventilating or other openings and shall operate at not over 600 volts, nominal.

Control Transformers and Resistors

(A) Class II, Division 1

(B) Class II, Division 2

1. Switching Mechanisms

(including overcurrent devices) associated with control transformers, solenoids, impedance coils, and resistor shall be provided with enclosure that are dusttight or otherwise identified for locations.

2. Coils and windings. Where not located in the same enclosure with switching machine, control transformers, solenoids, and impedance coils shall be provided with enclosures that are dusttight or otherwise identified for the locations.


3. Resistors. Resistors and resistance devices shall have dust-ignitionproof enclosures that are dusttight or otherwise identified for the locations.

Motors and Generators

(A). Class II, Division 1. In Class II, Division 1 locations, motors, generators, and other rotating electrical machinery shall be in conformance with either the following:


1. Identified for the location
2. Totally enclosed pipe - ventilated


(B). Class II, Division 2. locations, motors, generators, and other rotating electrical equipment shall be totally enclosed non-ventilated, totally enclosed pipe-ventilated, totally enclosed water-air-cooled, totally enclosed fan-cooled or dust-ignitionproof for which maximum full-load external temperature shall be in accordance with 5.0.1.8(D)(2) for normal operation when operating in free air(not dust blanketed)shall have no external openings.



EXCEPTION: If accumulation of nonconductive, nonabrasive dust will be moderate and if machines can be easily reached for routine cleaning and maintenance the following shall be permitted to be installed.

1). Standard open time machine without sliding contacts, centrifugal or other types of switching mechanism (including motor over current overloading and over temperature device), or integral resistance devices






2. *Standard open type-machines with such contacts, switching mechanism, resistance devices enclosed within dusttight housings without ventilating or other openings.*

3. *Self cleaning textile motors of the squirrel-cage type*

4. *Machines with sealed bearings, bearing isolators, and seals*




Ventilating Piping

Ventilating pipes for motors generators or other rotating electrical machinery, or for enclosures for electrical equipment, shall be of metal not less than 0.53 mm in thickness or of equally substantial noncombustible material and shall comply with all of the following:


(1). Lead directly to a source of clean air outside of the buildings.


(2). Be screened at the outer ends to prevent the entrance of small animals or birds.

(3). Be protected against physical damage and against rusting or other corrosive influences.




(A) Class II, Division 1. In class II, Division 1 locations, ventilating pipes, including their connections to motors or to the dust-ignitionproof enclosures for other equipment, shall be dusttight throughout their length. For metal pipes, seams and joints shall comply with one of the following:

- (1). Be riveted and soldered
 - (2). Be bolted and soldered
 - (3). Be welded
 - (4). Be rendered dusttight by some other equally effective means.
- 



(B) Class II, Division 2. In class II, Division 2 locations, ventilating pipes and their connections shall be sufficiently tight to prevent the entrance of appreciable quantities of dust into the ventilated equipment or enclosure and to prevent the escape of sparks, flame, or burning material that might ignite dust accumulations or combustible material in the vicinity. For metal pipes, lock seams and riveted or welded joints shall be permitted; and tight-fitting slip joints shall be permitted where some flexibility is necessary, as at connections to motors.




Luminaries

(A). Class II, Division 1. In class II division 1 locations, luminaires for fixed and portable lighting shall comply with 5.2.3.31 (A)(1) through (A)(4).


1. Marking. Each luminaire shall be identified for the location and shall be clearly marked to indicate the type and maximum wattage of the lamp for which it is designed.

2. Physical Damage. Each luminaire shall be protected against physical damage by a suitable guard or by location.



3. Pendant Luminaires. Pendant luminaires shall be suspended by threaded rigid metal conduit stems, by threaded steel intermediate metal conduit stems, by chains with approved fittings, or by other approved means. For rigid stems longer than 300mm, permanent and effective bracing against lateral displacement shall be provided at a level not more than 300 mm above the lower end of the stem, or flexibility in the form of a fitting or a flexible connector listed for the location shall be provided not more than supporting box or fitting.

4. Supports. Boxes, box assemblies or fittings used for the support of luminaires shall be identified for class II locations.



B. Class II, Division 2. In class 2 division 2 locations, luminaires shall comply with 5.2.31 (B) (1) through (B)(5).

1. Portable Lightning Equipment. shall be identified for the location. They shall be clearly marked to indicate the maximum wattage of lamps for which they are designed.

2. Fixed Lighting. Luminaires for fixed lighting shall be provided with enclosures that are dusttight or otherwise identified for the location. Each luminaire shall be clearly marked to indicate the maximum wattage of the lamp that shall be permitted without exceeding an exposed surface temperature in accordance 5.0.1.8 (D)(2) under normal conditions of use.

3. Physical Damage. Luminaires for fixed lighting shall be protected from physical damage by suitable guards or by locations.

4. Pendant Luminaires. Pendant luminaires shall be suspended by threaded rigid metal conduit stems, by threaded steel intermediate metal conduit stems, by chains with approved fittings, or by other approved means. Flexible cord shall not serve as the supporting means for a luminaire.

5. Electric-Discharge Lamps. Starting and control equipment for electric-discharge lamps, shall comply with the requirements of 5.2.3.21 (B)


Utilization Equipment

A. Class II, Division 1. In class II division 1 locations, all utilization equipment shall be identified for the location.

B. Class II, Division 2. In class II division 2 locations, all utilization equipment shall comply with 5.2.36 (B)(1) through (B)(4).

1. Heaters. Electrically heated utilization equipment shall be identified for the location.

2. Motors. Motors of motor-driven utilization equipment shall comply with 5.2.3.26(B)




3. Switches, Circuits, Breakers, and Fuses.

Enclosures for switches, circuit, breakers, and fuses shall comply with 5.2.3.16(B)

4. Transformers, Solenoids, Impedance coils, and Resistors.

Transformers, solenoids, impedance coils, and resistors shall comply with 5.2.3.21(B).




Flexible Cords – Class II, Division 1 and 2

A. Permitted Uses. Flexible cords used in Class II locations shall comply with all of the following:

1. The flexible cord shall be attached to the utilization equipment with a cord connector listed for the protection technique of the equipment wiring compartment.


2. Where the flexible cord is protected by location or by a suitable guard from damage; and only in an industrial establishment where conditions of maintenance and engineering supervision ensure that only qualified persons install and service the installation.




3. For electric submersible pumps with means for removal without entering the wet-pit. The extension of the flexible cord within a suitable raceway between the wet-pit and the power source shall be permitted.

4. For electric mixers intended for travel into and out of open-type mixing tanks or vats.

5. For temporary portable assemblies connecting of receptacles, switches, and other devices that are not considered portable utilization equipment but are individually listed for the location.






B. Installation. Where flexible cords are used, the cords shall comply with all of the following:


1. Be of a type listed for extra-hard usage.

Exception: Flexible cord listed for hard usage as permitted by 5.2.3.31(A)(3) and (B)(4).

2. Contain, in addition to the conductors of the circuit, an equipment grounding conductor complying with 4.0.2.4.


3. Be supported by clamps or by other suitable means in such a manner that there will be no tension on the terminal connections.





4. In division 1 locations, the cord shall be terminated with a cord connector listed for the location or a listed cord connector installed with a seal listed for the location. In division 2 locations, the cord shall be terminated with a listed dusttight cord connector.

5. Be of continuous length. Where 5.2.3.41(A)(5) is applied, cords shall be continuous length from the power source to the temporary portable assembly and from the temporary portable assembly to the utilization equipment.



Receptacles and Attachment Plugs


A. Class II, Division 1.

1. **Receptacles.** In class II, Division 1 locations, receptacles shall be part of the premises wiring.
2. **Attachment plugs.** Shall be of the type that provides for connections to the equipment grounding conductor of the flexible cord.

Signaling, Alarm, Remote-Control, and Communications Systems; and Meters, Instruments and Relays


A. Class II, Division 1. Locations, signaling, alarm, remote-control, and communications systems and meters, instruments, and relays shall comply with 5.2.3.51(A)(1) through (A)(3)


1. Contacts. Switches, circuit breakers, relays, contactors, fuses and current-breaking contacts for bells, horns, howlers, sirens, and other devices in which sparks or arcs maybe produced shall be provided with enclosures identified for the location.



2. Resistors and Similar Equipment. Resistors , transformer, choke coils, rectifiers, thermionic tubes and other heat-generating equipment shall be provided with enclosures identified for the location.


3. Rotating Machinery. Motors generators, and other rotating electrical machinery shall comply with 5.2.3.26(A).






B. Class II, Division 2. Locations, signaling, alarm, remote-control, and communications systems: and meters, instruments, and relays shall comply with 5.2.3.51 (B)(1) through (B)(4).

1. Contacts. Shall comply with 5.2.3.51 (A)(1) shall be installed in enclosures that are dusttight or otherwise identified for the location.






2. Transformers and Similar Equipment. The windings and terminal connections of transformers, choke coils, and similar equipment shall comply with 5.2.3.21(B)(2).

3. Resistors and similar Equipment. Resistors, resistance devices, thermionic tubes, rectifiers, and similar equipment shall comply with 5.2.3.21(B)(3).

4. Rotating machinery. Motors, generators and other rotating electrical machinery shall comply with 5.2.3.26(B).




Class III Locations


Scope

Article 5.3 covers the equipments for electrical and electronic equipment and wiring for all voltages in Class III, Division 1 and 2 locations where fire or explosion hazards may exist due to ignitable fibers/flyings.

General. Equipment installed in class III locations shall be able to functions at full rating without developing surface temperatures high enough to cause excessive dehydration or gradual carbonization of accumulated fibers/flyings.



Zone Equipment. Equipment listed and marked in accordance with 5.6.1.9 (C)(2) for Zone 20 locations and with a temperature class of not greater than T120°C (for equipment that may be overloaded) or not greater than T165°C (for equipment not subject to overloading) shall be permitted in Class III, Division 1 locations.



Wiring Methods

A. Class III, Division 1.

General. In Class III, Division 1 locations, the wiring method shall be in accordance with (1) through (5).

1. Rigid metal conduit, Type PVC conduit, Type RTRC Conduit, intermediate metal conduit, electrical metallic tubing, dusttight wire ways Type MC or MI cable with listed termination fittings.

2. Type PLTC and Type PLTC-ER cable in accordance with the provisions of article 7.25 including installation in cable tray systems. The cable shall be terminated with listed fittings.

3. Type ITC and Type ITC-ER cable as permitted in 7.27.1.4 and terminated with listed fittings.

A. Class III, Division 1.

4. Type MC, MI, MV, TC, or TC-ER cable installed in ladder, ventilated through, or ventilated channel cable trays in a single layer, with a space not less than the larger cable diameter between the two adjacent cables, shall be the wiring method employed. The cable shall be terminated with listed fittings.

5. Cablebus

A. Class III, Division 1

Flexible Connections. Where necessary to employ flexible connections, one or more of the following shall be permitted:


- dusttight flexible connectors
- Liquidtight flexible metal conduit with listed fittings.
- Liquidtight flexible nonmetallic conduit with listed fittings.

Boxes and Fittings. All boxes and fittings shall be dusttight.

Nonincendive Field Wiring. shall be permitted using any of the wiring methods permitted for unclassified locations. Installed in accordance with the control drawings.


Separate nonincendive field wiring circuits shall be installed in accordance with one of the following:

- In separate cables
- In multiconductor cables where the conductors of each circuit are within a grounded metal shield
- In multiconductor cables where the conductors of each circuit have insulation with a minimum thickness of 0.25mm



B. Class III, Division 2. In class III division 2 locations , the wiring method shall comply with 5.3.2.1(A)

Exception: In sections, compartments, or areas used solely for storage and containing no machinery open wiring on insulators shall be permitted where installed in accordance with Article 3.98.




Uninsulated Exposed Parts: Class III, Divisions 1 and 2

There shall be no uninsulated exposed parts, such as electrical conductors, buses, terminals, or components, that operate at more than 30 volts (15 volts in wet locations). These parts shall additionally be protected by a protection technique according to 5.0.1.7 (E), (F), or (G) that is suitable for the location.


Grounding and Bonding: Class II, Divisions 1 and 2.


Regardless of the voltage of the electrical system, wiring and equipment in class III, Division 1 and 2 locations shall be grounded as specified in article 2.50 and with the following additional requirement in 5.3.2.21(A) and (B).




A. Bonding. The locknut-bushing and double -locknut types of contacts shall not be depended on for bondings purposes, but bonding jumpers with proper fittings or other approved means of bonding shall be used.

B. Types of Equipment Bonding Conductors. Liquidtight flexible metal conduit shall include an equipment bonding jumper of the wire type in compliance with 2.50.5.13.





Exception: In class III, Division 1 and 2 locations the bonding jumper shall be permitted to be deleted where all of the following condition are met:

- *Listed liquidtight flexible metal conduit 1 800 mm or less in length, with fittings listed listed for grounding is used.*
 - *Overcurrent protection in the circuit is limited to 10 amperes or less*
 - *The load is not a power utilization load.*
- 

Equipment

Transformers and Capacitors: Class III, Divisions 1 and 2. Transformers and capacitors shall comply with 5.2.3.1(B).


Switches, circuit breakers, Motor controllers, and fuses: Class III, division I and 2. Switches, Circuit breakers, motor controllers, and fuses, including pushbuttons, relays, and similar devices, shall be provided with the dusttight enclosures.


Control Transformers and Resistors Class III, Divisions 1 and 2. Transformers, Impedance coils, and resistors used as or in conjunction with, control equipment for motors, generator and appliances shall be provides with duattovht enclosures complying with the temperature limitations in 5.3.1.5.

Motors and Generators -Class III, Divisions 1 and 2 Locations

Motors, generators, and other rotating machinery shall be totally enclosed nonventilated, totally enclosed pipe ventilated, or totally enclosed fan cooled.

Exception: In locations where only moderate accumulations of lint or flyings are likely to collect on, in, or in the vicinity of a rotating electrical machine and where such machine is readily accessible for routine cleaning and maintenance, one of the following shall be permitted:

- 
1. Self-cleaning textile motors of the squirrel-cage type.
 2. Standard open-type machines without sliding contacts, centrifugal or other types of switching mechanisms, including motor overload devices.

3. Standard open type machines having such contacts, switching mechanisms, or resistance devices enclosed within tight housings without ventilating or other openings.
- 

Ventilating piping- Class III, Divisions 1 and 2.

Ventilating pipes for motors, generators, or other rotating electrical machinery, or for enclosures for electric equipment, shall be of metal not less than 0.53 mm in the thickness, or of equally substantial noncombustible material, and shall comply with the following:

1. Lead directly to a source of clean air outside of buildings.

2. Be screened at the outer ends to prevent the entrance of small animals or birds.
3. Be protected against physical damage and against rusting or other corrosive influences.

Luminaires: Class III, Divisions 1 and 2

A. Fixed Lighting. Luminaires for fixed lighting shall provide enclosures for lamps and lampholders that are designed to minimize entrance of fibers/flying and to prevent the escape of sparks, burning material, or hot metal.

B. Physical Damage. A luminaire that may be exposed to physical damage shall be protected by a suitable guard.

C. Pendant Luminaires. Pendant luminaires shall be suspended by stems of threaded rigid metal conduit, by threaded intermediate metal conduit, threaded metal tubing of equivalent thickness or by chains with approved fittings.

D. Portable Lighting Equipment. Shall be equipped with handles and protected with substantial guards.

Utilization Equipment: Class III, Divisions 1 and 2

A. Heaters. Electrically heated utilization equipment shall be identified for Class III locations.

B. Motors. Motors of motor-driven utilization equipment shall comply with 5.3.3.26

C. Switches, Circuit Breakers, Motor Controllers, and Fuses. Shall comply with 5.3.3.16.

Flexible Cords: Class III, Divisions 1 and 2

Flexible cords shall comply with the following:

1. Be of a type listed for extra-hard usage
2. Contain, in addition to the conductors of the circuit, an equipment grounding conductor complying with 4.0.2.

3. Other suitable means in such a manner that there will be no tension on the terminal connections.
4. Be terminated with a listed dusttight cord connector.

Receptacles and Attachments Plugs: Class III, Divisions 1 and 2

Shall be grounding type, shall be designed so as to minimize the accumulation or the entry of fibers/flying and shall prevent the escape of spars or molten particles.


Signaling, Alarm, Remote-Control, and Local Loudspeaker intercommunications Systems-Class III, Divisions 1 and 2

Shall comply with the requirements of Article 5.3 regarding wiring methods, switches, transformers, resistors, motors, luminaires, and related components.

Electric Cranes, Hoists, and Similar Equipment: Class III, Divisions 1 and 2

Where installed for operation over combustible fibers or accumulations of flyings, traveling cranes and hoists for material handling, traveling cleaners for textile machinery, and similar equipment shall comply with 5.3.3.56(A) through (D).


A. Power Supply. The power supply to contact conductors shall be electrically isolated from all other systems, underground, and shall be equipped with an acceptable ground detector that gives an alarm and automatically de-energizes the contact conductors in case of fault to ground or gives a visual and audible alarm as long as power is supplied to the contact conductors and the ground fault remains.



B. Contact Conductors. Shall be located or guarded so as to be inaccessible to other than authorized persons and shall be protected against accidental contact with foreign objects.

C. Current Collectors. Shall be arranged or guarded so as to confine normal sparking and prevent escape of sparks or hot particles.

D. Control Equipment. Shall comply with 5.3.3.16 and 5.3.3.21



Storage Battery Charging

Equipment: Class III, Divisions 1 and 2. Shall be located in separate rooms built or lined with substantial noncombustible materials.

Intrinsically Safe System

Scope

This article covers the installation of intrinsically safe(I.S) apparatus, wiring, and systems for Articles 5.0 through 5.16.

Definitions

Different Intrinsically Safe Circuits. In which the possible interconnections have not been evaluated and identified as intrinsically safe.

Definitions

Intrinsically Safe Circuit [as applied to Hazardous (Classified) Locations]. A circuit in which any sparks or thermal effect is incapable of causing ignition of a mixture of flammable or combustible material in air under-prescribed test conditions.

Intrinsically Safe Condition. An assembly of interconnected intrinsically safe apparatus, associated apparatus? And interconnecting cables, in that those parts of the systems that may be used in hazardous (classified) locations are intrinsically safe circuits.


Equipment

All intrinsically safe apparatus and associated apparatus shall be listed.

Equipment Installation


A. Control Drawing. Intrinsically safe apparatus, associated apparatus, and other equipment shall be installed in accordance with the control drawings.

B. Location. Intrinsically safe apparatus shall be permitted to be installed in any hazardous (classified) location for which it has been identified.



C. Enclosures. General-purpose enclosure shall be permitted for intrinsically safe apparatus and associated apparatus unless otherwise specified in the manufacturer's documentation.

D. Simple Apparatus. Shall be permitted to be installed in any hazardous(classified) location in which the maximum surface temperature of the simple apparatus does not exceed the ignition temperature of the flammable gases or vapors, flammable liquids, combustible dusts, or ignitable fibers/flyings present.



Wiring Method

Any of the wiring methods suitable for unclassified locations, including those covered by Chapter 7 and 8, shall be permitted for installing intrinsically safe apparatus.

Separation of Intrinsically Safe Conductors

A. From Nonintrinsically Safe Circuit Conductors

1. In raceways, Cable Trays and Cables.

Conductors of intrinsically safe circuits shall not be placed in any raceways, cable tray, or cable with conductors of any nonintrinsically safe circuit.

2. Within Enclosures. Conductors of intrinsically safe circuit shall be secured so that any conductor that might come loose from a terminal is unlikely to come into contact with another terminal.

The conductors shall be separated from conductors of nonintrinsically safe circuits by one of the methods in (1) through (4).

1. Separation by at least 50 mm from conductors of any nonintrinsically safe circuits.

2. Separation from conductors of nonintrinsically safe circuits by use of a grounded metal partition 0.91 mm or thicker.

3. Separation from conductors of nonintrinsically safe circuits by use of an approved insulating partition that extends to within 1.5mm of the enclosure walls.

4. Where either (1) all of the intrinsically safe circuit conductors or (2) all of the nonintrinsically safe circuit conductors are in grounded metal-sheathed or metal-clad cables where the sheathing or cladding is capable of carrying fault current to ground.

Separation of Intrinsically Safe Conductors

3. Other (Not in Raceway or Cable Tray Systems). Conductors and cable of intrinsically safe circuits run in the other than raceway or cable tray system shall be separated by at least 50 mm and secured from conductors and cable of any nonintrinsically safe circuits.

B. From Different Intrinsically Safe Circuit Conductors. The clearance between two terminals for connection of field wiring of different intrinsically safe circuits shall at least 6 mm, unless this clearance is permitted to be reduced by the control drawing.

Separation of Intrinsically Safe Conductors

Different intrinsically safe circuits shall be separated from each other by one of the following means:

1. The conductors of each circuit are within a grounded metal shield.
2. The conductors of each circuit have insulation with a minimum thickness of 0.25 mm.

C. From Grounded Metal. The clearance between the uninsulated parts of field wiring conductors connected to terminals and grounded metal or other conducting parts shall be at least 3 mm.

Grounding

A. Intrinsically Safe Apparatus, Enclosures, and Raceways. If of metal, shall be connected to the equipment grounding conductor.

B. Associated Apparatus and Cable Shields. Shall be grounded in accordance with the required control.

C. Connection to Grounding Electrodes. Where connection to a grounding electrode is required, the grounding electrode shall be as specified in 2.50.3.3(A)(1), (A)(2), (A)(3), and (A)(4) and shall comply with 2.50.2.11(A)(4). Sections 2.50.3.3(A)(5), (A)(7), and (A)(8) shall not be used if any of the electrodes specified in 2.50.3.3 (A)(1), (A)(2),(A)(3), or (A)(4) are present.

Bonding

A. Intrinsically Safe

Apparatus. Intrinsically safe apparatus, if of metal, shall be bonded in the hazardous (classified) location in accordance with 5.1.2.26(A), 5.2.2.26(A), 5.5.1.26 or 5.6.1.25.

B. Metal Raceways. Where metal raceways are used for intrinsically safe system wiring, bonding at all ends of the raceways.

Sealing

Conduits and cables that are required to be sealed by 5.1.2.6, 5.5.1.16, and 5.6.1.16 shall be sealed to minimize the passage of gases, vapors, or dusts.

Identification

Labels required by this section shall be suitable for the environment where they are installed with consideration given to exposure to chemicals and sunlight.

Identification

A. Terminals. Intrinsically safe circuits shall be identified at terminal and junction locations in a manner that is intended to prevent unintentional interference with the circuits during testing and servicing.

