NFPA 70/99 Workshop

Healthcare Electrical Systems
2018

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Article 517--Health Care Facilities

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517.1 Scope.

- **The provisions of this article shall apply to electrical construction and installation criteria in health care facilities that provide services to human beings.**

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517.1 Scope.

- This article applies to electrical construction and installation criteria in health care facilities that provide services to human beings.
- The requirements in Parts II and III not only apply to single-function buildings but are also intended to be individually applied to their respective forms of occupancy within a multifunction building (e.g., a doctor's examining room located within a limited care facility would be required to meet 517.10).
- **Informational Note No. 1: For information concerning performance, maintenance, and testing criteria, refer to the appropriate health care facilities documents.**
- **Informational Note No. 2: Text that is followed by a reference in brackets has been extracted from NFPA 99-2018, Health Care Facilities Code, and NFPA 101-2018, Life Safety Code. Only editorial changes were made to the extracted text to make it consistent with this Code.**

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517.2 Definitions for Health Care Facilities

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Health Care Facilities.

- **Buildings, portions of buildings, or mobile enclosures in which human medical, dental, psychiatric, nursing, obstetrical, or surgical care are provided. [99:3.3.71]**
- **Informational Note: Examples of health care facilities include, but are not limited to, hospitals, nursing homes, limited care facilities, clinics, medical and dental offices, and ambulatory care centers, whether permanent or movable.**

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Hospital.

- **A building or portion thereof used on a 24-hour basis for the medical, psychiatric, obstetrical, or surgical care of four or more inpatients. [*101*:3.3.150]**

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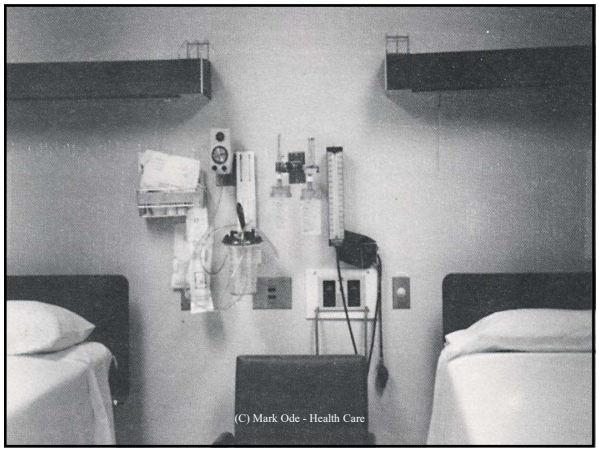

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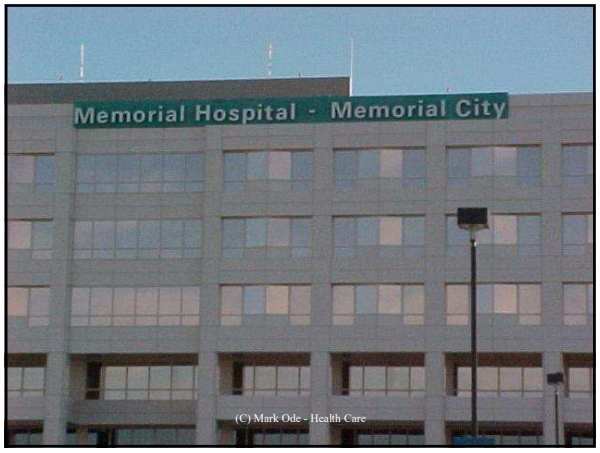

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Limited Care Facility.

- A building or portion thereof used on a 24-hour basis for the housing of four or more persons who are incapable of self-preservation because of age; physical limitation due to accident or illness; or limitations such as intellectual disability/developmental disability, mental illness, or chemical dependency.

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Ambulatory Health Care Facility.

- 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.
- Treatment 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. [101:3.3.196.1]

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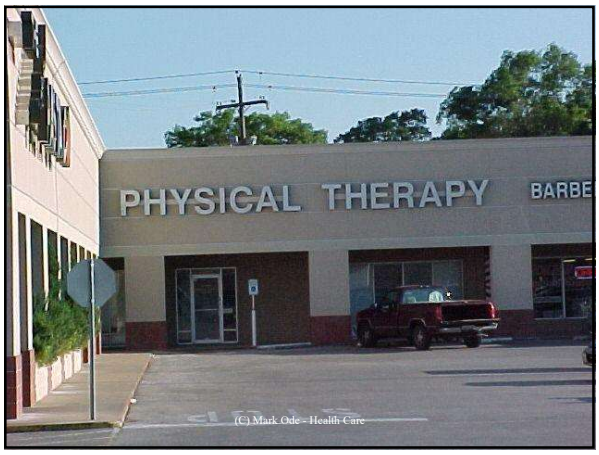

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Medical Office

- **A building or part thereof in which the following occur:**
- **Examinations and minor treatments/procedures are performed under the continuous supervision of a medical professional;**
- **The use of limited to minimal sedation and treatment or procedures that do not render the patient incapable of self-preservation under emergency conditions; and**
- **No overnight stays for patients or 24-hour operations.**
- **[99:3.3.106]**

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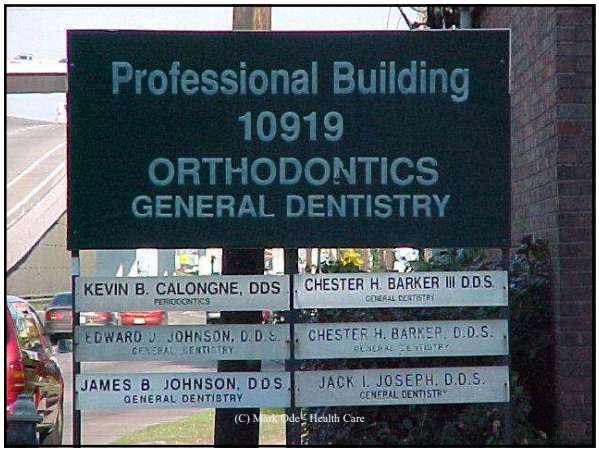

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NFPA 99--3.3.166 Site of intentional expulsion:

All points within 1 ft (0.3 m) of a point at which an oxygen-enriched atmosphere is intentionally vented to the atmosphere. (MED)

- **A.3.3.166 . This definition addresses the site of intended expulsion. Actual expulsion can occur at other sites remote from the intended site due to disconnections, leaks, or rupture of gas conduits and connections.**
- **Vigilance on the part of the patient care team is essential to ensure system integrity.**
- **For example, for a patient receiving oxygen via a nasal cannula or face mask, the site of expulsion normally surrounds the mask or cannula; for a patient receiving oxygen while enclosed in a canopy or incubator, the site of intentional expulsion normally surrounds the openings to the canopy or incubator; for a patient receiving oxygen while on a ventilator, the site of intentional expulsion normally surrounds the venting port on the ventilator.**

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NFPA 99--3.3.91 Laboratory

A building, space, room, or group of rooms intended to serve activities involving procedures for investigation, diagnosis, or treatment in which flammable, combustible, or oxidizing materials are to be used.

- **A.3.3.91 Laboratory. These laboratories are not intended to include isolated frozen section laboratories; areas in which oxygen is administered; blood donor rooms in which flammable, combustible, or otherwise hazardous materials normally used in laboratory procedures are not present; and clinical service areas not using hazardous materials.**

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NFPA 99--Chapter 6 Electrical Systems

- **6.1* Applicability.**
- **6.1.1 Electrical Installation.** Installation shall be in accordance with *NFPA 70.*
- **6.1.2** This chapter shall apply to new health care facilities as specified in Section 1.3.
- **6.3.1 Sources.** Each health care appliance requiring electrical line power for operation shall be supported by power sources that provide power adequate for each service.

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NFPA 99--Chapter 6 Electrical Systems

- **6.3.1 Sources.** Each health care appliance requiring electrical line power for operation shall be supported by power sources that provide power adequate for each service.

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II. Wiring and Protection

- **517.10. (A) Applicability**
- **Part II shall apply to patient care space of all health care facilities.**

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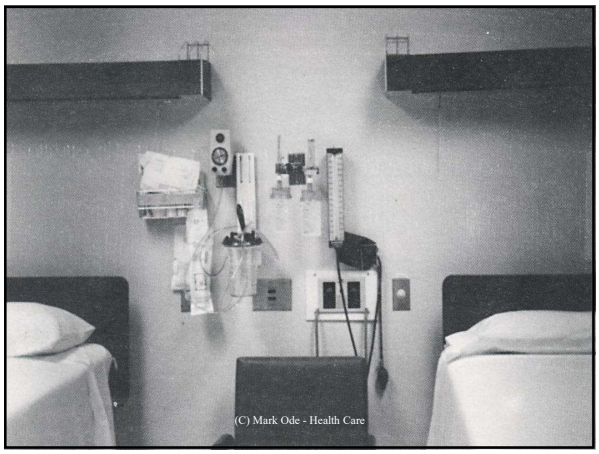

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517.10(B) Applicability (Health Care Facilities)

- New areas in the 2020 NEC **not covered** by the wiring and protection methods of **Part II of Article 517** *[Intramuscular injections (immunizations), etc.]* have been added to 517.10(B)
- Areas used exclusively for intramuscular injections (immunizations), psychiatry and psychotherapy, alternative medicine, and optometry are areas **not applicable** to Part II of Article 517
- Part II of Article 517 means that the wiring methods in a **patient care space** must consist of a **metal raceway system** or a cable having a metallic armor or sheath assembly that qualifies as an as an EGC in accordance with 250.118 [517.13(A)] ***and*** an have **insulated copper EGC** installed with the metallic raceway [517.13(B)] *(sometimes referred to as a "redundant" grounding)*
- Shock hazards are greatly reduced with **no invasive procedures** performed and **no electro-medical equipment** connected to the body or patient

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II. Wiring and Protection

- **(B) Not Covered.**
- **Part II shall not apply to the following:**
- **(1) Business offices, corridors, waiting rooms, and the like in clinics, medical and dental offices, and outpatient facilities**
- **(2) Areas of nursing homes and limited care facilities wired in accordance with Chapters 1 through 4 of this Code where these areas are used exclusively as patient sleeping rooms**
- **(3) Areas used exclusively for any of the following purposes:**
- **a. Intramuscular injections (immunizations)**
- **b. Psychiatry and psychotherapy**
- **c. Alternative medicine**
- **d. Optometry**
- **Informational Note: See NFPA 101-2018, Life Safety Code.**

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517.10(B) Not Covered - Wiring and Protection - Health Care Facilities

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517.11. General Installation — Construction Criteria

- **It is the purpose of this article to specify the installation criteria and wiring methods that will minimize electrical hazards by:**
  - **the maintenance of adequately low-potential differences only between exposed conductive surfaces**
  - **that are likely to become energized and**
  - **could be contacted by a patient.**

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Microspector-Test Equipment for Leakage

- **A battery-operated precision instrument for use on all hospital electrical equipment.**
- **This instrument measures and detects line voltage and leakage current between the grounding pole of a receptacle and the exposed conductive surfaces of nonelectrical equipment, or between the grounding pole and conductive surfaces of fixed or portable electrical equipment. (Neurodyne-Dempsey, Inc.)**

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NFPA 99--10.3.5.3 Touch Leakage Test Procedure.

- Measurements shall be made using the circuit, such as the one illustrated in Figure 10.3.5.3, with the appliance ground broken in two modes of appliance operation as follows:
- (1) Power plug connected normally with the appliance on
- (2) Power plug connected normally with the appliance off (if equipped with an on/off switch)

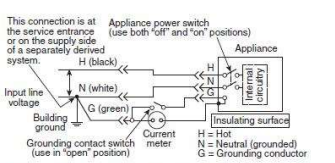

FIGURE 10.3.5.3 Example Test Circuit for Measuring Touch Leakage Current.

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NFPA 99--10.3.5.3 Touch Leakage Test Procedure.

- 10.3.5.3.1 If the appliance has fixed redundant grounding (e.g., permanently fastened to the grounding system), the touch leakage current test shall be conducted with the redundant grounding intact.

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NFPA 99--10.3.6* Lead Leakage Current Tests and Limits — Portable Equipment.

- 10.3.6.1 The leakage current between all patient leads connected together and ground shall be tested with the power plug connected normally and the device powered on.
- 10.3.6.2 The leakage current between all patient leads connected together and ground shall be measured with the ground switch open and with the ground switch closed.

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NFPA 99--10.3.6* Lead Leakage Current Tests and Limits — Portable Equipment.

- **10.3.6.3** An acceptable test configuration shall be as illustrated in Figure 10.3.6.3.
- **10.3.6.4** The leakage current shall not exceed 100 μA for ground wire closed and 500 μA ac for ground wire open.

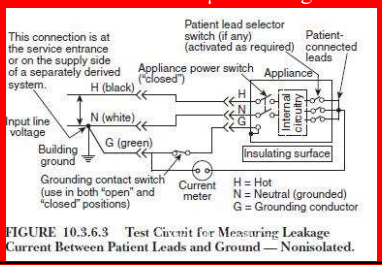

FIGURE 10.3.6.3 Test Circuit for Measuring Leakage Current Between Patient Leads and Ground — Nonisolated.

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A Conductive or Capacitive Path

- Informational Note: In a health care facility, it is difficult to prevent the occurrence of a conductive or capacitive path from the patient's body to some grounded object,
- because that path may be established accidentally or through instrumentation directly connected to the patient.

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Electrically Conductive Surfaces

- Other electrically conductive surfaces that may make an additional contact with the patient, or instruments that may be connected to the patient, then become possible sources of electric currents that can traverse the patient's body.
- The hazard is increased as more apparatus is associated with the patient, and, therefore, more intensive precautions are needed.

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Control of Electric Shock

- Control of electric shock hazard requires the limitation of electric current that might flow in an electric circuit involving the patient's body by
- raising the resistance of the conductive circuit that includes the patient, or
- by insulating exposed surfaces that might become energized,
- in addition to reducing the potential difference that can appear between exposed conductive surfaces in the patient vicinity, or
- by combinations of these methods.

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Externalized Direct Conductive Path

- A special problem is presented by the patient with an externalized direct conductive path to the heart muscle.
- The patient may be electrocuted at current levels so low that additional protection in the design of appliances, insulation of the catheter, and control of medical practice are required.

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517.12. Wiring Methods

- Except as modified in this article, wiring methods shall comply with the applicable requirements of Chapters 1 through 4 of this Code.

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517.13 Equipment Grounding Conductor for Receptacles and Fixed Electric Equipment in Patient Care Areas.

Wiring in patient care areas shall comply with 517.13(A) and (B).

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517.13(A) Wiring Methods.

- All branch circuits serving patient care spaces shall be provided with an effective ground-fault current path by installation in a metal raceway system or a cable having a metallic armor or sheath assembly.
- The metal raceway system, metallic cable armor, or sheath assembly shall itself qualify as an equipment grounding conductor in accordance with 250.118.

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2017 NEC Handbook Commentary

- These requirements apply to the branch circuits in spaces used for patient care and are not limited to patient rooms.
- Examining rooms, therapy areas, recreational areas, solaria, and certain patient corridors are also covered by these requirements.
- The branch-circuit wiring method used in these areas is one component of a two-part redundant grounding scheme unique to patient care spaces.

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2017 NEC Handbook Commentary

- The metal cable armor or sheath must qualify as an EGC in accordance with 250.118, independent of the second component of this grounding method required by 517.13(B).
- Metal-sheathed cable assemblies are not permitted as a general wiring method for life safety and critical branch circuits, because 517.31(C)(3) requires such wiring to be protected by installation in metal raceways.
- However, listed flexible raceway and metal-sheathed cable assemblies are allowed for limited applications as described in 517.31(C)(3)(3) a. through f (dealing with essential electrical systems, such as life safety branch and critical branch.)

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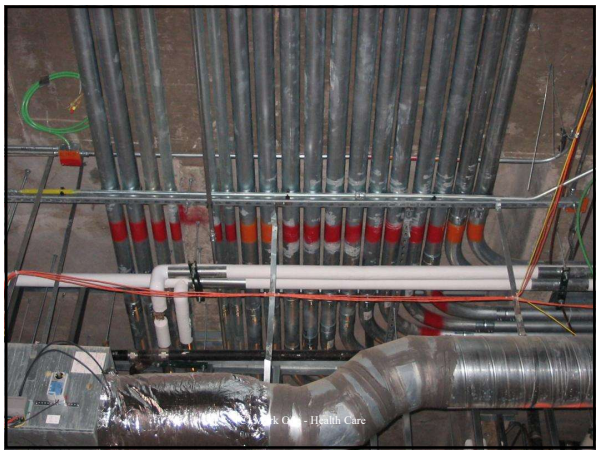

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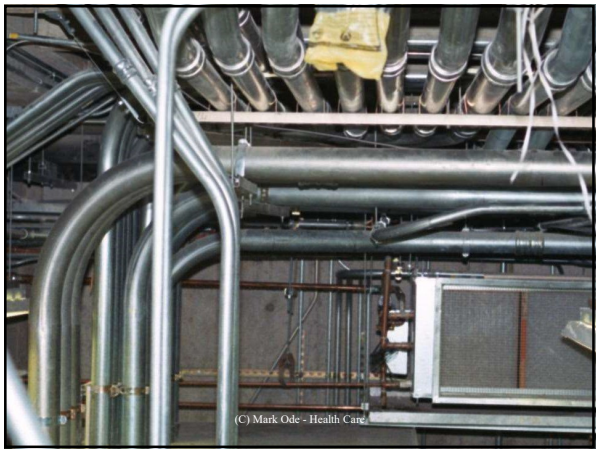

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250.118 Types of Equipment Grounding Conductors.

- The equipment grounding conductor run with or enclosing the circuit conductors shall be one or more or a combination of the following:
- (1) A copper, aluminum, or copper-clad aluminum conductor.
- This conductor shall be solid or stranded; insulated, covered, or bare; and in the form of a wire or a busbar of any shape.
- (2) Rigid metal conduit.
- (3) Intermediate metal conduit.
- (4) Electrical metallic tubing.

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250.118 Types of Equipment Grounding Conductors.

- (5) Listed flexible metal conduit meeting all the following conditions:
- a. The conduit is terminated in listed fittings.
- b. The circuit conductors contained in the conduit are protected by overcurrent devices rated at 20 amperes or less.
- c. The size of the conduit does not exceed metric designator 35 (trade size 1 1⁄4).
- d. The combined length of flexible metal conduit and flexible metallic tubing and liquidtight flexible metal conduit in the same effective ground-fault current path does not exceed 1.8 m (6 ft).
- e. If used to connect equipment where flexibility is necessary to minimize the transmission of vibration from equipment or to provide flexibility for equipment that requires movement after installation, a wire-type equipment grounding conductor shall be installed.

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250.118 Types of Equipment Grounding Conductors.

- (6) Listed liquidtight flexible metal conduit meeting all the following conditions:
- a. The conduit is terminated in listed fittings.
- b. For metric designators 12 through 16 (trade sizes 3⁄8 through 1⁄2), the circuit conductors contained in the conduit are protected by overcurrent devices rated at 20 amperes or less.
- c. For metric designators 21 through 35 (trade sizes 3⁄4 through 1 1⁄4), the circuit conductors contained in the conduit are protected by overcurrent devices rated not more than 60 amperes and there is no flexible metal conduit, flexible metallic tubing, or liquidtight flexible metal conduit in trade sizes metric designators 12 through 16 (trade sizes 3⁄8 through 1⁄2) in the effective ground-fault current path.

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250.118 Types of Equipment Grounding Conductors.

- d. The combined length of flexible metal conduit and flexible metallic tubing and liquidtight flexible metal conduit in the same effective ground-fault current path does not exceed 1.8 m (6 ft).
- e. If used to connect equipment where flexibility is necessary to minimize the transmission of vibration from equipment or to provide flexibility for equipment that requires movement after installation, a wire-type equipment grounding conductor shall be installed.

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250.118 Types of Equipment Grounding Conductors.

- (7) Flexible metallic tubing where the tubing is terminated in listed fittings and meeting the following conditions:
- a. The circuit conductors contained in the tubing are protected by overcurrent devices rated at 20 amperes or less.
- b. The combined length of flexible metal conduit and flexible metallic tubing and liquidtight flexible metal conduit in the same effective ground-fault current path does not exceed 1.8 m (6 ft).
- (8) Armor of Type AC cable as provided in 320.108.
- (9) The copper sheath of mineral-insulated, metal-sheathed cable.

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250.118 Types of Equipment Grounding Conductors.

- (10) Type MC cable that provides an effective ground-fault
- current path in accordance with one or more of the following:
- a. It contains an insulated or uninsulated equipment grounding conductor in compliance with 250.118(1)
- b. The combined metallic sheath and uninsulated equipment grounding/bonding conductor of interlocked metal tape–type MC cable that is listed and identified as an equipment grounding conductor
- c. The metallic sheath or the combined metallic sheath and equipment grounding conductors of the smooth or corrugated tube-type MC cable that is listed and identified as an equipment grounding conductor

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UL White Book

- Interlocked MC cable would not be allowed as a wiring method in a patient care area since the outside jacket is not acceptable as a grounding return path, unless using the new type with a No. 10 aluminum equipment grounding/bonding conductor.
- Corrugated or smooth tube type MC Cable with supplemental insulated EGC would be acceptable with the appropriate fittings.

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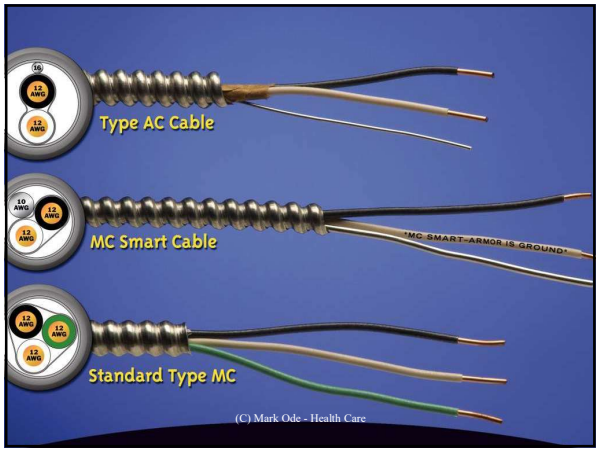

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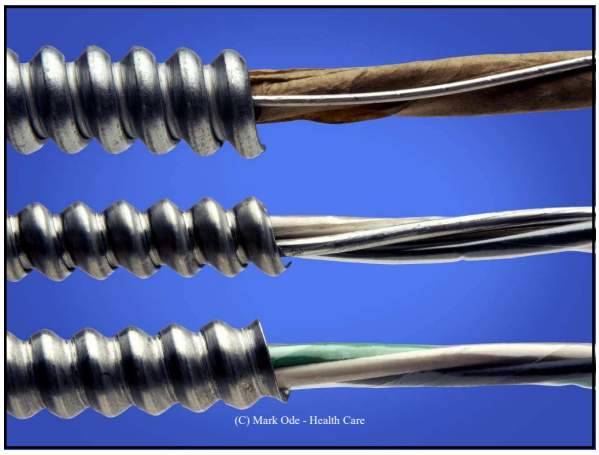

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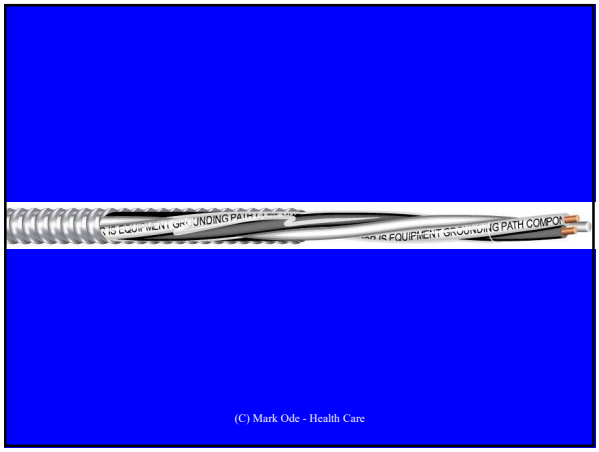

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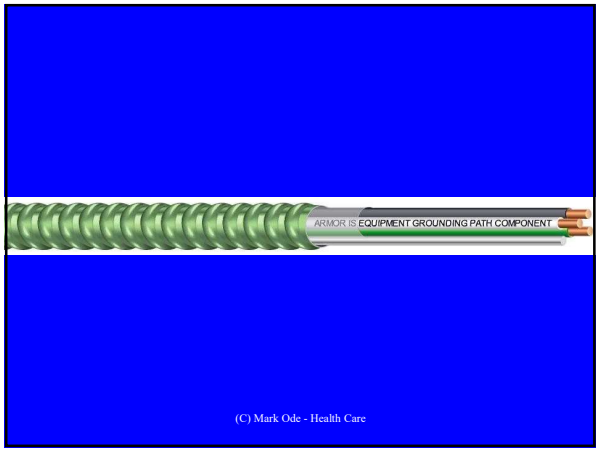

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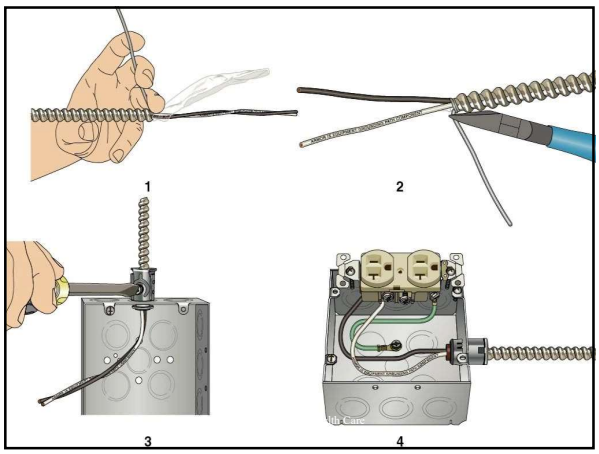

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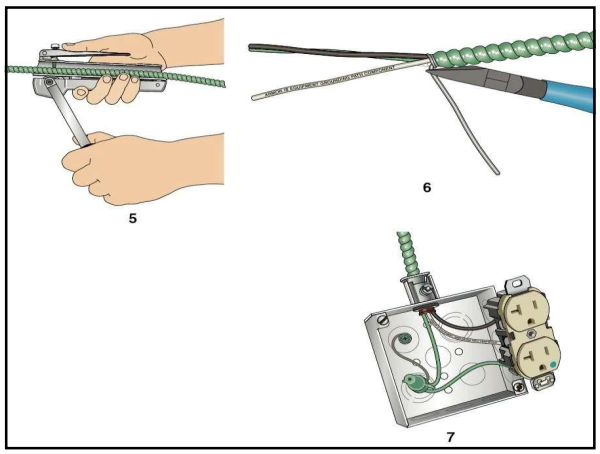

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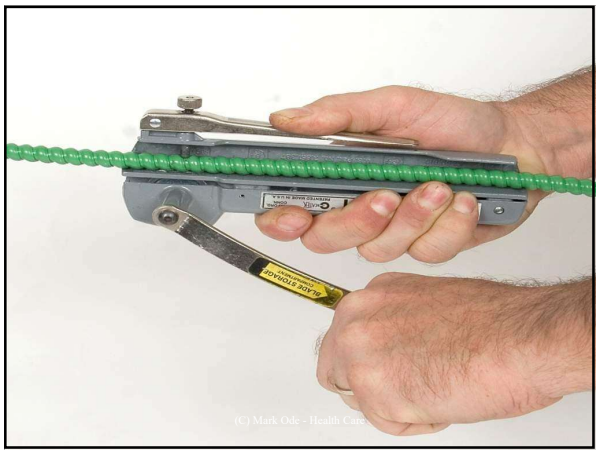

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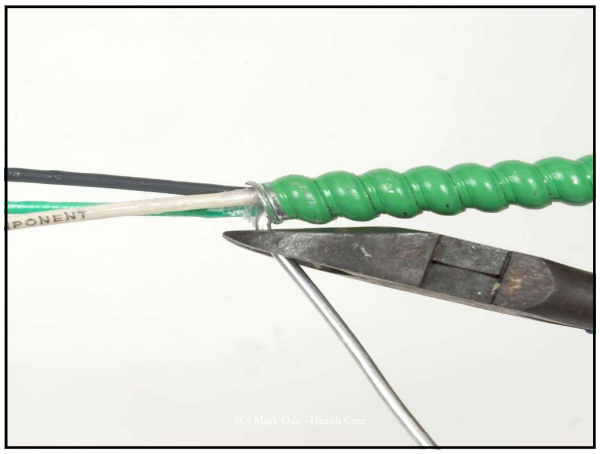

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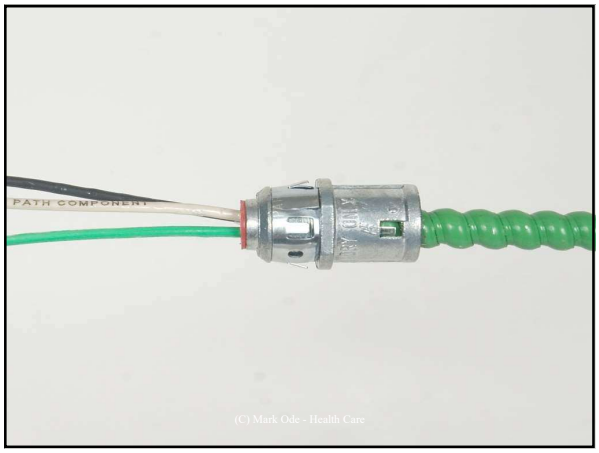

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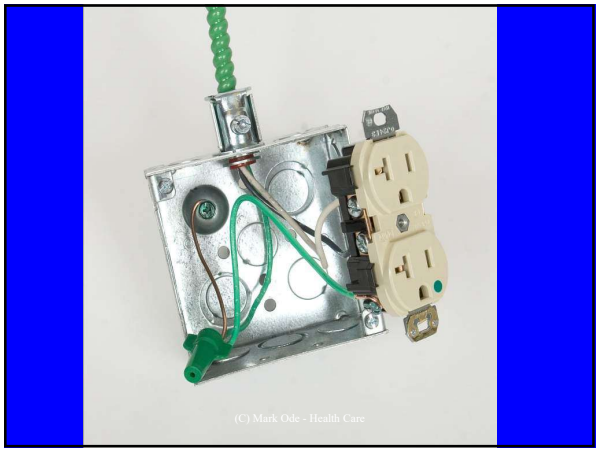

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Patient Care Space.