B. Wiring. Raceways, cable trays, and other wiring methods for intrinsically safe system wiring shall be identified with permanently affixed labels with the wording “ Intrinsic Safety Wiring” or equivalent.

C. Color Coding. Shall be permitted to identify intrinsically safe conductors where they are colored light blue and where no other conductors colored light blue are used.

Zone 0,1, and 2 Locations

Scope

This article covers the requirements for the zone classification system as an alternative to the division classification system covered in Article 5.0 for electrical and electronic equipment and wiring for all voltages in Class I, Zone 0, Zone 1, and Zone 2 hazardous (classified) locations where fire or explosion hazards may exist due to flammable gases, vapors, or liquids.

Definitions

Encapsulation “m”. Type of protection where electrical parts that could ignite an explosive atmosphere by either sparking or heating are enclosed in a compound in such a way that this explosive atmosphere cannot be ignited.

Definitions

Flameproof "d". Type of protection where the enclosed will withstand an internal explosion of a flammable mixture that has penetrated into the interior, without suffering damage and without causing ignition, through any joints or structural openings in the enclosure, of an external explosive gas atmosphere consisting of one or more of the gases or vapors for which it is designed.

Increased Safety "e". Type of protection applied to electrical equipment that does not produce arcs or sparks in normal service and under specified abnormal conditions, in which additional measures are applied so as to give increased security against possibility of excessive temperatures and of the occurrence of arcs and sparks.

Definitions

Intrinsic Safety "I". Type of protection where any spark or thermal effect is incapable of causing ignition of a mixture of flammable or combustible material in air under prescribed test conditions.

Oil Immersion "o". Type of protection where electrical equipment is immersed in a protective liquid in such a way that an explosive atmosphere that may be above the liquid or outside the enclosure cannot be ignited.

Definitions

Powder Filling “q”. Type of protection where electrical parts capable of igniting and explosive atmosphere are fixed in position and completely surrounded by filling material (glass or quartz powder) to prevent the ignition of external explosive atmosphere.

Pressurization “p”. Type of protection for electrical equipment that uses the technique of guarding against the ingress of the external atmosphere, which may be explosive, into and enclosure by maintaining a protective gas there in at a pressure above that of the external atmosphere.

Definitions

Type of Protection "n". Type of protection where electrical equipment, in normal operation, is not capable of igniting a surrounding explosive gas atmosphere and a fault capable of causing ignition is not likely to occur.

General

A. Documentation for Industrial Occupancies. All areas in industrial occupancies designated as hazardous (classified) locations shall be properly documented. This documentation shall be available to those authorized to design, install, inspect, maintain, or operate electrical equipment at the location.

B. Reference Standards. Important information relating to the topics covered in chapter 5 may be found in other publications.

**ZONE 20,21 AND 22 LOCATIONS
FOR COMBUSTIBLE DUSTS OR
IGNITIBLE FIBERS/FLYINGS**

ZONE 20,21 AND 22 LOCATIONS FOR COMBUSTIBLE DUSTS OR IGNITIBLE FIBERS/FLYINGS

Scope

This article covers the requirements for the zone classification system as an alternative to the division classification system covered in Article 5.0, 5.2 and 5.3 for electrical and electronic equipment and wiring for all voltages in Zone 20, 21 and 22 hazardous (classified) locations where fire and explosion hazards may exist due to combustible dusts or ignitable fibers/flyings.

Definitions

Protection by Encapsulation “m”.

Type of protection where electrical parts that could cause ignition of a mixture of combustible dust or fibers/flyings in air are protected by enclosing them in a compound in such a way that the explosive atmosphere cannot be ignited.

Protection by Enclosure “t”. Type of protection for explosive dust atmospheres where electrical apparatus is provided with an enclosure providing dust ingress protection and a means to limit surface temperatures.

Definitions

Protection by Intrinsic Safety

“i”. Type of protection where any spark or thermal effect is incapable of causing ignition of a mixture of combustible dust, fibers or flyings in air under prescribed test conditions.

Protection by Pressurization “p”.

Type of protection that guards against the ingress of a mixture of combustible dust or fibers/flyings in air into an enclosure containing electrical equipment by providing and maintaining a protective gas atmosphere inside the enclosure at a pressure above that of the external atmosphere.

GENERAL

A. Documentation for Industrial Occupancies. Areas designated as hazardous (classified) locations shall be properly documented. This documentation shall be available to those authorized to design, install, inspect, maintain or operate electrical equipment.

B. Reference Standards. Important information relating to topics in Chapter 5 can be found in other publications.

A. CLASSIFICATION OF LOCATIONS

Location shall be classified on the basis of the properties of the combustible dust or ignitable fibers/flyings that may be present, and the likelihood that a combustible or combustible concentration or quantity is present. Each room, section or area shall be considered individually in determining its classification. Where pyrophoric materials are the only materials used or handled, these locations are outside of the scope of this article.

B. ZONE 20, ZONE 21 AND ZONE 22 LOCATIONS

Are those in which combustible dust or ignitable fibers/flyings are or may be present in the air in layers, in quantities sufficient to produce explosive or ignitable mixtures. Zone 20, 21 and 22 locations shall include those specified in 5.6.1(B)(1), (B)(2) and (B)(3).

ZONE 20

- Ignitable concentrations of combustible dust or ignitable fibers/flyings are present continuously.
- Ignitable concentrations of combustible dust or ignitable fibers/flyings are present for long periods of time.

ZONE 21

- Ignitable concentrations of combustible dust or ignitable fibers/flyings are likely to exist occasionally under normal operating conditions; or
- Ignitable concentrations of combustible dust or ignitable fibers/flyings may exist frequently because of repair or maintenance operations or because of leakage; or
- Equipment is operated or processes are carried on, of such a nature that equipment breakdown or faulty operations could result in the release of ignitable concentrations of combustible dust or ignitable fibers/flyings and also cause simultaneous failure of electrical equipment in a mode to cause the electrical equipment to become a source of ignition.

ZONE 22

- Ignitable concentrations of combustible dust or ignitable fibers/flyings are not likely to occur in normal operation and, if they do occur, will only persist for a short period; or
- Combustible dust or fibers/flyings are handled, processed, or used but in which the dust or fibers/flyings are normally confined within closed containers or closed systems from which they can escape only as a result of the abnormal operation of the equipment with which the dust or fibers/flyings are handled, processed or used.

HAZARDOUS (CLASSIFIED) LOCATIONS - SPECIFIC

Scope

Cover occupancies or parts of occupancies that are or may be hazardous because of atmospheric concentrations of flammable liquids, gases, or vapors or because of deposits or accumulations of materials that may be readily ignitable.

General

The general rules of this code and the provisions of Articles 5.0 through 5.4 shall apply to electrical wiring and equipment in occupancies within the scope of Articles 5.11 through Articles 5.17, except as such rules are modified in Articles 5.11 through 5.17.

COMMERCIAL GARAGES, REPAIR AND STORAGE

Scope

These occupancies shall include locations used for service and repair operations in connection with self-propelled vehicles (including, but not limited to, passenger automobiles, buses, trucks and tractors) in which volatile flammable liquids or flammable gases are used for fuel or power.

Definitions

Major Repair Garage. A building or portion of a building where major repairs, such as engine overhauls, paintings, body and fender work and repairs that require draining of the motor vehicle fuel tank are performed on motor vehicles, including associated floor space used for offices, parking, or showrooms.

Minor Repair Garage. A building or portions of a building used for lubrication, inspection and minor automotive maintenance work, such as engine tune-ups, replacement of parts, fluid changes (e.g., oil, antifreeze, transmission fluid, brake fluid, air conditioning refrigerants), brake system repairs, tire rotation and similar routine maintenance work, including associated floor space used for offices, parking, or showrooms.

AREA CLASIFICACION, GENERAL

Where Class 1 liquids or gaseous fuels are stored, handled or transferred, electrical wiring and electrical utilization equipment shall be designed in accordance with the requirements for Class 1, Division 1 or 2 hazardous (classified) locations as classified in accordance with 5.0.1.5 and 5.0.1.6 in this article. A Class 1 location shall not extend beyond an unpierced wall, roof or other solid partition that has no openings.

A. PARKING GARAGES. Used for parking or storage shall be permitted to be unclassified.

AREA CLASIFICATION, GENERAL

B. REPAIR GARAGES, WITH DISPENSING. Major and minor repair garages that dispense motor fuels into the fuel tanks of vehicles, including flammable liquids having a flash point below 38°C such as gasoline or gaseous fuels such as natural gas, hydrogen or LPG, shall have the dispensing functions and components classified in accordance with Table 5.14.1.3(B)(1) in addition to any classification required by this section. Where Class 1 liquids, other than fuels, are dispensed, the area within 900mm of any fill or dispensing point, extending in all directions, shall be a Class 1, Division 2 locations.

WIRING AND EQUIPMENT IN CLASS 1 LOCATIONS

Wiring Located In Class 1 Locations. Within Class 1 locations as classified in 5.11.1.3, wiring shall conform to applicable provisions of Article 5.1.

Equipment Located In Class 1 Locations. Within Class 1 locations as defined in 5.11.1.3, equipment shall conform to applicable provisions of article 5.1.

SPECIAL EQUIPMENT

A. Battery Charging Equipment.

Battery chargers and their control equipment, and batteries being charged, shall not be located within locations classified in 5.11.1.3.

B. Electric Vehicle Charging Equipment.

1. General. All electrical equipment and wiring shall be installed in accordance with Article 6.25, except as noted in 5.11.1.10(B)(2) and (B)(3). Flexible cord shall be of a type identified for extra-hard usage.

2. Connector Locations. No connector shall be located within a Class 1 locations as defined in 5.11.1.3.

GROUND FAULT CIRCUIT INTERRUPTER (GFCI) PROTECTION FOR PERSONNEL

All 125-volt and 250-volt, single phase, 15-20-ampere receptacles installed in areas where electrical diagnostic equipment, electrical hand tools, or portable lighting equipment are to be used shall have ground fault circuit interrupter protection for personnel.

AIRCRAFT HANGARS

Scope

This Article shall apply to buildings or structures in any part of which aircraft containing Class 1 (flammable) liquids or Class 2 (combustible) liquids whose temperatures are above their flash points are housed or stored and in which aircraft might undergo service, repairs or alterations. It shall not apply to locations used exclusively for aircraft that have never contained fuel or unfueled aircraft.

Definitions

Aircraft Painting Hangar. An aircraft hangar constructed for the express purpose of spray/coating/dipping applications and provided with dedicated ventilation supply and exhaust.

CLASSIFICATION OF LOCATIONS

A. Below Floor Level. Any pit or depression below the level of the hangar floor shall be classified as a Class 1, Division 1 or Zone 1 location that shall extend up to said floor level.

B. Areas Not Cut Off or Ventilated. The entire area of the hangar, including any adjacent and communicating areas not suitably cut off from the hangar, shall be classified as Class 1, Division 2 or Zone 2 location up to a level 450mm above the floor.

WIRING AND EQUIPMENT IN CLASS 1 LOCATIONS

General

All wiring and equipment that is or may be installed or operated within any of the Class 1 locations defined in 5.13.1.3 shall comply with the applicable provisions of Article 5.1 or Article 5.5 for the division or zone in which they are used.

WIRING AND EQUIPMENT NOT INSTALLED IN CLASS 1 LOCATIONS

A. Fixed Wiring. All fixed wiring in a hangar but not installed in a Class 1 location as classified in 5.13.3 shall be installed in metal raceway or shall be type MI, TC, or MC cable.

B. Pendants. For pendants, flexible cord suitable for the type of service and identified for hard usage or extra-hard usage shall be used. Each such cord shall include a separate equipment grounding conductor.

WIRING AND EQUIPMENT NOT INSTALLED IN CLASS 1 LOCATIONS

C. Arcing Equipment. In locations above those described in 5.13.1.3, equipment that is less than 3000mm above wings and engines enclosures of aircraft and that may produce arcs, sparks or particles of hot metal, such as lamps and lamp holders for fixed lighting, cutouts, switches, receptacles, charging panels, generators, motors or other equipment having make and break or sliding contacts shall be of the totally enclosed type or constructed so as to prevent the escape of sparks or hot metal particles.

**WIRING AND EQUIPMENT NOT INSTALLED IN CLASS 1
LOCATIONS**

**WARNING!!!!!!!
KEEP 1.5 METERS CLEAR OF AIRCRAFT
ENGINES AND FUEL TANK AREAS**



MOTOR FUEL DISPENSING FACILITIES

DEFINITION

Motor Fuel Dispensing facility

The portion of property where motor fuels are stored and dispensed from a fixed equipment into the fuel tanks of motor vehicles or marine craft or into approved containers, including all equipment used in connection therewith.

CLASSIFICATION OF LOCATIONS

TYPES

- Unclassified Locations

Where it can be satisfactorily determine that flammable liquids having a flash point below 38°C, such as gasoline will not be handled, such location shall not be required to be classified.

- Classified Locations

(1) Class 1 locations

(2) Compressed Natural Gas, Liquefied Natural Gas, & Liquefied Petroleum Gas Areas

(3) Fuel Storage

(1) CLASS 1 LOCATIONS

Class 1 Locations shall be applied where Class 1 liquids are stored, handled, or dispensed and shall be used to delineate and classify motor fuel dispensing facilities and commercial garages as defined in Article 5.11.

Class 1 location shall not extend beyond an unpierced wall, roof, or other solid partition.

(2) COMPRESSED NATURAL GAS, LIQUEFIED NATURAL GAS, LIQUEFIED PETROLEUM GAS AREAS

The table shall be used to delineate and classify areas where CNG, LNG, compressed or liquefied dispensed as motor vehicle fuels along with Class I or Class II liquids that are also dispensed as motor vehicle fuels.

Where CNG, LNG dispensers are installed beneath a canopy or enclosure, either the canopy or enclosure shall be designed to prevent accumulation or entrapment of ignitable vapors or all electrical equipment installed shall be suitable for Class I, Division 2 hazardous locations.

(2) COMPRESSED NATURAL GAS, LIQUEFIED NATURAL LIQUEFIED PETROLEUM GAS AREAS

Dispensing devices for LP-Gas shall be located as follows:

1. At least 3000 mm from any dispensing devices for Class I liquids.
2. At least 1500 mm from any dispensing devices for Class I liquids where the ff. conditions exist:
 - A. The LP-Gas deliver nozzle and filter valve release no more than 4 cm³ of liquid upon disconnection.
 - B. The fixed maximum liquid level gauges remains closed during the entire refueling process.

(3) FUEL STORAGE

- A. Aboveground tanks storing CNG or LNG shall be separated from any adjacent property line that is or can be built upon, any public way, and the nearest important building on the same property. [30A: 12.3.1]
- B. Aboveground tanks storing hydrogen shall be separated from any adjacent property line that is or can be built upon, any public way, and the nearest important building on the same property. [30A: 12.3.2]
- C. Aboveground tanks storing LP-Gas shall be separated from any adjacent property line that is or can be built upon, any public way, and the nearest important building on the same property. [30A: 12.3.3]
- D. Aboveground tanks storing CNG, LNG, or LP-Gas shall be separated from each other by at least 6000 mm and from dispensing devices that dispense liquid or gaseous motor vehicle fuels by at least 6000 mm. [30A: 12.3.3]

(3) FUEL STORAGE

- E. Dispenser Installations Beneath Canopies. Where CNG or LNG dispenser are installed beneath a canopy or enclosure, either the canopy or enclosure shall be designed to prevent accumulation or entrapment of ignitable vapors or all electrical equipment installed beneath shall be suitable for Class I, Division 2 hazardous locations. [30A: 12.5]
- F. Specific Requirements for LP-Gas Dispensing Devices. Dispensing devices for LP-Gas shall be located as follows:
 - At least 3000 mm from any dispensing devices for Class I liquids.
 - At least 1500 mm from any dispensing devices for Class I liquids.

(C) MOTOR FUEL DISPENSING STATION IN BOATYARDS AND MARINAS

1) General. Electrical wiring and equipment located at or serving motor fuel dispensing locations shall be installed on the side of the wharf, pier, or dock opposite from the liquid piping system.

2) Classification of Class I, Division I & 2 Areas.

Closed Construction. Where the construction of floating docks, piers, or wharfs is closed so that there is no space between the bottom of the case of concrete-enclosed expanded foam, and the construction includes integral service.

Space below the surface of the floating docks, pier, or wharf that have areas or enclosure, such as tubs, voids, pits, vaults, boxes, depressions, fuel piping chases, or similar spaces, where flammable liquid or vapor can accumulate shall be a Class I, Division I location.

(C) MOTOR FUEL DISPENSING STATION IN BOATYARDS AND MARINAS

3) Open Construction. Where the construction of piers, wharfs, or docks is open, as in the case of deck built on stringers supported by pilings, floats, pontoons, or similar construction the following shall apply:

- The area 450 mm above the surface of the dock, pier, or wharf and extending 6000 mm horizontally in all directions.
- Enclosures such as tubs, voids, pits, vaults, boxes, depressions, piping chases, or similar spaces where flammable liquids or vapors can accumulate within 6000 mm of the dispenser shall be Class I, Division I locations.

UNDERGROUND WIRING

Underground wiring shall be installed in threaded rigid metal conduit or threaded steel intermediate metal conduit. Any portion of electrical wiring that is below the surface of a Class I, Division I location shall be sealed within 3000 mm of the point of emergence above grade.

Sealing

(a) At Dispenser.

A listed seal shall be provided in each conduit run entering or leaving a dispenser or any cavities in direct communication therewith.

(b) At Boundary.

Additional seals shall be provided in accordance with 5.1.2.6. Section 5.1.2.6(A)(4) and (B)(2) shall apply horizontal as well as to vertical boundaries of the defined Class I Locations.

Circuits Disconnects.

A) Emergency Electrical Disconnects- shall be provided with one or more clearly identified emergency shutoff devices or electrical disconnects.

B) Attended Self-Service Motor Fuel Dispensing Facilities – shall be readily accessible to the attendant.

C) Unattended Self-Service Motor Fuel Dispensing Facilities – shall be readily accessible to patrons and at least one additional device or disconnect shall be readily accessible for each group of dispensing devices on an individual island.

Provisions for Maintenance and Service of Dispensing Equipment

Each dispensing device shall be provided with a means to remove all external voltage sources, including power, communications, data, and video circuits and including feedback, during periods of maintenance and service of the dispensing equipment.

Grounding and Bonding

All metal raceways, metal armor or metallic sheath on cables, and all non-current-carrying metal parts of voltage, shall be grounded and bonded.
Grounding and bonding in Class I shall comply with 5.1.2.21

BULK STORAGE

The background features a light blue gradient. A large, dark blue, angular shape points towards the right, containing the text. Below it, a bright orange horizontal bar is partially visible, also pointing right.

WIRING AND EQUIPMENT ABOVE CLASS I LOCATIONS

a) Fixed Wiring

Shall be in metal raceways, Schedule 80 PVC conduit, Type RTRC marked with the suffix-XW, or Type MI, Type TC, or Type MC cable, or Type PLTC and Type PLTC-ER cable in accordance with the provisions of Article 7.25, including installation in cable tray system as permitted in 7.27.1.4. the cable shall be terminated with listed fittings.

a) Fixed Equipment.

Shall be of the totally enclosed type or be constructed so as to prevent the escape of sparks or hot metal particles.

c) Portable Luminaires or Other Utilization Equipment.

Shall comply with the provisions of Article 5.1 or Article 5. 5 for the Class of Location above which they are connected or used.

UNDERGROUND WIRING

Wiring Method

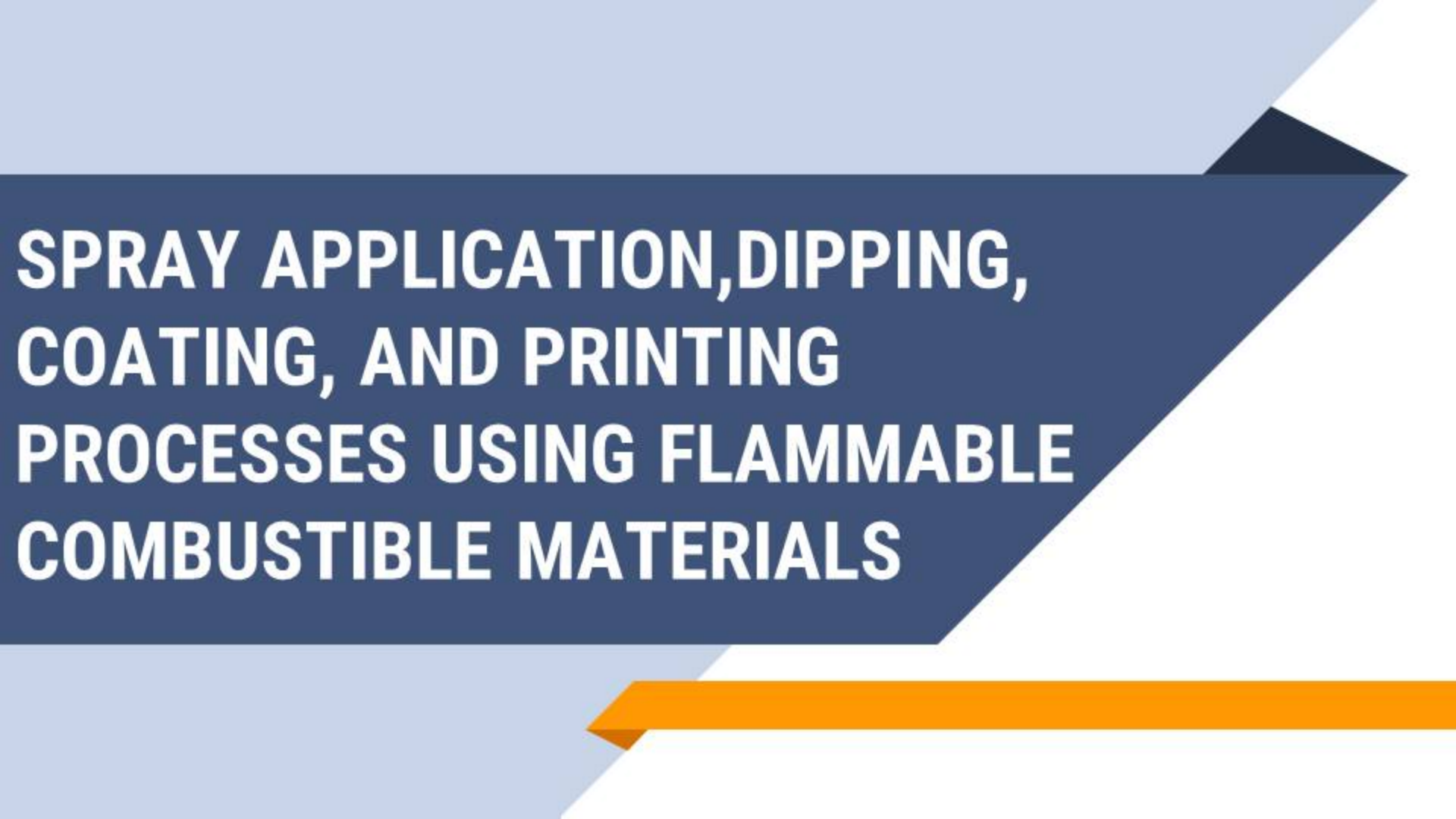
Shall be installed in threaded rigid metal conduit or threaded steel intermediate metal conduit or, where buried under not less than 600 mm of cover shall be permitted in Type PVC conduit, Type RTRC conduit, or listed cable.

Insulation

Conductor Insulation shall comply with 5.1.2.11.

Nonmetallic Wiring

Shall be included to provide for electrical continuity of the raceway system and for grounding of non-current-carrying metal parts



**SPRAY APPLICATION, DIPPING,
COATING, AND PRINTING
PROCESSES USING FLAMMABLE
COMBUSTIBLE MATERIALS**

DEFINITIONS

Limited Finishing Workstation – An apparatus that is capable of confining the vapors, mists, residues, dusts, or deposits that are generated by a spray application process but does not meet the requirements of a spray booth or spray room, as herein defined. [33:3.3.15.1]

Membrane Enclosure – A temporary enclosure used for the spraying of workpieces that cannot be moved into a spray booth where open spraying is not practical due to the proximity to other operations, finish quality, or concerns such as the collection of overspray.

Outdoor Spray Area – A spray area that is outside the confines of a building or that has a canopy or roof that does not limit the dissipation of the heat of a fire or dispersion of flammable vapors and does not restrict fire-fighting access and control.

DEFINITIONS

Spray Area – Any fully enclosed, partly enclosed, or unenclosed area in which dangerous quantities of flammable or combustible vapors, mists, residues, dusts, or deposits are present due to the operation of spray processes.

Spray Booth – A power-ventilated enclosure for a spray application operation or process that confines and limits the escape of the material being sprayed, including vapors, mists, dusts, and residues that are produced by the spraying operation and conducts or directs these materials to an exhaust system. [33:3.3.15]

Spray Room – A power-ventilated fully enclosed room used exclusively for open spraying of flammable or combustible materials. [33.3.3.16]

Unenclosed Spray Area – Any spray area that is not confined by a limited finishing workstation, spray booth, or spray room, as herein defined. [33:3.3.2.3.2]

OPEN CONTAINERS

Area Classification.

For open containers, supply containers, waste containers, spray gun cleaners, and solvent distillation units that contain Class I liquids that are located in ventilated areas.

For the purpose of electrical area classification, the Division system and the Zone system shall not be intermixed for any given source of release. [33:6.2.3]

SPRAY APPLICATION PROCESSES

Area Classification

For a spray application processes, the classification is based on quantities of flammable vapors, combustible mists, residues, dust, or deposits that are present in quantities sufficient to produce ignitable or explosive mixtures with air.

A. Zone Classification of Locations

- Classification of Locations
- Classification System
- Equipment

SPRAY APPLICATION PROCESSES

B. Class I, Division I or Class I, Zone 0 Locations.

The following spaces shall be considered Class I, Division I, or Class I, Zone I as applicable:

- The interior of any open or closed container or vessel of a flammable liquid.
- The interior of any dip tank or coating tank.
- The interior of any ink fountain, ink reservoir, or ink tank.

Wiring and Equipment in Class I Locations

- A. **Vapors.** All electrical wiring and equipment within Class I location defined in 5.16.1.3 shall comply with the applicable provisions of Article 5.1 or Article 5.5, as applicable.
- B. **Vapors and Residues.** Unless specifically listed for locations containing deposits of dangerous quantities of flammable or combustible vapors, mists, residues, or deposits, there shall be no electrical equipment in any spray area.
- C. **Illumination**
- D. **Portable Equipment.** Portable electric luminaires or other utilization equipment shall not be used in any spray area.
- E. **Electrostatic Equipment.** Electrostatic spraying or detearing equipment shall be installed and used only as provided by 5.16.3.6.
- F. **Static Electric Discharges.** All persons and all electrically conductive objects, including any metal parts of the process equipment or apparatus, containers of material, exhaust ducts, and piping systems that convey flammable or combustible liquids, shall be electrically grounded.

WIRING AND EQUIPMENT NOT WITHIN CLASSIFIED LOCATIONS

- A. **Wiring.** All fixed wiring above the Class I and II locations shall be in metal raceways, Type PVC conduit, Type RTRC conduit, or electrical nonmetallic tubing shall only be permitted to supply ceiling outlets or as extensions to the area below the floor of a Class I or II location.
- B. **Equipment.** Equipment that maybe produce arcs, sparks, or particles of hot metal, such as lamps and lampholder for fixed lighting , cutouts, switches, receptacles, motors, or other equipment having make and break contacts, shall be of the totally enclosed type or be constructed so as to prevent the escape of sparks or hot metal particles.

SPECIAL EQUIPMENT

Fixed Electrostatic Equipment.

This section shall apply to any equipment using electrostatically charged elements for the atomization, charging, and/or precipitation of hazardous materials for coatings device for other similar purposes in which charging device is attached to a mechanical support or manipulator.

- Power and Control Equipment
- Electrostatic Equipment
- High-Voltage Leads
- Support of Goods
- Automatic Controls
- Grounding
- Isolations
- Signs
- Insulators
- Other Than Nonincendive Equipment

ELECTRICAL AND OTHER SOURCES OF IGNITION

Electrical wiring and utilization equipment used within the classified areas inside and outside of membrane enclosures during spray painting shall comply with all of the following:

1. All power to the workpiece shall be removed during spray painting.
2. Workpiece shall be grounded.
3. Spray paint equipment shall be grounded.
4. Scaffolding shall be bonded to the workpiece and grounded by an approve method.

PRINTING, DIPPING, AND COATING PROCESSES

Classification of Locations

Classification of based quantities of flammable vapors, combustible, mists, residues, dusts, or deposits that are present or might be present in quantities sufficient to produce ignitable or explosive mixtures with air.

Equipment and Containers in Ventilated Areas

Open containers, supply containers, waste containers, and solvent distillation units that contain Class I liquids shall be located in areas ventilated in accordance with 5.16.4.

Static Electric Discharges

All persons and all electrically conductive objects, including any metal parts of the process equipment or apparatus, containers of material, exhaust ducts, and piping system that convey flammable or combustible liquids, shall be electrically grounded.

HEALTH CARE FACILITIES

The image features a dark blue arrow pointing to the right, which contains the text 'HEALTH CARE FACILITIES'. Below this arrow is a horizontal orange bar. The background consists of light blue and white geometric shapes, including a large white triangle pointing upwards and to the right.

DEFINITIONS

Alternate Power Sources – One or more generator sets, or battery system where permitted, intended to provide power during the interruption of the normal electrical service, or the public utility electrical service intended to provide power during interruption of service normally provided by the generating facilities on the premises.

Ambulatory Health Care Occupancy – An occupancy used to provide services or treatment simultaneously to four or more patients that provides, on an outpatient basis, one or more of the following:

1. Treatment for patients that renders the patients incapable of taking action for self-preservation under emergency conditions without assistance of others.
2. Anesthesia that renders the patients incapable of taking action for self-preservation under emergency conditions without the assistance of others.
3. Emergency or urgent care for patients who, due to the nature of their injury or illness, are incapable of taking action for self-preservation under emergency conditions without the assistance of others.

DEFINITION

Anesthetizing Location – Any area of a facility that has been designated to be used for the administration of any flammable or nonflammable inhalation anesthetic agent in the course of examination or treatment, including the use of such agents for relative analgesia.

Battery-Power Lighting Units – Individual unit equipment for backup illumination consisting of the following:

- Rechargeable battery
- Battery-charging means
- Provision for one or more lamps mounted on the equipment , or with terminals for remote lamps, or both
- Relaying device arranged to energize the lamps automatically upon failure of the supply to the unit equipment

DEFINITION

Critical Branch – A system of feeders and branch circuits supplying power for task illumination, fixed equipment, select receptacle, and select power circuit serving areas and functions related to patient care and that are automatically connected to alternate power sources by one or more transfer switches during interruption of normal power sources.

Electrical Life-Support Equipment – Electrically powered equipment whose continuous operation is necessary to maintain a patient's life

Panelboard Bonding – The equipment grounding terminal buses of the normal and essential branch-circuit panelboards serving the same individual patient care vicinity shall be connected together with an insulated continuous copper conductor not smaller than 5.5 mm² (2.6 mm dia.).

Use of Isolated Ground Receptacles

- Inside of a Patient Care Vicinity
- Outside of a Patient Care Vicinity

Critical Care (Category I) Spaces

- A. Patient Bed Location Branch Circuits
- B. Patient Bed Location Receptacles
 - Minimum Number of Supply
 - Receptacle Requirements
- C. Operating Room Receptacles
- D. Patient Care Vicinity Grounding and Bonding (Optional)
- E. Equipment Grounding and Bonding

- E. Equipment Grounding and Bonding
- F. Additional Protective Techniques in Critical Care (Category I) Spaces (Optional)
- G. Isolated Power System Equipment Grounding
- H. Special-Purpose Receptacle Grounding

Wet Procedure Locations

- A. Receptacle and Fixed Equipment
- B. Isolated Power Systems

Essential Electrical System

The image features a dark blue diagonal banner across the top and middle, containing the text 'Essential Electrical System' in white. Below this banner is a horizontal orange bar. The background consists of light blue and white geometric shapes, including a dark blue triangle pointing right at the top right and a white triangle pointing left at the bottom left.

SOURCES OF POWER

- A. Two Independent Power Sources
- B. Types of Power Sources
 - Generating Units
 - Fuel Cell System
- C. Location of Essential Electrical System Components

REQUIREMENTS FOR THE ESSENTIAL ELECTRICAL SYSTEM

- A. Separate Branches
- B. Transfer Switches
 - 1. Optional Loads
 - 2. Continuous Facilities
- C. Wiring Requirements
 - 1. Separation from Other Circuits
 - 2. Isolated Power Systems
 - 3. Mechanical Protection of the Essential Electrical System
- 4. Capacity of Systems
- D. Receptacle Identification
- E. Feeders from Alternative Power Source
- F. Coordination

LIFE SAFETY BRANCH

- A. Illumination of Means of Egress
- B. Exit Signs
- C. Alarm and Alerting Systems
- D. Communications Systems
- E. Generator Sets Locations
- F. Generator Set Accessories
- G. Elevator
- H. Automatic Doors

Critical Branch

- A. Task Illumination and Selected Receptacles
- B. Switching
- C. Subdivision of the Critical Branch

Equipment Branch Connection to Alternate Power Source

- A. Equipment for Delayed Automatic Connection
- B. Equipment for Delayed Automatic or Manual Connection
- C. AC Equipment for Nondelayed Automatic Connection

Type 2 Essential Electrical Systems for Nursing Homes and Limited Care Facilities

- A. Applicability
- B. Inpatient Hospital Care
- C. Facilities Contiguous or Located on the Same Site with Hospitals

Required Power Sources

- A. Two Independent Power Sources
- B. Types of Power Sources
- C. Location of Essential Electrical System Components

Essential Electrical System

- A. General
- B. Transfer Switches
- C. Capacity of System
- D. Separation from Other Circuits
 - In transfer switches
 - In exit or emergency luminaires supplied from two sources
 - In a common junction box attached to exit or emergency luminaires supplied from two sources
- E. Receptacle Identification

AUTOMATIC CONNECTION TO LIFE SAFETY BRANCH

The life safety branch shall be installed and connected to the alternate sources of power so that all functions specified herein shall be automatically restored to operation within 10 seconds after the interruption of the normal source.

- A. Illumination of Means of Egress
- B. Exit Signs
- C. Alarm and Alerting Systems

- Fire alarms
- Alarms required for systems used for the piping of nonflammable medical gases
- D. Communications System
- E. Dining and Recreation Areas
- F. Generator Set Location
- G. Elevator

ESSENTIAL ELECTRICAL SYSTEM FOR OTHER HEALTH CARE FACILITIES

- A. Essential Electrical Distribution
- B. Electrical Life Support Equipment
- C. Critical Care (Category 1) Patient Care Spaces
- D. General Care (Category 2) Patient Care Spaces
- E. Power Systems

INHALATION ANESTHETIZING LOCATIONS

Anesthetizing Location Classification

- A. Hazardous (Classified) Location
 - Use Location
 - Storage Location
- B. Other-Than-Hazardous (Classified) Location.

INHALATION ANESTHETIZING LOCATIONS

Wiring and Equipment

- A. Within Hazardous (Classified) Anesthetizing Locations
 1. Isolation
 2. Design and Installation
 3. Equipment Operating at More Than 10 Volts
 4. Extent of Location
 5. Receptacle and Attachment Plugs
 6. Flexible Cord Type
 7. Flexible Cord Storage

INHALATION ANESTHETIZING LOCATIONS

Wiring and Equipment

B. Above Hazardous (Classified) Anesthetizing Locations

1. Wiring Methods
2. Equipment Enclosure
3. Luminaires
4. Seals
5. Receptacle and Attachment Plugs
6. 250-Volts Receptacles and

Attachment Plugs Rated 50 and 60 Amperes

C. Other-Than-Hazardous (Classified) Anesthetizing Locations

1. Wiring Methods
2. Receptacles and Attachment Plugs
3. 250-Volts Receptacles and Attachment Plugs Rated 50 Amperes and 60 Amperes

X-Ray Installations

Applicability – Nothing in this part shall be construed as specifying safeguards against the useful beam or stray X-ray radiation.

- FBN No 1: Radiation safety and performance requirements of several classes of X-ray equipment are regular under Public Law 90-602 and are enforced by the Department of Health and Human Service
- FPN No 2: In addition, informing on radiation protection by the National Council on Radiation Protection and Measurement.

Connection to Supply Circuit

- A. Fixed and Stationary Equipment
- B. Portable, Mobile, and Transportable Equipment
- C. Over 1000-Volt Supply

Disconnecting Means

- A. Capacity – At least 50 percent of the input required for momentary rating of 100 percent of long-time rating of the X-ray Equipment.
- B. Location – shall be operable from a location readily accessible from the X-ray control.
- C. Portable Equipment

CONTROL CIRCUIT CONDUCTORS

- A. Number of Conductors in Raceway – the number of control circuit conductors installed in a raceway shall be determined in accordance with 3.0.1.17.
- B. Minimum Size of Conductors- Size of 0.75 mm³ or 1.25 mm² fixture wires as specified in 7.25.2.9 and flexible cords shall be permitted for the control and operating circuits of X-ray and auxiliary equipment where protected by not larger than 20-ampere overcurrent devices.

ISOLATED POWER SYSTEM

A. Installations

1. Isolated Power Circuits
2. Circuit Characteristics
3. Equipment Location
4. Isolation Transformers
 - a) Induction Rooms
 - b) Higher Voltages
5. Conductor Identification
6. Wire-Pulling Compounds

B. Line Isolating Monitor

1. Characteristics
2. Impedance
3. Ammeter

ASSEMBLY OCCUPANCIES

The image features a dark blue, angular shape on the left side, resembling a stylized arrow or a folded piece of paper. The text 'ASSEMBLY OCCUPANCIES' is written in white, bold, uppercase letters within this shape. Below the blue shape, there is a horizontal orange bar that also has a slight 3D effect, suggesting it is a ribbon or a thick line. The background is a light blue gradient.

ASSEMBLY OCCUPANCIES

SCOPE

This article covers all buildings or portions of buildings or structures designed or intended for the gathering together of 100 or more persons for such purposes as deliberation, worship, entertainment, eating, drinking, amusement, awaiting transportation, or similar purposes.

GENERAL CLASSIFICATIONS

A. Examples

Assembly occupancies shall include, but not be limited to, the following:

- Armories
- Assembly halls
- Auditoriums
- Bowling lanes
- Museums
- Courtrooms
- Pool rooms
- Multipurpose rooms
- Places of awaiting transportation
- Places of religious worship
- Dining and drinking
Restaurants facilities
- Exhibition Halls
- Gymnasiums
- Mortuary chapels
- Club rooms
- Conference rooms
- Dance halls
- Skating rinks

GENERAL CLASSIFICATIONS

B.) MULTIPLE OCCUPANCIES

Where an assembly occupancy forms a portion of a building containing other occupancies.

Occupancy of any room or space for assembly purposes by less than 100 persons in a building of other occupancy, and incidental to such other occupancy, shall be classified as part of the other occupancy and subject to the provisions applicable thereto.

GENERAL CLASSIFICATIONS

C.) THEATRICAL AREAS

Where any such building structure, or portion thereof, contains a projection booth or stage platform or area for the presentation of theatrical or musical productions, either fixed or portable, the wiring for that area, including associated audience seating areas, and all equipment that is used in the referenced area, and portable equipment and wiring for use in the production that will not be connected to permanently installed wiring.

OTHER ARTICLES

B.) TEMPORARY WIRING

In exhibition halls used for display booths, as in trade shows, the temporary wiring shall be installed in accordance with Article 5.90. Flexible cables and cords approved for hard or extra hard usage shall be permitted to be laid on floors where protected from contact by the general public.

C.) EMERGENCY SYSTEMS

"CABLE TRAY FOR TEMPORARY WIRING ONLY"

Control of emergency systems shall comply with Article 7.0.

WIRING METHODS

A.) GENERAL

The fixed wiring methods shall be metal raceways, flexible metal raceways, nonmetallic raceways encased in not less than 50 mm of concrete, Type MI, MC, or AC cable containing an insulated equipment grounding conductor sized in accordance with Table 2.50.6.13.

Exception: Fixed wiring methods shall be as provided in

(a) Audio signal processing, amplification, and reproduction equipment – Article 6.40

(b) Communications circuits – Article 8.0

(c) Class 2 and Class 3 remote-control and signaling circuits – Article 7.25

(d) Fire alarm circuits – Article 7.60

WIRING METHODS

B.) NONRATED CONSTRUCTION

In addition to the wiring methods of 5.18.1.4(a), nonmetallic-sheathed cable, Type AC cable, electrical nonmetallic tubing, and rigid nonmetallic conduit shall be permitted to be installed in those buildings or portions thereof that are not required to be of fire-rated construction by the applicable building code.

WIRING METHODS

C.) SPACES WITH FINISH RATING

Electrical nonmetallic tubing and rigid nonmetallic conduit shall be permitted to be installed in club rooms, conference and meeting rooms in hotels or motels, courtrooms, dining facilities, restaurants, mortuary chapels, museums, libraries, and places of religious worship where the following apply:

- 1. The electrical nonmetallic tubing or rigid nonmetallic conduit is installed concealed within walls, floors, and ceilings where the walls, floors, and ceilings provide a thermal barrier of material that has at least a 15-minute finish rating as identified in listings of fire-rated assemblies.*
- 2. The electrical nonmetallic tubing or rigid nonmetallic conduit is installed above suspended ceilings where the suspended ceilings provide a thermal barrier of material that has at least a 15-minute finish rating as identified in listings of fire-rated assemblies.*

SUPPLY

Portable switchboards and portable power distribution equipment shall be supplied only from listed power outlets of sufficient voltage and ampere rating. Such power outlets shall be protected by overcurrent devices. Such overcurrent devices and power outlets shall not be accessible to the general public. Provisions for connection of an equipment grounding conductor shall be provided. The neutral of feeders supplying solid-state, 3-phase, 4-wire dimmer systems shall be considered a current-carrying conductor.

5.20 THEATERS, AUDIENCE AREAS OF MOTION PICTURES AND TELEVISION STUDIOS, PERFORMANCE AREAS, AND SIMILAR LOCATIONS

DEFINITIONS

- **BORDERLIGHT**. *A permanently installed overhead strip light.*
- **BREAKOUT ASSEMBLY**. *An adapter used to connect a multipole connector containing two or more branch circuits to multiple individual branch-circuit connectors.*
- **BUNDLED**. *Cables or conductors that are physically tied, wrapped, taped or otherwise periodically bound together.*
- **CONNECTOR STRIP**. *A metal wireway containing pendant or flush receptacles.*
- **DROP BOX**. *A box containing pendant- or flush-mounted receptacles attached to a multiconductor cable via strain relief or a multipole connector.*
- **FOOTLIGHT**. *A border light installed on or in the stage.*
- **GROUPED**. *Cables or conductors positioned adjacent to one another but not in continuous contact with each other.*

WIRING METHODS

(a) **GENERAL.** The fixed wiring method shall be metal raceways, nonmetallic raceways encased in at least 50 mm of concrete, Type MI cable, MC cable, or AC cable containing an insulated equipment grounding conductor sized in accordance with Table 2.50.6.13.

Exception: Fixed wiring methods shall be as provided in Article 6.40 for audio signal processing, amplification, and reproduction equipment, in Article 8.0 for communication circuits, in Article 7.25 for Class 2 and Class 3 remote-control and signaling circuits, and in Article 7.60 for fire alarm circuits.

Wiring Methods

(b) **PORTABLE EQUIPMENT**. The wiring for portable switchboards, stage set lighting, stage effects, and other wiring not fixed as to location shall be permitted with approved flexible cords and cables as provided elsewhere in Article 5.20. Fastening such cables and cords by uninsulated staples or nailing shall not be permitted.

(c) **NONRATED CONSTRUCTION**. Nonmetallic-sheathed cable, Type AC cable, electrical nonmetallic tubing, and rigid nonmetallic conduit shall be permitted to be installed in those buildings or portions thereof that are not required to be of fire-rated construction by the applicable building code.




NUMBER OF CONDUCTORS IN RACEWAY

The number of conductors permitted in any metal conduit, rigid nonmetallic conduit as permitted in this article, or electrical metallic tubing for border or stage pocket circuits or for remote-control conductors shall not exceed the percentage fill shown in Table 1 of Chapter 9.

ENCLOSING AND GUARDING LIVE PARTS

Live parts shall be enclosed or guarded to prevent accidental contact by persons and objects. All switches shall be of the externally operable type. Dimmers, including rheostats, shall be placed in cases or cabinets that enclose all live parts.



BRANCH CIRCUITS

A branch circuit of any size supplying one or more receptacles shall be permitted to supply stage set lighting. The voltage rating of the receptacles shall not be less than the circuit voltage. Receptacle ampere ratings and branch-circuit conductor ampacity shall not be less than the branch-circuit overcurrent device ampere rating.

PORTABLE EQUIPMENT

Portable stage and studio lighting equipment and portable power distribution equipment shall be permitted for temporary use outdoors, provided the equipment is supervised by licensed electrical practitioner or non licensed electrical practitioner under the supervision of a licensed electrical practitioner while energized and barriered from the general public.