- Any space of a health care facility wherein patients are intended to be examined or treated. [99:3.3.136]
- Informational Note No. 1: The health care facility's governing body designates patient care space in accordance with the type of patient care anticipated.
- Informational Note No. 2: Business offices, corridors, lounges, day rooms, dining rooms, or similar areas typically are not classified as patient care spaces. [99:A.3.3.136]

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Category 3 (Basic Care) Space.

- Space in which failure of equipment or a system is not likely to cause injury to the patients, staff, or visitors but can cause patient discomfort. [99:3.3.136.3]
- Informational Note: Category 3 spaces, formerly known as basic care rooms, are typically where basic medical or dental care, treatment, or examinations are performed.
- Examples include, but are not limited to, examination or treatment rooms in clinics, medical and dental offices, nursing homes, and limited care facilities. [99:A.3.3.136.3]

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Category 2 (General Care) Space.

- Space in which failure of equipment or a system is likely to cause minor injury to patients, staff, or visitors. [99:3.3.136.2]
- Informational Note: Category 2 spaces were formerly known as general care rooms.
- Examples include, but are not limited to, inpatient bedrooms, dialysis rooms, in vitro fertilization rooms, procedural rooms, and similar rooms. [99:A.3.3.136.2]

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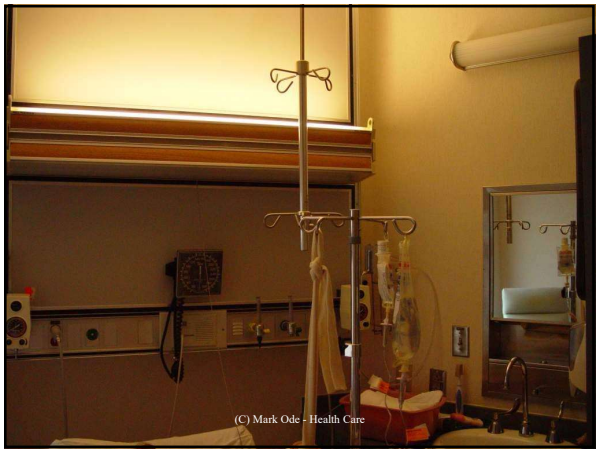

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Category 1 (Critical Care) Space.

- **Space in which failure of equipment or a system is likely to cause major injury or death of patients, staff, or visitors. [99:3.3.136.1]**
- **Informational Note: Category 1 spaces, formerly known as critical care rooms, are typically where patients are intended to be subjected to invasive procedures and connected to line-operated, patient care–related appliances.**
- **Examples include, but are not limited to, special care patient rooms used for critical care, intensive care, and special care treatment rooms such as angiography laboratories, cardiac catheterization laboratories, delivery rooms, operating rooms, post-anesthesia care units, trauma rooms, and other similar rooms. [99:A.3.3.136.1]**

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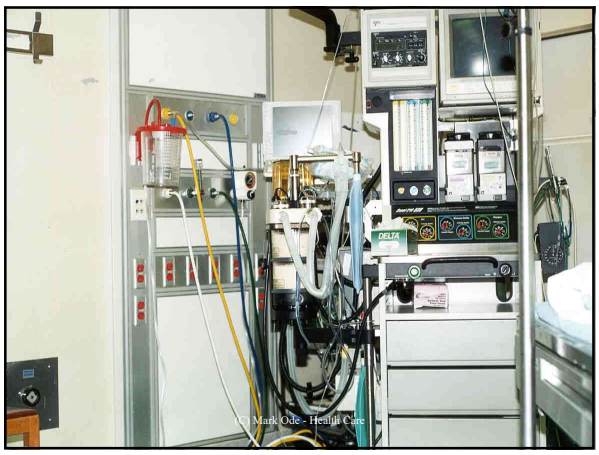

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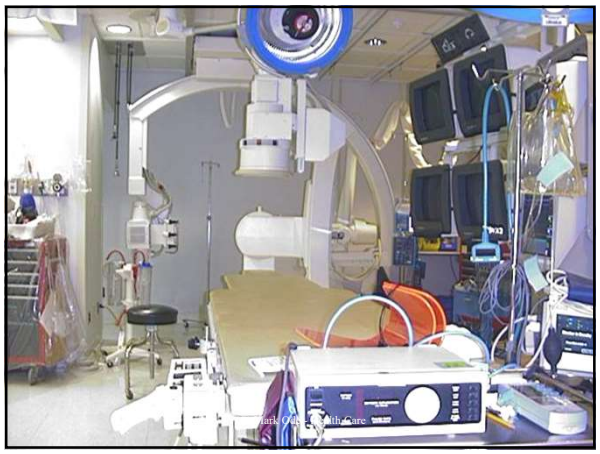

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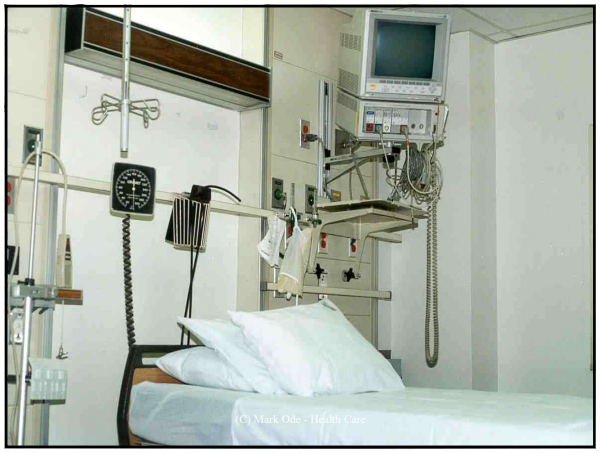

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Category 4 (Support) Space.

- **Space in which failure of equipment or a system is not likely to have a physical impact on patient care. [99:3.3.136.4]**
- **Informational Note: [Category 4] spaces were formerly known as support rooms [(spaces)]. Examples of support spaces include, but are not limited to, anesthesia work rooms, sterile supply, laboratories, morgues, waiting rooms, utility rooms, and lounges. [99:A.3.3.136.4]**

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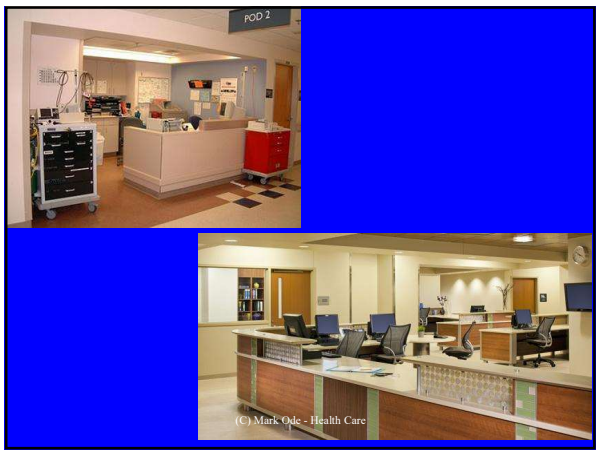

102

517.13(B) Insulated Equipment Grounding Conductor and Insulated Equipment Bonding Jumpers.

- (1) General. The following shall be directly connected to an insulated copper equipment grounding conductor that is clearly identified along its entire length by green insulation and installed with the branch circuit conductors in the wiring methods as provided in 517.13(A):
  - (1) The grounding terminals of all receptacles other than isolated ground receptacles
  - (2) Metal outlet boxes, metal device boxes, or metal enclosures

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517.13(B) Insulated Equipment Grounding Conductor and Insulated Equipment Bonding Jumpers.

- The following shall be directly connected to an insulated copper equipment grounding conductor that is clearly identified along its entire length by green insulation and installed with the branch circuit conductors in the wiring methods as provided in 517.13(A):
  - (3) All non–current-carrying conductive surfaces of fixed electrical equipment likely to become energized that are subject to personal contact, operating at over 100 volts
  - (4) Metal faceplates, by means of a metal mounting screw(s) securing the faceplate to a metal yoke or strap of a receptacle or to a metal outlet box. (was an exception and rewritten into positive text)

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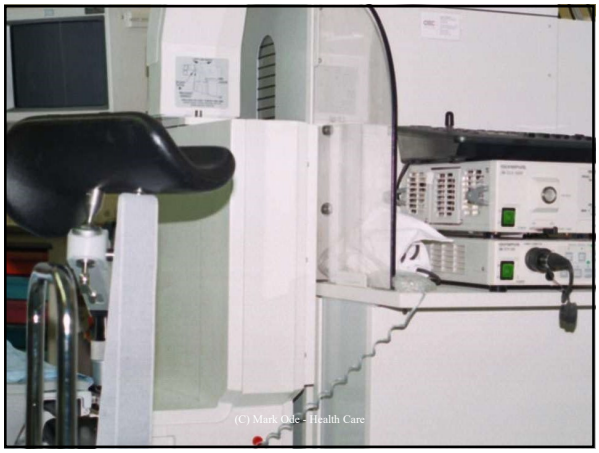

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517.13(B) Insulated Equipment Grounding Conductor and Insulated Equipment Bonding Jumpers.

- **Exception No. 1: For other than isolated ground receptacles, an insulated equipment bonding jumper that directly connects to the equipment grounding conductor is permitted to connect the box and receptacle(s) to the equipment grounding conductor. Isolated ground receptacles shall be connected in accordance with 517.16.**
- **Exception No. 2: Luminaires more than 2.3 m (7½ ft) above the floor and switches located outside of the patient care vicinity shall be permitted to be connected to an equipment grounding return path complying with 517.13(A) or (B).**

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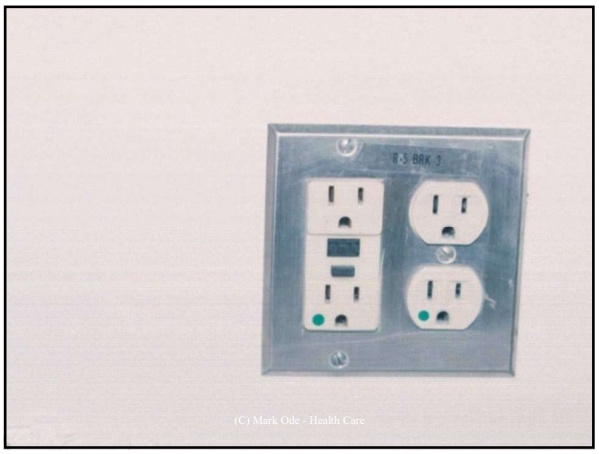

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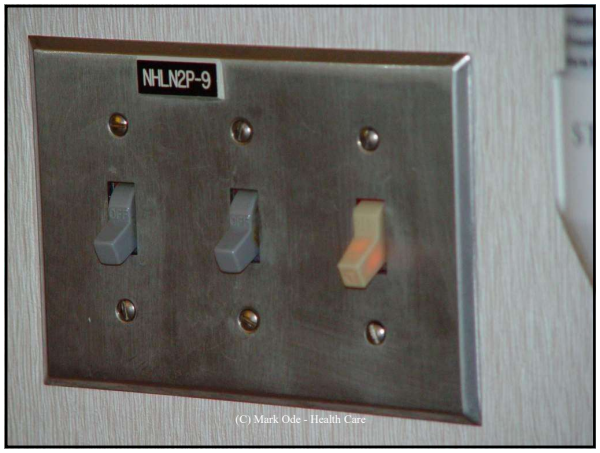

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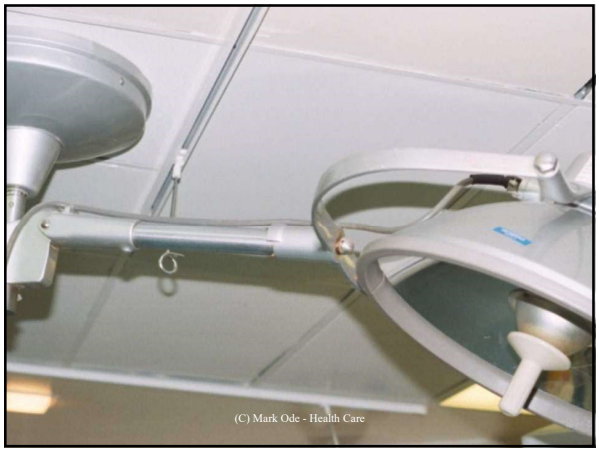

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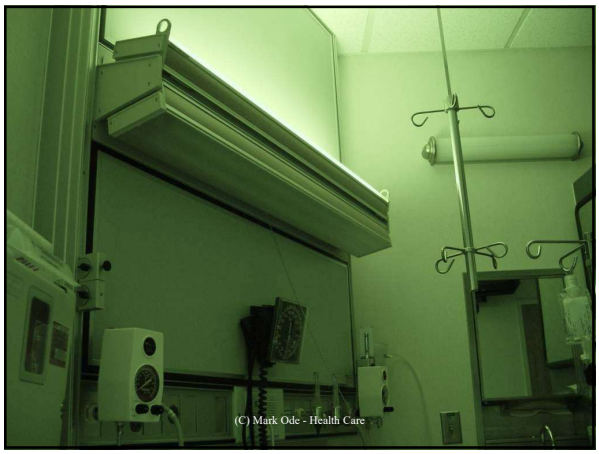

115

517.13(B) Insulated Equipment Grounding Conductor and Insulated Equipment Bonding Jumpers.

- (2) Sizing. Equipment grounding conductors and equipment bonding jumpers shall be sized in accordance with 250.122.

116

517.14. 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 10 AWG.
- Where two or more panelboards serving the same individual patient care vicinity are served from separate transfer switches on the essential electrical system, the equipment grounding terminal buses of those panelboards shall be connected together with an insulated continuous copper conductor not smaller than 10 AWG.
- This conductor shall be permitted to be broken in order to terminate on the equipment grounding terminal bus in each panelboard.

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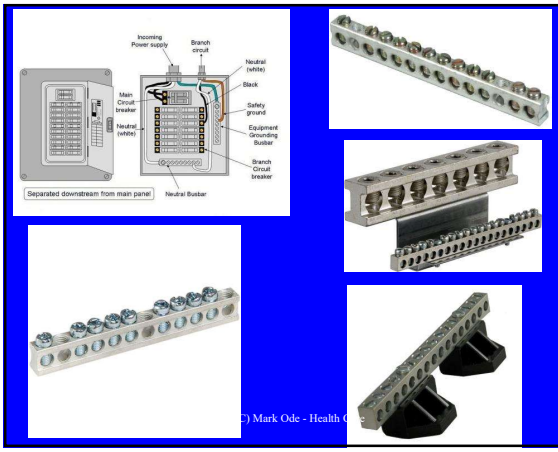

118

NFPA 99—A.6.3.2.5.1.5

- A.6.3.2.5.1.5 The requirement for grounding interconnection between the normal and essential power systems follows the principle of minimizing possible potential differences between the grounding pins of receptacles in one area by bringing the grounding conductors to a common point.

119

517.16. Use of Isolated Ground Receptacles.

- An isolated ground receptacle, if used, shall not defeat the purposes of the safety features of the grounding systems detailed in 517.13. [99:6.3.2.2.5(A)]
- (A) Inside of a Patient Care Vicinity. An isolated grounding receptacle shall not be installed within a patient care vicinity. [99:6.3.2.2.7.1(B)]

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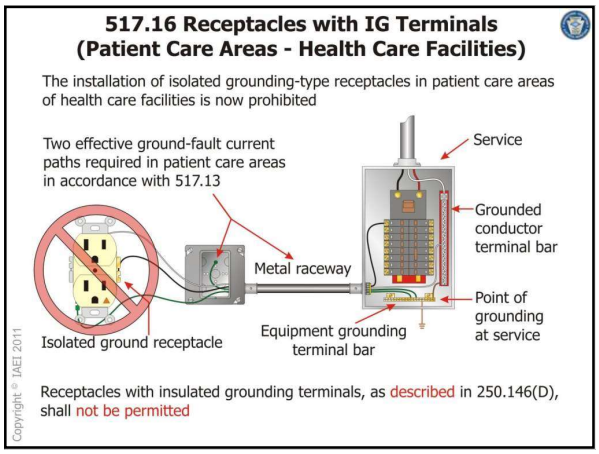

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517.16 Use of Isolated Ground Receptacles for Health Care Facilities

- Further revision to 517.16 in the 2020 NEC provides better explanation of use of **isolated receptacles outside the patent care vicinity**
- Where installed, an isolated ground receptacle **cannot eliminate** the **two equipment grounding paths** required by 517.13
- **517.16(B)(1)** revised for clarity to state that the equipment grounding terminals of isolated ground receptacles installed in a patient care space shall be connected to an isolated EGC ***AND*** this isolated EGC must be "**installed in a wiring method described in 517.13(A)**"
- Both grounding methods required in **517.13(A)** *(metal wiring method)* and **517.13(B)** *(wire-type insulated EGC)* must be present in wiring methods used for isolated grounding receptacles in addition to a separate EGC using a **green insulation with a yellow stripe** connected to the equipment grounding terminal of the isolated grounding receptacle terminal

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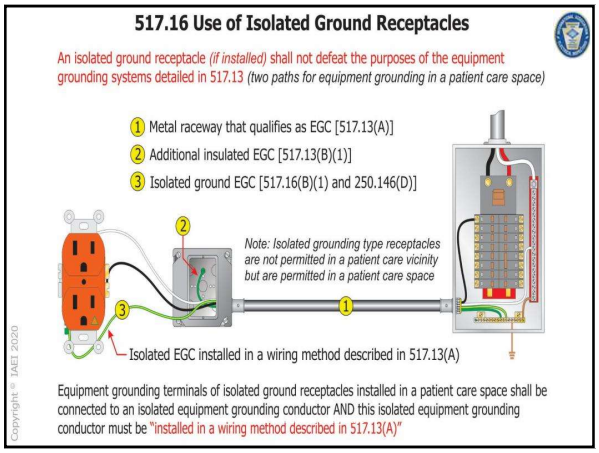

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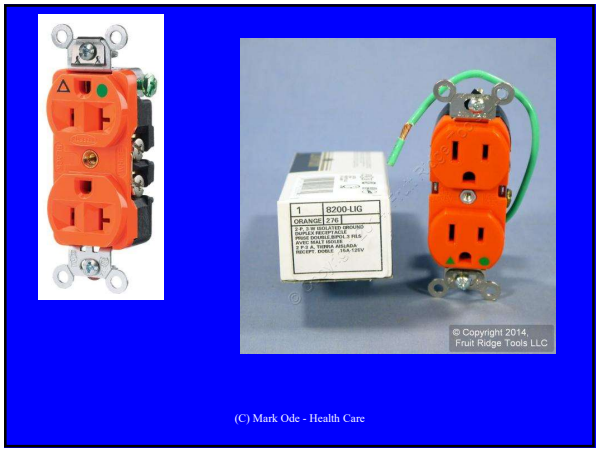

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517.16. Use of Isolated Ground Receptacles.

- **(B) Outside of a Patient Care Vicinity. Isolated ground receptacle(s) installed in patient care spaces outside of a patient care vicinity(s) shall comply with 517.16(B)(1) and (2).**
- **(1) The equipment grounding terminals of isolated ground receptacles installed in branch circuits for patient care spaces shall be connected to an insulated equipment grounding conductor in accordance with 250.146(D) installed in a method described in 517.13(A).**
- **The equipment grounding conductor connected to the equipment grounding terminals of isolated ground receptacles in patient care spaces shall be clearly identified along the equipment grounding conductor's entire length by green insulation with one or more yellow stripes.**

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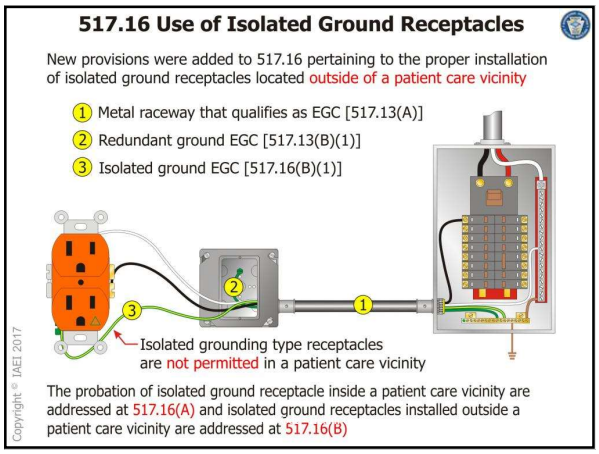

127

NFPA 99-- A.6.3.2.2.5

- A.6.3.2.2.5 Care should be taken in specifying a system containing isolated ground receptacles, because the grounding impedance is controlled only by the grounding wires and does not benefit from any conduit or building structure in parallel with it.

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517.16. Use of Isolated Ground Receptacles.

- (2) The insulated equipment grounding conductor required in 517.13(B)(1) shall be clearly identified along its entire length by green insulation, with no yellow stripes, and shall not be connected to the grounding terminals of isolated equipment ground receptacles but shall be connected to the box or enclosure indicated in 517.13(B)(1)(2) and to non–current-carrying conductive surfaces of fixed electrical equipment indicated in 517.13(B)(1)(3).

- Informational Note No. 1: This type of installation is typically used where a reduction of electrical noise (electromagnetic interference) is necessary, and parallel grounding paths are to be avoided.
- Informational Note No. 2: Care should be taken in specifying a system containing isolated ground receptacles, because the impedance of the effective ground-fault current path is dependent upon the equipment grounding conductor(s) and does not benefit from any conduit or building structure in parallel with the equipment grounding conductor.

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517.17 Ground-Fault Protection of Equipment

- (A) Applicability. The requirements of 517.17 shall apply to buildings or portions of buildings containing health care facilities with Category 1 (critical care) spaces or utilizing electrical life-support equipment, and buildings that provide the required essential utilities or services for the operation of Category 1 (critical care) spaces or electrical life-support equipment.