Fixed Stage Switchboards

GENERAL

Fixed stage switchboard shall comply with 5.20.2(1) through (4)

- (1) Fixed stage switchboard shall be listed
- (2) Fixed Stage switch board shall be readily accessible but shall not be required to be located on or adjacent to the stage.
- (3) A fixed stage switchboard shall contain overcurrent protective devices for all branch circuits supplied by that switchboard.
- (4) A fixed stage switchboard shall be permitted to supply both stage and non-stage equipment.

Fixed Stage Switchboards

DIMMERS

DISCONNECTION AND OVERCURRENT PROTECTION

Where dimmers are installed in ungrounded conductors, each dimmer shall have overcurrent protection not greater than 125 percent of the dimmer rating and shall be disconnected from all ungrounded conductors when the master or individual switch or circuit breaker supplying such dimmer is in the open position.

RESISTANCE- OR REACTOR-TYPE DIMMERS

Resistance- or series reactor-type dimmers shall be permitted to be placed in either the grounded or the ungrounded conductor of the circuit. Resistance- or reactor-type dimmers placed in the grounded neutral conductor of the circuit shall not open the circuit.

Fixed Stage Switchboards

DIMMERS

AUTOTRANSFORMER-TYPE DIMMERS

The circuit supplying an autotransformer-type dimmer shall not exceed 250 volts between conductors. The grounded conductor shall be common to the input and output circuits.

SOLID-STATE-TYPE DIMMERS

The circuit supplying a solid-state dimmer shall not exceed 250 volts between conductors unless the dimmer is listed specifically for higher voltage operation. Where a grounded conductor supplies a dimmer, it shall be common to the input and output circuits. Dimmer chassis shall be connected to the equipment grounding conductor.

Fixed Stage Switchboards

TYPE OF SWITCHBOARD

(A) MANUAL. Dimmers and switches are operated by handles mechanically linked to the control devices.

(B) REMOTELY CONTROLLED. Devices are operated electrically from a pilot-type control console or panel. Pilot control panels either shall be part of the switchboard or shall be permitted to be at another location.

(C) INTERMEDIATE. A stage switchboard with circuit interconnections is a secondary switchboard (patch panel) or panelboard remote to the primary stage switchboard. It shall contain overcurrent protection. Where the required branch-circuit overcurrent protection is provided in the dimmer panel, it shall be permitted to be omitted from the intermediate switchboard.

Fixed Stage Equipment Other Than Switchboards

CIRCUIT LOADS

CIRCUITS RATED 20 AMPERES OR LESS

Footlights, border lights, and proscenium sidelights shall be arranged so that no branch circuit supplying such equipment carries a load exceeding 20 amperes.

CIRCUITS RATED GREATER THAN 20 AMPERES

Where only heavy-duty lampholders are used, such circuits shall be permitted to comply with Article 2.10 for circuits supplying heavy-duty lampholders.

Fixed Stage Equipment Other Than Switchboards

CONDUCTOR INSULATION

Foot, border, proscenium, or portable strip lights and connector strips shall be wired with conductors that have insulation suitable for the temperature at which the conductors are operated, but not less than 125°C. The ampacity of the 125°C conductors shall be that of 60°C conductors. All drops from connector strips shall be 90°C wire sized to the ampacity of 60°C cords and cables with no more than 150 mm of conductor extending into the connector strip.

Fixed Stage Equipment Other Than Switchboards

FOOTLIGHTS

METAL TROUGH CONSTRUCTION

Where metal trough construction is employed for footlights, the trough containing the circuit conductors shall be made of sheet metal not lighter than 0.8 mm and treated to prevent oxidation. Lampholder terminals shall be kept at least 12 mm from the metal of the trough. The circuit conductors shall be soldered to the lampholder terminals.

Fixed Stage Equipment Other Than Switchboards

FOOTLIGHTS

OTHER-THAN-METAL TROUGH CONSTRUCTION

Footlights shall consist of individual outlets with lampholders wired with rigid metal conduit, intermediate metal conduit, or flexible metal conduit, Type MC cable, or mineral-insulated, metal-sheathed cable. The circuit conductors shall be soldered to the lampholder terminals.

DISAPPEARING FOOTLIGHTS

Disappearing footlights shall be arranged so that the current supply is automatically disconnected when the footlights are replaced in the storage recesses designed for them.

Fixed Stage Equipment Other Than Switchboards

BORDERS, PROSCENIUM SIDELIGHTS, DROP BOXES, AND CONNECTOR STRIPS

GENERAL

Borders and proscenium sidelights shall be as follows:

- 1) Constructed as specified in 5.20.3.3*
- 2) Suitably stayed and supported*
- 3) Designed so that the flanges of the reflectors or other adequate guards protect the lamps from mechanical damage and from accidental contact with scenery or other combustible material*

Fixed Stage Equipment Other Than Switchboards

BORDERS, PROSCENIUM SIDELIGHTS, DROP BOXES, AND CONNECTOR STRIPS

CORDS AND CABLES FOR BORDER LIGHT GENERAL

Cords and cables for supply to border lights shall be listed for extra-hard usage. The cords and cables shall be suitably supported. Such cords and cables shall be employed only where flexible conductors are necessary. Ampacity of the conductors shall be as provided in 4.0.1.5.

Fixed Stage Equipment Other Than Switchboards

BORDERS, PROSCENIUM SIDELIGHTS, DROP BOXES, AND CONNECTOR STRIPS

CORDS AND CABLES FOR BORDER LIGHT

CORDS AND CABLES NOT IN CONTACT WITH HEAT-PRODUCING EQUIPMENT

Listed multiconductor extra-hard-usage-type cords and cables not in direct contact with equipment containing heat-producing elements shall be permitted to have their ampacity determined by table 5.20.3.4. Maximum load current in any conductor with an ampacity determined by table 5.20.3.4 shall not exceed the values in table 5.20.3.4.

Fixed Stage Equipment Other Than Switchboards

RECEPTACLES

Receptacles for electrical equipment on stages shall be rated in amperes. Conductors supplying receptacles shall be in accordance with Articles 3.10 and 4.0.

CONNECTOR STRIPS, DROP BOXES, FLOOR POCKETS, AND OTHER OUTLET ENCLOSURES

Receptacles for the connection of portable stagelighting equipment shall be pendant or mounted in suitable pockets or enclosures and shall comply with 5.20.3.5. Supply cables for connector strips and drop boxes shall be as specified in 5.20.3.4(b).

Fixed Stage Equipment Other Than Switchboards

BACKSTAGE LAMPS (BARE BULBS)

Lamps (bare bulbs) installed in backstage and ancillary areas where they can come in contact with scenery shall be located and guarded so as to be free from physical damage and shall provide an air space of not less than 50 mm between such lamps and any combustible material.

Exception: Decorative lamps installed in scenery shall not be considered to be backstage lamps for the purpose of this section.

Fixed Stage Equipment Other Than Switchboards

SMOKE VENTILATOR CONTROL

Where stage smoke ventilators are released by an electrical device, the circuit operating the device shall be normally closed and shall be controlled by at least two externally operable switches, one switch being placed at a readily accessible location on stage and the other where designated by the authority having jurisdiction. The device shall be designed for the full voltage of the circuit to which it is connected, no resistance being inserted.

Table 5.20.3.4 Ampacity of Listed Extra-Hard-Usage Cords and Cables with Temperature Ratings of 75°C and 90°C*

[Based on Ambient Temperature of 30°C]

Conductor Size [mm ² (mm dia.)]	Temperature Rating of Cords and Cable		Maximum Rating of Overcurrent Device
	75 ⁰ C	90 ⁰ C	
2.0 (1.6)	24	28	15
3.5 (2.0)	32	35	20
5.5 (2.6)	41	47	25
8.0 (3.2)	57	65	35
14	77	87	45
22	101	114	60
30	133	152	80

*Ampacity shown is the ampacity for multiconductor cords and cables where only three copper conductors are current-carrying. If the number of current-carrying conductors in a cord or cable exceeds three and the load diversity factor is a minimum of 50 percent, the ampacity of each conductor shall be reduced as shown in the following table.

Number of Conductors	Percent of Ampacity
4-6	80
7-24	70
25-42	60
43 and above	50

Ultimate insulation temperature. In no case shall conductors be associated together in such a way with respect to the kind of circuit, the wiring method used, or the number of conductors such that the temperature limit of the conductors will be exceeded.

Portable Switchboards on Stage

ROAD SHOW CONNECTION PANEL (A TYPE OF PATCH PANEL)

A panel designed to allow for road show connection of portable stage switchboards to fixed lighting outlets by means of permanently installed supplementary circuits. The panel, supplementary circuits, and outlets shall comply with 5.20.4.1(a) through (d).

Portable Switchboards on Stage

ROAD SHOW CONNECTION PANEL (A TYPE OF PATCH PANEL)

- (A) **LOAD CIRCUITS.** circuits shall terminate in grounding-type polarized inlets of current and voltage rating that match the fixed-load receptacle.
- (B) **CIRCUIT TRANSFER.** Circuits that are transferred between fixed and portable switchboards shall have all circuit conductors transferred simultaneously.
- (C) **OVERCURRENT PROTECTION.** The supply devices of these supplementary circuits shall be protected by branch-circuit overcurrent protective devices. The individual supplementary circuit, within the road show connection panel and theater, shall be protected by branch-circuit overcurrent protective devices of suitable ampacity installed within the road show connection panel.
- (D) Panel construction shall be in accordance with Article 4.8.

SUPPLY

Portable switchboards shall be supplied only from power outlets of sufficient voltage and ampere rating. Such power outlets shall include only externally operable, enclosed fused switches or circuit breakers mounted on stage or at the permanent switchboard in locations readily accessible from the stage floor. Provisions for connection of an equipment grounding conductor shall be provided.

5.22 CONTROL SYSTEM FOR PERMANENT AMUSEMENT ATTRACTIONS

ENTERTAINMENT DEVICE. A mechanical or electromechanical device that provides an entertainment experience.

PERMANENT AMUSEMENT ATTRACTION. Ride devices, entertainment devices, or combination thereof, that are installed so that portability or relocation is impracticable.

RIDE DEVICE. A device or combination of devices that carry, convey, or direct a person(s) over or through a fixed or restricted course within a defined area for the primary purpose of amusement or entertainment.

VOLTAGE LIMITATIONS. Control voltage shall be a maximum of 150 volts, nominal, ac to ground or 300 volts dc to ground.

MAINTENANCE. The conditions of maintenance and supervision shall ensure that only qualified person service that permanent amusement attraction.

CONTROL CIRCUITS

POWER SOURCES FOR CONTROL CIRCUITS

A.) POWER LIMITED CONTROL CIRCUITS. Power-limited control circuits shall be supplied from a source that has a rated output of not more than 30 volts and 1000 volts.

(1) CONTROL TRANSFORMERS. Transformers used to supply power limited control circuits shall comply with the applicable sections within Parts 4.50.1 and 4.50.2

(2) OTHER POWER-LIMITED CONTROL POWER SOURCES. Power-limited control power sources, other than transformers, shall be protected by overcurrent devices rated at not more than 167 percent of the volt-ampere rating of the source divided by the rated voltage. The fusible overcurrent devices shall not be interchangeable with fusible overcurrent devices of higher ratings. The overcurrent device shall be permitted to be an integral part of the power source.

CONTROL CIRCUITS

POWER SOURCES FOR CONTROL CIRCUITS

B.) NON-POWER LIMITED CONTROL CIRCUITS. Non-Power-limited control circuits shall not exceed 300 volts. The power output of the source shall not be required to be limited.

- 1. CONTROL TRANSFORMERS.** Transformers used to supply non-power-limited control circuits shall comply with the applicable sections within Parts 4.50.1 and 4.50.2
- 2. OTHER NON-POWER-LIMITED CONTROL POWER SOURCES.** Non-Power-limited control power sources, other than transformers, shall be protected by overcurrent devices rated at not more than 125 percent of the volt-ampere rating of the source divided by the rated voltage. The fusible overcurrent devices shall not be interchangeable with fusible overcurrent devices of higher ratings. The overcurrent device shall be permitted to be an integral part of the power source.

CONTROL CIRCUITS WIRING METHODS

CONDUCTORS, BUSBARS AND SLIP RINGS

Insulated control circuit conductors shall be copper and shall be permitted to be stranded or solid. Listed multi-conductor cable assemblies shall be permitted.

Exception No.1: Busbars and slip rings shall be permitted to be materials other than copper.

Exception No.2: Conductors used as specific-purpose devices, such as thermocouples and resistive thermal devices, shall be permitted to be materials other than copper.

CONTROL CIRCUITS WIRING METHODS

CONDUCTOR SIZING

A.) CONDUCTORS WITHIN LISTED COMPONENT OR ASSEM. Conductors of size 30 AWG or larger shall be permitted within a listed component or as part of the wiring of a listed assembly.

B.) CONDUCTORS WITHIN AN ENCLOSURE OR OPERATOR. Conductors of size 30 AWG or larger shall be permitted in a listed and Jacketed Multi-conductor cable within an enclosure or operator station.

C.) CONDUCTORS OUTSIDE OF AN ECLOSURE OR OPERATOR STATION. The size of conductors in a listed an jacketed multi-conductor cable shall not be smaller than 26 AWG. Single conductor shall not be smaller than 0.75 mm^2 (1.0 mm diameter) and shall be installed only where part of a recognized wiring method of chapter 3.

CONTROL CIRCUITS WIRING METHODS

CONDUCTOR AMPACITY.

Conductor sized 1.25 mm^2 (1.3 mm diameter) and smaller shall not exceed the continuous current values provided in Table 5.22.3.3.

OVERCURRENT PROTECTION FOR CONDUCTORS

Conductors 30 AWG through 1.25 mm^2 (1.3 mm diameter) shall have overcurrent protection in accordance with the appropriate conductor ampacity in Table 5.22.3.3. Conductors larger than 1.25 mm^2 (1.3 mm diameter) shall have overcurrent protection in accordance with the appropriate conductor ampacity in Table 3.10.2.6(B)(16).

CONTROL CIRCUITS WIRING METHODS

CONDUCTORS OF DIFFERENT CIRCUITS IN THE SAME CABLE, CABLE TRAY, ENCLOSURE, OR RACEWAY

Control circuit shall be permitted to be installed with other circuits as specified in 5.33.3.5(A) and (B).

A.) TWO OR MORE CONTROL CIRCUITS. Control circuits shall be permitted to occupy the same cable, cable tray, enclosure, or raceway without regard to whether the individual circuits are alternating current or direct current, provided all conductors are insulated for the maximum voltage of any conductor in the cable, cable tray, enclosure, or raceway.

B.) CONTROL CIRCUITS WITH POWER CIRCUITS. Control circuits shall be permitted to be installed with power conductors as specified in 5.22.3.5(B)(1) through (B)(3).

TABLE 5.22.3.3 CONDUCTOR AMPACITY BASED ON COPPER CONDUCTORS WITH 60° C and 75° C INSULATION IN AN AMBIENT TEMPEARATURE OF 30 ° C

CONDUCTOR SIZE mm ² (mm diameter)	AMPACITY	
	60° C	75° C
0.05 (0.25)	-	0.50
0.08 (0.32)	-	0.80
0.125 (0.40)	-	1
0.20 (0..50)	2	2
0.325 (0.65)	3	3
0.50 (0.80)	5	5
0.75 (1.0)	7	7
1.25 (1.2)	10	10

CONTROL CIRCUITS WIRING METHODS

UNGROUNDING CONTROL CIRCUITS

Separately derived ac circuits and systems 50 volts or greater and 2-wire dc circuits and 60 volts or greater shall be permitted to be ungrounded, provided that all the following conditions are met:

- 1.) Continuity of control power is required for orderly shutdown.
- 2.) Ground detectors are installed on the control system.

CONTROL CIRCUITS WET LOCATIONS

Where wet contact is likely to occur, ungrounded 2-wire direct-current control circuits shall be limited to 30 volts maximum for continuous dc or 12.4 volts peak for direct current that is interrupted at a rate of 10 to 200 Hz.

5.25 CARNIVALS, CIRCUSES, FAIRS, AND SIMILAR EVENTS

DEFINITIONS

OPERATOR. The individual responsible for starting, stopping and controlling an amusement ride or supervising a concession.

PORTABLE STRUCTURES. Unit designed to be moved including, but not limited to, amusement rides, attractions, concessions, tents, trailers, trucks, and similar units.

OTHER ARTICLES

(A) PORTABLE WIRING AND EQUIPMENT. Wherever the requirements of other articles of this Code and Article 5.25 differ, the requirements of Article 5.25 shall apply to the portable wiring and equipment.

(B) PERMANENT STRUCTURES. Articles 5.18 and 5.20 shall apply to wiring in permanent structures.

(C) AUDIO SIGNAL PROCESSING, AMPLIFICATION, AND REPRODUCTION EQUIPMENT. Article 6.40 shall apply to the wiring and installation of audio signal processing, amplification, and reproduction equipment.

(D) ATTRACTIONS UTILIZING POOLS, FOUNTAINS, AND SIMILAR INSTALLATIONS WITH CONTAINED VOLUMES OF WATER. This equipment shall be installed to comply with the applicable requirements of Article 6.80.

OVERHEAD CONDUCTOR CLEARANCES

- (A) **VERTICAL CLEARANCES.** Conductors shall have a vertical clearance to ground in accordance with 2.25.1.18. These clearances shall apply only to wiring installed outside of tents and concessions.
- (B) **CLEARANCE TO RIDES AND ATTRACTIONS.** Amusement rides and amusement attractions shall be maintained not less than 4 500 mm in any direction from overhead conductors operating at 600 volts or less, except for the conductors supplying the amusement ride or attraction. Amusement rides or attractions shall not be located under or within 4 500 mm horizontally of conductors operating in excess of 600 volts.

POWER SOURCES

SERVICES

Services shall comply with 5.25.2.1(a) and 5.25.2.1(b).

(A) GUARDING. Service equipment shall not be installed in a location that is accessible to unqualified persons, unless the equipment is lockable.

(B) MOUNTING AND LOCATION. Service equipment shall be mounted on solid backing and be installed so as to be protected from the weather, unless of weatherproof construction.

WIRING METHODS

(A) TYPE. Where flexible cords or cables are used, they shall be listed for extra hard usage. Where flexible cords or cables are used and are not subject to physical damage, they shall be permitted to be listed for hard usage. Where used outdoors, flexible cords and cables shall also be listed for wet locations and shall be sunlight resistant. Extra-hard usage flexible cords or cables shall be permitted for use as permanent wiring on portable amusement rides and attractions where not subject to physical damage.

(B) SINGLE-CONDUCTOR. Single-conductor cable shall be permitted only in sizes 30 mm² or larger.

(C) OPEN CONDUCTORS. Open conductors are prohibited except as part of a listed assembly or festoon lighting installed in accordance with article 2.25.

(D) SPLICES. Flexible cords or cables shall be continuous without splice or tap between boxes or fittings.

WIRING METHODS

(E) CORD CONNECTORS. Cord connectors shall not be laid on the ground unless listed for wet locations. Connectors and cable connections shall not be placed in audience traffic paths or within areas accessible to the public unless guarded.

(F) SUPPORT. Wiring for an amusement ride, attraction, tent, or similar structure shall not be supported by any other ride or structure unless specifically designed for the purpose.

(G) PROTECTION. Flexible cords or cables accessible to the public shall be arranged to minimize the tripping hazard and shall be permitted to be covered with nonconductive matting, provided that the matting does not constitute a greater tripping hazard than the uncovered cables. It shall be permitted to bury cables.

(H) BOXES AND FITTINGS. A box or fitting shall be installed at each connection point, outlet, switchpoint, or junction point.

Rides, Tents and Concessions.

- A. DISCONNECTING MEANS.** Each ride and concession shall be provided with a fused disconnect switch or circuit breaker located within sight and within 1 800 mm of the operator's station. The disconnecting means shall be readily accessible to the operator, including when the ride is in operation. Where accessible to unqualified persons, the enclosure for the switch or circuit breaker shall be of the lockable type. A shunt trip device that opens the fused disconnect or circuit breaker when a switch located in the ride operator's console is closed shall be a permissible method of opening the circuit.
- B. PORTABLE WIRING INSIDE TENTS AND CONCESSIONS.** Electrical wiring for lighting, where installed inside of tents and concessions, shall be securely installed and, where subject to physical damage, shall be provided with mechanical protection. All lamps for general illumination shall be protected from accidental breakage by a suitable fixture or lampholder with a guard.

PORTABLE DISTRIBUTION OR TERMINATION BOXES

(A) CONSTRUCTION. Boxes shall be designed so that no live parts are exposed to accidental contact. Where installed outdoors, the box shall be of weatherproof construction and mounted so that the bottom of the enclosure is not less than 150 mm above the ground.

(B) BUSBARS AND TERMINALS. Busbars shall have an ampere rating not less than the overcurrent device supplying the feeder supplying the box. Where conductors terminate directly on busbars, busbar connectors shall be provided.

(C) RECEPTACLES AND OVERCURRENT PROTECTION. Receptacles shall have overcurrent protection installed within the box. The overcurrent protection shall not exceed the ampere rating of the receptacle, except as permitted in Article 4.30 for motor loads.

(D) SINGLE-POLE CONNECTORS. Where single-pole connectors are used, they shall comply with 5.30.2.12

Ground-Fault Circuit-Interrupter (GFCI) Protection

WHERE GFCI PROTECTION IS REQUIRED. The ground-fault circuit interrupter shall be permitted to be an integral part of the attachment plug or located in the power-supply cord, within 300 mm of the attachment plug. Listed cord sets incorporating ground-fault circuit-interrupter for personnel shall be permitted.

- (1) 125-volt and/or 250-volt, single-phase, 15- and 20-ampere nonlocking type receptacles used for disassembly and reassembly or readily accessible to the general public.
- (2) Equipment that is readily accessible to the general public and supplied from a 125-volt and/or 250-volt, single-phase, 15- or 20-ampere branch circuit.

Ground-Fault Circuit-Interrupter (GFCI) Protection

(B) WHERE GFCI PROTECTION IS NOT REQUIRED. Receptacles that only facilitate quick disconnecting and reconnecting of electrical equipment shall not be required to be provided with GFCI protection. These receptacles shall be of the locking type.

(C) WHERE GFCI PROTECTION IS NOT PERMITTED. Egress lighting shall not be protected by a GFCI.

GROUNDING AND BONDING

EQUIPMENT BONDING

The following equipment connected to the same source shall be bonded:

- (1) Metal raceways and metal-sheathed cable
- (2) Metal enclosures of electric equipment
- (3) Metal frames and metal parts of rides, concessions, tents, trailers, trucks, or other equipment that contain or support electrical equipment

EQUIPMENT GROUNDING CONDUCTOR CONTINUITY ASSURANCE

The continuity of the grounding conductor system used to reduce electrical shock hazards as required by 2.50.6.5, 2.50.7.9, 4.6.1.3(c), and 5.90.1.4(d) shall be verified each time that portable electrical equipment is connected.

Grounding and Bonding

EQUIPMENT GROUNDING

The equipment grounding conductor shall be bonded to the system grounded conductor at the service disconnecting means or, in the case of a separately derived system such as a generator, at the generator or first disconnecting means supplied by the generator. The grounded circuit conductor shall not be connected to the equipment grounding conductor on the load side of the service disconnecting means or on the load side of a separately derived system disconnecting means.

MOTION PICTURE AND TELEVISION STUDIOS AND SIMILAR LOCATIONS

Scope

This article shall apply to TV studios and motion picture studios using rather film or electronic cameras, except as provided in 5.20.1.1. and exchanges, factories, laboratories, stages, or a portion of the building in which film or tape more than 22mm in width is exposed, developed, printed, cut, edited, rewound, repaired, or stored

Definitions

AC power Distribution Box(AC plugging box, Scatter Box). An ac distribution center or box grounding – type polarizing receptacles that may contain overcurrent protective device.

Bull Switch. Externally operated wall-mounted safety switch which is design for the connection of portable cables and chords.

Location (Shooting Location). area in which production or part of it is filmed or recorded.

Location Board (Deuce Board). Portable equipment which contains contactors and overcurrent protection devices for stage lighting.

Definitions

Motion Picture Studio (Lot). Structures used in the entertainment industry for the purpose of motion picture or TV production.

Plugging Box. A DC device which consist of one or more, 2-pole, 2-wire, nonpolarized, nongrounding type receptacles intended for dc circuits only.

Portable Equipment. Equipment intended to be moved from one place to another

Single-Pole Separable Connector. Device used to establish connection or disconnection between 1 or 2 cables and a single - pole, panel mounted separable connector.

Spider(Cable Splicing Block). Device that contains busbars that are insulated from each other for splicing or distributing power to portable cables and chords.

Definitions

Stage Effect (Special Effect). An equipment used to simulate a distinctive visual or audible effect.

Stage Property. Article or object used as a visual element in a motion picture or television production, except backgrounds and costumes

Stage Set. Specific area set up with temporary scenery and properties designed and arranged for a particular scene.

Stand lamp Work Light). A portable stand containing a general – purpose luminaire or lamp holder for the purpose of providing general illumination in the studio or stage.

TV studio or Motion picture stage (Sound Stage). Portion of a building usually insulated from the outside noise and natural light used for production.

Portable Equipment. Portable stage and studio lighting equipment and portable power distribution equipment shall be permitted for temporary outdoor use with the supervision by a qualified personnel.

Stage or Set

Permanent wiring. Shall be a type MC cable, Type AC cable containing an insulated equipment grounding conductor size in accordance to table 2.50.6.13, type MI cable, or in approved raceway

A. Stage set wiring. The wiring for stage set lighting and other supply wiring not fixed as to location shall be done with listed hard usage flexible cords and cables.

B. Stage Effects and Elec. Equipment used as Stage Properties. The wiring for stage effects and electrical equipment used as stage properties shall be permitted to be wired with single or multiconductor listed flexible cords or cables if the conductors are protected from physical damage and secured to the scenery by approved cable ties or by insulated staples. Splices or taps shall be permitted where such are made with listed devices and the circuit is protected at not more than 20 amperes.

C. Other Electrical Equipment. Chords cables other than extra hard usage where supplied as a part of a listed assembly, shall be permitted.

Stage lighting and effect control. Switches used for studios stages set lighting and effects shall be of the externally operable type.

Plug boxes. Each receptacle of dc plugging boxes shall be rated at not less than 30A.

Enclosing and guarding live parts

A. Live parts. Shall be enclosed or guarded to prevent accidental contact by persons and objects.

B. Switches. Shall be of the externally operable type.

C. Rheostats. Shall be placed in approved cases or cabinets that enclose all live parts, having only the operating handles exposed.

D. Current. Shall be enclosed, guarded, or located so that persons cannot accidentally come into contact with them or bring conductive material into contact with them.

Portable luminaires. Shall be equipped with flexible chords, composition or metal-sheathed porcelain sockets, and substantial ground.

Portable arc lamps

- **Portable carbon arc lamps.** Shall be substantially constructed and provided with an enclosure designed to retain sparks and carbons and to prevent persons or materials from coming into contact with the arc or bare live parts. The enclosures shall be ventilated.

- **Portable noncarbon arc electric-discharge lamps.** Portable noncarbon arc lamps, including enclosed arc lamps, and associated ballasts shall be listed. Interconnecting cord sets and interconnecting cords and cables shall be extra-hard usage type and listed.

Overcurrent Protection

General

Automatic overcurrent protective devices (circuit breakers or fuses) for motion picture studio stage set lighting and the stage cables for such stage set lighting shall be as given in 5.30.2.8(a) through (g).


The maximum ampacity allowed on a given conductor, cable, or cord size shall be as given in the applicable tables of Articles 3.10 and 4.0.

Overcurrent Protection

A. Stage cables. Shall be protected using overcurrent devices set at not more than 400 percent of the ampacity given in the applicable tables of Articles 3.10 and 4.0.


B. Feeders. The overcurrent devices shall be permitted to be multipole or single-pole gang operated. The overcurrent device setting for each feeder shall not exceed 400 percent of the ampacity of the feeder, as given in the applicable tables of Article 3.10.

C. Cable protection. Shall be protected by bushings where they pass through enclosures and shall be arranged so that tension on the cable is not transmitted to the connections. Where power conductors pass through metal, the requirements of 3.0.1.20 shall apply.



D. Location Boards. Overcurrent protection like circuit breakers and Fuses in the location boards shall have an ampere rating of not over 400 percent of the ampacity of the cables between the location boards and the plugging boxes.

E. Plugging Box. The rating of the fuses or the setting of the circuit breaker shall not be over 400 percent of the rated ampacity of the cables or cords as given in the applicable tables of Articles 3.10 and 4.0. Plugging boxes shall not be permitted on ac systems



F. Alternating-Current Power Distribution Boxes. Alternating current power distribution boxes used on sound stages and shooting locations shall contain connection receptacles of a polarized, grounding type.

G. Lighting. Work lights, stand lamps, and luminaires (fixtures) rated 1000 watts or less and connected to dc plugging boxes shall be by means of plugs containing two cartridge fuses not larger than 20 amperes, or they shall be permitted to be connected to special outlets on circuits protected by fuses or circuit breakers rated at not over 20 amperes. Plug fuses shall not be used unless they are on the load side of the fuse or circuit breakers on the location boards.

Sizing of Feeder Conductors for TV Studio Sets

General

It shall be permissible to apply the demand factors listed in Table 5.30.2.9(a) to that portion of the maximum possible connected load for studio or stage set lighting for all permanently installed feeders between substations and stages and to all permanently installed feeders between the main stage switchboard and stage distribution centers or location boards.

Table 5.30.2.9(a) Demand Factors for Stage Set Lighting

Portion of Stage Set Lighting Load to Which Demand Factor Applied (volt-amperes)	Feeder Demand Factor
First 50 000 or less at	100 %
From 50 001 to 100 000 at	75%
From 100 001 to 200 000 at	60%
Remaining over 200 000 at	50%

Portable feeders. A demand factor of 50 percent of maximum possible connected load shall be permitted for all portable feeders.

Grounding. Type MC, MI, metal raceways, and all non-current-carrying metal shall be grounded as specified in Article 2.50.

Plugs and Receptacles

- **Rating.** Plugs and receptacles shall be rated in amperes. The voltage rating of the plugs and receptacles shall not be less than the circuit voltage. Shall not be less than the feeder or branch-circuit overcurrent device ampere rating. Table 2.10.2.3(b)(2) shall not apply.
- **Interchangeability.** Plugs and receptacles used in portable professional motion picture and television equipment shall be permitted to be interchangeable for ac or dc use on the same premises.


Single-Pole Separable Connectors

A. General - The use of single-pole separable connectors shall comply with at least one of the following conditions:

1. Connection and disconnection of connectors are only possible where the supply connectors are interlocked to the source and it is not possible to connect or disconnect connectors when the supply is energized.

2. Line connectors are of the listed sequential-interlocking type so that load connectors shall be connected in the following sequence:

- a. Equipment grounding conductor connection
- b. Grounded circuit conductor connection, if provided
- c. Ungrounded conductor connection, and that disconnection shall be in the reverse order




3. A caution notice shall be provided adjacent to the line connectors, indicating that plug connection shall be in the following order:


a. Equipment grounding conductor connectors

b. Grounded circuit-conductor connectors, if provided

c. Ungrounded conductor connectors, and that disconnection shall be in the reverse order

B. Interchangeability. Shall be permitted to be interchangeable for ac or dc use or for different current ratings on the same premises, provided they are listed for ac/dc use and marked in a suitable manner to identify the system to which they are connected.






Branch Circuits. A branch circuit of any size supplying one or more receptacles shall be permitted to supply stage set lighting loads.

Dressing Rooms. Fixed wiring shall be installed in accordance with the wiring methods covered in Chapter 3. Wiring for portable dressing rooms shall be approved.

Viewing, Cutting, and Patching Tables

Lamps at Tables. Only composition or metal-sheathed, porcelain, keyless lamp holders equipped with suitable means to guard lamps from physical damage.



Cellulose Nitrate Film Storage Vaults

Lamps in Cellulose Nitrate Film Storage Vaults. Shall be installed in rigid fixtures of the glass-enclosed and gasketed type. Lamps shall be controlled by a switch having a pole in each ungrounded conductor.

Electrical Equipment in Cellulose Nitrate Film Storage Vaults

- No receptacles, outlets, heaters, portable lights, or other portable electric equipment shall be located in cellulose nitrate film storage vaults
- Electric motors shall be permitted, provided they are listed for the application and comply with Article 5.0, Class I, Division 2.

Substations

- **Substations.** Wiring and equipment of over 600 volts, nominal, shall comply with Article 490.
- **Portable Substations.** Wiring and equipment in portable substations shall conform to the sections applying to installations in permanently fixed substations working spaces shall be permitted to be reduced, provided that the equipment shall be arranged so that the operator can work safely
- **Overcurrent Protection of Direct-Current Generators.** Shall have overcurrent protection in accordance with 4.45.1.12(e).

Direct-Current Switchboards.

General

Switchboards of not over 250 volts dc between conductors, where located in substations or switchboard rooms accessible to licensed electrical practitioner or non licensed electrical practitioner under the supervision of a licensed electrical practitioner only, shall not be required to be dead-front.

Circuit Breaker Frames. Frames of dc circuit breakers installed on switchboards shall not be required to be grounded.

MOTION PICTURE PROJECTION ROOMS

Scope

This article apply to motion picture projection rooms, motion picture projectors, and associated equipment of the professional and nonprofessional types using incandescent, carbon arc, xenon, or other light source equipment that develops hazardous gases, dust, or radiation.

Definitions

Nonprofessional Projector. Nonprofessional projectors are those types other than as described in 5.40.1.2.

Professional Projector. A type of projector using 35- or 70-mm film that has a minimum width of 35 mm and has on each edge 212 perforations per meter, or a type using carbon arc, xenon, or other light source equipment that develops hazardous gases, dust, or radiation.

Equipment and Projectors of the Professional Type

Motion Picture Projection Room Required. Professional-type projector shall be located within a projection room. All projection ports, spotlight ports, viewing ports, and similar openings shall be provided with glass or other approved material so as to completely close the opening. Such rooms shall not be considered as hazardous (classified) locations as defined in Article 5.0.

Location of Associated Electrical Equipment

A. Motor Generator Sets, Transformers, Rectifiers, Rheostats, and Similar Equipment. Shall be located in a separate room. Where placed in the projection room, they shall be located or guarded so that arcs or sparks cannot come in contact with film, and the commutator end or ends of motor generator sets shall comply with one of the conditions in 5.40.2.2(a)(1) through (a)(6).

1. Types. Be of the totally enclosed, enclosed fan-cooled, or enclosed pipe-ventilated type.

2. Separate Rooms or Housings. Be enclosed in separate rooms or housings built of noncombustible material constructed so as to exclude flyings or lint, and properly ventilated from a source of clean air.

3. Solid Metal Covers. Have the brush or sliding-contact end of motor-generator enclosed by solid metal covers.

4. Tight Metal Housings. Have brushes or sliding contacts enclosed in substantial, tight metal housings.

5. Upper and Lower Half Enclosures. Have the upper half of the brush or sliding-contact end of the motor-generator enclosed by a wire screen or perforated metal and the lower half enclosed by solid metal covers.

6. Wire Screens or Perforated Metal. Have wire screens or perforated metal placed at the commutator of brush ends. No dimension of any opening in the wire screen or perforated metal shall exceed 1.27mm, regardless of the shape of the opening and of the material used.





Switches, Overcurrent Devices, or Other Equipment. Shall not be installed in projection rooms.

Emergency Systems. Control of emergency systems shall comply with Article 7.0.

Work Space. Each motion picture projector, floodlight, spotlight, or similar equipment shall have clear working space not less than 800mm wide on each side and at the rear thereof.

Exception: One such space shall be permitted between adjacent pieces of equipment.







Conductor Size. Shall not be smaller than 8.0mm² and shall be of sufficient size for the projector employed. Conductors for incandescent-type projectors shall conform to normal wiring standards as provided in 2.10.2.5.

Flexible Cords. Cords approved for hard usage, as provided in Table 4.0.1.4, shall be used on portable equipment


Conductors on Lamps and Hot Equipment. Insulated conductors having a rated operating temperature of not less than 200°C shall be used on all lamps or other equipment where the ambient temperature at the conductors as installed will exceed 50°C.





Listing Requirements. Projectors and enclosures for arc, xenon and incandescent lamps and rectifiers, transformers, rheostats, and similar equipment shall be listed.

Marking. Projectors and other equipment shall be marked with the manufacturer's name or trademark and with the voltage and current for which they are designed in accordance with 1.10.1.21.



Nonprofessional Projectors

Motion Picture Projection Room Not Required. Projectors of the nonprofessional or miniature type, where employing cellulose acetate (safety) film, shall be permitted to be operated without a projection room.

Listing Requirements. Projection equipment shall be listed.

Audio Signal Processing, Amplification, and Reproduction Equipment

Audio Signal Processing, Amplification, and Reproduction Equipment. Audio signal processing, amplification, and reproduction equipment shall be installed as provided in Article 6.40.

MANUFACTURES BUILDINGS

Scope

This article covers requirements for a manufactured building and building components as herein defined.

Definitions.

Building Component. Any subsystem, subassembly, or other system designed for use in or integral with or as part of a structure, include structural, electrical, mechanical, plumbing, and fire protection systems, and other systems affecting health and safety.

Definitions

Building System. Plans, specifications, and documentation for a system of manufactured building or for a type or a system of building components, including such variations thereof as are specifically permitted by regulation, and which variations are submitted as part of the building system or amendment thereto.

Closed Construction. Any building, building component, assembly, or system manufactured in such a manner that all concealed parts of processes of manufacture cannot be inspected before installation at the building site without disassembly, damage, or destruction.

Definitions

Manufactured Building. Any building that is of closed construction and is made or assembled in manufacturing facilities on or off the building site for installation, or for assembly and installation on the building site.

Wiring Methods

A. Methods Permitted. All raceway and cable wiring methods included in this Code and such other wiring systems specifically intended and listed for use in manufactured buildings shall be permitted.

B. Securing Cables. In closed construction, cables shall be permitted to be secured only at cabinets, boxes, or fittings where 5.5 mm² (2.6mm dia.) or smaller conductors are used and protection against physical damage is provided.

Wiring Methods

Supply Conductors. Provisions shall be made to route the service-entrance, service-lateral, feeder, or branch-circuit supply to the service.

Installation of Service-Entrance Conductors. Service entrance conductors shall be installed after erection at the building site. *(Exception: Where point of attachment is known prior to manufacture.)*

Service Equipment. Service equipment shall be installed in accordance with 2.30.6.1.


Protection of Conductors and Equipment. Protection shall be provided for exposed conductors and equipment during processes of manufacturing, packaging, in transit, and erection at the building site

Boxes

A. Other Dimensions. Boxes of dimensions other than those required in Table 3.14.2.2(a) shall be permitted to be installed where tested, identified, and listed to applicable standards.

B. Not Over 1640 cm³. Any box not over 1640 cm³ in size, intended for mounting in closed construction, shall be affixed with anchors or clamps so as to provide a rigid and secure installation.


C. Receptacle or Switch with Integral Enclosure. Shall be tested, identified, and listed to applicable standards, to be permitted to be installed.



Bonding and Grounding. Shall follow in accordance with Parts 2.50.5, 2.50.6, and 2.50.7.

Grounding Electrode Conductor. Provisions shall be made to route a grounding electrode conductor from the service, feeder, or branch-circuit supply.

Component Interconnections. Shall be permitted for on-site interconnection of modules or other building components. And shall be equal to the wiring method employed in insulation, temperature rise, and fault-current withstand and shall be capable of enduring the vibration and minor relative motions occurring in the components of manufactured building.



AGRICULTURAL BUILDINGS

Scope. The provisions of this article shall apply to the following agricultural buildings or that part of a building or adjacent areas of similar or like nature as specified in 5.47.1.1(A) and 5.47.1.1(B)

A. Excessive Dust and Dust with Water. Agricultural buildings where excessive dust and dust with water may accumulate, including all areas of poultry, livestock, and fish confinement systems, where litter dust or feed dust, including mineral feed particles, may accumulate

B. Corrosive Atmosphere. Agricultural buildings where a corrosive atmosphere exists.

Definitions

Distribution Point. An electrical supply point from which service drops, service laterals, feeders, or branch circuits to agricultural buildings etc. are supplied.

Equipotential Plane. An area where wire mesh or other conductive elements are embedded and to prevent a difference in voltage from developing within the plane.

Site-Isolating Device. Disconnecting means installed for the purposes of isolation, system maintenance, emergency disconnection, or connection of optional standby systems.

Other Articles. For agricultural buildings not having conditions as specified in 5.47.1.1, the electrical installations shall be made in accordance with the applicable articles in this Code.

Surface Temperatures. Electrical equipment or devices installed in accordance with the provisions of this article. shall be installed in a manner such that they will function at full rating without developing surface temperatures in excess of the specified normal safe operating range of the equipment or device.

Wiring Methods.

A. Wiring Systems. Types UF, NMC, copper SE cables, jacketed Type MC cable, rigid nonmetallic conduit, liquidtight flexible nonmetallic conduit, or other cables or raceways suitable for the location and The wiring methods of Part 5.2.2 shall be permitted for areas described in 5.47.1.1(a).

B. Mounting. All cables shall be secured within 200 mm of each cabinet, box, or fitting.

C. Equipment Enclosures, Boxes, Conduit Bodies, and Fittings

In cases of:

1. Excessive Dust. Equipment enclosures, boxes, conduit bodies, and fittings installed in areas of buildings shall have no openings (such as holes for attachment screws) through which dust could enter the enclosure.

2. Damp or Wet Locations. Damp locations shall be placed or equipped so as to prevent moisture from entering or accumulating within the enclosure, box, conduit body, or fitting. On the other hand wet locations shall be listed for use in wet locations and equipment enclosures shall be weatherproof.

3. Corrosive Atmosphere. Shall have corrosion resistance properties suitable for the conditions.

D. Flexible Connections. Where necessary to employ flexible connections, dusttight flexible connectors, liquidtight flexible conduit, or flexible cord listed and identified for hard usage shall be used.

E. Physical Protection. All electrical wiring and equipment subject to physical damage shall be protected.

F. Separate Equipment Grounding Conductor. Shall follow under the scope of article 5.47.

G. Receptacles. Shall have ground fault circuit-interruption protection:

1. In areas having an equipotential plane,
2. Outdoors,
3. Damp or wet locations,
4. Dirt confinement areas for livestock

Switches, Receptacles, Circuit Breakers, Controllers, and Fuses

Switches, including pushbuttons, relays, and similar devices, receptacles, circuit breakers, controllers, and fuses, shall be provided with enclosures as specified in 5.47.1.5(c).

Motors

Motors and other rotating electrical machinery shall be totally enclosed or designed so as to minimize the entrance of dust, moisture, or corrosive particles.

Luminaires (Lighting Fixtures)

Luminaires (lighting fixtures) shall comply with 5.47.1.8(a) through 5.47.1.8(c).

A. Minimize the Entrance of Dust. Shall be installed to minimize the entrance of dust, foreign matter, moisture, and corrosive material.

B. Exposed to Physical Damage. Shall be protected by a suitable guard

C. Exposed to Water. Shall be watertight

Electrical Supply to Building(s) or Structure(s) from a Distribution Point

Overhead electrical supply shall comply with 5.47.1.9(a) and 5.47.1.9(b), or with 5.47.1.9(c).

Underground electrical supply shall comply with 5.47.1.9(c) and 5.47.1.9(d).

Site-Isolating Device. Site-isolating devices shall comply with 5.47.1.9(a)(1) through (a)(9).

1. Where Required. A site-isolating device shall be installed at the distribution point where two or more agricultural buildings, structures, associated farm dwelling(s), or other buildings are supplied from the distribution point.

2. Location. The site-isolating device shall be pole-mounted and shall meet the clearance requirements of 2.30.2.3(a).


3. Operation. The site-isolating device shall simultaneously disconnect all ungrounded service conductors from the premises wiring.

4. Bonding Provisions. The site-isolating device enclosure shall be bonded to the grounded circuit conductor and the grounding electrode system.

5. Grounding. At the site-isolating device, the system grounded conductor shall be connected to a grounding electrode system via a grounding electrode conductor.


6. Rating. The site-isolating device shall be rated for the calculated load as determined by Part 2.20.5.

7. Overcurrent Protection. The site-isolating device shall not be required to provide overcurrent protection.



8. Accessibility. Shall be capable of being remotely operated by an operating handle installed at a readily accessible location, The operating handle of the site-isolating device, when in its highest position, shall not be more than 2 000 mm above grade or a working platform.

9. Series Devices. An additional site-isolating device for the premises wiring system shall not be required where a site-isolating device meeting all applicable requirements of this section is provided by the serving utility as part of their service requirements.



B. Service Disconnecting Means and Overcurrent Protection at the Building(s) or Structure(s). Where the service disconnecting means and overcurrent protection are located at the building(s) or structure(s), the requirements of 5.47.1.9(b)(1) through (b)(3) shall apply.