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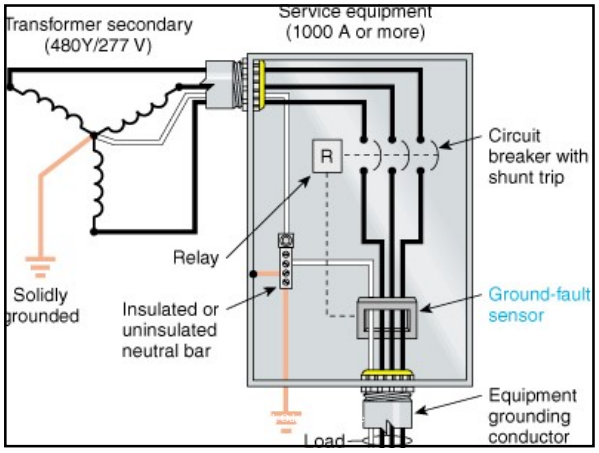

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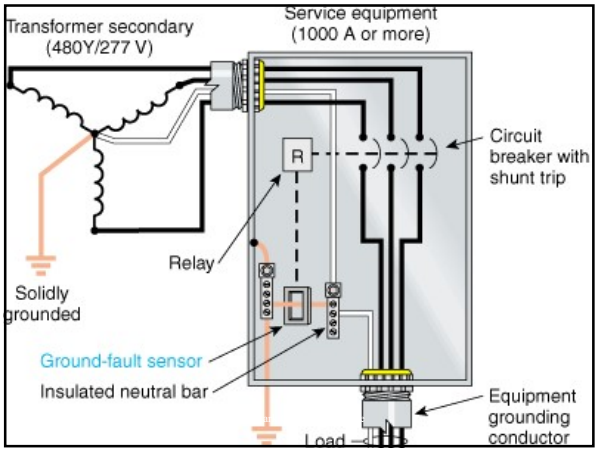

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2017 NEC Handbook Commentary

- If ground-fault protection of equipment (GFPE) is applied to the service providing power to a health care facility, an additional level of ground-fault protection is required downstream.
- Section 517.17(B) requires GFPE for every feeder.
- This requirement is unlike the requirements of 210.13, 215.10, and 230.95 where mandatory GFPE is based on the rating of the disconnecting means (1000 amperes or more).
- The second level of GFPE is based on the need to provide selectivity between the feeder protective devices and the service or building supply protective devices.

133

517.17 Ground-Fault Protection

- (B) Feeders. Where ground-fault protection of equipment is provided for operation of the service disconnecting means or feeder disconnecting means as specified by 230.95 or 215.10, an additional step of ground-fault protection shall be provided in all next level feeder disconnecting means downstream toward the load.
- Such protection shall consist of overcurrent devices and current transformers or other equivalent protective equipment that shall cause the feeder disconnecting means to open.
- The additional levels of ground-fault protection of equipment shall not be installed on the load side of an essential electrical system transfer switch.

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2017 NEC Handbook Commentary

- Multiple-occupancy buildings may be multiple medical office or clinic-type occupancies or may be multiple occupancies of mixed use in which one or more of the occupancies are health care facilities.
- The selectivity required by 517.17(C) is accomplished through the installation of GFPE for all feeder disconnecting means in the first level of distribution downstream of the GFPE-protected service equipment or building disconnecting means specified in 215.10 or 230.95.
- Therefore, any feeder supplied from this level of distribution will be required to have GFPE regardless of the occupancy type or use group.

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2017 NEC Handbook Commentary

- The requirement for the second level of GFPE does not apply to all health care facilities located in multiple-occupancy buildings.
- This requirement applies only where the health care facility governing authority has classified certain portions of the facility as critical care space or where the types of procedures for which the facility is approved or licensed require the use of life support equipment.
- If there are no designated critical care spaces or life support equipment is not used, second-level GFPE is not required.
- Based on these criteria, most general medical and dental practices located in multiple-occupancy buildings are not required to have GFPE.
- In addition, if the service is not provided with GFPE (either because it is not required by the *NEC*® or, if optional, has not been incorporated as part of the design), the second level of GFPE is unnecessary.

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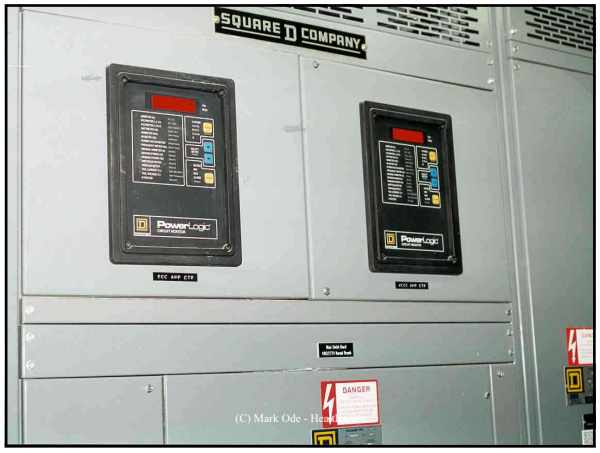

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517.17 Ground-Fault Protection

- (C) Selectivity. Ground-fault protection of equipment for operation of the
- service and feeder disconnecting means shall be fully selective such that the feeder device, but not the service device, shall open on ground faults on the load side of the feeder device.
- Separation of ground-fault protection time-current characteristics shall conform to manufacturer's recommendations and shall consider all required tolerances and disconnect operating time to achieve 100 percent selectivity.
- Informational Note: See 230.95, Informational Note, for transfer of alternate source where ground-fault protection is applied.
- (D) Testing. When equipment ground-fault protection is first installed, each level shall be performance tested to ensure compliance with 517.17(C).

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517.17 Ground-Fault Protection

- (D) Testing.
- When ground-fault protection of equipment is first installed, each level shall be performance tested to ensure compliance with 517.17(C).
- This testing shall be conducted by a qualified person(s) using a test process in accordance with the instruction provided with the equipment.
- A written record of this testing shall be made and shall be available to the authority having jurisdiction.

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230.95 Ground-Fault Protection of Equipment.

- Informational Note: Where ground-fault protection is provided for the service disconnect and interconnection is made with another supply system by a transfer device, means or devices may be needed to ensure proper ground-fault sensing by the ground-fault protection equipment.

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2017 NEC Handbook Commentary

- In the case of existing multiple-occupancy buildings that have GFPE for the service equipment, a tenant build-out or a renovation for a new health care occupancy may result in the need to also provide second-level GFPE for all other occupancies.
- Careful analysis of the impact of this requirement on the existing service equipment may warrant an alternative approach such as installation of another service if permitted by 230.2(A) through (D).
- Section 517.45 requires clinics or ambulatory care facilities that use life support equipment or have areas designated as critical care to be provided with an essential electrical system that includes an alternate power source.
- It is not intended that ground-fault protection be installed between the on-site generator and the transfer switch or on the load side of the essential electrical system transfer switch.

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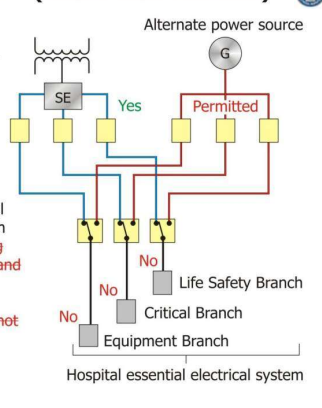
517.17(B) Feeder GFP (Health Care Facilities)

Where ground-fault protection is provided as specified by 230.95 or 215.10, an additional step of GFP is required in all next level feeder disconnecting means downstream toward the load

Additional levels of GFP shall not be installed as follows:
(1) On the load side of an essential electrical system transfer switch
~~(2) Between the on-site generating unit(s) described in 517.35(B) and the essential electrical system transfer switch(es)~~
~~(3) On electrical systems that are not solidly grounded wye systems (greater than 150 volts to 600 volts phase-to-phase)~~



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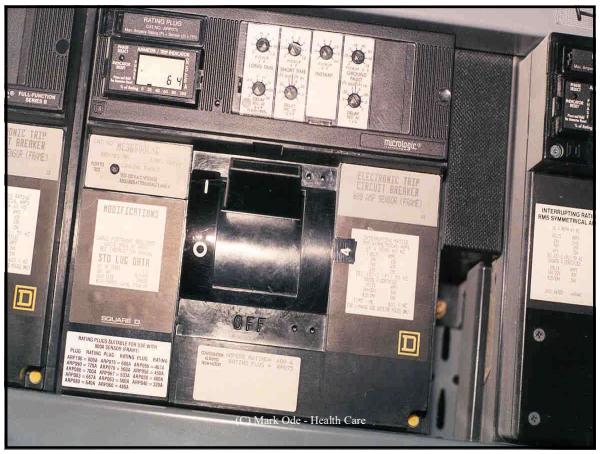

146

517.17(D) Performance Testing of GFP Equipment at Health Care Facilities

- Revision were made in the 2020 NEC to provide clarity by requiring a **qualified person** *(written record)* to perform a **test process of GFP** primary current injection
- Previously, GFP systems were required to be performance tested when the equipment ground-fault protection was first installed with little detail
- This performance testing is now required to be conducted by a **qualified person(s)** using a test process in accordance with the **instruction** provided with the equipment and a **written record** of this testing must be kept and made available to the authority having jurisdiction
- Same *Code* language found at **230.95(C)** was inserted at 517.17(D) for performance testing of ground-fault protection systems of health care

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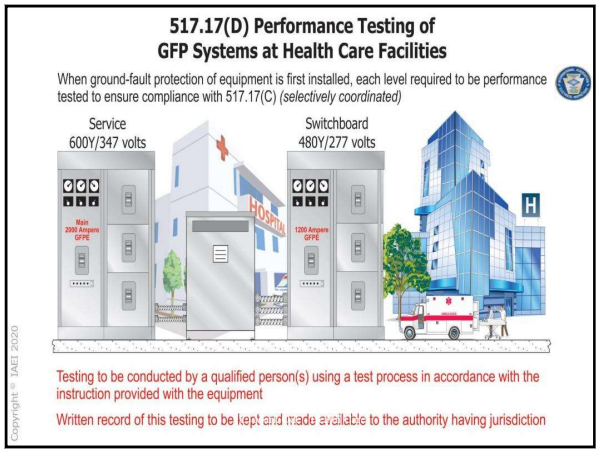

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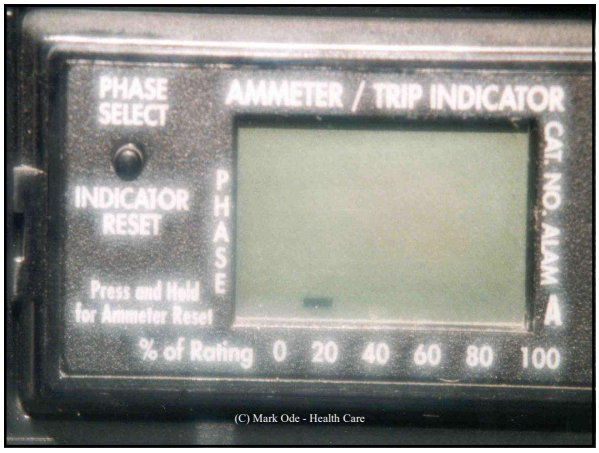

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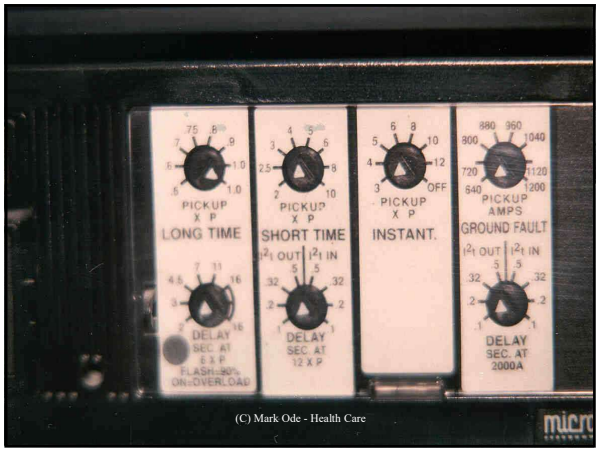

150

517.18. General Care (Category 2) Spaces

- (A) Patient Bed Location. Each patient bed location shall be supplied by at least two branch circuits, one from the critical branch and one from the normal system.
- All branch circuits from the normal system shall originate in the same panelboard.
- The electrical receptacles or the cover plate for the electrical receptacles supplied from the critical branch shall have a distinctive color or marking so as to be readily identifiable and shall also indicate the panelboard and branch-circuit number supplying them. (Already covered in 517.31(E).)
- Branch circuits serving patient bed locations shall not be part of a multiwire branch circuit.

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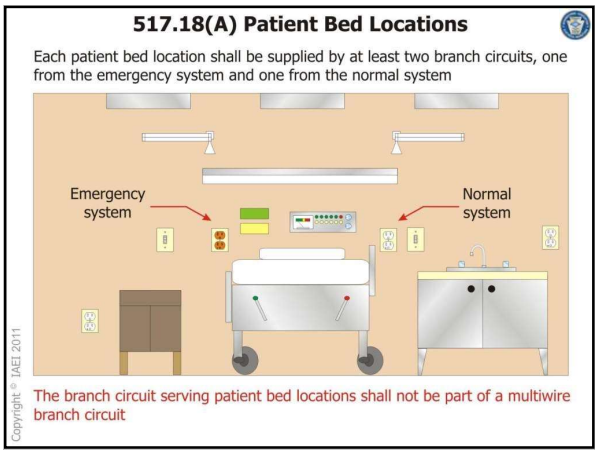

152

NFPA 99-- A.6.3.2.4

- A.6.3.2.4 The requirement that branch circuits be fed from not more than one distribution panel was introduced for several reasons.
- A general principle is to minimize possible potential differences between the grounding pins of receptacles in one area by bringing the grounding conductors to a common point.
- A specific reason is to simplify maintenance by making it easier to find the source for the receptacles in a room.
- This is particularly a problem in hospitals where emergency conditions might require rapid restoration of power.

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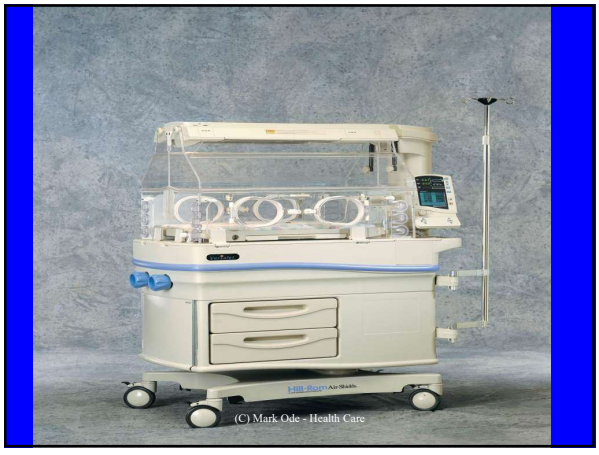

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Definition---Patient Bed Location.

- **The location of a patient sleeping bed, or the bed or procedure table of a critical care space. [99:3.3.125]**

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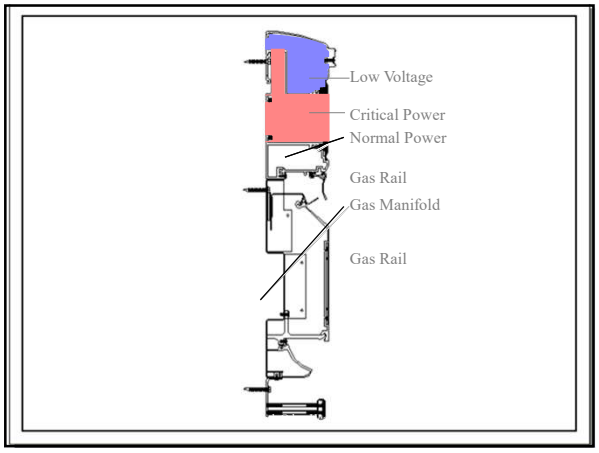

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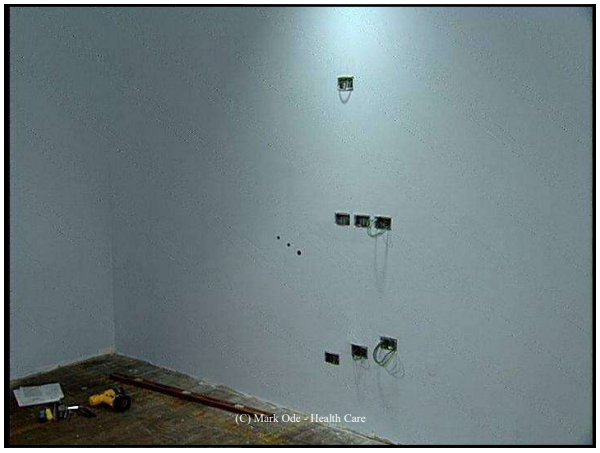

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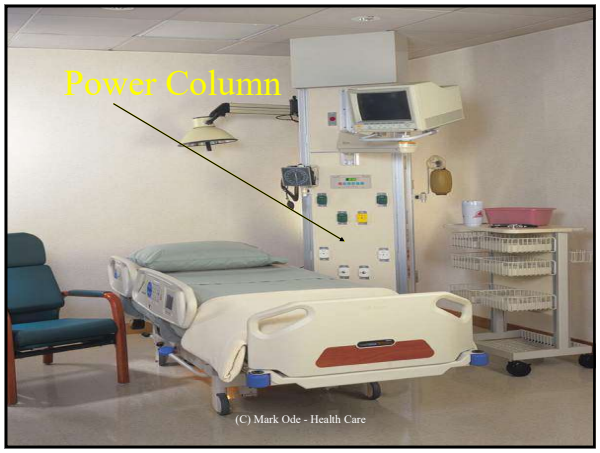

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517.18(A) Patient Bed Location

- **Exception No. 1: Branch circuits serving only special purpose outlets or receptacles, such as portable X-ray outlets, shall not be required to be served from the same distribution panel or panels.**
- **Exception No. 2: The requirements of 517.18(A) shall not apply to patient bed locations in clinics, medical and dental offices, and outpatient facilities; psychiatric, substance abuse, and rehabilitation hospitals; sleeping rooms of nursing homes; and limited care facilities meeting the requirements of 517.10(B)(2).**
- **Exception No. 3: A general care (Category 2) patient bed location served from two separate transfer switches on the critical branch shall not be required to have circuits from the normal system.**

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2017 NEC Handbook Commentary

- Patient bed locations in general care spaces are prohibited from deriving all their branch circuits from the essential electrical system.
- At least one branch circuit for each location must originate in a normal system panelboard.
- This supply circuit arrangement correlates with the limitations imposed by 517.34 regarding the types of loads permitted to be supplied by the critical branch of the essential electrical system.
- Exception No. 3 allows both of the required branch circuits for a general care patient bed location to be supplied by the critical branch, provided they are supplied by two separate transfer switches.

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2017 NEC Handbook Commentary

- Two critical branch circuits have a higher reliability than one normal and one critical branch circuit.
- Multiwire branch circuits are required by 210.4(B) to be simultaneously disconnected from all ungrounded conductors.
- This could result in unintended and potentially dangerous interruption of power to lighting or receptacle loads at a patient bed location.
- Because of this concern, multiwire branch circuits are not permitted to be used to meet the requirements of 517.18(A).

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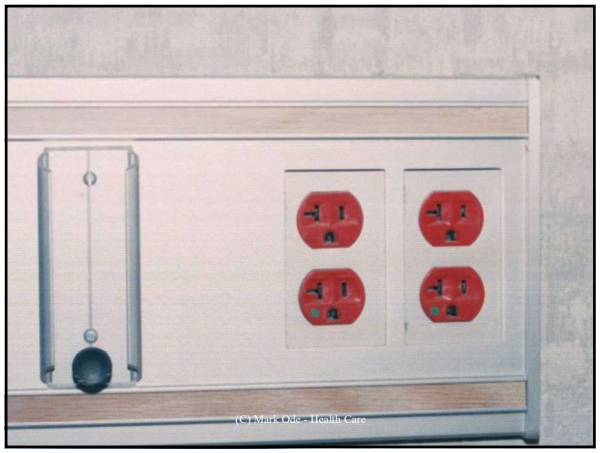

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517.18(B) Patient Bed Location Receptacles.

- **(B) Patient Bed Location Receptacles.** Each patient bed location shall be provided with a minimum of eight receptacles.
- They shall be permitted to be of the single, duplex, or quadruplex-type or any combination of the three.
- All receptacles shall be listed "hospital grade" and shall be so identified.
- The grounding terminal of each receptacle shall be connected to an insulated copper equipment grounding conductor sized in accordance with Table 250.122.

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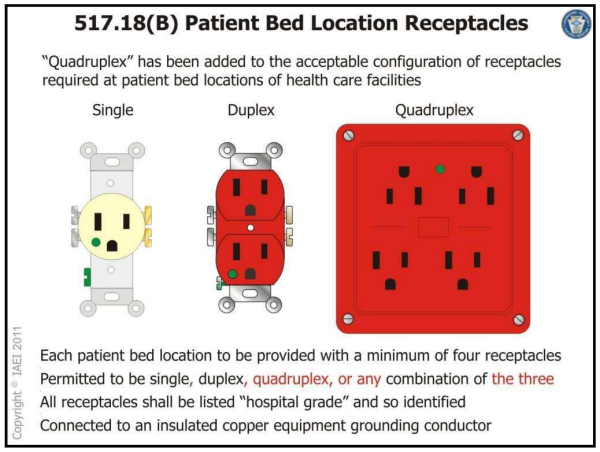

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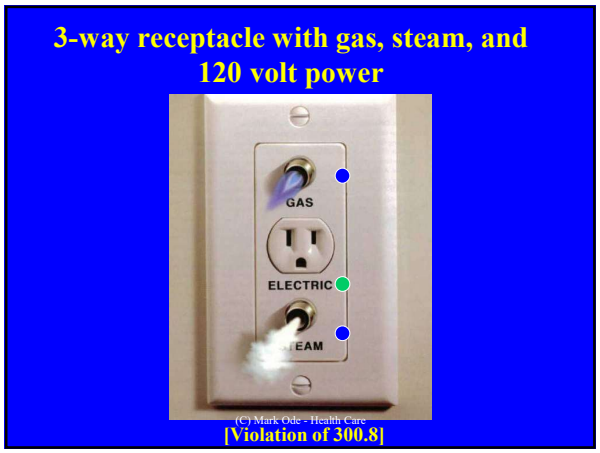

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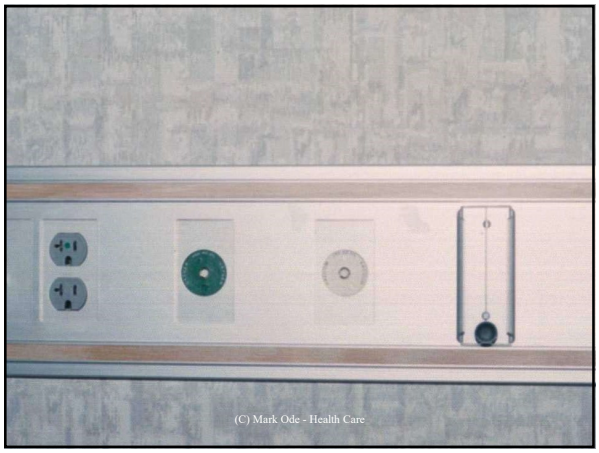

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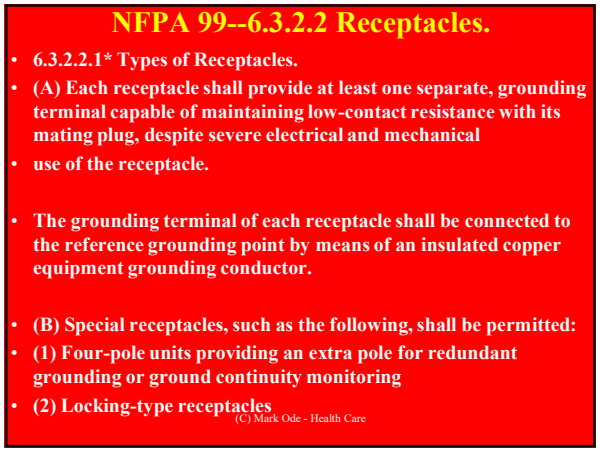

180

NFPA 99--6.3.2.2 Receptacles.

- (C) All non-locking-type, 125-volt, 15- or 20-ampere single, duplex, or quadruplex type receptacles, or any combination thereof, located in operating rooms and at patient bed locations in Category 1 spaces shall be listed and identified as hospital grade.
- (D) Receptacles that are located within patient rooms, bathrooms, playrooms, and activity rooms of pediatric units or spaces with similar risk as determined by the health care facility's governing body by conducting a risk assessment, other than infant nurseries, shall be listed and identified as "tamper resistant" or shall employ a listed tamper-resistant cover.

181

NFPA 99—A.6.3.2.2.1

- A.6.3.2.2.1 It is best, if possible, to employ only one type of receptacle (standard three-prong type) for as many receptacles being served by the same line voltage to avoid the inability to connect life-support equipment in emergencies.
- The straight-blade, three-prong receptacle is now permitted in all locations in a hospital.
- Previously, special receptacles were specified in operating room locations and have caused compatibility problems.

182

UL 498, the Standard on Attachment Plugs and Receptacles

- UL 498, the Standard on Attachment Plugs and Receptacles, covers the testing and listing requirements for regular receptacles as well as those listed for use in hospitals as "hospital-grade" receptacles.
- Section 127 of the standard requires that hospital grade receptacles comply with all of the standard requirements for a normal receptacle plus those additional tests located in Section 128 through 136.

183

184

185

UL 498, the Standard on Attachment Plugs and Receptacles

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- Section 127 of the standard requires that hospital grade receptacles comply with all of the standard requirements for a normal receptacle plus those additional tests located in Section 128 through 136.

186

UL 498, the Standard on Attachment Plugs and Receptacles.

- It must be subjected to an abrupt plug removal test without breakage or that will prevent the full insertion of an attachment plug, or that will adversely affect any live parts within the receptacle.
- It is subjected to a grounding contact temperature test.
- The grounding path in the hospital grade receptacle must not exceed a temperature rise of 30 degrees C above normal ambient air temperature (20 degrees C) with a current of 25 amperes or 125% of the maximum branch circuit rating.

187

UL 498, the Standard on Attachment Plugs and Receptacles

- A hospital grade receptacle must also pass a total resistance test between the mated attachment plug grounding terminal and the grounding terminal on the receptacle.
-
- The total resistance allowed between these two points cannot exceed 0.01 ohms even during the temperature test.
- The hospital grade receptacle is subjected once to a fault current test by being tested on a circuit capable of delivering 1000 Amps through shorted busbars.
- The grounding path through the receptacle must be maintained even after the fault current test.

188

UL 498, the Standard on Attachment Plugs and Receptacles

- There is a grounding contact overstress test where a grounding pin is inserted into the receptacle in various different directions while maintaining the proper maximum resistance between the two points.
-
- There is a terminal strength test where the terminals are subjected to a straight 20 pounds foot stress for one minute for each No. 12 wire after torqueing it to a 14 inch pound foot point.
- 110.14(D). (D) Installation. Where a tightening torque is indicated as a numeric value on equipment or in installation instructions provided by the manufacturer, a calibrated torque tool shall be used to achieve the indicated torque value, unless the equipment manufacturer has provided installation instructions for an alternative method of achieving the required torque.