1. Conductor Sizing

2. Conductor Installation

3. Grounding and Bonding


C. Service Disconnecting Means and Overcurrent Protection at the Distribution Point. Shall meet the requirements of 2.50.2.13 and Parts 2.25.1 and 2.25.2.

D. Direct-Buried Equipment Grounding Conductors. Shall be insulated or covered.


Equipotential Planes and Bonding of Equipotential Planes

The installation and bonding of equipotential planes shall comply with 5.47.1.10(a) and 5.47.1.10(b). For the purposes of this section, the term livestock shall not include poultry.

A. Where Required. Equipotential planes shall be installed in all concrete floor confinement areas in livestock buildings, and in all outdoor confinement areas such as feedlots, containing metallic equipment that may become energized and is accessible to livestock. The equipotential plane shall encompass the area where the livestock stands while accessing metallic equipment that may become energized.



B. Bonding. Equipotential planes shall be bonded to the electrical grounding system. The bonding conductor shall be copper, insulated, covered or bare, and not smaller than 8.0 mm². The means of bonding to wire mesh or conductive elements shall be by pressure connectors or clamps of brass, copper, copper alloy, or an equally substantial approved means. Slatted floors that are supported by structures that are a part of an equipotential plane shall not require bonding.



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Mobile Homes, Manufactured Homes, and Mobile Home Parks

DEFINITIONS

- **Appliance fixed** – an appliance that is fastened otherwise secured at a specific location.
- **Appliance portable** – an appliance that is actually move.
- **Feeder assembly** – the over head conductors, including the grounding conductor, together with the necessary fittings and equipment or a power supply cord listed for mobile home use.
- **Laundry area** – an area containing or design to contain a laundry tray, clothes washer or clothes dryer.
- **Manufactured homes** – a structure, transportable in one or more section, which traveling mode, is 2,400 mm or more width or 12,200 mm more length.

DEFINITIONS

- **Mobile home** – a factory assembled structure or structures transportable in one or more sections.
- **Mobile home accessory building** – any awning, cabana, fence or porch establish for the use of the occupant of the mobile home on a mobile home lot.
- **Mobile home park** – a contiguous parcel of land is use for accommodation of occupied mobile homes.
- **Mobile home service equipment** – the equipment containing the disconnecting means over current protective devices and receptacles.
- **Park electrical wiring system** – all electrical wiring, luminaires, equipment and appurtenances related to electrical installation within a mobile home park, including the mobile home service equipment.

GENERAL REQUIREMENTS

- A. **Mobile Home Not Intended as a Dwelling Unit** – for example, those equipped for sleeping purposes only, mobile studio dressing room, banks, clinics, etc. – shall not be required to meet the provisions of this article pertaining to the number or capacity of circuits required.
- B. **In other Than Mobile Home Parks** – mobile homes installed in other than mobile home parks shall comply with the provisions of this article.
- C. **Connection to Wiring System** – the provisions of this article shall apply to mobile homes intended for connection to a wiring system rated 230 volts nominal, 2 wire AC, with one grounded phase conductor.
- D. **Listed and Labeled** – all electrical materials, devices and appliances shall be labeled and listed by a qualified testing agency.

MOBILE AND MANUFACTURE HOMES

- **Power Supply**
 - A. Feeder** – the power supply to the mobile home shall be a feeder assembly.
 - B. Power supply cord** – it shall be permanently installed attached to the panel board or to junction box.
 - C. Attachment Plug Cap** – shall be a 2-pole, 3-wire, grounding type, rated 50 amperes , 250 volts.
 - D. Overall Length of a Power-Supply Cord** – it is measured from the end of the cord, including bared leads, to the face of the attachment plug cap shall not be less than 6400 mm and shall not exceed to 11 mm.
 - E. Marking** – the power supply cored shall bear the following markings, for use mobile homes- 40 or 50 amperes.

MOBILE AND MANUFACTURE HOMES

- F. **Point of Entrance** – the point of entrance of the feeder assembly to the mobile home shall be in the exterior wall, floor, or roof.
- G. **Protected** – the cord passes through the wall or floor , it shall be protected by means of conduits and bushing or equivalent.
- H. **Protection Against Corrosion and Mechanical Damage** – permanent provisions shall be made for the protection of the attachment plug cap of the power supply cord against corrosion and mechanical damage.
- I. **Mast Weather-head or Raceway** – where the calculated load exceeds 50 amperes or where the a permanent feeder is used.

DISCONNECTING MEANS AND BRANCH CIRCUITS

- **Protective equipment**
 - A. Disconnecting means** – a single disconnecting means shall be provided in each mobile home consisting of a circuit breaker, or a switch and fuses and its accessories installed in a readily accessible location.
 - B. Branch-Circuit Protective Equipment** – shall be installed in each mobile home and shall include overcurrent protection for each branch circuit consisting of either circuit breakers or fuses.
 - C. Two-Pole Circuit Breakers** – where circuit breakers are provided for branch-circuit protection, 230 volt circuit shall be protected by a 2-pole common or companion trip.

BRANCH CIRCUITS

- A. **Lighting** – the number of branch circuits shall be based on 33 volt-amperes/m² times outside dimensions of the mobile homes divided by 230 volts.
- B. **Small Appliances** – the number of circuits required elsewhere in this section, shall be provided for all receptacle outlets required by 5.50.2.4 in these rooms.
- C. **Laundry area** – it is provided a 20-ampere branch circuit shall be provided to supply the laundry receptacle outlets.
- D. **General appliances** – including furnace, water heater and range, etc.. There shall be one or more circuits of adequate rating.
- E. **Bathrooms** – receptacles outlets shall be supplied by at least one 20-ampere branch circuit.

RECEPTACLE OUTLETS

- A. **Grounding-Type Receptacle Outlets** – receptacle outlets shall comply with the following: be of grounding type, be installed according to 4.6.1.4.
- B. **Ground-fault Circuit Interrupters** – all 20 ampere receptacle outlets installed in the location specified in 5.50.2.4 (1) through (5) shall have GFCI protection personnel.
- C. **Cord-Connected Fixed Appliances** – a grounding type receptacle outlet shall be provided for each cord connected fixed appliances.
- D. **Receptacle Outlets Required** – receptacle outlets shall be installed at wall spaces 600 mm wide or more.
- E. **Pipe Heating Cables Outlet** – for the connection of pipe heating cables, a receptacle outlet shall be located on the underside of the unit.
- F. **Receptacle Outlet not Permitted** – receptacle outlets shall not be permitted in the following locations:
 - Receptacle outlet shall not be installed within or directly over bathtub or shower place.
 - A receptacle shall not be installed in a face-up position in any counter top.
 - Receptacle outlet shall not be installed above electric baseboard heaters, unless provided for in the listing or manufacturers instruction.

LUMINAIRES AND APPLIANCES

- a) **Fasten Appliances in Transit** – means shall be provided to securely fasten appliances when the mobile home is in transit.
- b) **Accessibility** – every appliances shall be accessible for inspection, service, repair, or replacement without removal or payment construction.
- c) **Pendants** – listed pendant-type luminaires or pendant cords shall be permitted.
- d) **Bathtub and Shower Luminaires** – where a luminaire is installed over a bathtub or in a shower shall be of the enclosed and gasket type listed for wet locations.

WIRING METHODS AND MATERIALS

A. Grounded Conductors

Insulated – the grounded circuit conductor shall be insulated from the grounding conductors and from equipment enclosures and other grounded parts.

Connection of Ranges and Clothes Dryers – connection of ranges and clothes dryers with either 230 volts, 2 wire ratings or 115/230 volt, 3 wire rating

B. Equipment Grounding Means

- 1) Supply cord or permanent feeder
- 2) Electrical system
- 3) Cord-connected appliances

TESTING

- A. **Dielectric Strength test** – the wiring of each mobile home shall be subjected to a 1-minute, 900 volt, dielectric strength test between live parts. Alternatively, the test shall be permitted to be performed at 1080 volts for 1 second.
- B. **Continuity and Operational Test and Polarity Checks**
 - 1) An electrical continuity test to ensure that all exposed electrically conductive parts are properly bonded.
 - 2) An electrical operational test to demonstrate that all equipment is connected and working in order
 - 3) Electrical polarity checks of permanently wired equipment.

INTERCONNECTION OF MULTIPLE-SECTION MOBILE OR MANUFACTURED HOME UNITS

- A. **Wiring Methods** – approved and listed fixed type wiring method shall be used to join portions of a circuit that must be electrically joined and are located in adjacent sections after the home is installed on its support foundation.
- B. **Disconnecting Means** – multiunit manufactured homes, not having permanently installed feeders, that are to be moved from one location to another shall be permitted to have disconnecting means with branch circuit protective equipment in each unit.

SERVICE AND FEEDERS

Distribution System – the mobile home park secondary electrical distribution system to mobile home lots shall be single phase, 230 volt and 115/230 volts, nominal. For purpose of this part, where the park service exceeds 230 volts, nominal, transformers and secondary panel boards be treated as service.

Allowable Demand Factor – park electrical wiring systems shall be calculated on the larger of the following.

1. 16000 volt amperes for each mobile home lot.
2. The load calculated in accordance with 5.20.2.9 for the largest typical mobile homes.

ALLOWABLE DEMAND FACTOR

Demand factors for service and factors

Table 5.50.3.2 Demand Factors for Services and Feeders

Number of Mobile Homes	Demand Factor (%)
1	100
2	55
3	44
4	39
5	33
6	29
7-9	28
10-12	27
13-15	26
16-21	25
22-40	24
41-60	23
60 and over	22

SERVICE EQUIPMENT

Mobile Home Service Equipment – the mobile service equipment shall be located adjacent to the mobile home and not mounted in or on the mobile home. The service equipment shall be located in sight from and not more than 9,000 mm from the exterior wall of the mobile home service.

Rating – mobile home service equipment shall be rated at not less than 100 amperes at 230 or 115/230 volts, and provisions shall be made for connecting a mobile home feeder assembly by a permanent wiring method.

Additional receptacles – additional receptacles shall be permitted for connection of electrical equipment located outside the mobile home.

Mounting High – outdoor mobile home disconnecting means shall be installed so the bottom of the enclosure containing means is not less than 600 mm above finished grade of working platform.

Marking – where a 250 volt or 125/250 volt receptacles is used in mobile home service equipment , the service equipment shall be mark as follows:

- Turn disconnecting switch for circuit breaker off before inserting or removing plug
- Plug must be fully inserted or removed

FEEDER

- A. **Feeder Conductors** – shall consist of either a listed cord, or a permanently installed feeder consisting of four insulated, color coded conductors shall be identified by the factory.
- B. **Feeder capacity** – mobile home and manufactured home lot feeder circuit conductors shall have a capacity not less than the loads supplied, shall be rated not less than 100 amperes, and shall be permitted to be sized in accordance with 3.10.2.6(B)(7).

Recreational Vehicles and Recreational Vehicle Parks

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DEFINITIONS

- **Air Conditioning or Comfort Cooling Equipment** – all of that equipment intended or installed for the purpose of processing the treatment of air so as to control simultaneously or individually its temperature, humidity, cleanliness, and distribution to meet the requirements of conditioned space.
- **Appliance Fixed** – an appliance that is fastened or otherwise secured at a specific locations.
- **Camping Trailer** – a vehicular portable unit mounted on wheels and constructed with collapsible partial side walls that fold for towing by another vehicle and unfold at the campsite.
- **Converter** – a device that changes electrical energy from one form t another, as from alternating current to different current.
- **Frame** – chassis rail and any welded addition thereto of metal thickness of 1.35 mm or greater.
- **Low Voltage** - an electromotive force rated 24 volts nominal or less.
- **Motor Home** – a vehicular unit designed to provide temporary living quarters for recreational, camping, or travel use built on permanently attached to a self propelled motor vehicle chassis.
- **Recreational Vehicle** – a vehicular type unit primarily designed as temporary living quarters for recreational, camping, or travel use, which either has its own motive power or is mounted on or drawn by another vehicle.

COMBINATION ELECTRICAL SYSTEM

General – vehicle wiring suitable for connection to a battery or dc supply source shall be permitted to be connected to a 230-volt or 115-volt source.

Bonding Voltage Converter Enclosures – the non-current-carrying metal enclosure of the voltage converter shall be connected to the frame of the vehicle with minimum 8.0 mm² (3.2 mm dia.) copper conductor.

Dual-Voltage Fixtures, Including Luminaires or Applications - fixtures, including luminaires, or appliances having both 230-volts or 115-volts and low voltage connections shall be listed for dual voltage.

Receptacles and Plug Caps – where a recreational vehicle is equipped with an ac system, a low-voltage system, or both, receptacles and plug caps of the low voltage system shall differ in configuration from those of the ac system.

OTHER POWER SOURCES

Mounting – generators shall be mounted in such a manner as to be effectively bonded to the recreational vehicle chassis.

Generator Protection – equipment shall be installed to ensure that the current-carrying conductors from the engine generator and from an outside source are not connected to a vehicle circuit at the same time.

Installation of Storage Batteries and Generators – storage batteries and internal-combustion-driven generator units shall be secured in place to avoid displacement from vibration and road shock.

Ventilation of Generator Compartments – compartments accommodating internal-combustion-driven generator units shall be provided with

ventilation in accordance with instructions provided by the manufacturer of the generator units.

Supply Conductors – the supply conductors from the engine generator to the first termination on the vehicle shall be of the stranded type and be installed in listed flexible conduit or listed liquid tight flexible conduit. The point of first termination shall be in one of the following:

- 1) **Panel board**
- 2) **Junction box with receptacle**
- 3) **Enclosed transfer switch**
- 4) **Receptacle assembly listed in conjunction with the generator**

- **Multiple Supply Source**
 - A. **Multiple Supply source** – where a multiple supply system consisting of an alternate power source and a power-supply cord is installed, the feeder from the alternate power source shall be protected by an over current device.
 - B. **Multiple Supply Source Capacity** – the multiple supply source shall not be required to be of the same capacity.
 - C. **Power-Supply Assembly Not Less Than 30 Amperes** – the external power supply assembly shall be permitted to be less than the calculated load but not less than 30 amperes.

RECEPTACLE OUTLETS REQUIRED

- A. **Spacing** – receptacle outlets shall be installed at wall spaces 600 mm wide or more so that no point along the floor line is more than 1800 mm, measured horizontally, from an outlet in that space.
- B. **Ground fault Circuit Interrupter Protection** – where provided, each 250 volt and 125 volt, single phase, 15 or 20 ampere receptacle outlet shall have ground fault circuit interrupter protection personnel.
- C. **Face-Up Position** – a receptacle shall not be installed in a face-up position in any countertop or similar horizontal surface.

MEANS FOR CONNECTING TO POWER SUPPLY

Assembly – the power supply assembly or assemblies shall be factory supplied or factory installed and be of one of the types specified herein:

- 1) **Separable** – where a separable power supply assembly consisting of a cord with a female connector and molded attachment plug cap is provided.
- 2) **Permanently Connected** – each power supply assemble shall be connected directly to the terminals of the panel board or conductors within a junction box provided with means to prevent strain from being transmitted to the terminals.

Cord – the cord exposed usable length shall be measured from the point of entrance to the recreational vehicle or the face of the flanged surface

inlet to the face of the attachment plug at the supply end.

Attachment Plugs

- 1) **Units with One 15-amperes branch Circuits** – recreational vehicle having only one 15-ampere branch circuit as permitted by 5.51.4.3 shall have attachment plug shall be two pole, 3-wire grounding type, rated 15 amperes , 230 -volt or 125-volt.
- 2) **Unit with One 20-Ampere Branch Circuit** – recreational vehicles having only one 20-ampere branch circuit as permitted in 5.51.4.3 shall have an attachment plug that shall be 2-pole, 3-wire rounding type, rated 20-amperes, 230-volt and/or 125 volt.

FACTORY TEST

Factory Test – each recreational vehicle design with a 230-volt or a 115/230 volt electrical system shall withstand the applied voltage without electrical breakdown of a 1 minute, 900 volt ac or 1280 volt dc dielectric test.

Calculated Load

Basis of Calculation – Electrical service and feeders shall be calculated on the basis of not less than 1200 volt-amperes per site equipped with 50-ampere, 230-volt, 208Y/120 or 115/230-volt supply facilities.

Demand Factor – the demand factor for a given number of sites shall apply all sites indicated. For example, 20 sites calculated at 45 percent of 3600 volt amperes result in a permissible demand of 1620 volt amperes per site or a total of 32,400 volt amperes for 20 sites

RECREATIONAL VEHICLE PARK

Type Receptacle Provided

20 Ampere – every recreational vehicle site with electrical supply shall be equipped with recreational vehicle site supply equipment with at least one 20 ampere, 250 volt and/ or 125 volt receptacle.

30 Ampere – a minimum of 20 percent of all recreational vehicle sites, with electrical supply shall each be equipped with a 50 ampere, 125/250 volt receptacle . Receptacle shall also be equipped with 30 ampere, 250 volt and/ or 125 volt receptacle.

Tent Site – dedicated tent sites with a 15 or 20-ampere electrical supply shall be permitted to be

excluded when determining the percentage of recreational vehicle sites with 30 or 50 ampere receptacles.

Additional receptacles – additional receptacles shall be permitted for the connection of electrical equipment outside the recreational vehicle within the recreational vehicle park.

GFCI Protection – all 250 volt and 125 volt, single phase, 15 and 20 ampere receptacles shall have listed ground fault circuit interrupter protection for personnel. The GFCI devices used in RV site electrical equipment shall not be required to be weather or tamper resistant in accordance with 4.6.1.9 and 4.6.1.12.

• **Grounding**

Grounding electrode – power outlets or recreational vehicle site supply equipment, shall not be required to have a grounding electrode.

• **Grounding Recreational Vehicle Site Supply Equipment**

Exposed Non-Current Carrying Metal Parts – exposed non current carrying metal parts of fixed equipment, metal boxes, cabinets, and fittings that are not electrically connected to grounded equipment shall be grounded by an equipment grounding conductors.

Secondary Distribution System – each secondary distribution system shall be grounded at the transformer.

Grounded Conductor Not to Be Used as an Equipment Ground – the grounded conductor shall not be used as an equipment grounding conductor for recreational vehicles or equipment within the recreational vehicle park.

No Connection on the Load Side – no connection to a grounding electrode shall be made to the grounded conductor on the load side of the service disconnecting means except as covered in 2.50.2.11(A).

- **Protection of Outdoor Equipment**

Wet Locations – all switches circuit breakers, receptacles, control equipment, and metering devices located in wet locations shall be weatherproof.

Meters – if secondary meters are installed, meters sockets without meters installed shall be blanked off with an approved blanking plate.

- **Clearance for Over Head Conductors** – open conductors not over 1000 volts, nominal, shall have a vertical clearance of not less than 5,500 mm and a horizontal clearance of not less than 900 mm in all areas subject to recreational vehicle

movement. In all other areas, clearances shall conform to 2.25.1.18 and 2.25.1.19.

- **Receptacles** - a receptacle to supply electric power to a recreational vehicle shall be one of the configurations.

50 ampere – 125/250 volt or 50 ampere, 3 pole, 4 wire grounding type for 115/230 volt systems.

30 ampere – 250 volt or 125 volt, 30 ampere, 2 pole, 3 wire grounding type for 230 volt and/ or 115/230 volt amperes.

20 ampere – 250 volt or 125 volt, 20 ampere, 2 pole, 3 wire grounding type for 230 volt and/ or 115/230 volt systems.

Park Trailers

The image features a dark blue, arrow-shaped graphic pointing to the right, which contains the text 'Park Trailers'. Below this graphic is a horizontal orange bar with a 3D effect, set against a background of light blue and white geometric shapes.

DEFINITION

Park Trailer

A unit that is built on a single chassis mounted on wheels and has a gross trailer area not exceeding 37m² in the set-up mode. A park trailer is intended for seasonal use and not intended as a permanent dwelling unit or for commercial uses such as banks, clinics, offices, or similar.

Labels required in this article shall be made of etched, metal-stamped, or embossed brass or stainless steel; plastic laminates not less than 0.13 mm thick; or anodized or alclad aluminum not less than 0.5mm thick or the equivalent

LOW VOLTAGE SYSTEM

LOW-VOLTAGE SYSTEMS

Wiring

- Copper conductors shall be used.
- Shall conform to the requirements or shall have insulation in accordance with Table 3.10.3.1(A) or the equivalent. Conductor sizes 14mm² through 0.75mm²(1.0mm dia.) or SAE shall be listed. Single-wire, low-voltage conductors shall be of the stranded type.

LOW-VOLTAGE SYSTEMS

Marking. All insulated low-voltage conductors shall be surface marked at intervals not greater than 1200mm as follows:

Battery and other low-voltage circuits shall be physically separated by at least a 13-mm gap or other approved means from circuits of a different power source. Where circuits of different power sources cross, the external jacket of the nonmetallic-sheathed cables shall be deemed adequate separation.

Ground connections shall be by means of copper conductors and copper or copper-alloy terminals of the solderless type identified for the size of wire used.

LOW-VOLTAGE SYSTEMS

Wiring Methods

The chassis-grounding terminal of the battery shall be connected to the unit chassis with a minimum 8.0mm^2 (3.2mm dia.) copper conductor. In the event the unbonded lead from the battery exceeds 8.0mm^2 (3.2mm dia.), the bonding conductor size shall not be less than that of the unbonded lead.

Battery Installations

Where batteries are installed in a compartment, the compartment shall be ventilated with openings having a minimum area of 1100mm^2 at both the top and bottom.

LOW-VOLTAGE SYSTEMS

Overcurrent Protection:

- Shall be protected by overcurrent protective devices rated not in excess of the ampacity of copper conductors, in accordance with Table 5.52.2.1(E)(1)
- Circuit breakers or fuses shall be of an approved type, including automotive types. Fuseholders shall be clearly marked with maximum fuse size and shall be protected against shorting and physical damage by a cover or equivalent means.

LOW-VOLTAGE SYSTEMS

Wire Size [mm ² (mm dia.)]	Ampacity	Wire Type
0.75	6	Stranded only
1.25	8	Stranded only
2.0(1.6)	15	Stranded or solid
3.5(2.0)	20	Stranded or solid
5.5(2.6)	30	Stranded or solid

LOW-VOLTAGE SYSTEMS

Overcurrent Protection

- The overcurrent protective device shall be installed in an accessible location on the unit within 450mm of the point where the power supply connects to the unit circuits. If located outside the park trailer, the device shall be protected against weather and physical damage.

Switches

- Switches shall have a dc rating not less than the connected load.

Luminaires

- All low-voltage interior luminaires rated more than 4watts, employing lamps rated more than 1.2 watts, shall be listed.

COMBINATION ELECTRICAL SYSTEMS

COMBINATION ELECTRICAL SYSTEMS

Unit wiring suitable for connection to a battery or other low-voltage supply source shall be permitted to be connected to a 230-volt or 115/230-volt source, provided that the entire wiring system and equipment are rated and installed in full conformity with Parts 5.52.1, 5.52.3, 5.52.4, and 5.52.5 requirements of this article covering 230-volt or 115/230-volt electrical systems. Circuits fed from ac transformers shall not supply dc appliances.

COMBINATION ELECTRICAL SYSTEMS

All converters and transformers shall be listed for use in recreation units and designed or equipped to provide over-temperature protection. To determine the converter rating, the following percentage shall be applied to the total connected load, including average battery-charging rate, of all 12-volt equipment:

The first 20 amperes of load at 100 percent plus

The second 20 amperes of load at 50 percent plus

All load above 40 amperes at 25 percent

Exception: A low-voltage appliance that is controlled by a momentary switch (normally open) that has no means for holding in the closed position shall not be considered as a connected load when determining the required converter rating. Momentarily energized appliances shall be limited to those used to prepare the unit for occupancy or travel. 331

COMBINATION ELECTRICAL SYSTEMS

Bonding Voltage Converter Enclosures:

- The non-current -carrying metal enclosure of the voltage converter shall be connected to the frame of the unit with an 8mm² copper conductor minimum. The grounding conductor for the battery and the metal enclosure shall be permitted to be the same conductor.

Dual-Voltage Fixtures Including Luminaires or Appliances:

- Fixtures, including luminaires, or appliances having both 230-volt or 115/230-volt and low-voltage connections shall be listed for dual voltage.

NOMINAL 230-VOLT OR 115/230-VOLT SYSTEMS

RECEPTACLE OUTLETS REQUIRED

Spacing

- Receptacle outlets shall be installed at the wall spaces 600mm wide or more so that no point along the floor line is more than 1800mm, measured horizontally from an outlet in that space.

Exception No.1: Bath and hallway areas.

Exception No.2: Wall spaces occupied by kitchen cabinets, wardrobe cabinets, built-in furniture, behind doors that may open fully against a wall surface; or similar facilities.

RECEPTACLE OUTLETS REQUIRED

Location

Shall be installed as follows:

1. Adjacent to countertops in the kitchen [at least one on each side of the sink if countertops are on each side are 300mm or over in width and depth]
2. Adjacent to the refrigerator and gas range space, except where a gas-fired refrigerator or cooking appliance, requiring no external electrical connection is factory-installed

RECEPTACLE OUTLETS REQUIRED

Ground-Fault Circuit-Interrupter Protection:

Each 250-volt and 125-volt, single-phase, 15- or 20-ampere receptacle shall have ground-fault circuit- interrupter protection for personnel in the following locations:

1. Where the receptacles are installed to serve kitchen countertop surfaces
2. Within 1800mm of any lavatory or sink

Exception: Receptacles installed for appliances in dedicated spaces, such as for dishwashers, disposals, refrigerators, freezers, and laundry equipment.

RECEPTACLE OUTLETS REQUIRED

Ground-Fault Circuit-Interrupter Protection:

3. In the area occupied by a toilet, shower, tub, or any combination thereof
4. On the exterior of the unit

Exception: Receptacles that are located inside of an access panel that is installed on the exterior of the unit to supply power for an installed appliance shall not be required to have ground-fault circuit-interrupter protection.

RECEPTACLE OUTLETS REQUIRED

Pipe Heating Cable Outlet:

Where a pipe heating cable is installed, the outlet shall be as follows:

1. Located within 600mm of the cold water inlet
2. Connected to an interior branch circuit, other than a small-appliance branch circuit

RECEPTACLE OUTLETS REQUIRED

Receptacle Outlets Not Permitted :

1. **Shower or Bathtub Space.** Receptacle outlets shall not be installed in or within reach(750mm) of a shower or bathtub space.
2. **Face-Up Position.** A receptacle shall not be installed in a face-up position in any countertop or other horizontal surface.

BRANCH-CIRCUIT PROTECTION

Rating:

1. Not more than the circuit conductors
2. Not more than 150 percent of the rating of a single appliances rated 13.3 amperes or more and supplied by an individual branch circuit
3. Not more than the overcurrent protection size marked on a air conditioner or other motor-operated appliances

BRANCH-CIRCUIT PROTECTION

Protection for smaller Conductors:

- A 20-ampere fuse or circuit breaker shall be permitted for protection for fixtures, including luminaires, leads, cords, or small appliances, and 2.0 mm² (1.6 mm dia.) tap conductors not over 1800mm long for recessed luminaires.

POWER SUPPLY

Feeder:

- The power supply to the park trailer shall be a feeder assembly consisting of not more than one listed 30-ampere park or 50-ampere park trailer power supply cord, with an integrally molded or securely attached cap, or a permanently installed feeder.

Power-Supply Cord:

- If the park trailer has a power-supply cord, shall be permanently attached to the panel board, or to a junction box permanently connected to the panel board, with the free end terminating in a molded-on attachment plug cap

POWER SUPPLY

Mast Weather head or Raceway

Where the calculated load exceed 50 amperes or where a permanent feeder is used, the supply shall be by means of one of the following:

1. One mast weather head installation, installed in accordance with the Article 2.30, containing four continuous, insulated, color-coded feeder conductors, one of which shall be an equipment grounding conductor
2. A metal raceway, rigid nonmetallic conduit, or liquid tight flexible conduit from the disconnecting means in the park trailer to the underside of the park trailer, with provisions for the attachment to a suitable junction box or fitting to the raceway on the underside of the park trailer

CORD

Cord Length

- The cord-exposed usable length shall be measured from the point of entrance to the park trailer or the face of the flanged surface inlet (motor base attachment plug) to the face of the attachment plug at the supply end. The cord-exposed usable length, measured to the point of entry on the unit exterior, shall be a minimum of 7000 mm where the point of entrance is at the side of the unit, or shall be a minimum 8500 mm where the point of entrance is at the rear of the unit. The maximum length shall not exceed 11m.

CORD

Cord Length

- Where the cord entrance into the unit is more than 900mm above the ground, the minimum cord lengths above shall be increased by the vertical distance of the cord entrance heights above 900mm.

CORD

Location

The point of entrance of a power-supply assembly shall be located on either side or the rear, within 450mm of an outside wall.

Labeling at Electrical Entrance

Each park trailer have a safety label with the signal word WARNING in minimum 6mm high letters and body text in minimum 3mm high letters on a contrasting background. The safety label shall be affixed to the exterior skin, at or near the point of entrance of the power-supply assembly and shall read, as appropriate:

CORD

THIS CONNECTION IS FOR
110-125-VOLT AC, 60 HZ,
30 AMPERE SUPPLY

THIS CONNECTION IS FOR
208Y/120-VOLT or 115/230-VOLT AC
3-POLE, 4-WIRE,
60 HZ, _____ AMPERE SUPPLY.

CORD

THIS CONNECTION IS FOR
230-VOLT AC, 2-POLE, 3-WIRE,
60-HZ, _____ AMPERE SUPPLY

Followed by

DO NOT EXCEED THE CIRCUIT RATING.

EXCEEDING THE CIRCUIT RATING MAY CAUSE A FIRE AND RESULT IN
DEATH OR SERIOUS INJURY.

The correct ampere rating shall be marked in the blank space.

PANELBOARD

Listed and Appropriately Rated

- A listed and appropriately rated panelboard shall be used. An equipment grounding material bar shall be attached inside the metal enclosure of the panelboard.

Location

- The panelboard shall be installed in a readily accessible location. Working clearance for the panelboard shall not be less than 600mm wide and 750mm deep.

PANELBOARD



Exception: Where the panelboard cover is exposed to the inside aisle space, one of the working clearance dimensions shall be permitted to be reduced to a minimum 550mm. A panelboard shall be considered exposed where the panelboard cover is within 50mm of the aisles finished surface or not more than 25mm from the backside of doors that enclose the space.

BRANCH CIRCUITS

Two to Five 15- or 20-Ampere Circuits

- A maximum of five 15 or 20-ampere circuits to supply lights, receptacle outlets, and fixed appliances shall be permitted.
- Such park trailers shall be permitted to be equipped with a panelboard rated at 230 volt maximum or 120/240 volt maximum and listed for a 30-ampere-rated main power supply assembly.

More Than Five Circuits

Lighting - Based on $33 \text{ volt-amperes/m}^2$ multiplied by the outside dimensions of the park trailer (coupler excluded) divided by 230 volts or 115 volts to determine the number of 15- or 20-ampere lighting area circuits

BRANCH CIRCUITS

General Appliances

1. The total rating of fixed appliances shall not exceed 50 percent of the circuit rating if lighting outlets, general-use receptacles, or both are also supplied.
2. For fixed appliances with a motor(s) larger than 1/8 horsepower, the total calculated load shall be based on 125 percent of the largest motor plus the sum of the other loads. Where a branch circuit supplies continuous load(s) or any combination of continuous and noncontinuous loads, the branch-circuit conductor size shall be in accordance with 2.10.19(A)

CALCULATIONS

The following method shall be employed in computing the supply-cord and distribution panelboard load for each feeder assembly for each park trailer in lieu of the procedure shown in Article 220 and shall be based on either a 2-wire, 230-volt supply, or 3-wire, 208Y/120-volt or 115/230-volt supply with 115-volt loads balanced between the two phases of the 3-wire system.

CALCULATIONS

Lighting and Small-Appliance Load:

- **Lighting Volt-Amperes:** Length times width of the park trailer floor (outside dimensions) times 33 volt-amperes m^2 . For example,

$$\text{Length} \times \text{width} \times 33 = \text{lighting volt-amperes}$$

- **Small-Appliance Volt-Amperes:** Number of circuits times 1500 volt-amperes for each 20-ampere appliance receptacle circuit including 1500 volt-amperes for laundry circuit. For example,

$$\text{No. of circuits} \times 1500 = \text{small-appliance volt-amperes}$$

CALCULATIONS

Lighting and Small-Appliance Load:

- Total: Lighting volt-amperes plus small-appliances volt-amperes = total volt-amperes
- First 3000 total volt-amperes at 100 percent plus remainder at 35 percent = volt-amperes to be divided by 230 volts to obtain current (amperes).

CALCULATIONS

Total Load for Determining Power Supply

1. Nameplate amperes for motors and heater loads (exhaust fans, air conditioners, electric, gas, or oil heating). Omit smaller of the heating and cooling loads, except include blower motor if used as air-conditioner evaporator motor. Where an air-conditioner is not installed and a 50-ampere power-supply cord is provided, allow 15 amperes per phase for air conditioning.
2. Total of nameplate amperes for disposal, dishwasher, water heater, clothes dryer, wall-mounted oven, cooking units. Where the number of these appliances exceeds three, use of 75 percent of total.
3. Derive amperes for freestanding range (as distinguished from separate ovens and cooking units) by dividing the following values by 230 volts.
4. If outlets or circuits are provided for other than factory-installed appliances, include the anticipated load.

WIRING METHODS

Conduit and Tubing

Where rigid metal conduit or intermediate metal conduit is terminated at an enclosure with a locknut and bushing connection, two locknuts shall be provided, one inside and one outside of the enclosure. All cut ends of conduit and tubing shall be reamed or otherwise finished to remove rough edges.

Nonmetallic Boxes

Nonmetallic boxes shall be acceptable only with nonmetallic-sheathed cable or nonmetallic raceways.

Boxes

In walls and ceilings constructed of wood or other combustible material, boxes and fittings shall be flush with the finished surface or project therefrom.

WIRING METHODS

Mounting

Wall and ceiling boxes shall be mounted in accordance with Article 3.14.

Exception No.1: Snap-in-type boxes or boxes provided with special wall or ceiling brackets that securely fasten boxes in walls or ceilings shall be permitted.

Exception No.2: A wooden plate providing a 38mm minimum width backing around the box and a thickness of 13mm or greater (actual) attached directly to the wall panel shall be considered as approved means for mounting outlet boxes.

WIRING METHODS

Cable Sheath

- The sheath of nonmetallic-sheathed cable, and the armor of metal-clad cable and Type AC cable, shall be continuous between outlet boxes and other enclosures.

Cable Supports:

- Where connected with cable connectors or clamps, cables shall be supported within 300 mm of outlet boxes, panelboards, and splice boxes on appliances. Supports shall be provided at intervals not exceeding 1400mm at other places.

WIRING METHODS

Protected

- Metal-clad, Type AC, or nonmetallic-sheathed cables and electrical nonmetallic tubing shall be permitted to pass through the centers of the wide side of 2 by 4 wood studs. However, they shall be protected where they pass through 2 by 2 wood studs or at other wood studs or frames where the cable or tubing would be less than 32 mm from the inside or outside surface.
- Steel plates on each side of the cable or tubing, or a steel tube, with not less than 1.35mm wall thickness, shall be installed to protect the cable or tubing. These plates or tubes shall be securely held in place. Where nonmetallic-sheathed cable pass through punched, cut, or drilled slots or holes in metal members, the cable shall be protected by bushing or grommets securely fastened in the opening prior to the installation of the cable.

WIRING METHODS

Nonmetallic Box Without Cable Clamps

Nonmetallic-sheathed cables shall be supported within 200mm of a nonmetallic outlet box without cable clamps. Where wiring devices with integral enclosures are employed with a loop of extra cable to permit future replacement of the device, the cable loop shall be considered as an integral portion of the device.

Physical Damage

Where subject to physical damage, exposed nonmetallic cable shall be protected by covering boards, guard strips, raceways, or other means.

WIRING METHODS

Moisture or Physical Damage

Where outdoor or under-chassis wiring is 115 volts, nominal, or over and is exposed to moisture or physical damage, the wiring shall be protected by rigid metal conduit, by intermediate metal conduit, by electrical metallic tubing, by rigid nonmetallic conduit, or by Type MI cable that is closely routed against frames and equipment enclosures or other raceway or cable identified for the application.

Component Interconnections

Fittings and connectors that are intended to be concealed at the time of assembly shall be listed and identified for the interconnection of building components. Such fittings and connectors shall be equal to the wiring method employed in insulation, temperature rise, and fault-current withstanding, and shall be capable of enduring the vibration and shock occurring in park trailers.

WIRING METHODS

Method of Connecting Expandable Units:

1. Cord-and-Plug Connected

- The portion of a branch circuit that is installed in an expandable unit shall be permitted to be connected to the portion of the branch circuit in the main body of the vehicle by means of a flexible cord or attachment plug and cord listed for hard usage. Where the attachment plug and cord are located within the park trailer's interior, use of plastic thermoset or elastomer parallel cord Type SPT-3, SP-3, or SPE shall be permitted.
- Where the receptacle provided for connection of the cord to the main circuit is located on the outside of the park trailer, it shall be protected with a ground-fault circuit interrupter for personnel and be listed for wet locations. A cord located on the outside of a park trailer shall be identified for outdoor use.
- Unless removable or stored within the unit interior, the cord assembly shall have permanent provisions for protection against corrosion and mechanical damage while the park trailer is in transit.

WIRING METHODS

2. Direct Wires Connected

- Where concealed, the flexible cord shall be installed in nonflexible conduit or tubing that is continuous from the outlet or junction box inside the park trailer to a weatherproof outlet box, junction box, or strain relief fitting listed for use in wet locations that is located on the underside of the park trailer. The outer jacket of flexible cord shall be continuous into the outlet or junction box.
- The flexible cord shall be listed for hard usage and for use in wet locations.
- The flexible cord shall be permitted to be exposed on the underside of the vehicle.
- The flexible cord shall be permitted to pass through the interior of a wall or floor assembly or both a maximum concealed length of 600 mm before terminating at an outlet or junction box.

WIRING METHODS

2. Direct Wires Connected

- Where the flexible cord passes through the floor to an exposed area inside of the park trailer, it shall be protected by means of conduit and bushings or equivalent.
- Where subject to physical damage, the flexible cord shall be protected with RMC, IMC, Schedule 80 PVC, reinforced thermosetting resin conduit (RTRC) listed for exposure to physical damage, or other approved means and shall extend at least 150mm above the floor.

WIRING METHODS

Prewiring for Air-Conditioning Installation

- An overcurrent protective device with a rating compatible with the circuit conductors shall be installed in the panelboard an wiring connections completed.
- The load end of the circuit shall terminate in a junction box with a blank cover or other listed enclosure. Where a junction box with a blank cover is used, the free ends of the conductors shall be adequately capped or taped.
- A safety label with the word **WARNING** in minimum 6mm high letters and body text in minimum 3mm high letters on a contrasting background shall be affixed on or adjacent to the junction box and shall read as follows:

WIRING METHODS

WARNING

AIR-CONDITIONING CIRCUIT.

THIS CONNECTION IS FOR AIR CONDITIONERS RATED
110-125-VOLT AC, 60 HZ, _____ AMPERES MAXIMUM.

DO NOT EXCEED CIRCUIT RATING.

EXCEEDING THE CIRCUIT RATING MAY CAUSE A FIRE AND RESULT
IN DEATH OR SERIOUS INJURY

WIRING METHODS

WARNING

AIR-CONDITIONING CIRCUIT.

THIS CONNECTION IS FOR AIR CONDITIONERS RATED
230-VOLT AC, 60 HZ, _____ AMPERES MAXIMUM.

DO NOT EXCEED CIRCUIT RATING.

EXCEEDING THE CIRCUIT RATING MAY CAUSE A FIRE AND RESULT IN
DEATH OR SERIOUS INJURY

An ampere rating, not to exceed 80 percent of the circuit rating, shall
be legibly marked in the blank space.

WIRING METHODS

Prewiring for Other Circuits

- An overcurrent protection device with a rating compatible with the circuit conductors shall be installed in the panelboard with wiring connections completed.
- The load end of the circuit shall terminate in a junction box with a blank cover or a device listed for the purpose. Where a junction box with blank cover is used, the free ends of the conductors shall be adequately capped or taped.

WIRING METHODS



Prewiring for Other Circuits

A safety label with the signal word **WARNING** in minimum 6mm high letters and body text in minimum 3mm high letters on a contrasting background shall be affixed on or adjacent to the junction box or device listed for the purpose and shall read as follows:

WIRING METHODS

WARNING

THIS CONNECTION IS FOR ___RATED___ VOLT AC, 60 HZ,
_____ AMPERES MAXIMUM.

DO NOT EXCEED CIRCUIT RATING.

EXCEEDING THE CIRCUIT RATING MAY CAUSE A FIRE AND RESULT IN
DEATH OR SERIOUS INJURY.

An ampere rating not exceed 80 percent of the circuit rating shall be legibly marked in the blank space.

SWITCHES

Lighting Circuits

For lighting circuits, switches shall be rated not less than 10 amperes, 250 volts or 125 volts, and in no case less than the connected load.

Motors or Other Loads

For motors or other loads, switches shall have ampere or horsepower ratings, or both, adequate for loads controlled. (An ac general-use snap switch shall be permitted to control a motor 2 hp or less with full-load current not over 80 percent of the switch ampere rating.)

INTERIOR EQUIPMENT GROUNDING

Exposed Metal Parts

In electrical system, all exposed metal parts, enclosures, frames, luminaire canopies, and so forth, shall be effectively bonded to the grounding terminals or enclosure of the panelboard.

Equipment Grounding Conductors

Bare conductors or conductors with insulation or individual covering that is green or green with one or more yellow stripes shall be used for equipment grounding conductors only.

INTERIOR EQUIPMENT GROUNDING

Grounding of Electrical Equipment

1. Connection of metal raceway (conduit or electrical metallic tubing), the sheath of Type MC and Type MI cable where the sheath is identified for grounding, or the armor of Type AC cable to metal enclosures.
2. A connection between the one or more equipment grounding conductors and a metal box by means of a grounding screw, which shall be used for no other purposes, or a listed grounding device.
3. The equipment grounding conductor in nonmetallic-sheathed cable shall be permitted to be secured under a screw threaded into the luminaire canopy other than a mounting screw or cover screw or attached to a listed grounding means (plate) in a nonmetallic outlet box for luminaire mounting (grounding means shall also be permitted for luminaire attachment screws).

INTERIOR EQUIPMENT GROUNDING

Grounding Connection in Nonmetallic Box

A connection between the one or more grounding conductors brought into a nonmetallic outlet box shall be arranged so that a connection can be made to any fitting or device in that box that requires grounding.

Grounding Continuity

Where more than one equipment grounding conductor of a branch circuit enters a box, all such conductors shall be in good electrical contact with each other, and the arrangement shall be such that the disconnection or removal of a receptacle, fixture, including a luminaire, or other device fed from the box will not interfere with or interrupt the grounding continuity

INTERIOR EQUIPMENT GROUNDING

Cord-Connected Appliances

Cord-connected appliances, such as washing machines, clothes dryers, refrigerators, and the electrical system of gas ranges, and so on, shall be grounded by means of an approved cord with equipment grounding conductor and grounding-type attachment plug.

Bonding of Non-Current-Carrying Metal Parts

Required Bonding

All exposed non-current-carrying metal parts that are likely to become energized shall be effectively bonded to the grounding terminal or enclosure of the panelboard.

Bonding Chassis

A bonding conductor shall be connected between any panelboard and an accessible terminal on the chassis. Aluminum or copper-clad aluminum conductors shall not be used for bonding if such conductors or their terminals are exposed to corrosive elements.

Exception: Any park trailer that employs a unitized metal chassis-frame construction to which the panelboard is securely fastened with a bolt(s) and nut(s) or by welding or riveting shall be considered to be bonded.

OUTDOOR OUTLETS, FIXTURES, INCLUDING LUMINAIRES, AIR-COOLING EQUIPMENT, AND SO ON

A park trailer provided with a branch circuit designed to energize outside heating equipment or air-conditioning equipment, or both, located outside the park trailer, other than room air conditioners, shall have such branch circuit conductors terminate in a listed outlet box or disconnecting means located on the outside of the park trailer.

A safety label with the word **WARNING** in minimum 6mm high letters and body text in minimum 3mm high letters on a contrasting background shall be affixed within 150mm from the listed box or disconnecting means shall read as follows:

WARNING

THIS CONNECTION IS FOR HEATING AND/OR AIR-CONDITIONING EQUIPMENT.

THE BRANCH CIRCUIT IS RATED AT NOT MORE THAN _____ AMPERES, AT _____ VOLTS, 60 HZ, _____ CONDUCTOR AMPACITY. A DISCONNECTING MEANS SHALL BE LOCATED WITHIN SIGHT OF THE EQUIPMENT.