189

UL 498, the Standard on Attachment Plugs and Receptacles

- There is a mold stress relief test that is connected to the temperature test and the receptacle cannot change in any direction greater than 10%.
- There is an impact test to ensure the receptacle cannot break with a 5 pound weight dropped from a height of 18 inches.
- Finally there is an assembly security test where the receptacle can withstand the application of a 100 pound foot pressure on the receptacle without breakage of the receptacle or permanent deformation of the receptacle.

190

517.18(B) Patient Bed Location Receptacles.

- Exception No. 1: Requirements of 517.18(B) shall not apply to psychiatric, substance abuse, and rehabilitation hospitals meeting the requirements of Section 517.10(B)(2).
- Exception No. 2: Psychiatric security rooms shall not be required to have receptacle outlets installed in the room.
- Informational Note: It is not intended that there be a total, immediate replacement of existing non-hospital grade receptacles.
- It is intended, however, that non-hospital grade receptacles be replaced with hospital-grade receptacles upon
  - modification of use,
  - renovation, or
  - as existing receptacles need replacement.

191

517.18(C) Designated General Care (Category 2) Pediatric Locations.

Receptacles that are located within the patient rooms, bathrooms, playrooms, and activity rooms of pediatric units or spaces with similar risk as determined by the governing body, other than nurseries, shall be listed tamper-resistant or shall employ a listed tamper-resistant cover. [99:6.3.2.2.6.2(F)]



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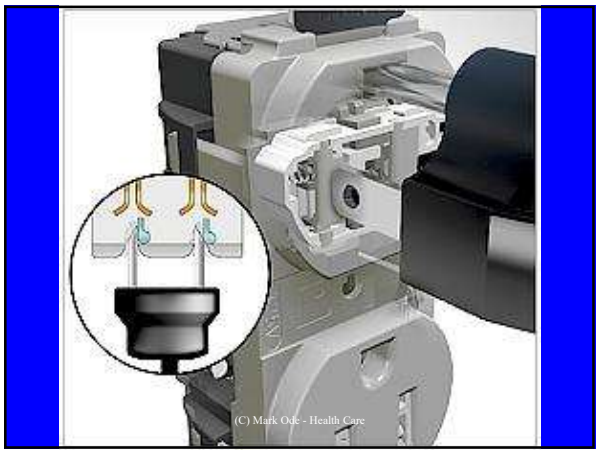


193

2017 NEC Handbook Commentary

- Unlike the requirement in 406.12, this requirement covers all receptacles installed in specified rooms of pediatric locations.
- Safeguarding can be achieved through the use of either listed tamper-resistant receptacles or listed tamper-resistant covers.
- The use of locking covers over ordinary receptacles does not meet this requirement.
- Only 125-volt, 15- and 20-ampere tamper-resistant receptacles are available; therefore, other receptacle types are likely to require a tamper-resistant cover.
- Exhibit 517.2 shows a listed hospital-grade tamper-resistant receptacle that can be used to comply with 517.18(C).
- The receptacle is identified by a green dot on its face, and the letters "TR" located at the top right of the receptacle.
- Exhibit 517.3 shows a listed tamper-resistant, hospital-grade, GFCI receptacle installed adjacent to a bathroom sink in a pediatric ward.

194

195

196

197

198

517.19 Critical Care (Category 1) Spaces.

- (A) Patient Bed Location Branch Circuits. Each patient bed location shall be supplied by at least two branch circuits, one or more from the critical branch and one or more circuits from the normal system.
- At least one branch circuit from the critical branch shall supply an outlet(s) only at that bed location.
- The electrical receptacles or the cover plates for the electrical receptacles supplied from the life safety and critical branches shall have a distinctive color or marking so as to be readily identifiable. [99:6.4.2.2.6.2(C)]

199

EXHIBIT 517.4 *A receptacle from the normal system (left) and the critical branch (right). Note the label that indicates the panelboard and the circuit number. (Courtesy of the International Association of Electrical Inspectors)*

200

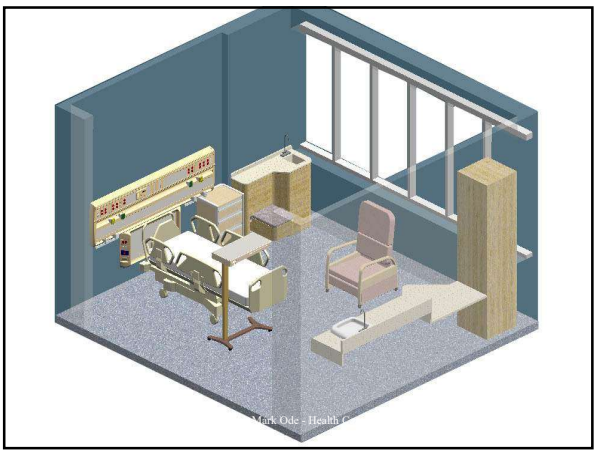
201

General Care Room?

202

Critical Care Room?

203

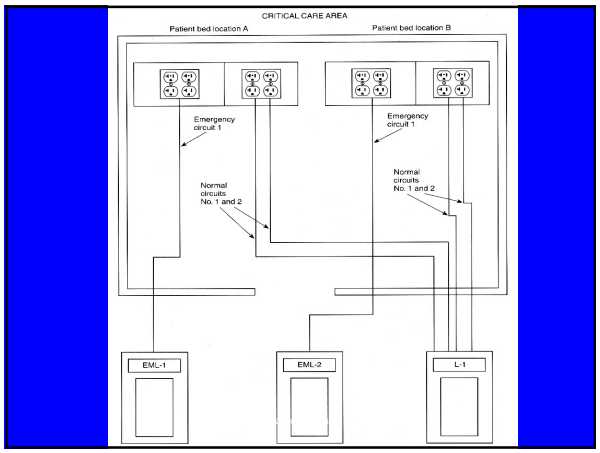


204

517.19 Critical Care (Category 1) Spaces.

- All branch circuits from the normal system shall be from a single panelboard.
- Critical branch receptacles shall be identified and shall also indicate the panelboard and circuit number supplying them.
- The branch circuit serving patient bed locations shall not be part of a multiwire branch circuit.
- Exception No. 1: Branch circuits serving only special-purpose receptacles or equipment in critical care (Category 1) spaces shall be permitted to be served by other panelboards.
- Exception No. 2: Critical care (Category 1) spaces served from two separate critical branch transfer switches shall not be required to have circuits from the normal system.

205



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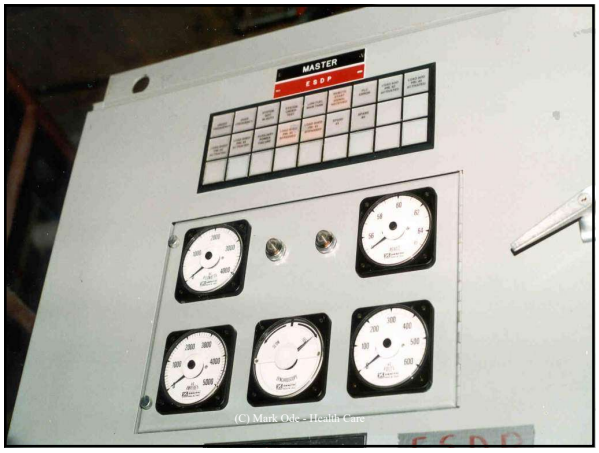

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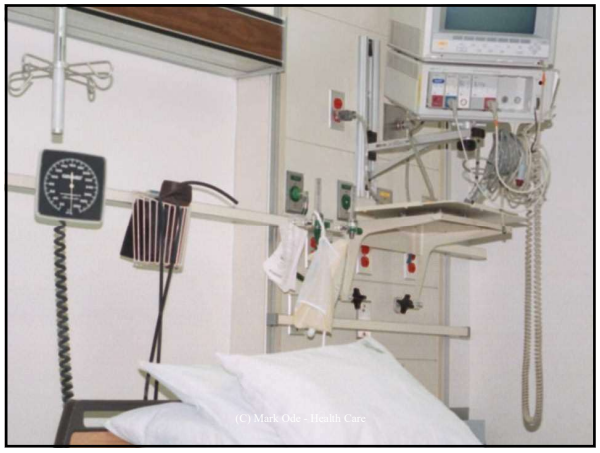

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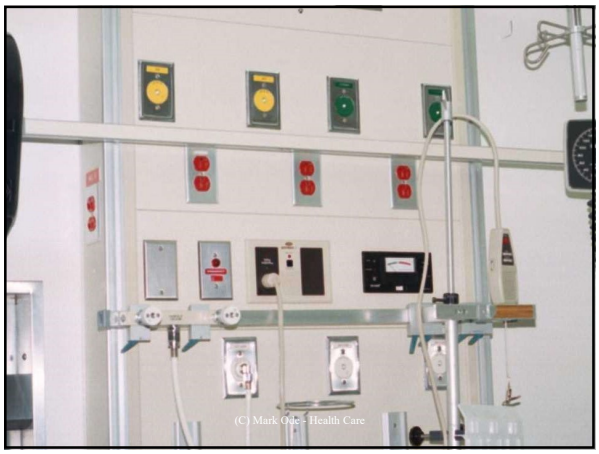

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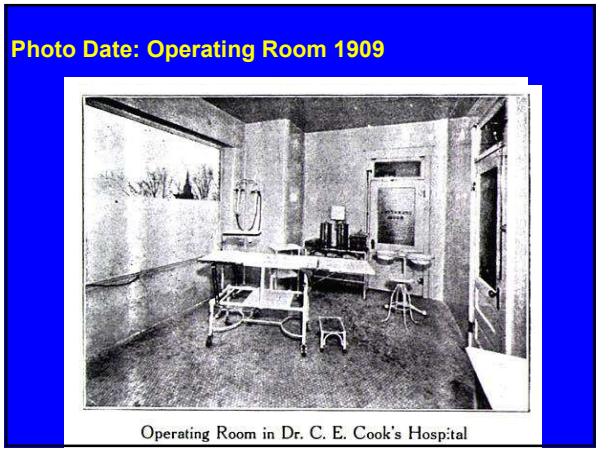

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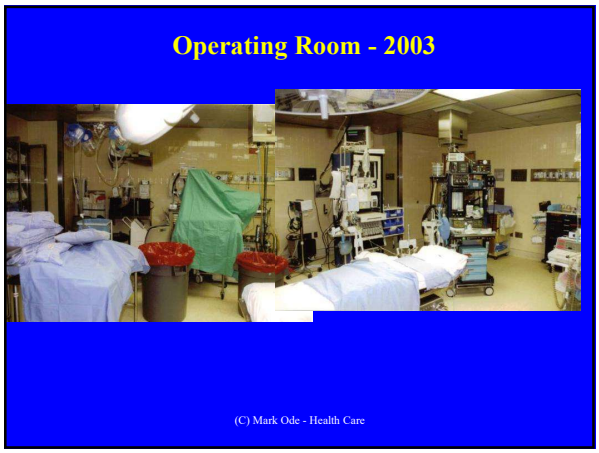

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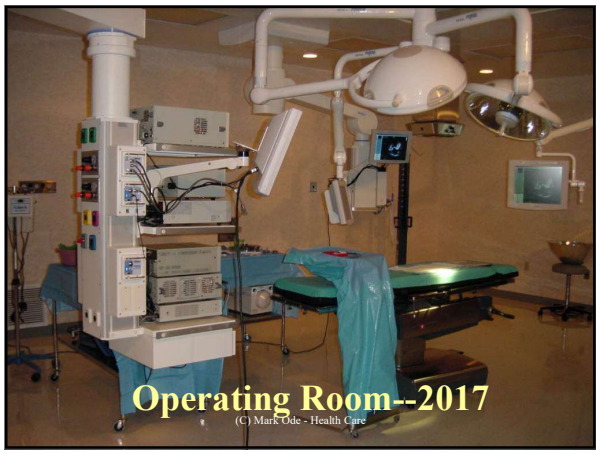

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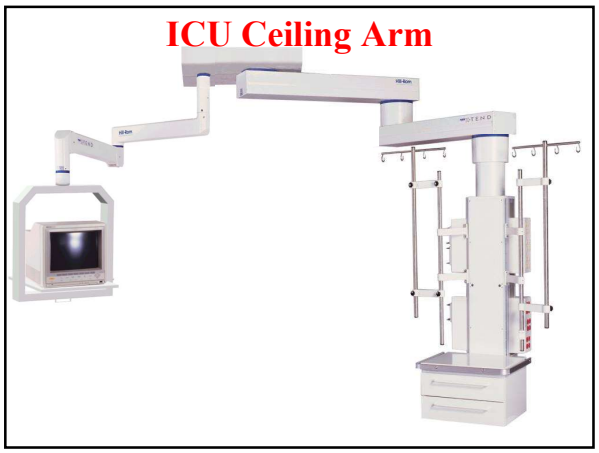
ICU Ceiling Arm



223

Critical Care (Category 1) Space.

- Space in which failure of equipment or a system is likely to cause major injury or death of patients, staff, or visitors. [99:3.3.127.1]
- Informational Note: [Category 1] spaces, formerly known as critical care rooms [(spaces)], are typically where patients are intended to be subjected to invasive procedures and connected to line-operated, patient care–related appliances.
- Examples include, but are not limited to, special care patient rooms used for critical care, intensive care, and special care treatment rooms such as angiography laboratories, cardiac catheterization laboratories, delivery rooms, operating rooms, post-anesthesia care units, trauma rooms, and other similar rooms. [99:A.3.3.127.1]

224

225

517.19(A) Patient Bed Location Branch Circuits.

- At least one branch circuit from the emergency system shall supply an outlet(s) only at that bed location.

  All branch circuits from the normal system shall be from a single panelboard.
- Emergency system receptacles shall be identified and shall also indicate the panelboard and circuit number supplying them.
- The branch circuit serving patient bed locations shall not be part of a multi-wire branch circuit.

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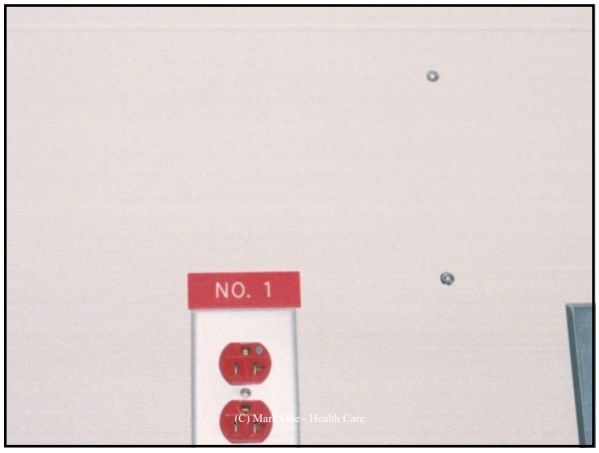

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229

517.19(B) Patient Bed Location Receptacles.

- (1) Minimum Number and Supply. Each patient bed location shall be provided with a minimum of 14 receptacles, at least one of which shall be connected to either of the following:
  - (1) The normal system branch circuit required in 517.19(A)
  - (2) A critical branch circuit supplied by a different transfer switch than the other receptacles at the same patient bed location

(C) Mark Ode - Health Care

230

2017 NEC Handbook Commentary

- Each patient bed location in critical care spaces must be supplied by at least two branch circuits, one from the normal system and one from the critical branch, as shown in Exhibit 517.5.
- The normal circuits must be supplied from the same panel (L-1).
- The critical branch circuits are permitted to be supplied from different panels (EES-1 and EES-2).
- However, the critical branch circuit to patient bed location A cannot supply receptacles for patient bed location B.
- Patient bed location receptacles can also be supplied by two different critical branch circuits, instead of one critical branch and one normal, provided the critical branch circuits are supplied from two different transfer switches.
- The requirements for the number and type of branch circuits in critical care spaces are intended to ensure that critical care patients will not be without electrical power.

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231

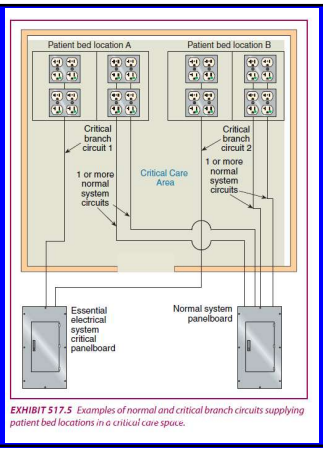

EXHIBIT 517.5 Examples of normal and critical branch circuits supplying patient bed locations in a critical care space.

232

517.19(B) Patient Bed Location Receptacles.

- (2) Receptacle Requirements. The receptacles required in 517.19(B)(1) shall be permitted to be single, duplex, or quadruplex type or any combination thereof.
- All receptacles shall be listed "hospital grade" and shall be so identified.
- The grounding terminal of each receptacle shall be connected to the reference grounding point by means of an insulated copper equipment grounding conductor.

(C) Mark Ode - Health Care

233

517.19(C) Operating Room Receptacles.

- (1) Minimum Number and Supply. Each operating room shall be provided with a minimum of 36 receptacles divided between at least two branch circuits.
- At least 12 receptacles, but no more than 24, shall be connected to either of the following:
  - (1) The normal system branch circuit required in 517.19(A)
  - (2) A critical branch circuit supplied by a different transfer switch than the other receptacles at the same location
- (2) Receptacle Requirements. The receptacles shall be permitted to be of the locking or nonlocking type, single, duplex, or quadruplex types or any combination of the three.
- All nonlocking-type receptacles shall be listed hospital grade and so identified. The grounding terminal of each receptacle shall be connected to the reference grounding point by means of an
- insulated copper equipment grounding conductor.

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234

517.19(D) Patient Care Vicinity Grounding and Bonding (Optional).

- A patient care vicinity shall be permitted to have a patient equipment grounding point.
- The patient equipment grounding point, where supplied, shall be permitted to contain one or more listed grounding and bonding jacks.
- An equipment bonding jumper not smaller than 10 AWG shall be used to connect the grounding terminal of all grounding-type receptacles to the patient equipment grounding point.
- The bonding conductor shall be permitted to be arranged centrically or looped as convenient.
- Informational Note: Where there is no patient equipment grounding point, it is important that the distance between the reference grounding point and the patient care vicinity be as short as possible to minimize any potential differences.

235

517.2 Definition---Patient Care Vicinity.

- A space, within a location intended for the examination and treatment of patients, extending 1.8 m (6 ft) beyond the normal location of the patient bed, chair, table, treadmill, or other device that supports the patient during examination and treatment and extending vertically to 2.3 m (7 ft 6 in.) above the floor. [99:3.3.128]

236

2017 NEC Handbook Commentary

- The patient care vicinity is defined not only by the location of a patient bed but also by other equipment that supports a patient during examination or treatment.
- The vicinity is also determined by equipment in its normal location used for treatment or in the architect's plans, rather than the temporary location of equipment subject to movement by housekeeping staff or for the convenience of the medical staff.

237

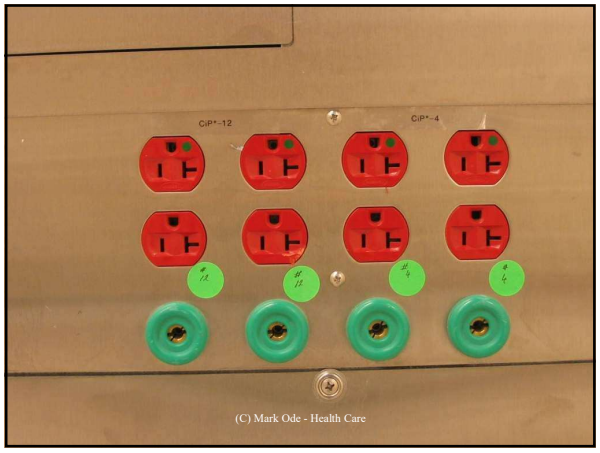
Definition of Patient Equipment Grounding Point.

- A jack or terminal that serves as the collection point for redundant grounding of electrical appliances serving a patient care vicinity or for grounding other items in order to eliminate electromagnetic interference problems. [99:3.3.129]

238

EXHIBIT 517.6 A patient equipment grounding point. (Courtesy of the International Association of Electrical Inspectors)

239



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241

517.19(D) Patient Care Vicinity Grounding and Bonding (Optional).

- Informational Note: Where there is no patient equipment grounding point, it is important that the distance between the reference grounding point and the patient care vicinity be as short as possible to minimize any potential differences.

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242

517.19(E) Equipment Grounding and Bonding.

- Where a grounded electrical distribution system is used and metal feeder raceway or Type MC or MI cable that qualifies as an equipment grounding conductor in accordance with 250.118 is installed, grounding of enclosures and equipment,
  - such as panelboards, switchboards, and switchgear,
- shall be ensured by one of the following bonding means at each termination or junction point of the metal raceway or Type MC or MI cable:

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243

517.19(E) Panelboard Grounding and Bonding.

- (1) A grounding bushing and a continuous copper bonding jumper, sized in accordance with 250.122, with the bonding jumper connected to the junction enclosure or the ground bus of the panel
- (2) Connection of feeder raceways or Type MC or MI cable to threaded hubs or bosses on terminating enclosures
- (3) Other approved devices such as bonding-type locknuts or bushings.
- Standard locknuts shall not be used for bonding.

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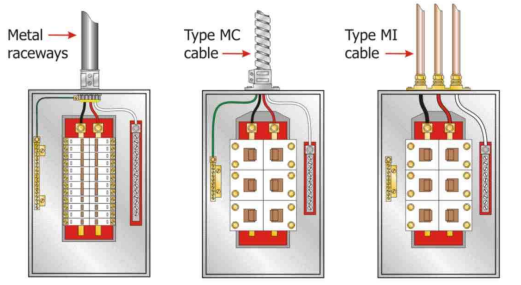
244

517.19(D) Panelboard Grounding and Bonding

Section 517.19(D) covers grounding and bonding requirements for feeders supplying critical branch switchboards or panelboards. Bonding shall be ensured by any of the means specified in 517.19(D)(1), (2), or (3).



Type MC cable and Type MI cable are required to be suitable as equipment grounding conductors in accordance with 250.118.

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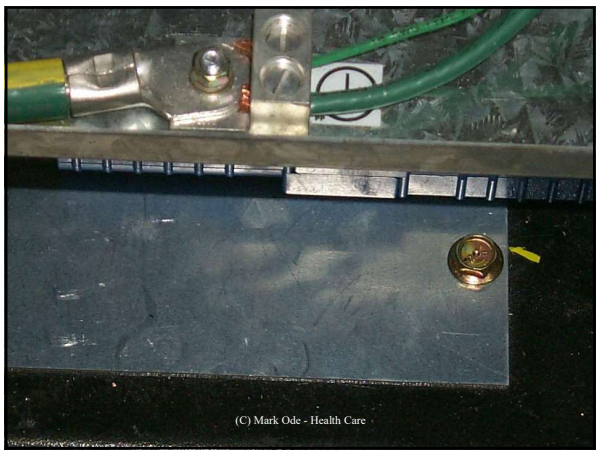

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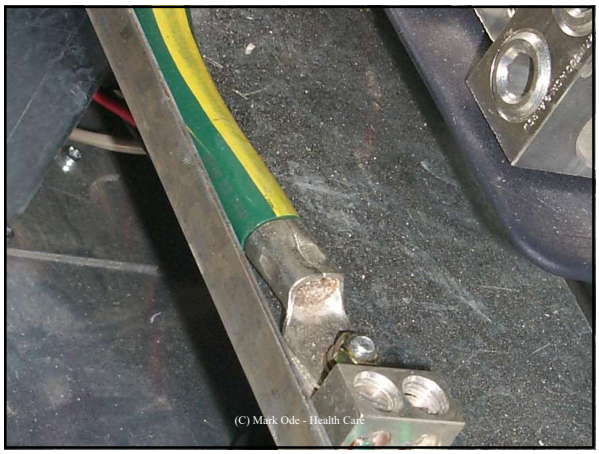
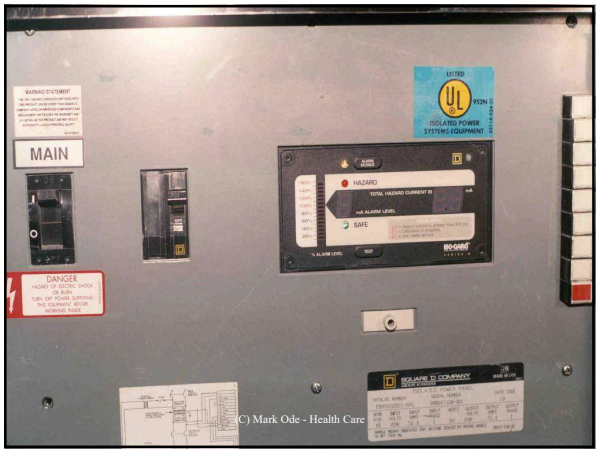


247

517.19(E) Additional Protective Techniques in Critical Care (Category 1) Spaces (Optional).

- Isolated power systems shall be permitted to be used for critical care (Category 1) spaces, and, if used, the isolated power system equipment shall be listed as isolated power equipment.
- The isolated power system shall be designed and installed in accordance with 517.160.
- *Exception: The audible and visual indicators of the line isolation monitor shall be permitted to be located at the nursing station for the area being served.*

248



249

517.19(G) Isolated Power System Equipment Grounding.

- Where an isolated ungrounded power source is used and limits the first-fault current to a low magnitude, the equipment grounding conductor associated with the secondary circuit shall be permitted to be run outside of the enclosure of the power conductors in the same circuit.
- Informational Note: Although it is permitted to run the grounding conductor outside of the conduit, it is safer to run it with the power conductors to provide better protection in case of a second ground fault.
- Installing the EGC inside the raceway with the conductors delivering the fault current reduces the impedance of the grounding path.

250

517.19(G) Special-Purpose Receptacle Grounding.

- The equipment grounding conductor for special-purpose receptacles, such as the operation of mobile X-ray equipment, shall be extended to the reference grounding points of branch circuits for all locations likely to be served from such receptacles.
- Where such a circuit is served from an isolated ungrounded system, the grounding conductor shall not be required to be run with the power conductors; however, the equipment grounding terminal of the special-purpose receptacle shall be connected to the reference grounding point.

251

252

517.20 Wet Procedure Locations.

- (A) Receptacles and Fixed Equipment.
- Wet procedure locations shall be provided with special protection against electric shock by one of the following means:
- (1) Power distribution system that inherently limits the possible ground-fault current due to a first fault to a low value, without interrupting the power supply
- (2) Power distribution system in which the power supply is interrupted if the ground-fault current does, in fact, exceed a value of 6 mA

253

6.3.2.3 Wet Procedure Locations.

- 6.3.2.3.9 Where GFCI protection is used in an operating room, one of the following shall apply:
- (1) Each receptacle shall be an individual GFCI device.
- (2) Each receptacle shall be individually protected by a single GFCI device.

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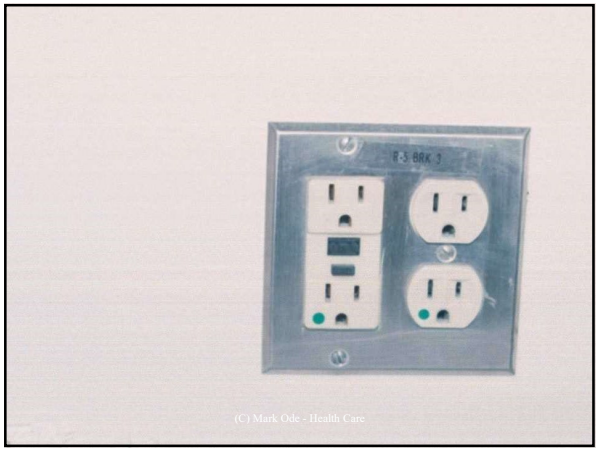

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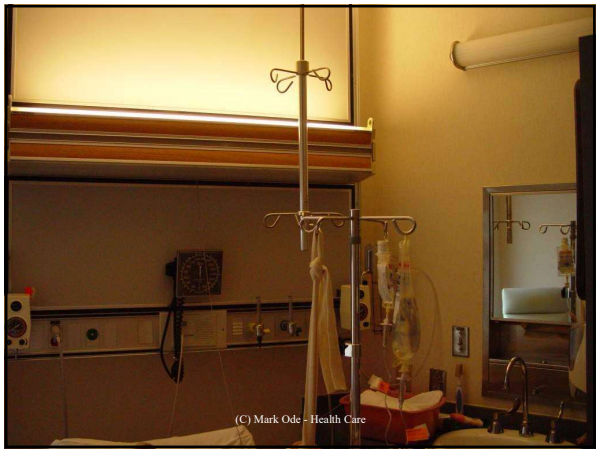

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257

Definition of Wet Procedure Locations.

- The area in a patient care space where a procedure is performed that is normally subject to wet conditions while patients are present, including standing fluids on the floor or drenching of the work area, either of which condition is intimate to the patient or staff. [99:3.3.171]
- Informational Note: Routine housekeeping procedures and incidental spillage of liquids do not define a wet procedure location. [99:A.3.3.171]

258

6.3.2.3 Wet Procedure Locations.

- **6.3.2.3.1*** Wet procedure locations shall be provided with special protection against electric shock.
- **A.6.3.2.1** Assignment of degree of reliability of electrical systems in health care facilities depends on the careful evaluation of the variables at each particular installation. For further information, see ANSI/IEEE 493-2007, *Recommended Practice for the Design of Reliable Industrial and Commercial Power Systems.*
- **6.3.2.3.2** This special protection shall be provided as follows:
- (1) Power distribution system that inherently limits the possible ground-fault current due to a first fault to a low value, without interrupting the power supply
- (2) Power distribution system in which the power supply is interrupted if the ground-fault current does in fact exceed the trip value of a Class A GFCI

259

6.3.2.3 Wet Procedure Locations.

- **6.3.2.3.3 Patient beds, toilets, bidets, and wash basins shall not be required to be considered wet procedure locations.**
- **6.3.2.3.4* Operating rooms shall be considered to be a wet procedure location, unless a risk assessment conducted by the health care governing body determines otherwise.**
- **A.6.3.2.3.4 In conducting a risk assessment, the health care governing body should consult with all relevant parties, including, but not limited to, clinicians, biomedical engineering staff, and facility safety engineering staff.**

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6.3.2.3 Wet Procedure Locations.

- **6.3.2.3.8* Operating rooms defined as wet procedure locations shall be protected by either isolated power or ground-fault circuit interrupters.**
- **A.6.3.2.3.8 The health care health care facility's governing body and designer of record should evaluate the type of protection to be provided against electrical shock to patients and caregivers in wet procedure locations.**
- **The application considerations should include but not be limited to the reliability of power to critical equipment and systems.**

261

517.20 (A) Receptacles and Fixed Equipment.

- **Exception: Branch circuits supplying only listed, fixed, therapeutic and diagnostic equipment shall be permitted to be supplied from a grounded service, single- or 3-phase system, provided that**
- **(a) Wiring for grounded and isolated circuits does not occupy the same raceway, and**
- **(b) All conductive surfaces of the equipment are connected to an insulated copper equipment grounding conductor.**

262

517.20 (B) Isolated Power Systems.

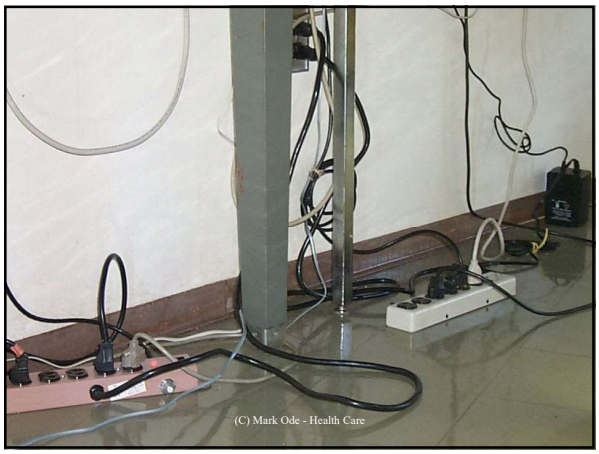
- **Where an isolated power system is utilized, the isolated power equipment shall be listed as isolated power equipment, and the isolated power system shall be designed and installed in accordance with 517.160.**
- **Informational Note: For requirements for installation of therapeutic pools and tubs, see Part VI of Article 680.**

263

Relocatable Power Taps UL Category XBYS

- **This category covers relocatable power taps rated 250 V ac or less, 20 A or less. They are intended for indoor use to supply power to cord-and-plug-connected electrical utilization equipment.**
- **Relocatable power taps are provided with an attached power-supply cord and attachment plug. The electrical enclosure may be provided with one or more receptacle outlets. Relocatable power taps may also be supplied with up to six lengths of flexible cord not exceeding 1-1/2 feet in length from the main body of the product. Each length may be terminated in a separate single cord connector (receptacle outlet).**
- **Relocatable power taps may be provided with USB (Universal Serial Bus) charging outlets and LED lighting when three or more receptacle outlets are provided.**

264



265

Relocatable Power Taps UL Category XBYS

- Relocatable power taps may be provided with fuses or other supplementary overcurrent protection, switches, suppression components and/or indicator lights in any combination, or connections for cable, communications, telephone and/or antenna.
- Relocatable power taps are intended to be directly connected to a permanently installed branch-circuit receptacle outlet. Relocatable power taps are not intended to be series connected (daisy chained) to other relocatable power taps or to extension cords.
- Relocatable power taps are not intended for use at construction sites and similar locations.

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Relocatable Power Taps UL Category XBYS

- Relocatable power taps are not intended to be permanently secured to building structures, tables, work benches or similar structures, nor are they intended to be used as a substitute for fixed wiring. The cords of relocatable power taps are not intended to be routed through walls, windows, ceilings, floors or similar openings of buildings.
- Relocatable power taps have not been investigated and are not intended for use with general patient care areas or critical patient care areas of health care facilities as defined in Article 517 of ANSI/NFPA 70, "National Electrical Code."

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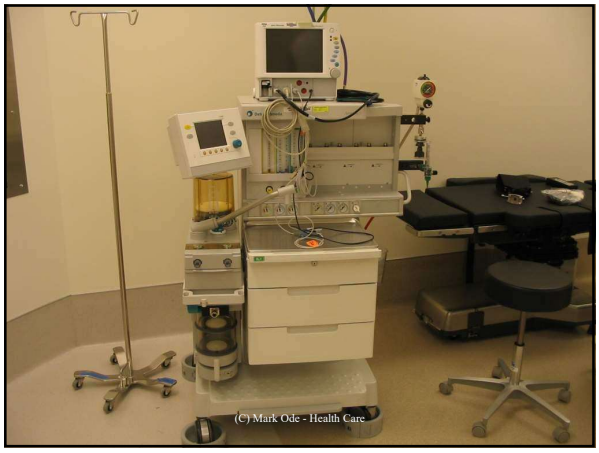

269

NFPA 99--6.3.2.6 and NEC Article 517 Part VII Isolated Power Systems

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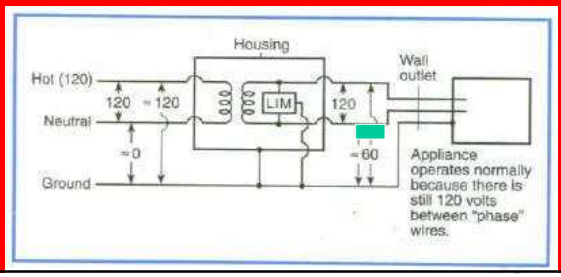
Electrical Distribution System-6.3.2.6 Isolated Power Systems.

- What is 'isolated power'?
  - Isolation performance
  - Grounding continuous: from input side to output side
  - Simplified schematic diagram



271

NFPA 99--6.3.2.9* Isolated Power Systems.

- 6.3.2.9.1 Isolation Transformer. An isolated power system shall not be required to be installed in any patient care space, except as specified in 6.3.2.3.
- 6.3.2.9.1.1 The isolation transformer shall be listed and approved for the purpose.
- 6.3.2.9.1.2 The primary winding shall be connected to a power source so that it is not energized with more than 600 V (nominal).
- (A) If present, the neutral of the primary winding shall be grounded in an approved manner.
- (B) If an electrostatic shield is present, it shall be connected to the reference grounding point.

272

NFPA 99--A.6.3.2.9 Isolated Grounding

- Patient protection is provided primarily by an adequate grounding system.
- The ungrounded secondary of the isolation transformer reduces the cross-sectional area of grounding conductors necessary to protect the patient against voltage resulting from fault current by reducing the maximum current in case of a single probable fault in the grounding system.
- The line isolation monitor is used to provide warning when a single fault occurs.
- Excessive current in the grounding conductors will not result in a hazard to the patient unless a second fault occurs.

273

NFPA 99--A.6.3.2.9 Isolated Grounding

- If the current in the grounding system does not exceed 10 mA, even under fault conditions, the voltage across 3 m (9.84 ft) of No. 12 AWG wire will not exceed 0.2 mV, and the voltage across 3 m (9.84 ft) of No. 18 AWG grounding conductor in a flexible cord will not exceed 0.8 mV.
- Allowing 0.1 mV across each connector, the voltage between two pieces of patient-connected equipment will not exceed 2 mV.
- The reference grounding point is intended to ensure that all electrically conductive surfaces of the building structure, which could receive heavy fault currents from ordinary (grounded) circuits, are grounded in a manner to bypass these heavy currents from the operating room.

274

NFPA 99--6.3.2.9* Isolated Power Systems.

- 6.3.2.9.1.3 Wiring of isolated power systems shall be in accordance with 517.160 of *NFPA 70*.

275

517.160 Isolated Power Systems.

- (A) Installations.
- (1) Isolated Power Circuits. Each isolated power circuit shall be controlled by a switch or circuit breaker that has a disconnecting pole in each isolated circuit conductor to simultaneously disconnect all power.
- Such isolation shall be accomplished by means of one or more isolation transformers, by means of generator sets, or by means of electrically isolated batteries.
- Conductors of isolated power circuits shall not be installed in cables, raceways, or other enclosures containing conductors of another system.

276

277

6.3.2.6 Isolated power systems.
- Isolation transformer
- Line isolation monitor (LIM): digital or analog

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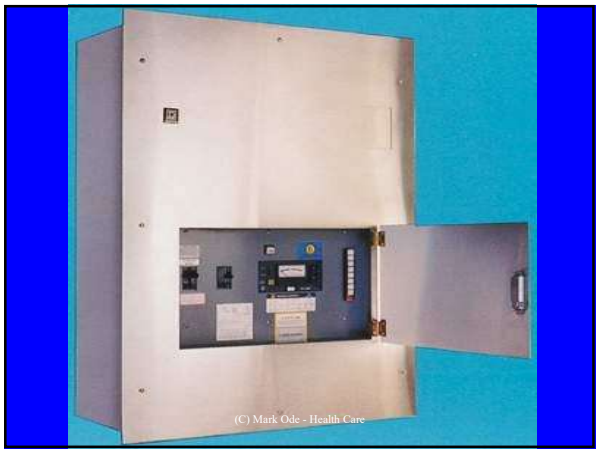

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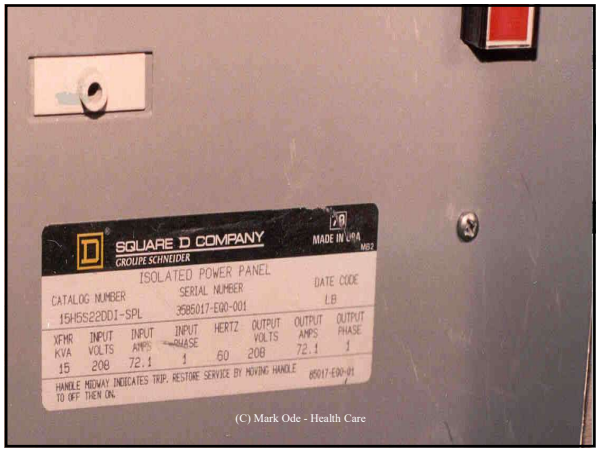

282

517.160(A)(2) Circuit Characteristics.

- (2) Circuit Characteristics. Circuits supplying primaries of
- isolating transformers shall operate at not more than 600 volts
- between conductors and shall be provided with proper overcurrent protection.
- The secondary voltage of such transformers shall not exceed 600 volts between conductors of each circuit.
- All circuits supplied from such secondaries shall be ungrounded and shall have an approved overcurrent device of proper ratings in each conductor.
- Circuits supplied directly from batteries or from motor generator sets shall be ungrounded and shall be protected against overcurrent in the same manner as transformer-fed secondary circuits.
- If an electrostatic shield is present, it shall be connected to the reference grounding point. [99:6.3.2.6.1]

283

NFPA 99--6.3.2.9.2 Impedance of Isolated Wiring.

- 6.3.2.9.2.1* The impedance (capacitive and resistive) to ground of either conductor of an isolated system shall exceed 200,000 ohms when installed.
- The installation at this point shall include receptacles but is not required to include lighting fixtures or components of fixtures.
- This value shall be determined by energizing the system and connecting a low-impedance ac milli-ammeter (0 to 1 mA scale) between the reference grounding point and either conductor in sequence.

284

NFPA 99--6.3.2.9.2 Impedance of Isolated Wiring.

- This test shall be permitted to be performed with the line isolation monitor *(see 6.3.2.9.3.1)* connected, provided that the connection between the line isolation monitor and the reference grounding point is open at the time of the test.
- After the test is made, the milli-ammeter shall be removed and the grounding connection of the line isolation monitor shall be restored.

285

NFPA 99--6.3.2.9.2 Impedance of Isolated Wiring.

- When the installation is completed, including permanently connected fixtures, the reading of the meter on the line isolation monitor, which corresponds to the unloaded line condition, shall be made.
- This meter reading shall be recorded as a reference for subsequent line impedance evaluation.
- This test shall be conducted with no phase conductors grounded.

286

NFPA 99--6.3.2.9.2 Impedance of Isolated Wiring.

- 6.3.2.9.2.2 An approved capacitance suppressor shall be permitted to be used to improve the impedance of the permanently installed isolated system; however, the resistive impedance to ground of each isolated conductor of the system shall be at least 1 megohm prior to the connection of the suppression equipment.
- Capacitance suppressors shall be installed so as to prevent inadvertent disconnection during normal use.

287

517.160(A)(3) Equipment Location

- (3) Equipment Location. The isolating transformers, motor generator sets, batteries and battery chargers, and associated primary or secondary overcurrent devices shall not be installed in hazardous (classified) locations.
- The isolated secondary circuit wiring extending into a hazardous anesthetizing location shall be installed in accordance with 501.10.

288

517.160.(A)(4) Isolation Transformers

- (4) Isolation Transformers. An isolation transformer shall not serve more than one operating room except as covered in (A)(4)(a) and (A)(4)(b).
- For purposes of this section, anesthetic induction rooms are considered part of the operating room or rooms served by the induction rooms.
- (a) *Induction Rooms.* Where an induction room serves more than one operating room, the isolated circuits of the induction room shall be permitted to be supplied from the isolation transformer of any one of the operating rooms served by that induction room.

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517.160.(A)(4) Isolation Transformers

- (b) *Higher Voltages.* Isolation transformers shall be permitted to serve single receptacles in several patient areas where the following apply:
- (1) The receptacles are reserved for supplying power to equipment requiring 150 volts or higher, such as portable X-ray units.
- (2) The receptacles and mating plugs are not interchangeable with the receptacles on the local isolated power system. [99:13.4.1.2.6.6]

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517.160(A)(5) Conductor Identification.

- (1) Isolated Conductor No. 1 — Orange with at least one distinctive colored stripe other than white, green, or gray along the entire length of the conductor
- (2) Isolated Conductor No. 2 — Brown with at least one distinctive colored stripe other than white, green, or gray along the entire length of the conductor

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517.160(A)(5) Conductor Identification.

- For 3-phase systems, the third conductor shall be identified as yellow with at least one distinctive colored stripe other than white, green, or gray along the entire length of the conductor.
- Where isolated circuit conductors supply 125-volt, single-phase, 15- and 20-ampere receptacles, the striped orange conductor(s) shall be connected to the terminal(s) on the receptacles that are identified in accordance with 200.10(B) for connection to the grounded circuit conductor.

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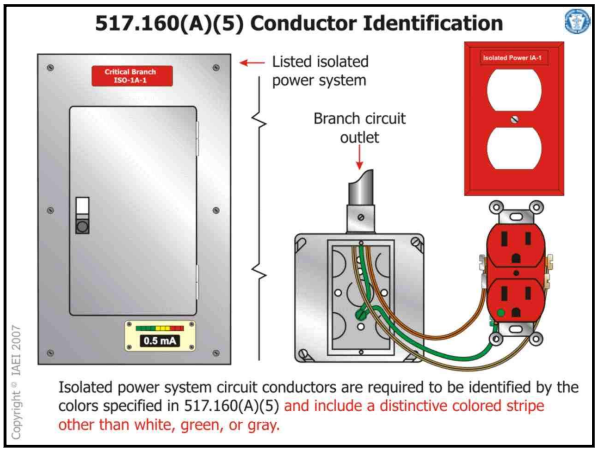

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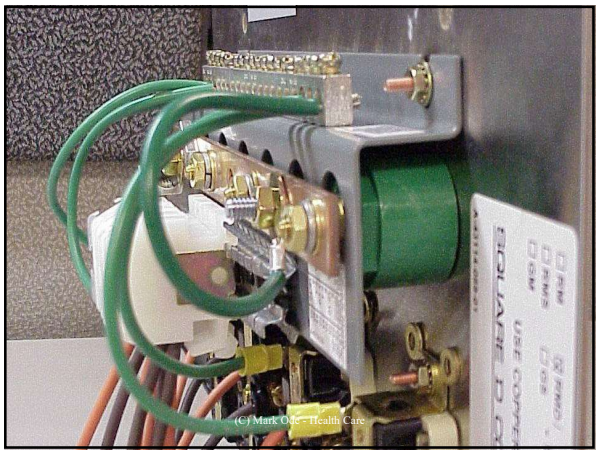

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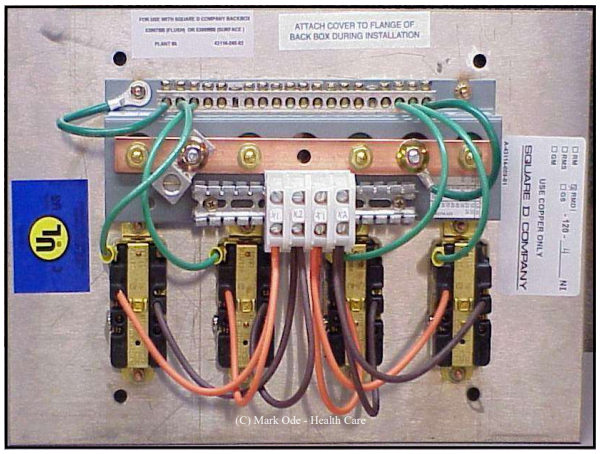

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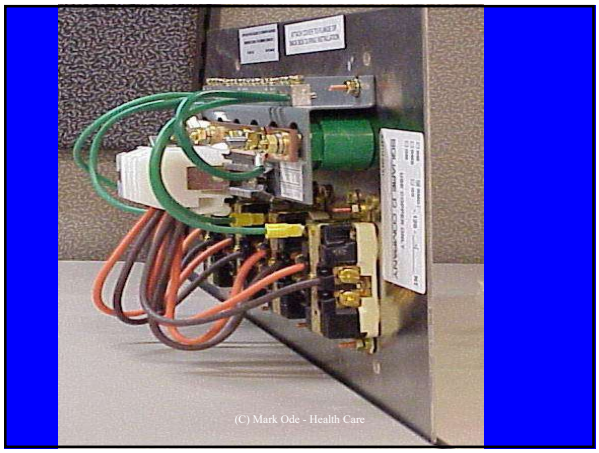

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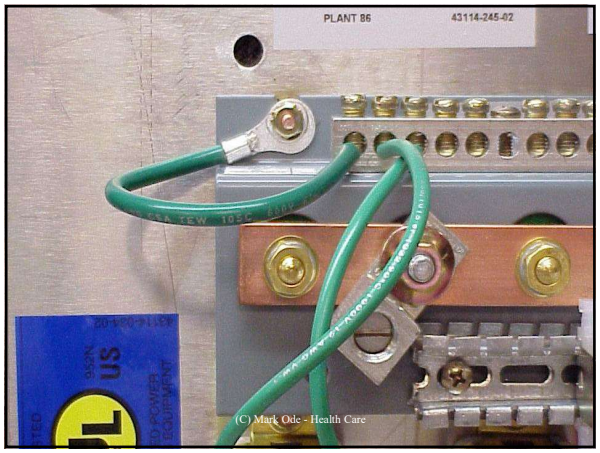

298

517.160(A)(6) Wire-Pulling Compounds.

- **Wire-pulling compounds that increase the dielectric constant shall not be used on the secondary conductors of the isolated power supply.**
- **Informational Note No. 1: It is desirable to limit the size of the isolation transformer to 10 kVA or less and to use conductor insulation with low leakage to meet impedance requirements.**
- **Informational Note No. 2: Minimizing the length of branch circuit conductors and using conductor insulations with a dielectric constant less than 3.5 and insulation resistance constant greater than 6100 megohm-meters (20,000 megohmfeet) at 16°C (60°F) reduces leakage from line to ground, reducing the hazard current.**

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6.3.2.9.3 Line Isolation Monitor.

- 6.3.2.9.3.1* In addition to the usual control and protective devices, each isolated power system shall be provided with an approved, continually operating line isolation monitor that indicates possible leakage or fault currents from either isolated conductor to ground.

301

6.3.2.9.3 Line Isolation Monitor.

- A.6.3.2.9.3.1 Protection for the patient is provided primarily by a grounding system.
- The ungrounded secondary of the isolation transformer reduces the maximum current in the grounding system in case of a single fault between either isolated power conductor and ground.
- The line isolation monitor provides warning when a single fault occurs, or when excessively low impedance to ground develops, which might expose the patient to an unsafe condition if an additional faul occurs.
- Excessive current in the grounding conductors will not result from a first fault.
- A hazard exists if a second fault occurs before the first fault is cleared.

302

6.3.2.9.3 Line Isolation Monitor.

- 6.3.2.9.3.2 The monitor shall be designed such that a green signal lamp, conspicuously visible in the area where the line isolation monitor is utilized, remains lighted when the system is adequately isolated from ground;
- and an adjacent red signal lamp and an audible warning signal (remote if desired) shall be energized when the total hazard current (consisting of possible resistive and capacitive leakage currents) from either isolated conductor to ground reaches a threshold value of 5.0 mA under normal line voltage conditions.
- The line isolation monitor shall not alarm for a fault hazard current of less than 3.7 mA.

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6.3.2.9.3 Line Isolation Monitor.

- 6.3.2.9.3.3* The line isolation monitor shall comply with either of the following:
  - (1) It shall have sufficient internal impedance such that, when properly connected to the isolated system, the maximum internal current that will flow through the line isolation monitor, when any point of the isolated system is grounded, shall be 1 mA.
  - (2) It shall be permitted to be of the low-impedance type such that the current through the line isolation monitor, when any point of the isolated system is grounded, will not exceed twice the alarm threshold value for a period not exceeding 5 milliseconds.
- A.6.3.2.9.3.3 It is desirable to reduce this monitor hazard current, provided that this reduction results in an increased "not alarm" threshold value for the fault hazard current.

304

6.3.2.9.3 Line Isolation Monitor.

- 6.3.2.9.3.4* An ammeter connected to indicate the total hazard current of the system (contribution of the fault hazard current plus monitor hazard current) shall be mounted in a plainly visible place on the line isolation monitor with the "alarm on" zone (total hazard current = 5.0 mA) at approximately the center of the scale.
- A line isolation monitor shall be located in the operating room.

305

517.160(B) Line Isolation Monitor.

- (1) Characteristics. In addition to the usual control and overcurrent protective devices, each isolated power system shall be provided with a listed continually operating line isolation monitor that indicates total hazard current.
- The monitor shall be designed so that a green signal lamp,
  - conspicuously visible to persons in each area served by the isolated power system,
- remains lighted when the system is adequately isolated from ground.

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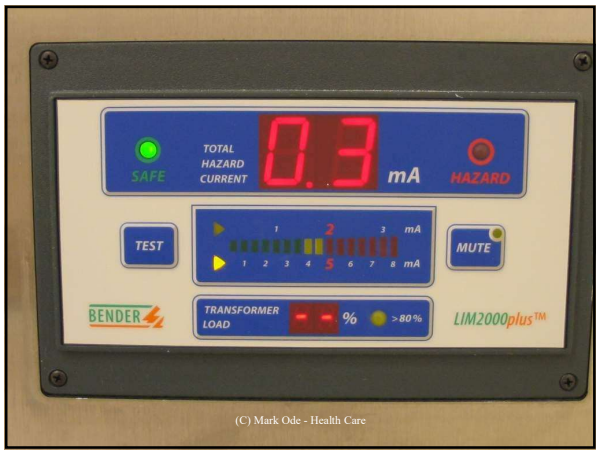

308

517.160(B) Line Isolation Monitor.