EXCEEDING THE CIRCUIT RATING MAY CAUSE A FIRE AND RESULT IN DEATH OR SERIOUS INJURY.

The correct voltage and ampere rating shall be given.

FACTORY TESTS

FACTORY TESTS (ELECTRICAL)

Circuits of 230 Volts or 115/230 Volts

- Each park trailer designed with a 230-volt or 115/230-volt electrical system shall withstand the applied voltage without electrical breakdown of a 1-minute, 900-volt dielectric strength test, or a 1-second, 1080-volt dielectric strength test, with all switches closed, between ungrounded and grounded conductors and the park trailer ground. During the test, all switches and controls shall be in the “on” position.

FACTORY TESTS (ELECTRICAL)

Circuits of 230 Volts or 115/230 Volts

Fixtures, including luminaires, and permanently installed appliances shall not be required to withstand this test. Each park trailer shall be subjected to the following:

- A continuity test to ensure that all metal parts are properly bonded
- Operational tests to demonstrate that all equipment is properly connected and in working order
- Polarity checks to determine that connections have been properly made

FLOATING BUILDINGS

The image features a dark blue, arrow-shaped graphic pointing to the right, which contains the text 'FLOATING BUILDINGS'. Below this graphic is a horizontal orange bar with a 3D effect, set against a background of light blue and white geometric shapes.

DEFINITION

Floating Building

A building unit, as defined in Article 1.1, that floats on water, is moored in a permanent location, and has a premises wiring system served through connection by permanent wiring to an electrical supply system not located on the premises.

SERVICES AND FEEDERS

LOCATION OF SERVICE EQUIPMENT

- The service equipment for a floating building shall be located adjacent to, but not in or on, the building or any floating structure. The main overcurrent protective device that feeds the floating structure shall have ground fault protection not exceeding 100mA. Ground fault protection of each individual branch or feeder circuit shall be permitted as a suitable alternative.

FEEDER CONDUCTORS



Each floating building shall be supplied by a single set of feeder conductors from its service equipment.

Exception: Where the floating building has multiple occupancy, each occupant shall be permitted to be supplied by a single set of feeder conductors extended from the occupants service equipment to the occupants panelboard.

INSTALLATION OF SERVICES AND FEEDERS

Flexibility

- Flexibility of the wiring system shall be maintained between floating buildings and the supply conductors. All wiring shall be installed so that motion of the water surface and changes in the water level will not result in unsafe conditions.

Wiring Methods:

- Liquidtight flexible metal conduit or liquidtight flexible nonmetallic conduit with approved fittings shall be permitted for feeders and where flexible connections are required for services. Extra-hard usage portable power cable listed for both wet locations and sunlight resistance shall be permitted for a feeder to a floating building where flexibility is required. Other raceways suitable for the location shall be permitted to be installed where flexibility is not required.

GROUNDING

INSULATED NEUTRAL

- The neutral conductor shall be connected to the equipment grounding terminal in the service equipment, and, except for that connection, it shall be insulated from the equipment grounding conductors, equipment enclosures, and all other grounded parts.

EQUIPMENT GROUNDING

Electrical Systems

- All enclosures and exposed metal parts of electrical systems shall be connected to the grounding bus.

Cord-Connected Appliances

- Where required to be grounded, cord-connected appliances shall be grounded by means of an equipment grounding conductor in the cord and a grounding-type attachment plug.

BONDING OF NON-CURRENT-CARRYING METAL PARTS

- All metal parts in contact with the water, all metal piping, and all non-current-carrying metal parts that are likely to become energized shall be connected to the grounding bus in the panelboard.

MARINAS AND BOATYARDS

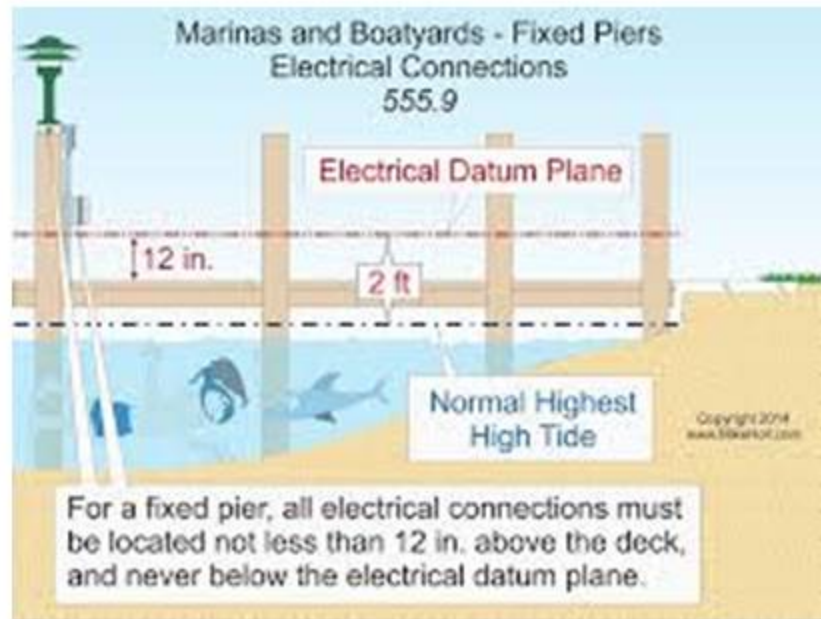
The background features a light blue gradient. A large, dark blue arrow-shaped graphic points from the left towards the right, containing the text. Below this, a horizontal orange bar with a 3D effect is positioned. The overall design is modern and geometric.



DEFINITIONS

Electrical Datum Plane

In land areas subject to tidal fluctuation, the electrical datum plane is a horizontal plane 2 ft above the highest tide level and water level for the area occurring under normal circumstances, that is, maximum high tide.

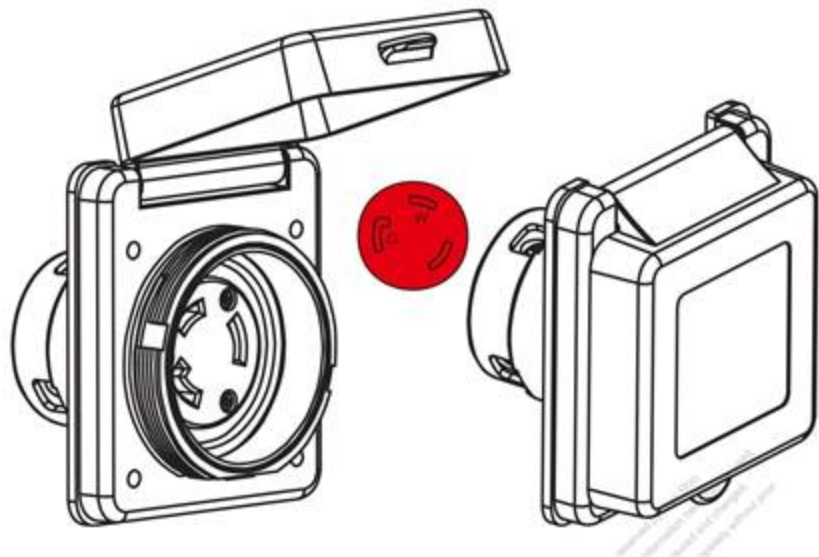




DEFINITIONS.

Marine Power Outlet

An enclosed assembly that can include equipment such as receptacles, circuit breakers, fused switches, fuses, a watt-hour meter(s), panel boards, and monitoring means approved for marine use.





GROUND-FAULT PROTECTION.

The **overcurrent protective devices** that supply the marina, boatyards and commercial and noncommercial docking facilities **shall** have ground-fault protection not exceeding **30mA**.



Distribution System.

Yard and pier distribution systems shall not exceed 1000 V phase to phase.

Transformers.

Transformers and enclosures shall be specifically approved for the intended location. The bottom of enclosures for transformers shall not be located below the electrical datum plane.



Location of Service Equipment

The service equipment for floating docks or marinas shall be location adjacent to, but not on or in, the floating structure.

Electrical Connections.

All electrical connections shall be located at least 305 mm (1.2 in) above the deck of a fixed pier but not below the electrical datum plane.



ELECTRICAL EQUIPMENT ENCLOSURES.

(A) Securing and Supporting. Electrical equipment enclosures installed on piers above deck level shall be securely and substantially supported by structural members, independent of any conduit connected to them. If enclosures are not attached to mounting surfaces by means of external ears or lugs, the internal screw heads shall be sealed to prevent seepage of water through mounting holes.

(B) Location. Electrical equipment enclosures on piers shall be located so as not to interfere with mooring lines.



Circuit Breakers, Switches, Panel boards and Marine Power Outlets.

Circuit breakers and switches installed in gasketed enclosures shall be arranged to permit required manual operation without exposing the interior of the enclosure. All such enclosures shall be arranged with a weep hole to discharge condensation.

Load Calculations for Service and Feeder Conductors.

General lighting and other loads shall be calculated in accordance with Part III of Article 2.20, and, in addition, the demand factor set forth in Table 5.55.1.12 shall be permitted for each service and/or feeder circuit supplying receptacles that provide shore power for boats.



TABLE 5.55.1.12 DEMAND FACTORS

Number of Shore Power Receptacles	Sum of the Rating of the Receptacles (%)
1-4	100
5-8	90
9-14	80
15-30	70
31-40	60
41-50	50
51-70	40
≥71	30

Notes:

1. Where shore power accommodations provide two receptacles specifically for an individual boat slip and these receptacles have different voltages (for example, one 30 A, 125 V and one 50 A, 125/250 V), only the receptacle with the larger kilowatt demand **shall** be required to be calculated.
2. If the facility being installed includes individual kilowatt-hour submeters for each slip and is being calculated using the criteria listed in Table 5.55.1.12, the total demand amperes may be multiplied by 0.9 to achieve the final demand amperes.



WIRING METHODS AND INSTALLATION.

(A) Wiring Methods

(1) **General.** Wiring methods of Chapter 3 shall be permitted where identified for use in wet locations.

(2) **Portable Power Cables.** Extra-hard usage portable power cables rated not less than 75°C, 600 V; listed for both wet locations and sunlight resistance; and having an outer jacket rated to be resistance to temperature extremes, oil, gasoline, ozone, abrasion, acids, and chemicals shall be permitted as follows:



(B) INSTALLATION

(1) Overhead Wiring. Overhead wiring shall be installed to avoid possible contact with masts and other parts of boats being moved in the yard.

Conductors and cables shall be routed to avoid wiring closer than 6000 mm from the outer edge or any portion of the yard that can be used for moving vessels or stepping or un-stepping masts.

(2) Outside Branch Circuits and Feeders.

Outside branch circuits and feeders shall comply with Article 2.25 except that clearances for overhead wiring in portions of the yard other than those described in a certain table shall not be less than 5500 mm above grade.



(3) PORTABLE POWER CABLES.

- (a) Where portable power cables are permitted by a certain table, the installation **shall** comply with the following:
- (1) Cables **shall be** properly supported.
 - (2) Cables **shall be** located on the underside of the pier.
 - (3) Cables **shall be** securely fastened by nonmetallic clips to structural members other than the deck planking.
 - (4) Cables **shall not be** installed where subject to physical damage.
 - (5) Where cables pass through structural members, they **shall be** protected against chafing by a permanently installed oversized sleeve of nonmetallic material.



(4) PROTECTION

Rigid metal conduit, reinforced thermosetting resin conduit (RTRC) listed for aboveground use, or rigid polyvinyl chloride (PVC) conduit suitable for the location, shall be installed to protect wiring above decks of piers and landing stages and below the enclosure that it serves. The conduit shall be connected to the enclosure by full standard threads or fittings listed for use in damp or wet locations, as applicable.





GROUNDING

Wiring and equipment Within the scope of this article shall be grounded as specified in an article in Chapter 2 and as required by a certain table.

(A) Equipment to Be Grounded. The following items shall be connected to an equipment Wounding conductor run with the circuit conductors in the same raceway, cable, or trench:

- (1) Metal boxes, metal cabinets, and all other metal enclosures
- (2) Metal frames of utilization equipment
- (3) Grounding terminals of grounding-type receptacles



GROUNDING

(B) Type of Equipment Grounding Conductor. The equipment grounding conductor shall be an insulated conductor with a continuous outer finish that is either green or green with one or more yellow stripes. The equipment Wounding conductor of Type MI cable shall be permitted to be identified at terminations. For conductors larger than 14 mm^2 , or where multiconductor cables are used, reidentification of conductors as allowed in certain tables shall be permitted.



GROUNDING

(C) Size of Equipment Grounding Conductor. The insulated equipment grounding conductor shall be sized in accordance with a certain table but not smaller than **3.5 mm² (2.0 mm dia.)**.

(D) Branch-Circuit Equipment Grounding Conductor. The insulated equipment conductor for branch circuits shall terminate at a grounding terminal in a remote panelboard or the grounding terminal in the main service equipment.

(E) Feeder Equipment Grounding Conductors. Where a feeder supplies a remote panelboard, an insulated equipment grounding conductor shall extend from a grounding terminal in the service equipment to a grounding terminal in the remote panelboard.



DISCONNECTING MEANS FOR SHORE POWER CONNECTION(S)

Disconnecting means shall be provided to isolate each boat from its supply connection(s).

(A) Type. The disconnecting means shall consist of a circuit breaker, switch, or both, and shall be properly identified as to which receptacle it controls.

(B) Location. The disconnecting means shall be readily accessible, located not more than 762 mm the receptacle it controls, and shall be located in the supply circuit ahead of the receptacle. Circuit breakers or switches located in marine power outlets complying with this section shall be permitted as the disconnecting means.



RECEPTACLES

Receptacles shall be mounted not less than 305 mm above the deck surface of the pier and not below the electrical datum plane on a fixed pier.

(A) Shore Power Receptacles

(1) Enclosures. Receptacles intended to supply shore power to boats shall be housed in marine power outlets listed as marina power outlets or listed for set locations, or shall be installed in listed enclosures protected from the weather or in listed weatherproof enclosures. The integrity of the assembly shall not be affected when the receptacles are in use with any type of booted or non-booted attachment plug/cap inserted.



(A) SHORE POWER RECEPTACLES

(2) Strain Relief. Means **shall be** provided where necessary to reduce the strain on the plug and receptacle caused by the weight and catenary angle of the shore power cord.

(3) Branch Circuits. Each single receptacle that supplies shore power to boats **shall be** supplied from a marine power outlet or panelboard by an individual branch circuit of the voltage class and rating corresponding to the rating of the receptacle.


(4) Ratings. Shore power for boats **shall be** provided by single receptacles rated not less than **30 amperes**.



(B) OTHER THAN SHORE POWER.


(1) Ground-Fault Circuit-Interrupter (GFCI) Protection for Personnel. Fifteen- and **20-ampere**, single-phase, **250-volt** and/or **125-volt** receptacles installed outdoors, in boathouses, in buildings or structures used for storage, maintenance, or repair **shall be** provided with GFCI protection for personnel.

(2) Marking. Receptacles other than those supplying shore power to boats **shall be** permitted to be housed in marine power outlets with the receptacles that provide shore power to boats, provided they are marked to clearly indicate that they are not to be used to supply power to boats.



Motor Fuel Dispensing Stations Hazardous (Classified) Locations. Electrical wiring and equipment located at or serving motor fuel dispensing locations shall comply with Article 5.14 in addition to the requirements of this article.

Repair Facilities - Hazardous (Classified) Locations. Electrical wiring and equipment located at facilities for the repair of marine craft containing flammable or combustible liquids or gases shall comply with Article 5.11 in addition to the requirements of this article.



Marine Hoists, Railways, Cranes, and Monorails. Motors and controls for marine hoists, railways, cranes, and monorails **shall not be** located below the electrical datum plane. Where it is necessary to provide electric power to a mobile crane or hoist in the yard and a trailing cable is utilized, it **shall be** a listed portable power cable rated for the conditions of use and be provided with an outer jacket of distinctive color for safety.

Signage. Permanent safety signs **shall be** installed to give notice of electric shock hazard risks to persons using or swimming near a boat dock or marina and **shall** comply with all of the following:



(1) The signage **shall** comply with 1.10.1.21(B)(1) and be of sufficient durability to withstand the environment.

(2) The signs **shall be** clearly visible from all approaches to a marina or boatyard facility.

(3) The signs **shall** state "WARNING -- POTENTIAL ELECTRICAL SHOCK HAZARD -- A CURRENTS MAY BE PRESENT IN THE WATER."

TEMPORARY INSTALLATIONS

The image features a dark blue diagonal banner on a light blue background. The banner contains the text 'TEMPORARY INSTALLATIONS' in white, bold, sans-serif font. Below the banner, there is a horizontal orange bar with a 3D effect, and a white diagonal shape at the bottom right corner.



TIME CONSTRAINTS

(A) During the Period of Construction. Temporary electric power and lighting installations **shall be** permitted during the period of construction, remodeling, maintenance, repair, or demolition of buildings, structures, equipment, or similar activities.

(B) 90 Days. Temporary electric power and lighting installations **shall be** permitted for a period not to exceed 90 days for holiday decorative lighting and similar purposes.



TIME CONSTRAINTS

(C) Emergencies and Tests. Temporary electric power and lighting installations **shall be** permitted during emergencies and for tests, experiments, and developmental work.

(D) Removal. Temporary wiring **shall be** removed immediately upon completion of construction or purpose for which the wiring was installed.



GENERAL

- (A) Services.** Services shall be installed in conformance with a certain article as applicable.
- (B) Feeders.** Overcurrent protection shall be provided in accordance to some prementioned tables.
- (C) Branch Circuits.** All branch circuits shall originate in an approved power outlet, switchgear, switchboards, or panelboard, motor control center, or fused switch enclosure.



GENERAL

(D) Receptacles

(1) All Receptacles. All receptacles shall be of the grounding continuous type. Unless installed in a metal raceway that qualifies as an equipment with grounding conductor in accordance with a certain table cable that or a continuous metal-covered conductor qualifies as an equipment grounding circuits shall in accordance with a prementioned table, all branch circuits shall include a separate equipment grounding conductor, and all receptacles shall be electrically connected to the equipment grounding conductor(s).

(2) Receptacles in Wet Locations. All 15- and 20-ampere, 125- and 250-volt receptacles installed in a wet location shall comply with a table in Chapter 4.



GENERAL

(E) Disconnecting Means. Suitable disconnecting switches or plug connectors shall be installed to permit the disconnection of all ungrounded conductors of each temporary circuit. Multiwire branch circuits shall be provided with a means to disconnect simultaneously all ungrounded conductors at the power outlet or panelboard where the branch circuit originated. Identified handle ties shall be permitted.

(F) Lamp Protection. All lamps for general illumination shall be protected from accidental contact or breakage by a suitable luminaire or lamp-holder with a guard



GENERAL

(G) Splices. A box, conduit body, or other enclosure, with a cover installed, **shall be** required for all splices except where:

- (1) The circuit conductors being spliced are all from nonmetallic multiconductor cord or cable assemblies, provided that the equipment grounding continuity is maintained with or without the box.
- (2) The circuit conductors being spliced are all from metal sheathed cable assemblies terminated in listed fittings that mechanically secure the cable sheath to maintain effective electrical continuity.



GENERAL

(H) Protection from Accidental Damage. Flexible cords and cables **shall be** protected from accidental damage. Sharp corners and projections **shall be** avoided. Where passing through doorways or other pinch points, protection **shall be** provided to avoid damage.

(I) Termination(s) at Devices. Flexible cords and cables entering enclosures containing devices requiring termination **shall be** secured to the box with fittings listed for connecting flexible cords and cables to boxes designed for the purpose.



GENERAL

(J) Support. Cable assemblies and flexible cords and cables shall be supported in place at intervals at dam ensure that they will be protected from physical damage. Support shall be in the form of staples, cable or similar type fittings installed so as not to cause damage. Cable assemblies and flexible cords and cables installed as branch circuits or feeders shall not be installed on the floor or on the ground. Extension cords shall not be required to comply with 5.90.1.4(J). Vegetation Shall not be used for support of overhead spans of branch circuits or feeders.



LISTING OF DECORATIVE LIGHTING

Decorative lighting used for holiday lighting and similar purposes, in accordance with 5.90.1.3(B), shall be listed and shall be labeled on the product.



GROUND-FAULT PROTECTION FOR PERSONNEL

Ground-fault protection for personnel for all temporary wiring installations **shall be** provided to comply with 5.90.1.6(A) and (B). This section **shall** apply only to temporary wiring installations used to supply temporary power to equipment used by personnel during construction, remodeling, maintenance, repair, or demolition of buildings, structures, equipment, or similar activities. This section **shall** apply or to power derived from an electric utility company or from an on-site-generated power source.



(A) RECEPTACLE OUTLETS

(1) Receptacle Outlets Not Part of Permanent Wiring. All 250-volt and 125-volt, single-phase, 15-, 20-, and 30-ampere receptacle outlets that are not a part of the permanent wiring of the building or structure and that are in use by personnel **shall** have ground-fault circuit-interrupter protection for personnel.


(2) Receptacle Outlets Existing or Installed as Permanent Wiring. Ground-fault circuit-interrupter protection for personnel **shall be** provided for all 250-volt and 125-volt, single-phase, 15-, 20-, and 30-ampere receptacle outlets installed or existing as part of the permanent wiring of the building or structure and used for temporary electric power.

(3) Receptacles on 15-kW or less Portable Generators. All 125-volt and 125/250-volt, single-phase, 15-, 20-, and 30-ampere receptacle outlets that are a part of a 15-kW or smaller portable generator **shall** have listed ground-fault circuit-interrupter protection for personnel.



(B) Use of Other Outlets

- (1) GFCI Protection.** Ground-fault circuit-interrupter protection for personnel.
- (2) SPGFCI Protection.** Special purpose ground-fault circuit-interrupter protection for personnel.
- (3) Assured Equipment Grounding Conductor Program.** A written assured equipment grounding conductor program continuously enforced at the site by one or more designated persons to ensure that equipment grounding conductors for all cord sets, receptacles that are not a part of the permanent wiring of the building or structure, and equipment connected by cord and plug are installed and maintained in accordance with the applicable requirements of some previous topics, and 5.90.1.4(D).



(a) The following tests shall be performed on all cord sets, receptacles that are not part of the permanent wiring of the building or structure, and cord-and-plug-connected equipment required to be connected to an equipment grounding conductor:

(1) All equipment grounding conductors shall be tested for continuity and shall be electrically continuous.

(2) Each receptacle and attachment plug shall be tested for correct attachment of the equipment grounding conductor. The equipment grounding conductor shall be connected to its proper terminal.

(3) All required tests shall be performed as follows:

- a. Before first use on site
- b. When there is evidence of damage
- c. Before equipment is returned to service following any repairs
- d. At intervals not exceeding 3 months



THANKS!