- An adjacent red signal lamp and an audible warning signal (remote if desired) shall be energized when the total hazard current (consisting of possible resistive and capacitive leakage currents) from either isolated conductor to ground reaches a threshold value of 5 mA under nominal line voltage conditions.
- The line monitor shall not alarm for a fault hazard of less than 3.7 mA or for a total hazard current of less than 5 mA.

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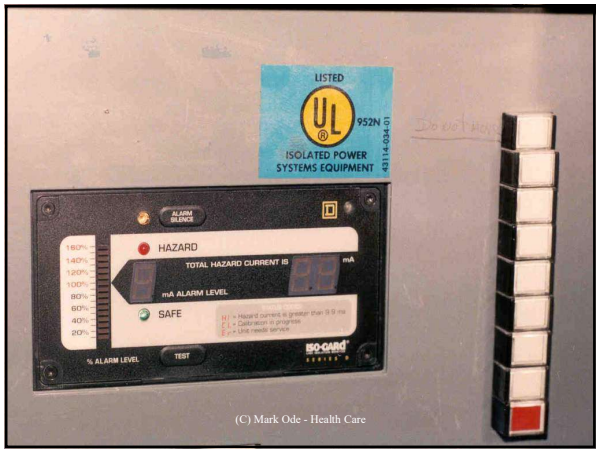

310

517.160(B)(1) Line Isolation Monitor.

- Exception: A system shall be permitted to be designed to operate at a lower threshold value of total hazard current.
- A line isolation monitor for such a system shall be permitted to be approved, with the provision that the fault hazard current shall be permitted to be reduced
- but not to less than 35 percent of the corresponding threshold value of the total hazard current, and
- the monitor hazard current is to be correspondingly reduced to not more than 50 percent of the alarm threshold value of the total hazard current.

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EXHIBIT 517.7 *An example of a hospital isolated power system panel with built-in isolation transformer, line isolation monitor, load center, and grounded busbar. (Courtesy of Schneider Electric)*

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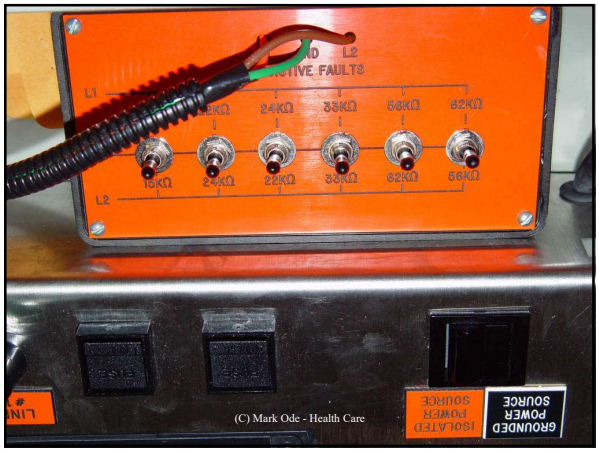

315

517.160(B)(2) Impedance.

- The line isolation monitor shall be designed to have sufficient internal impedance such that, when properly connected to the isolated system, the maximum internal current that can flow through the line isolation monitor, when any point of the isolated system is grounded, shall be 1 mA.
- *Exception: The line isolation monitor shall be permitted to be of the low-impedance type such that the current through the line isolation monitor, when any point of the isolated system is grounded, will not exceed twice the alarm threshold value for a period not exceeding 5 milliseconds.*
- Informational Note: Reduction of the monitor hazard current, provided this reduction results in an increased "not alarm" threshold value for the fault hazard current, will increase circuit capacity.

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517.160(B)(3) Ammeter.

- An ammeter calibrated in the total hazard current of the system
  - (contribution of the fault hazard current plus monitor hazard current)
- shall be mounted in a plainly visible place on the line isolation monitor with the "alarm on" zone at approximately the center of the scale.
- Exception:
- The line isolation monitor shall be permitted to be a composite unit, with a sensing section cabled to a separate display panel section on which the alarm or test functions are located.
- Informational Note: It is desirable to locate the ammeter so that it is conspicuously visible to persons in the anesthetizing location.

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517.21. Ground-Fault Circuit-Interrupter Protection for Personnel

- Ground-fault circuit-interrupter protection for personnel shall not be required for receptacles installed in those critical care (Category 1) spaces where the toilet and basin are installed within the patient room.
- Commentary in NEC Handbook: A basin and toilet may be located within the patient room or as part of the bed assembly.
- Although the presence of a basin and toilet meets the definition of a bathroom, the receptacles serving the critical care space are exempt from the GFCI requirement because of the specialized use of a critical care space.
- A bathroom attached to the patient room is still required to have GFCI protection for receptacles. It also does not exempt receptacles in other bathrooms for patients, staff, or the public from the requirements of 210.8(B).

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PART VI.
COMMUNICATIONS, SIGNALING SYSTEMS, DATA SYSTEMS, FIRE ALARM SYSTEMS, AND SYSTEMS LESS THAN 120 VOLTS, NOMINAL

320

517.80 Patient Care Spaces.

- Equivalent insulation and isolation to that required for the electrical distribution systems in patient care areas shall be provided for communications, signaling systems, data system circuits, fire alarm systems, and systems less than 120 volts, nominal.
- Class 2 and Class 3 signaling and communications systems and power-limited fire alarm systems shall not be required to comply with the grounding requirements of 517.13, to comply with the mechanical protection requirements of 517.31(C)(3)(5), or to be enclosed in raceways, unless otherwise specified by Chapter 7 or 8.
- Secondary circuits of transformer-powered communications or signaling systems shall not be required to be enclosed in raceways unless otherwise specified by Chapter 7 or 8. [99:6.4.2.2.6.6]

321

NEC Handbook Commentary

- One of the major objectives of Article 517 is to minimize patients' exposure to any level of current that could injure them.
- The equivalent insulation and isolation of these circuits from the patient is for protection of patients from any shock hazard that could result from inadvertent contact with energized circuit conductors or parts associated with the limited energy systems.
- Nurse call, intercom, speaker, cable television, and fire alarm systems are examples of the types of circuits covered by this requirement.
- Class 2 and Class 3 remote control and signaling circuits, as well as power-limited fire alarm circuits that are installed in patient care spaces, are not required to comply with the same grounding or mechanical protection requirements as power and lighting circuits.
- This does not remove applicable installation requirements, such as the use of a raceway, if specified in Chapter 7 or Chapter 8.

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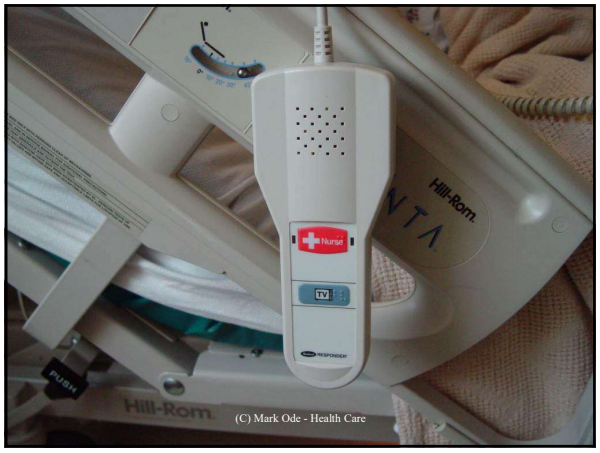

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325

517.81 Other-Than-Patient-Care Areas.

- **In other-than patient- care areas, installations shall be in accordance with the applicable provisions of other parts of this *Code*.**

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517.82 Signal Transmission Between Appliances.

- **(A) General. Permanently installed signal cabling from an appliance in a patient location to remote appliances shall employ a signal transmission system that prevents hazardous grounding interconnection of the appliances.**
- Informational Note: See 517.13(A) for additional grounding requirements in patient care areas.
- **(B) Common Signal Grounding Wire. Common signal grounding wires (i.e., the chassis ground for single-ended transmission) shall be permitted to be used between appliances all located within the patient care vicinity, provided the appliances are served from the same reference grounding point.**

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Part III. Essential Electrical System

- **517.25 Scope. The essential electrical system for these facilities shall comprise a system capable of supplying a limited amount of lighting and power service, which is considered essential for life safety and orderly cessation of procedures during the time normal electrical service is interrupted for any reason.**
- **This includes clinics, medical and dental offices, outpatient facilities, nursing homes, limited care facilities, hospitals, and other health care facilities serving patients.**
- **Informational Note: For information on the need for an essential electrical system, see NFPA 99-2015, *Health Care Facilities Code*.**

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517.26 Application of Other Articles (Health Care Facilities)

- New text was added in the 2020 NEC to give needed guidance to what parts of Article 700 that Article 517 amends
- Revision added **four specific amendments** to Article 517 from requirements of Article 700 that does not apply to the **life safety branch** of the **essential electrical system** of a health care facility
  - **700.4** *(emergency system equipment required to be suitable for the available fault current)* does not apply
  - **700.10(D)** *(fire protection)* does not apply
  - **700.17** *(Branch Circuits for Emergency Lighting)* has been **replaced** with a provision that states that branch circuits that supply emergency lighting is required to be installed to provide service from a source complying with 700.12 *(Sources of Power)* when normal supply for lighting is interrupted or where single circuits supply luminaires containing secondary batteries
  - **700.32** *(selective coordination)* is also "amended" from Article 517

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517.26 Application of Other Articles (Health Care Facilities) *(cont.)*

- New text was added in the 2020 NEC to give needed guidance to want parts of Article 700 that Article 517 amends *(cont.)*
- Revisions brought about as a result of the work of the **NFPA 99 Electrical Systems Technical Committee**
- Changes meant to improve the **correlation** between NFPA 99 *(Health Care Facilities Code)* and the *NEC*
- NFPA 99 has jurisdiction over **performance requirements** for electrical systems in health care facilities while the *NEC* has jurisdiction over the **installation requirements**
- Life safety branch of the essential electrical system of a health care facility is required to conform to Article 700 with the exception of the performance requirements as described earlier

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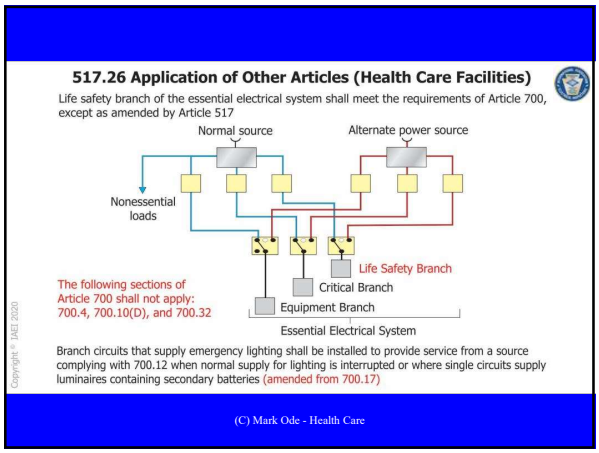

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517.26 Application of Other Articles.

- **517.26 Application of Other Articles. The life safety branch of the essential electrical system shall meet the requirements of Article 700, except as amended by Article 517.**
- **Informational Note No. 1: For additional information, see NFPA 110-2013, *Standard for Emergency and Standby Power Systems*.**
- **Informational Note No. 2: For additional information, see 517.29 and NFPA 99-2015, *Health Care Facilities Code*.**
- **NEC Handbook Commentary**
- **Where a requirement in Article 517 differs from a requirement in Article 700, Article 517 takes precedence.**
- **For example 517.31(B) differs from 700.5 in smaller facilities with a maximum demand on the essential electrical system of 150 kilovolt-amperes or less.**
- **In those cases, a single transfer switch is permitted to supply the entire essential electrical system.**

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517.29 Essential Electrical Systems for Hospitals and Other Health Care Facilities.

- **(A) Applicability. The requirements of Part III, 517.29 through 517.30, shall apply to critical care (Category 1) and general care (Category 2) hospitals and other health care facilities using Type 1 essential electrical systems where patients are sustained by electrical life-support equipment.**
- Informational Note No. 1: For performance, maintenance, and testing requirements of essential electrical systems in hospitals, see NFPA 99-2015, *Health Care Facilities Code*. For installation of centrifugal fire pumps, see NFPA 20-2013, *Standard for the Installation of Stationary Pumps for Fire Protection*.
- Informational Note No. 2: For additional information on Type 1 and Type 2 essential electrical systems, see NFPA 99-2015, *Health Care Facilities Code*.
- **(B) Critical care (Category 1) spaces shall be served only by a Type 1 essential electrical system. [99:6.3.2.2.10.1]**

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NFPA 99--6.7* Essential Electrical Systems.

- **6.7.1 Sources.**
- **6.7.1.1* Design Considerations. Dual sources of normal power shall not constitute an alternate source of power as described in this chapter.**
- **6.7.1.2 On-Site Generator Set.**
- **6.7.1.2.1 Current-sensing devices, phase and ground, shall be selected to minimize the extent of interruption to the electrical system due to abnormal current caused by overload or short circuits, or both.**
- **6.7.1.2.2 Essential electrical systems shall have a minimum of the following two independent sources of power: a normal source generally supplying the entire electrical system and one or more alternate sources for use when the normal source is interrupted.**

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NFPA 99--6.7* Essential Electrical Systems.

- **6.7.1.2.3 Where the normal source consists of generating units on the premises, the alternate source shall be either another generating set or an external utility service.**
- **6.7.1.2.4 General. Generator sets installed as an alternate source of power for essential electrical systems shall be designed to meet the requirements of such service.**
- **6.7.1.2.4.1 Type 1 and Type 2 essential electrical system power sources shall be classified as Type 10, Class X, Level 1 generator sets per NFPA 110.**

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517.30 Sources of Power.

- **(A) Two Independent Power Sources. Essential electrical systems shall have a minimum of the following two independent sources of power: a normal source generally supplying the entire electrical system and one or more alternate source(s) for use when the normal source is interrupted. [99:6.4.1.1.4]**
- **(B) Types of Power Sources.**
- **(1) Generating Units. Where the normal source consists of generating units on the premises, the alternate source shall be either another generating set or an external utility service. [99:6.4.1.1.5]**

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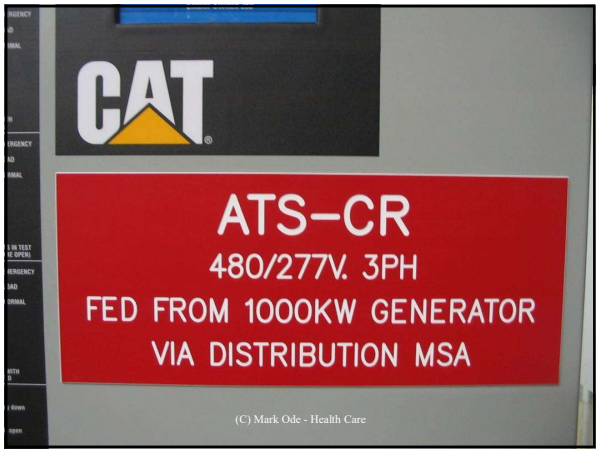

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517.30 Sources of Power.

- **(2) Fuel Cell Systems. Fuel cell systems shall be permitted toserve as the alternate source for all or part of an essential electrical system, provided the following conditions apply:**
- **(1) Installation of fuel cells shall comply with the requirements in Parts I through VII of Article 692 for 1000 volts or less and Part VIII for over 1000 volts.**
- **Informational Note: For information on installation of stationary fuel cells, see NFPA 853-2015, the *Standard for Installation of Stationary Fuel Cell Power Systems*. [99:6.4.1.2.7]**
- **(2) N + 1 units shall be provided where N units have sufficient capacity to supply the demand loads of the portion of the system served. [99:6.4.1.7.2]**
- **(3) System shall be able to assume loads within 10 seconds of loss of normal power source.**

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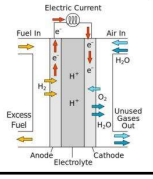
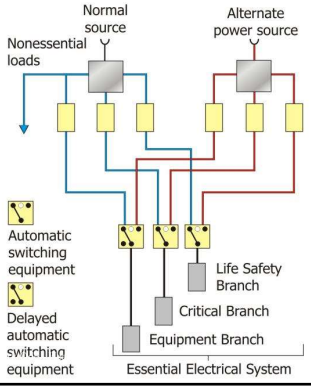
517.30(B) Sources of Power
Essential Electrical System (Hospital)

Requirements for two independent sources of power and an alternate source of power for the essential electrical system for hospitals and other health care facilities were revised and relocated to 517.30 *(was 517.35)*

Fuel cell systems will now be permitted to serve as the alternate source for all or part of an essential electrical system





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517.30 Sources of Power.

- **(4) System shall have a continuing source of fuel supply, together with sufficient on-site fuel storage for the essential system type.**
- **(5) A connection shall be provided for a portable diesel generator to supply life safety and critical portions of the distribution system. [99:6.4.1.1.7(1) through (5)]**
- **(6) Fuel cell systems shall be listed for emergency system use.**

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517.30(B)(3) Sources of Power – Battery Systems

- **Battery systems** are now permitted to serve as the **alternate source** for all or part of an **essential electrical system** of a health care facility
- **Two independent sources of power** required with one being the normal power source *(typically a utility supplied source of power)* and one or more alternate power sources for use when the normal power source is interrupted
- Battery systems are a recognized essential electrical system source by **NFPA 99** *(Health Care Facilities Code)*
- 2014 *NEC* recognized a battery system located on the premises as an acceptable alternate source of power for an essential electrical system
- Battery systems can supply power to critical life-support equipment until the main power can be restored

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517.30 Sources of Power

- **(C) Location of Essential Electrical System Components.**
- **Essential electrical system components shall be located to minimize interruptions caused by natural forces common to the area (e.g., storms, floods, earthquakes, or hazards created by adjoining structures or activities).**
- **Installations of electrical services shall be located to reduce possible interruption of normal electrical services resulting from similar causes as well as possible disruption of normal electrical service due to internal wiring and equipment failures.**
- **Feeders shall be located to provide physical separation of the feeders of the alternate source and from the feeders of the normal electrical source to prevent possible simultaneous interruption.**

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517.30 Sources of Power

- **Informational Note: Facilities in which the normal source of power is supplied by two or more separate central station-fed services experience greater than normal electrical service reliability than those with only a single feed.**
- **Such a dual source of normal power consists of two or more electrical services fed from separate generator sets or a utility distribution network that has multiple power input sources and is arranged to provide mechanical and electrical separation so that a fault between the facility and the generating sources is not likely to cause an interruption of more than one of the facility service feeders.**

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517.31(C)(1)(a) Identification of Essential Electrical Systems

- **Identification and marking requirements** for the life safety branch and critical branch of **essential electrical systems** was added to 517.31(C)(1)(a). Raceways and cables required to be **field- or factory-marked** as components of the essential electrical system at intervals **not to exceed 7.6 m (25 ft)**
- Raceways, cables, or enclosures of the life safety and critical branch of the essential electrical systems of a health care facility required be "**readily identified**" as a component of the essential electrical system (EES)
- **No specific color-coding, etc.** specified for "readily identifying" the EES
- This added identification marking requirement correlates 517.31 with the identification requirements for emergency systems in **700.10**

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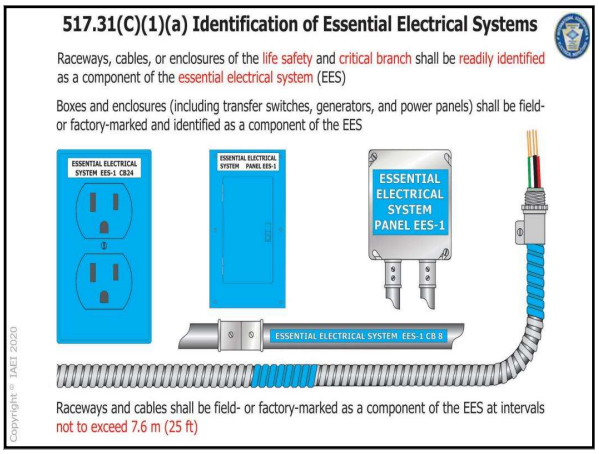

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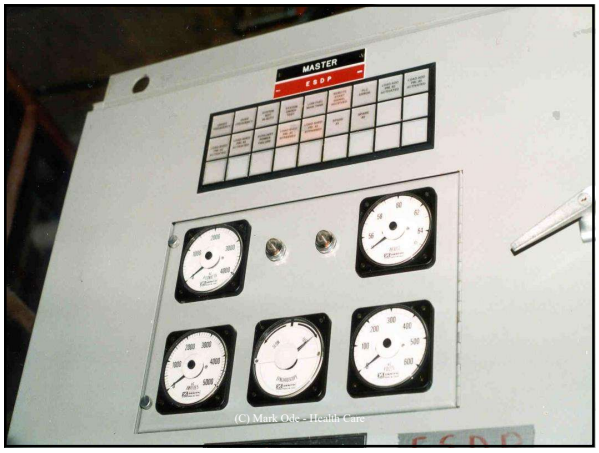

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NFPA 99--6.4 Category 1 Spaces.

- 6.4.1 Category 1 spaces shall be served by a Type 1 EES.
- 6.4.2 Category 1 spaces shall not be served by a Type 2 EES.
- 6.4.3 Category 1 spaces shall be served by circuits from a critical branch panel(s) served from a single automatic transfer switch and a minimum of one circuit served by the normal power distribution system or by a system originating from a second critical branch automatic transfer switch.
- 6.4.4 A Type I EES serving a Category 1 space shall be permitted to serve Category 2 spaces in the same facility.

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NFPA 99--6.7.1.2.5 Use for Essential Electrical System.

- 6.7.1.2.5.1 The generating equipment used shall be either reserved exclusively for such service or normally used for other purposes of peak demand control, internal voltage control, load relief for the external utility, or cogeneration.
- If normally used for such other purposes, two or more sets shall be installed, such that the maximum actual demand likely to be produced by the connected load of the life safety and critical branches,
  - as well as medical air compressors, medical–surgical vacuum pumps, electrically operated fire pumps, jockey pumps, fuel pumps, and generator accessories,
- shall be met by a multiple generator system, with the largest generator set out of service (not available).

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NFPA 99--6.7.1.2.5 Use for Essential Electrical System.

- The alternate source of emergency power for illumination and identification of means of egress shall be the essential electrical system.
- The alternate power source for fire protection signaling systems shall be the essential electrical system.
- 6.7.1.2.5.2 A single generator set that operates the essential electrical system shall be permitted to be part of the system supplying the other purposes as specified in 6.7.1.2.5.1, provided that any such use will not decrease the mean period between service overhauls to less than 3 years.

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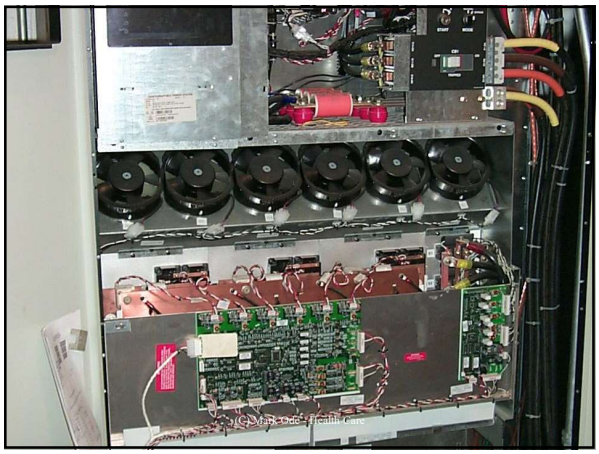

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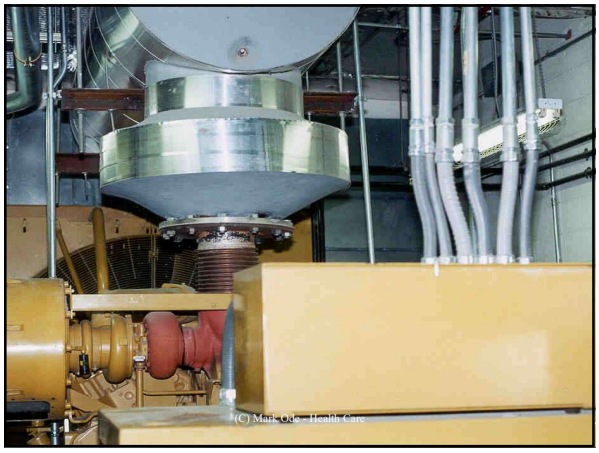

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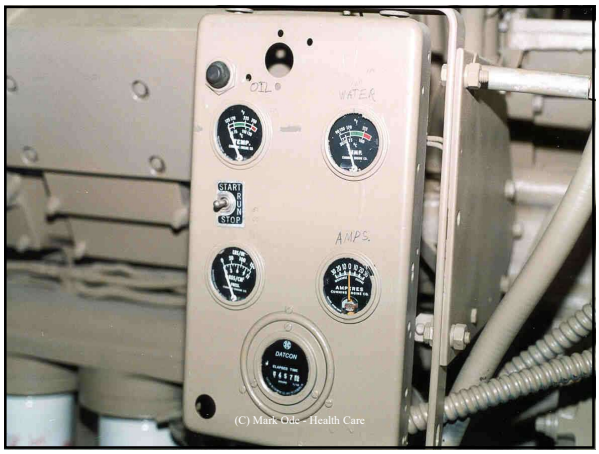

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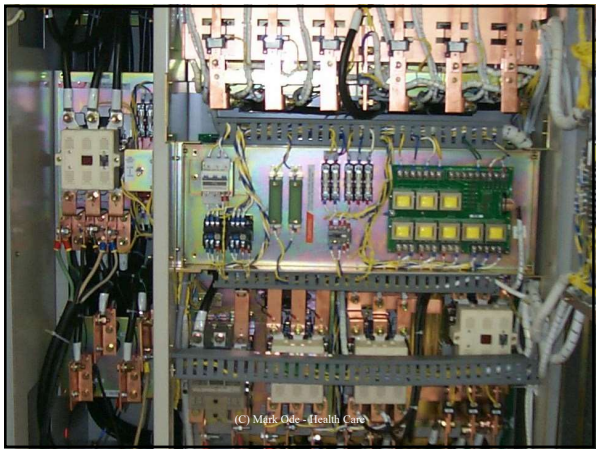

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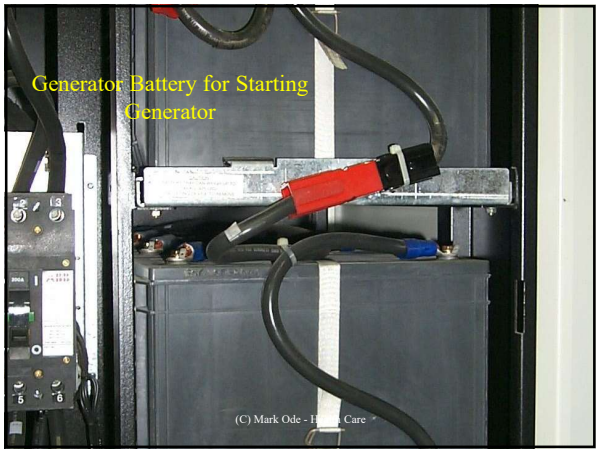

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517.31 Requirements for the Essential Electrical System.

- **(A) Separate Branches. Essential electrical systems for hospitals shall be comprised of three separate branches capable of supplying a limited amount of lighting and power service that is considered essential for life safety and effective hospital operation during the time the normal electrical service is interrupted for any reason.**
- **The three branches are life safety, critical, and equipment.**
- **The division between the branches shall occur at transfer switches where more than one transfer switch is required [99:6.4.2.2.1.2]**

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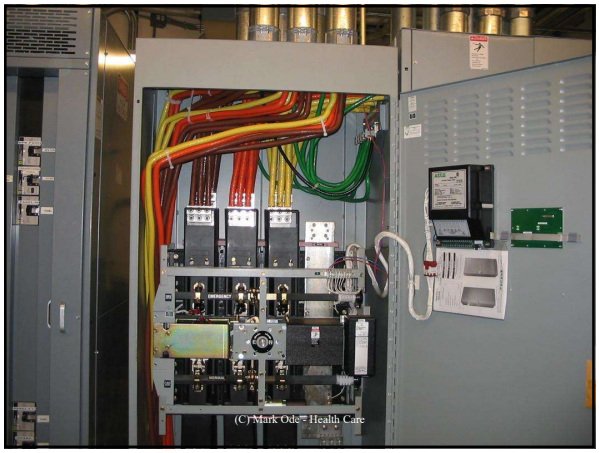

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517.31 Requirements for the Essential Electrical System.

- **(B) Transfer Switches. The number of transfer switches to be used shall be based on reliability and design. Each branch of the essential electrical system shall have one or more transfer switches.**
- **One transfer switch and downstream distribution system shall be permitted to serve one or more branches in a facility with a maximum demand on the essential electrical system of 150 kVA.**
- **Informational Note No. 1: See NFPA 99-2015, *Health Care Facilities Code*, 6.4.3.2, Transfer Switches; 6.4.2.1.5, Automatic Transfer Switch Features; 6.4.2.1.5.15, Nonautomatic Transfer Switch Features; and 6.4.2.1.7, Nonautomatic Transfer Device Features.**
- **Informational Note No. 2: See Informational Note Figure 517.31(a).**
- **Informational Note No. 3: See Informational Note Figure 517.31(b).**

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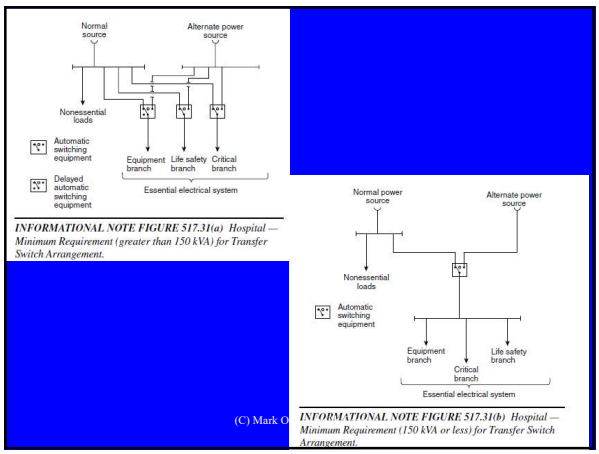

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NEC Handbook Commentary

- **In larger health care facilities, 517.31(B) requires one or more transfer switches to supply each branch of the essential electrical system.**
- **In a small health care facility with an essential load not exceeding 150 kilovolt-amperes, the essential electrical system can be served by a single transfer switch that can handle all loads.**
- **This is based on the assumption that the alternate source of power is sufficiently large to handle the simultaneous transfer of all systems in the event of a normal power loss.**
- **For further explanation of loads permitted on an essential electrical system, see NFPA 99.**

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517.31 Requirements for the Essential Electrical System.

- (1) Optional Loads. Loads served by the generating equipment not specifically named in Article 517 shall be served by their own transfer switches such that the following conditions apply:
  - (1) These loads shall not be transferred if the transfer will overload the generating equipment.
  - (2) These loads shall be automatically shed upon generating equipment overloading.
- (2) Contiguous Facilities. Hospital power sources and alternate power sources shall be permitted to serve the essential electrical systems of contiguous or same site facilities.

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517.31 Requirements for the Essential Electrical System.

- (C) Wiring Requirements.
- (1) Separation from Other Circuits The life safety branch and critical branch of the essential electrical system shall be kept entirely independent of all other wiring and equipment and shall not enter the same raceways, boxes, or cabinets with each other or other wiring.
- Where general care locations are served from two separate transfer switches on the essential electrical system in accordance with 517.18(A), Exception No. 3, the general care circuits from the two separate systems shall be kept independent of each other.

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517.31 Requirements for the Essential Electrical System.

- Where critical care locations are served from two separate transfer switches on the essential electrical system in accordance with 517.19(A), Exception No. 2, the critical care circuits from the two separate systems shall be kept independent of each other.
- Wiring of the life safety branch and the critical branch shall be permitted to occupy the same raceways, boxes, or cabinets of other circuits not part of the branch where such wiring complies with one of the following:
  - (1) Is in transfer equipment enclosures
  - (2) Is in exit or emergency luminaires supplied from two sources
  - (3) Is in a common junction box attached to exit or emergency luminaires supplied from two sources
  - (4) Is for two or more circuits supplied from the same branch and same transfer switch

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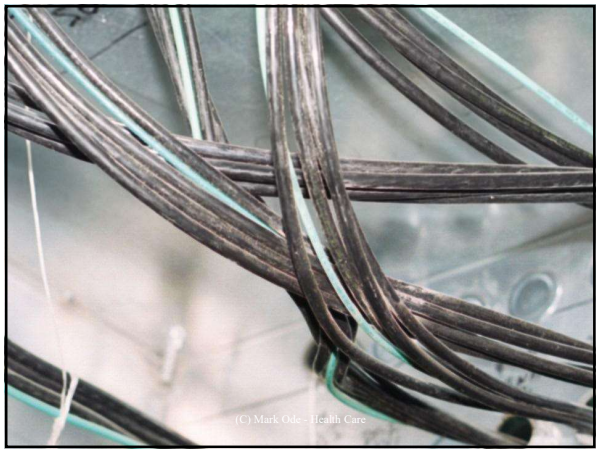

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517.31 Requirements for the Essential Electrical System.

- The wiring of the equipment branch shall be permitted to occupy the same raceways, boxes, or cabinets of other circuits that are not part of the essential electrical system.
- NEC Handbook Commentary
- The life safety branch and critical branch of the essential electrical system are not permitted to occupy the same raceways, boxes, or cabinets with each other or other wiring.
- However, circuits on the life safety or critical branch are allowed with other circuits of the same branch.
- Where general care or critical care spaces are supplied from two transfer switches on an essential electrical system, the separate feeder and branch circuits are to be kept independent of each other.
- The issue of a failure in one circuit affecting the other is the same whether there is a normal and an essential circuit or two essential circuits.

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517.31 Requirements for the Essential Electrical System.

- (2) Isolated Power Systems. Where isolated power systems are installed in any of the areas in 517.34(A)(1) and (A)(2), each system shall be supplied by an individual circuit serving no other load.
- 517.34 Critical Branch.
- (A) Task Illumination and Selected Receptacles. The critical branch of the essential electrical system shall supply power for task illumination, fixed equipment, selected receptacles, and special power circuits serving the following areas and functions related to patient care:
- (1) Critical care (Category 1) spaces that utilize anesthetizing gases, task illumination, selected receptacles, and fixed equipment
- (2) The isolated power systems in special environments

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517.31 Requirements for the Essential Electrical System.

- (3) Mechanical Protection of the Essential Electrical System.
- The wiring of the life safety and critical branches shall be mechanically protected.
- Where installed as branch circuits in patient care spaces, the installation shall comply with the requirements of 517.13(A) and (B).
- Only the following wiring methods shall be permitted:
  - (1) Nonflexible metal raceways, Type MI cable, Type RTRC marked with the suffix –XW, or Schedule 80 PVC conduit.
  - Nonmetallic raceways shall not be used for branch circuits that supply patient care areas.
  - (2) Where encased in not less than 50 mm (2 in.) of concrete, Schedule 40 PVC conduit, flexible nonmetallic or jacketed metallic raceways, or jacketed metallic cable assemblies listed for installation in concrete. Nonmetallic raceways shall not be used for branch circuits that supply patient care areas.

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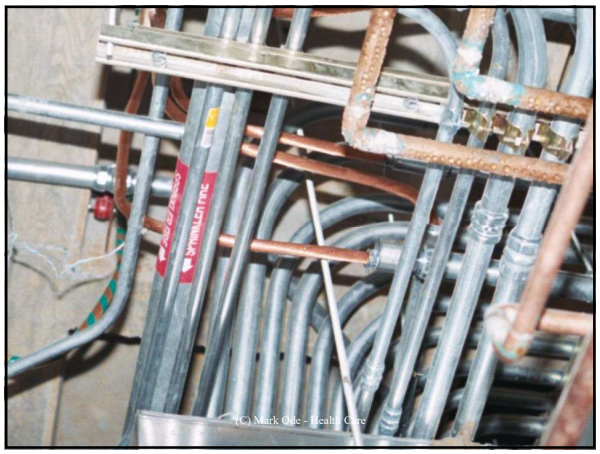

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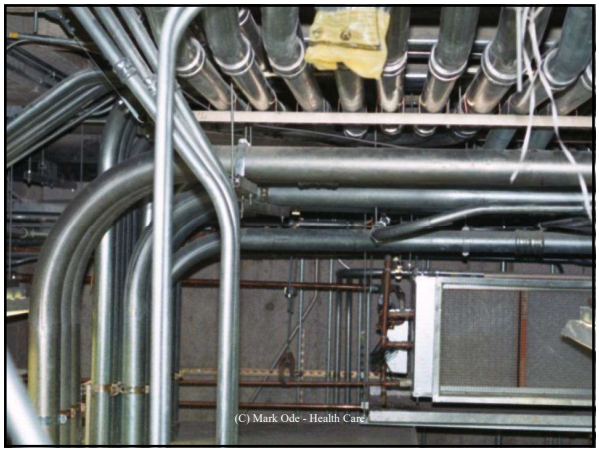

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517.31 Requirements for the Essential Electrical System.

- (3) Listed flexible metal raceways and listed metal sheathed cable assemblies in any of the following:
  - a. Where used in listed prefabricated medical headwalls
  - b. In listed office furnishings
  - c. Where fished into existing walls or ceilings, not otherwise accessible and not subject to physical damage
  - d. Where necessary for flexible connection to equipment
  - e. For equipment that requires a flexible connection due to movement, vibration, or operation
  - f. Luminaires installed in rigid ceiling structures where there is no access above the ceiling space after the luminaire is installed

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NEC Handbook Commentary

- Section 517.31(C)(3)(3)(c) permits fishing flexible metal raceways and metal-sheathed cables in existing installations.
- This facilitates installations in renovated areas where the existing walls or ceilings remain intact.
- The secondary conductors of limited energy systems, such as nurse call, telephone, and alarm circuits, are exempt from being run in raceways, provided they comply with their applicable articles.
- Although this requirement allows substantial latitude in the wiring method, the restrictions of 300.22 (ducts, plenums, and other air-handling spaces) apply, unless cables specifically

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517.31 Requirements for the Essential Electrical System.

- (4) Flexible power cords of appliances or other utilization equipment connected to the emergency system.
- (5) Cables for Class 2 or Class 3 systems permitted by Part VI of this Article, with or without raceways.
- Informational Note: See 517.13 for additional grounding requirements in patient care areas.

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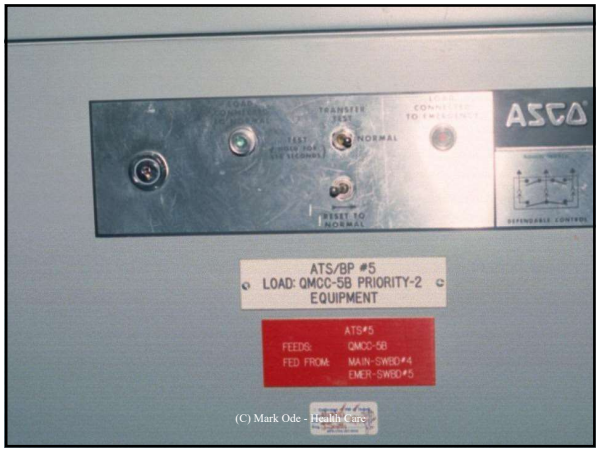

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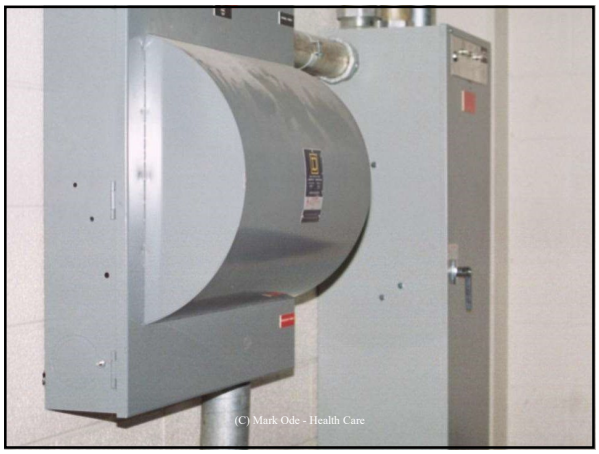

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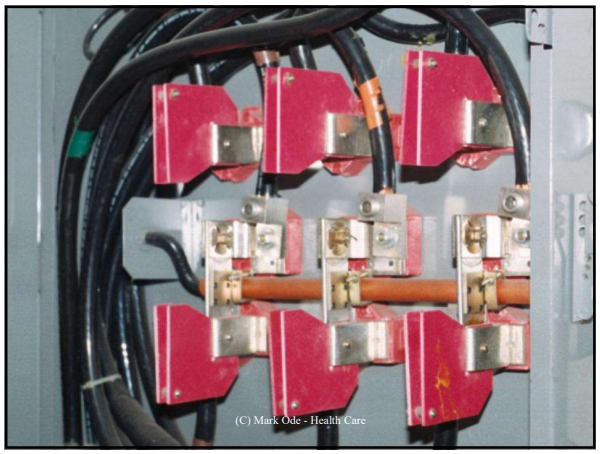

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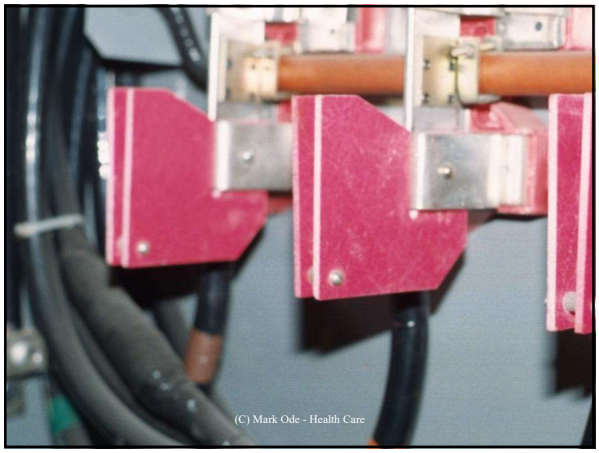

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517.31 Requirements for the Essential Electrical System.

- (D) Capacity of Systems. The essential electrical system shall have the capacity and rating to meet the maximum actual demand likely to be produced by the connected load.
- Feeders shall be sized in accordance with 215.2 and Part III of Article 220.
- The generator set(s) shall have the capacity and rating to meet the demand produced by the load at any given time.
- Demand calculations for sizing of the generator set(s) shall be based on any of the following:
  - (1) Prudent demand factors and historical data
  - (2) Connected load
  - (3) Feeder calculation procedures described in Article 220
  - (4) Any combination of the above
- The sizing requirements in 700.4 and 701.4 shall not apply to hospital generator set(s).

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517.31 Requirements for the Essential Electrical System.

- (E) Receptacle Identification. The cover plates for the electrical receptacles or the electrical receptacles themselves supplied from the essential electrical system shall have a distinctive color or marking so as to be readily identifiable. [99:6.4.2.2.6.2(C)]

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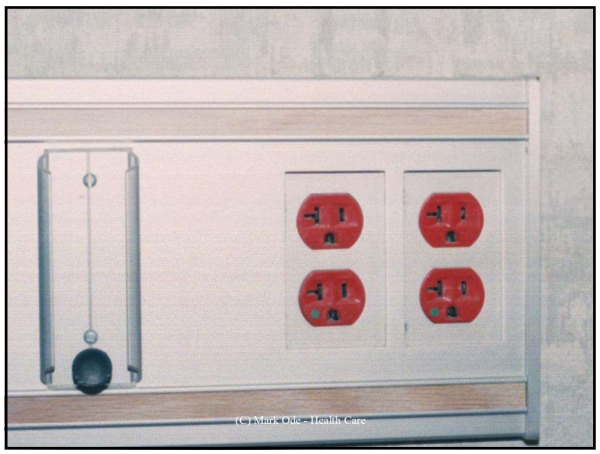

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517.31 Requirements for the Essential Electrical System.

- (F) Feeders from Alternate Power Source. A single feeder supplied by a local or remote alternate source shall be permitted to supply the essential electrical system to the point at which the life safety, critical, and equipment branches are separated.
- Installation of the transfer equipment shall be permitted at other than the location of the alternate power source.

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517.31 Requirements for the Essential Electrical System.

- (G) Coordination. Overcurrent protective devices serving the essential electrical system shall be coordinated for the period of time that a fault's duration extends beyond 0.1 second.
- *Exception No. 1: Between transformer primary and secondary overcurrent protective devices, where only one overcurrent protective device or set of overcurrent protective devices exists on the transformer secondary.*
- *Exception No. 2: Between overcurrent protective devices of the same size (ampere rating) in series.*
- Informational Note: The terms *coordination* and *coordinated* as used in this section do not cover the full range of overcurrent conditions.

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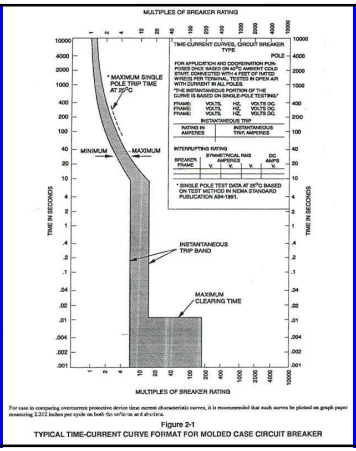

Figure 2-1
TYPICAL TIME-CURRENT CURVE FORMAT FOR MOLDED CASE CIRCUIT BREAKER

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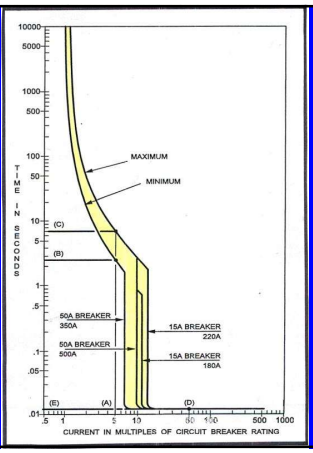

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517.32 Branches Requiring Automatic Connection.

- (A) Those functions of patient care depending on lighting or appliances that are connected to the essential electrical system shall be divided into the life safety branch and the critical branch, as described in 517.33 and 517.34.
- (B) The life safety and critical branches shall be installed and connected to the alternate power source specified in 517.30(A) and (B) so that all functions specified herein for the life safety and critical branches are automatically restored to operation within 10 seconds after interruption of the normal source. [99:6.4.3.1]

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517.33. Life Safety Branch

- No functions other than those listed in 517.33(A) through (H) shall be connected to the life safety branch.
- The life safety branch of the essential electrical system shall supply power for the following lighting, receptacles, and equipment.
- (A) Illumination of Means of Egress.
- (B) Exit Signs.
- (C) Alarm and Alerting Systems.
- (D) Communications Systems.
- (E) Generator Set and Transfer Switch Location.
- (F) Generator Set Accessories
- (G) Elevators.
- (H) Automatic Doors

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517.33. Life Safety Branch

- (A) Illumination of Means of Egress. Illumination of means of egress, such as lighting required for corridors, passageways, stairways, and landings at exit doors, and all necessary ways of approach to exits.
- Switching arrangements to transfer patient corridor lighting in hospitals from general illumination circuits to night illumination circuits shall be permitted, provided only one of two circuits can be selected and both circuits cannot be extinguished at the same time.
- Informational Note: See NFPA *101*-2015, *Life Safety Code*, Sections 7.8 and 7.9.

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517.33. Life Safety Branch

- (B) Exit Signs. Exit signs and exit directional signs.
- Informational Note: See NFPA *101*-2012, *Life Safety Code*, Section 7.10.
- (C) Alarm and Alerting Systems. Alarm and alerting systems including the following:
  - (1) Fire alarm systems
  - (2) Alarm and alerting systems (other than fire alarm systems) shall be connected to the life safety branch or critical branch. [99:6.4.2.2.3.3]
  - (3) Alarms for systems used for the piping of nonflammable medical gases
  - (4) Mechanical, control, and other accessories required for effective life safety systems operation shall be permitted to be connected to the life safety branch.
- NEC Handbook Commentary: HVAC controls are permitted to be on the life safety branch because the operation of an HVAC system and associated dampers can impact smoke control and life safety.

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517.33. Life Safety Branch

- (D) Communications Systems. Hospital communications systems, where used for issuing instructions during emergency conditions.
- [99:6.4.2.2.3.2(3)]
- (E) Generator Set Locations. Generator set locations as follows:
- (1) Task illumination
- (2) Battery charger for emergency battery-powered lighting unit(s)
- (3) Select receptacles at the generator set location and essential electrical system transfer switch locations. [99:6.4.2.2.3.2(4)]

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517.33. Life Safety Branch

- (F) Generator Set Accessories. Generator set accessories as required for generator performance.
- Loads dedicated to a specific generator, including the fuel transfer pump(s), ventilation fans, electrically operated louvers, controls, cooling system, and other generator accessories essential for generator operation, shall be connected to the life safety branch or to the output terminals of the generator with overcurrent protective devices. [99:6.4.2.2.3.4]
- NEC Handbook Commentary: This requirement permits loads that are specifically required for the proper operation of the generator to connect to the life safety branch, via an automatic transfer switch, or to the generator itself.

414

Stationary Engine Generator Assemblies - UL 2200

415

517.33. Life Safety Branch

- (G) Elevators. Elevator cab lighting, control, communications, and signal systems. [99:6.4.2.2.3.2(5)]
- (H) Automatic Doors. Electrically powered doors used for building egress. [99:6.4.2.2.2.3.2(6)]

416

517.34. Critical Branch

- (A) Task Illumination and Selected Receptacles. The critical branch of the essential electrical system shall supply power for task illumination, fixed equipment, selected receptacles, and special power circuits serving the following areas and functions related to patient care:
- (1) Critical care (Category 1) spaces that utilize anesthetizing gases, task illumination, selected receptacles, and fixed equipment
- (2) The isolated power systems in special environments

417

517.34. Critical Branch

- (3) Patient care spaces, task illumination, and selected receptacles in the following:
  - a. Infant nurseries
  - b. Medication preparation areas
  - c. Pharmacy dispensing areas
  - d. Selected acute nursing areas
  - e. Psychiatric bed areas (omit receptacles)
  - f. Ward treatment rooms
  - g. Nurses' stations (unless adequately lighted by corridor luminaires)

418

517.34. Critical Branch

- (4) Additional specialized patient care task illumination and receptacles, where needed
- (5) Nurse call systems
- (6) Blood, bone, and tissue banks
- (7) Telephone and data equipment rooms and closets

419

517.34. Critical Branch

- (8) Task illumination, selected receptacles, and selected power circuits for the following:
  - a. General care (Category 2) beds (at least one duplex receptacle in each patient bedroom)
  - b. Angiographic labs
  - c. Cardiac catheterization labs
  - d. Coronary care units
  - e. Hemodialysis rooms or areas
  - f. Emergency room treatment areas (selected)
  - g. Human physiology labs
  - h. Intensive care units
  - i. Postoperative recovery rooms (selected)

420

Electrical Distribution System

6.3.2.2 All patient care spaces.

6.3.2.2.11 Battery-powered Lighting Units.

[NOT exit lights; NOT on life-safety branch. Requirement in NFPA 99 since 1996 edition. Not really part of the elec. distr. system.]

6.3.2.2.11.1 One or more battery-powered lighting units shall be provided within locations where deep sedation and general anesthesia is administered.

421

517.34. Critical Branch

- **(9) Additional task illumination, receptacles, and selected power circuits needed for effective facility operation, including single-phase fractional horsepower motors, shall be permitted to be connected to the critical branch. [99:6.4.2.2.4.2(9)]**

- **NEC Handbook Commentary**
- **The critical branch is intended to serve a limited number of receptacles and locations in order to reduce the load and minimize the chances of a fault condition.**
- **Receptacles in general patient care area corridors are permitted on the critical branch, but they must be identified in some manner (color-coded or labeled) as part of the essential electrical system, in accordance with 517.31(E).**

422

517.34. Critical Branch

- **(B) Switching. It shall be permitted to control task illumination on the critical branch.**

- **(C) Subdivision of the Critical Branch. It shall be permitted to subdivide the critical branch into two or more branches.**

- **Informational Note: It is important to analyze the consequences of supplying an area with only critical care branch power when failure occurs between the area and the transfer switch.**
- **Some proportion of normal and critical power or critical power from separate transfer switches may be appropriate.**

423

424

Alternate Power Source.

- **One or more generator sets, or battery systems where permitted,**
- **intended to provide power during the interruption of the normal electrical services or the public utility electrical service**
- **intended to provide power during interruption of service normally provided by the generating facilities on the premises.**

425

517.35 Equipment Branch Connection to Alternate Power Source.

- The equipment branch shall be installed and connected to the alternate power source such that the equipment described in 517.35(A) is automatically restored to operation at appropriate time-lag intervals following the energizing of the essential electrical system.

- Its arrangement shall also provide for the subsequent connection of equipment described in 517.35(B). **[99:**6.4.2.2.5.2]

- **Exception: For essential electrical systems under 150 kVA, deletion of the time-lag intervals feature for delayed automatic connection to the equipment system shall be permitted.**

426

517.35. Equipment Branch Connection to Alternate Power Source.

- **(A) Equipment for Delayed Automatic Connection. The following equipment shall be permitted to be arranged for delayed automatic connection to the alternate power source:**
- **(1) Central suction systems serving medical and surgical functions, including controls. Such suction systems shall be permitted on the critical branch.**
- **(2) Sump pumps and other equipment required to operate for the safety of major apparatus, including associated control systems and alarms.**

427

517.35. Equipment Branch Connection to Alternate Power Source.

- **(3) Compressed air systems serving medical and surgical functions, including controls. Such air systems shall be permitted on the critical branch.**
- **(4) Smoke control and stair pressurization systems, or both.**
- **(5) Kitchen hood supply or exhaust systems, or both, if required to operate during a fire in or under the hood.**

428

517.35. Equipment Branch Connection to Alternate Power Source.

- ***Exception: Heating of general patient rooms and infection/isolation rooms during disruption of the normal source shall not be required under any of the following conditions:***
- ***(a) The outside design temperature is higher than −6.7°C (20°F).***
- ***(b) The outside design temperature is lower than −6.7°C (20°F), and where a selected room(s) is provided for the needs of all confined patients, only such room(s) need be heated.***
- ***(c) The facility is served by a dual source of normal power.***
- **Informational Note No. 1: The design temperature is based on the 97.5 percent design value as shown in Chapter 24 of the ASHRAE *Handbook of Fundamentals* (2013).**
- **Informational Note No. 2: For a description of a dual source of normal power, see 517.30(C).**

429

517.35. Equipment Branch Connection to Alternate Power Source.

- (2) An elevator(s) selected to provide service to patient, surgical, obstetrical, and ground floors during interruption of normal power.
  - In instances where interruption of normal power would result in other elevators stopping between floors, throw-over facilities shall be provided to allow the temporary operation of any elevator for the release of patients or other persons who may be confined between floors.
- (3) Hyperbaric facilities.
- (4) Hypobaric facilities.
- (5) Automatically operated doors.
- (6) Minimal electrically heated autoclaving equipment shall be permitted to be arranged for either automatic or manual connection to the alternate source.
- (7) Controls for equipment listed in 517.35.
- (8) Other selected equipment shall be permitted to be served by the equipment system. [99:6.4.2.2.5.4(9)]

430

517.35. Equipment Branch Connection to Alternate Power Source.

- **(C) AC Equipment for Nondelayed Automatic Connection.**
- **Generator accessories, including but not limited to, the transfer fuel pump, electrically operated louvers, and other generator accessories essential for generator operation shall be arranged for automatic connection to the alternate power source. [99:6.5.2.2.3.2]**

431

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

- **Informational Note: Nursing homes and other limited care facilities can be classified as critical care (Category 1) or general care (Category 2) patient care space depending on the design and type of care administered in the facility.**
- **For small, less complex facilities, only minimal alternate lighting and alarm service may be required.**
- **At nursing homes and other limited care facilities where patients are not sustained by electrical life-support equipment or inpatient hospital care the requirements of 517.40 through 517.41 apply.**
- **If the level of care is comparable to that provided in a hospital, see the essential electrical system requirements of 517.29 through 517.30.**

432

433

434

NEC Handbook Commentary

- For the smaller, less complex facility, only a minimum alternate lighting and alarm service needs to be furnished. At nursing homes or limited care facilities where patients are sustained by electrical life-support equipment or inpatient hospital care is provided, the requirements of 517.41 through 517.44 apply.
- Because the level of care is comparable to that provided in a hospital, an essential electrical system is required for this type of nursing home.

435

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

- (A) Applicability. The requirements of Part III, 517.40(C) through 517.41, shall apply to nursing homes and limited care facilities.
- Exception: The requirements of Part III, 517.40(C) through 517.41, shall not apply to freestanding buildings used as nursing homes and limited care facilities, provided that the following apply:
- (1) Admitting and discharge policies are maintained that preclude the provision of care for any patient or resident who may need to be sustained by electrical life-support equipment.

436

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

- (2) No surgical treatment requiring general anesthesia is offered.
- (3) An automatic battery-operated system(s) or equipment shall be effective for at least 1½ hours and is otherwise in accordance with 700.12 and that shall be capable of supplying lighting for exit lights, exit corridors, stairways, nursing stations, medical preparation areas, boiler rooms, and communications areas. This system shall also supply power to operate all alarm systems.
- Informational Note: See NFPA *101*-2015, *Life Safety Code*.

437

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

- (B) Inpatient Hospital Care Facilities. For those nursing homes and limited care facilities that admit patients who need to be sustained by electrical life support equipment, the essential electrical system from the source to the portion of the facility where such patients are treated shall comply with the requirements of Part III, 517.29 through 517.30.
- NEC Handbook Commentary
- Regardless of how the facility is designated, the type of electrical system required corresponds with the level of patient care provided. If inpatient care requires the use of life support equipment, a hospital-type essential electrical system must be installed. The type of care that can be provided at a nursing home or limited care facility is generally controlled through the administrative agency that licenses and regulates the facility.

438

439

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

- (C) Facilities Contiguous or Located on the Same Site with Hospitals. Nursing homes and limited care facilities that are contiguous or located on the same site with a hospital shall be permitted to have their essential electrical systems supplied by the hospital.
- Informational Note No.1: For performance, maintenance, and testing requirements of essential electrical systems in nursing homes and limited care facilities, see NFPA 99-2015, *Health Care Facilities Code*.
- Informational Note No. 2: Where optional loads include contiguous or same-site facilities not covered in this *Code*, see the requirements of Article 700 of this *Code*; NFPA *101*-2015, *Life Safety Code*; and other applicable NFPA requirements for emergency egress under load-shed conditions.

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440

NEC Handbook Commentary

- A single alternate power supply is permitted to serve a single building or campus with multiple types of health care occupancies.
- This is the same allowance specified in 517.31(B)(2) for a campus having only hospital occupancies.
- The use of multiple alternate sources is permitted and may be desirable to ensure reliability.

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441

517.41 Required Power Sources.

- (A) Two Independent Power Sources. Essential electrical systems shall have a minimum of the following two independent sources of power: a normal source generally supplying the entire electrical system and one or more alternate sources for use when the normal source is interrupted. [99:6.4.1.1.4]
- (B) Types of Power Sources. Where the normal source consists of generating units on the premises, the alternate source shall be either another generating set or an external utility service. [99:6.4.1.1.5]

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442

517.41 Required Power Sources.

- (C) Location of Essential Electrical System Components.
- Essential electrical systems shall be located to minimize interruptions caused by natural forces common to the area (e.g., storms, floods, earthquakes, or hazards created by adjoining structures or activities).
- Installations of electrical services shall be located to reduce possible interruption of normal electrical services resulting from similar causes as well as possible disruption of normal electrical service due to internal wiring and equipment failures.
- Feeders shall be located to give physical separation of the feeders of the alternate source and from the feeders of the normal electrical source to prevent possible simultaneous interruption.

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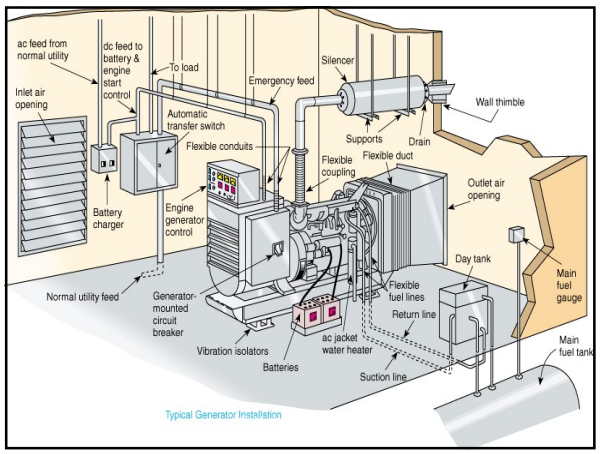
443



444

517.42 Essential Electrical Systems.

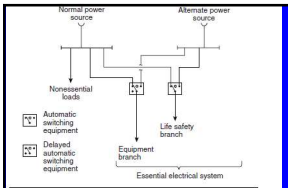
- (A) General. Essential electrical systems for nursing homes and limited care facilities shall be divided into the following two branches, the life safety branch and the equipment branch. [99:6.5.2.2.1.2]
- The division between the branches shall occur at transfer switches where more than one transfer switch is required.
- Informational Note No. 1: Essential electrical systems are comprised of two separate branches capable of supplying a limited amount of lighting and power service, which is considered essential for the protection of life and safety and effective operation of the institution during the time normal electrical service is interrupted for any reason.
- Informational Note No. 2: For more information see NFPA 99-2015, *Health Care Facilities Code*.

445

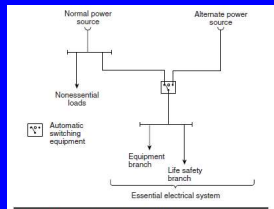
517.42 Essential Electrical Systems.

- (B) Transfer Switches. The number of transfer switches to be used shall be based on reliability, design, and load considerations. [99:6.5.2.2.1.4]
- (1) Each branch of the essential electrical system shall have one or more transfer switches. [99:6.5.2.2.1.4(A)]
- (2) One transfer switch shall be permitted to serve one or more branches or systems in a facility with a continuous load on the switch of 150 kVA (120 kW) or less. [99:6.5.2.2.1.4(B)]
- Informational Note No. 1: See NFPA 99-2015, *Health Care Facilities Code*, 6.5.3.2, Transfer Switch Operation Type II; 6.4.2.1.5, Automatic Transfer Switch Features; and 6.4.2.1.7, Nonautomatic Transfer Device Features.
- Informational Note No. 2: See Informational Note Figure 517.42(a).
- Informational Note No. 3: See Informational Note Figure 517.42(b).

446



INFORMATIONAL NOTE FIGURE 517.42(a) Nursing Home and Limited Health Care Facilities — Minimum Requirement (greater than 150 kVA) for Transfer Switch Arrangement.



INFORMATIONAL NOTE FIGURE 517.42(b) Nursing Home and Limited Health Care Facilities — Minimum Requirement (150 kVA or less) for Transfer Switch Arrangement.

447

517.42 Essential Electrical Systems.

- (C) Capacity of System. The essential electrical system shall have adequate capacity to meet the demand for the operation of all functions and equipment to be served by each branch at one time.
- (D) Separation from Other Circuits. The life safety branch and equipment branch shall be kept entirely independent of all other wiring and equipment. [99:6.5.2.2.4.1]
- These circuits shall not enter the same raceways, boxes, or cabinets with other wiring except as follows:
- (1) In transfer switches
- (2) In exit or emergency luminaires supplied from two sources
- (3) In a common junction box attached to exit or emergency luminaires supplied from two sources
- Informational Note: For further information see NFPA 99-2015 *Health Care Facilities Code*, A.6.5.2.2.4.1.

448

517.42(E) Receptacle Identification.

- (E) Receptacle Identification. The electrical receptacles or the cover plates for the electrical receptacles supplied from the life safety or equipment branches shall have a distinctive color or marking to be readily identifiable. [99:6.5.2.2.4.2]
- Informational Note: If color is used to identify these receptacles, the same color should be used throughout the facility. [99:A.6.5.2.2.4.2]

449

517.44 Connection to Equipment Branch.

- The equipment branch shall be installed and connected to the alternate power source so that the equipment listed in 517.44(A) shall be automatically restored to operation at appropriate time-lag intervals following the restoration of the life safety branch to operation. [99:6.5.2.2.3.1(A)]
- The equipment branch arrangement shall also provide for the additional connection of equipment listed in 517.44(B). [99:6.5.2.2.3.1]
- *Exception: For essential electrical systems under 150 kVA, deletion of the time-lag intervals feature for delayed automatic connection to the equipment branch shall be permitted.*

450

517.44 Connection to Equipment Branch.

- (A) Delayed Automatic Connections to Equipment Branch. The following equipment shall be permitted to be connected to the equipment branch and shall be arranged for delayed automatic connection to the alternate power source:
- (1) Task illumination and selected receptacles in the following:
  - (a) Patient care spaces
  - (b) Medication preparation spaces
  - (c) Pharmacy dispensing areas
  - (d) Nurses' stations (unless adequately lighted by corridor luminaires)

451

517.44 Connection to Equipment Branch.

- (2) Supply, return, and exhaust ventilating systems for airborne infectious isolation rooms
- (3) Sump pumps and other equipment required to operate for the safety of major apparatus and associated control systems and alarms
- (4) Smoke control and stair pressurization systems
- (5) Kitchen hood supply or exhaust systems, or both, if required to operate during a fire in or under the hood
- (6) Nurse call systems

452

VI. Communications, Signaling Systems, Data Systems, Fire Alarm Systems, and Systems Less Than 120 Volts, Nominal

453

517.80 Patient Care Areas.

- Equivalent insulation and isolation to that required for the electrical distribution systems in patient care areas shall be provided for communications, signaling systems, data system circuits, fire alarm systems, and systems less than 120 volts, nominal.
- Class 2 and Class 3 signaling and communications systems and power-limited fire alarm systems shall not be required to comply with the grounding requirements of 517.13, to comply with the mechanical protection requirements of 517.30(C)(3)(5), or to be enclosed in raceways, unless otherwise specified by Chapter 7 or 8.

454

Stationary Engine Generator Assemblies - UL 2200

455

Stationary Generator Standard

- Initial publication September 1998
- First formal U.S. standard for generators
- Scope
  - Stationary engine generator assemblies
  - 600V or less
  - Ordinary locations

456

Comprehensive Evaluation

- UL 2200 includes an evaluation of:
  - fire hazards
  - electric shock hazards
  - casualty hazards, including power interruption consequences
  - reliability analysis

457

Electrical Component Evaluation

- Control panels
- Safety control reliability analysis
- Cycling durability tests
- Circuit analysis
- System software

458

Mechanical Component Evaluation

- Fuel tanks
- Venting
- Combustion Engine

459

460

Applicable Codes and Standards

- **National Electrical Code - NFPA 70**
- **Health Care Facilities - NFPA 99**
- **Emergency and Standby Power Systems - NFPA 110**
- **Stationary Combustion Engines - NFPA 37**

461

Portable Generators

- Not covered by UL 2200
- Listed using different requirements

462

Emergency Power Sources and Requirements

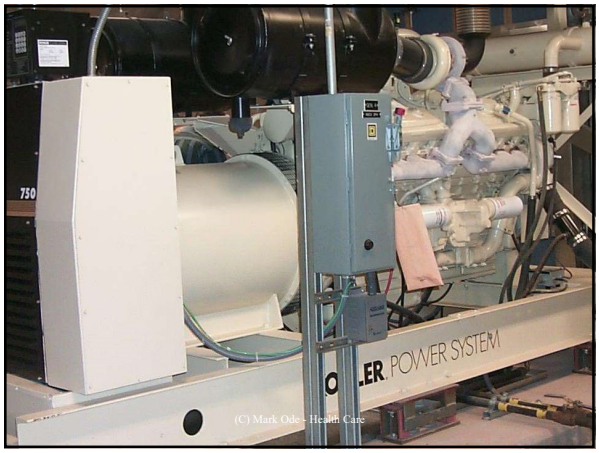
- Article 700 covers emergency power sources and systems
- Article 701 covers legally required standby systems
- Article 760 covers fire alarm systems
- Article 695 covers fire pumps

463

Article 700--Emergency Systems

- 700.1. Scope. This article applies to the electrical safety of the installation, operation, and maintenance of emergency systems
  - consists of circuits and equipment intended to supply, distribute, and control electricity for illumination or power, or both, to required facilities when the normal electrical supply or system is interrupted.
- Emergency systems are systems legally required and classed as emergency by
  - municipal, state, federal, or other codes, or by any governmental agency having jurisdiction.

464



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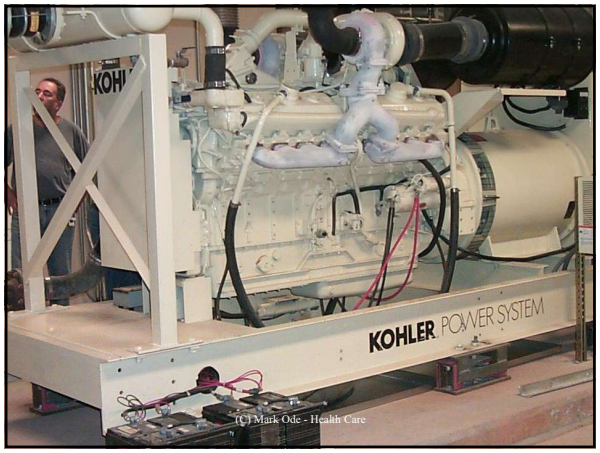

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467

Emergency systems

- are intended to automatically supply illumination or power, or both, to designated areas and equipment in the event of failure of the normal supply
- or in the event of accident to elements of a system intended to supply, distribute, and control power and illumination essential for safety to human life.

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Emergency Systems Provide Power

- **for such functions as ventilation where essential to maintain life, fire detection and alarm systems, elevators, fire pumps, public safety communications systems, industrial processes where current interruption would produce serious life safety or health hazards, and similar functions.**

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470

700.3. Tests and Maintenance

- **(A) Conduct or Witness Test. The authority having jurisdiction shall conduct or witness a test of the complete system upon installation and periodically afterward.**
- **(B) Tested Periodically. Systems shall be tested periodically on a schedule acceptable to the authority having jurisdiction to ensure the systems are maintained in proper operating condition.**

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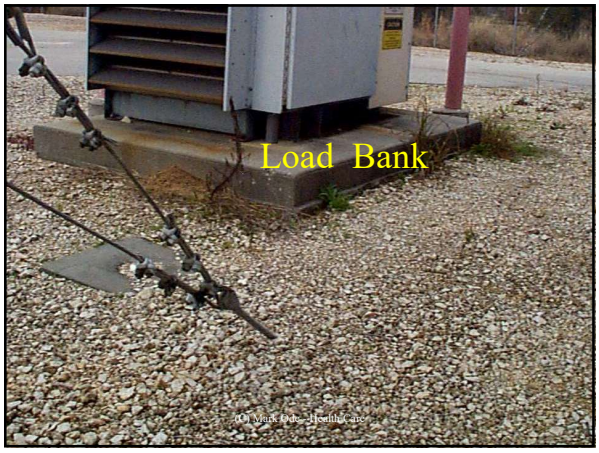
700.3. Tests and Maintenance

- **(C) Battery Systems Maintenance.** Where battery systems or unit **equipment are involved, including batteries used for starting, control, or ignition in auxiliary engines, the authority having jurisdiction shall require periodic maintenance.**
- **(D) Written Record.** A written record shall be kept of such tests and maintenance.
- **(E) Testing Under Load.** Means for testing all emergency lighting and power systems during maximum anticipated load conditions shall be provided.
- **Informational Note: For testing and maintenance procedures of emergency power supply systems (EPSSs), see NFPA 110-2010, *Standard for Emergency and Standby Power Systems*.** (C) Mark Ode - Health Care

472



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473

700.4. Capacity

- **(A) Capacity and Rating.**
- **An emergency system shall have adequate capacity and rating for all loads to be operated simultaneously.**
- **The emergency system equipment shall be suitable for the maximum available fault current at its terminals.**

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474

700.4(B) Selective Load Pickup, Load Shedding, and Peak Load Shaving.

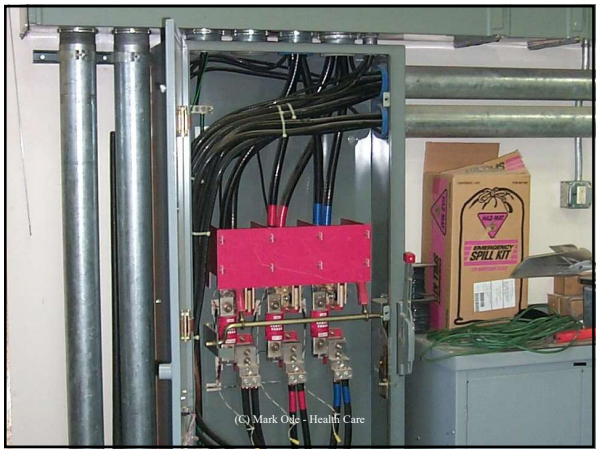
- **The alternate power source shall be permitted to supply emergency, legally required standby, and optional standby system loads where the source has adequate capacity or where automatic selective load pickup and load shedding is provided as needed to ensure adequate power to**
  - **(1) the emergency circuits,**
  - **(2) the legally required standby circuits, and**
  - **(3) the optional standby circuits, in that order of priority.**
- **The alternate power source shall be permitted to be used for peak load shaving, provided these conditions are met.**

475

700.5. Transfer Equipment

- (A) General. Transfer equipment, including automatic transfer switches, shall be automatic, identified for emergency use, and approved by the authority having jurisdiction.
- Transfer equipment shall be designed and installed to prevent the inadvertent interconnection of normal and emergency sources of supply in any operation of the transfer equipment.
- Transfer equipment and electric power production systems installed to permit operation in parallel with the normal source shall meet the requirements of Article 705.

476



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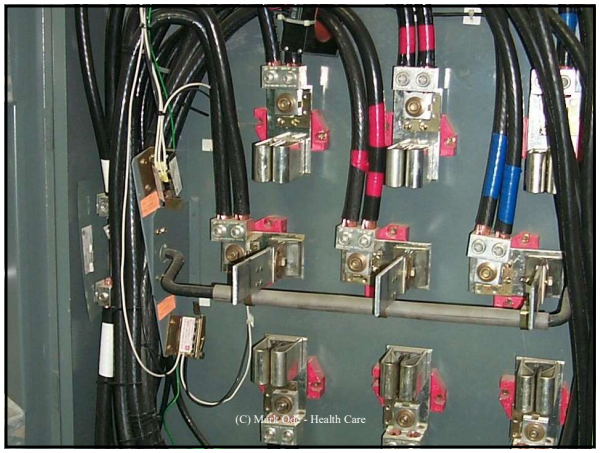

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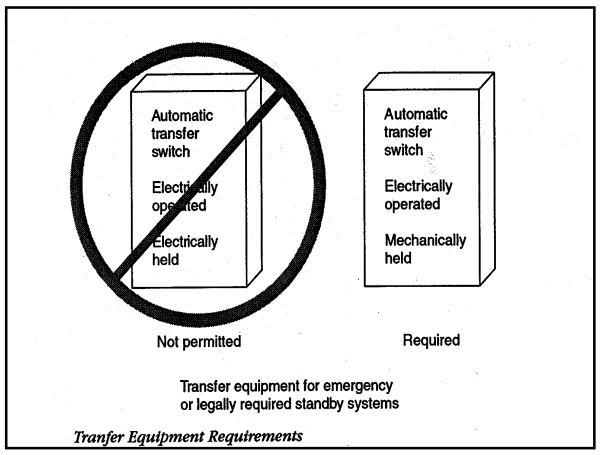
700.5. Transfer Equipment

- **(B) Bypass Isolation Switches. Means shall be permitted to bypass and isolate the transfer equipment. Where bypass isolation switches are used, inadvertent parallel operation shall be avoided.**
- **(C) Automatic Transfer Switches. Automatic transfer switches shall be electrically operated and mechanically held.**
- **Automatic transfer switches, rated 600 VAC and below, shall be listed for emergency system use.**
- **(D) Use. Transfer equipment shall supply only emergency loads.**

479



480

700.10. Wiring, Emergency System

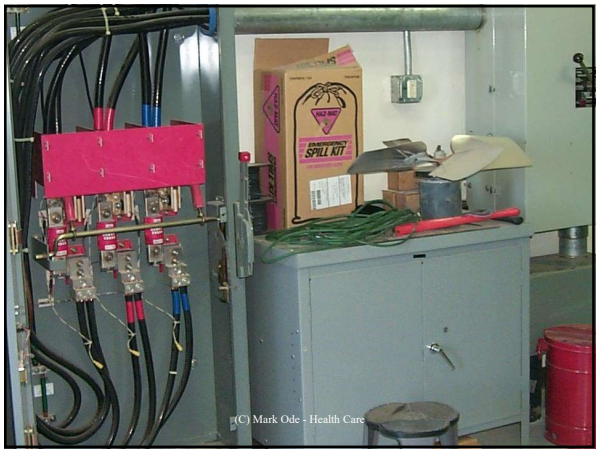
- (A) Identification.
- All boxes and enclosures (including transfer switches, generators, and power panels) for emergency circuits shall be permanently marked so they will be readily identified as a component of an emergency circuit or system.

481

700.10. Wiring, Emergency System

- (B) Wiring. Wiring of two or more emergency circuits supplied from the same source shall be permitted in the same raceway, cable, box, or cabinet.
- Wiring from an emergency source or emergency source distribution overcurrent protection to emergency loads shall be kept entirely independent of all other wiring and equipment, unless otherwise permitted in (1) through (5):
- (1) Wiring from the normal power source located in transfer equipment enclosures
- (2) Wiring supplied from two sources in exit or emergency luminaires

482



483

700.10. Wiring, Emergency System

- (3) Wiring from two sources in a listed load control relay supplying exit or emergency luminaires, or in a common junction box, attached to exit or emergency luminaires
- (4) Wiring within a common junction box attached to unit equipment, containing only the branch circuit supplying the unit equipment and the emergency circuit supplied by the unit equipment

484

700.10. Wiring, Emergency System

- (5) Wiring from an emergency source to supply any combination of emergency, legally required, or optional loads in accordance with (a), (b), (c), and (d):
- a. From separate vertical switchboard sections, with or without a common bus, or from individual disconnects mounted in separate enclosures.
- b. The common bus or separate sections of the switchboard or the individual enclosures shall be permitted to be supplied by single or multiple feeders without overcurrent protection at the source.
- *Exception to (5)(b): Overcurrent protection shall be permitted at the source or for the equipment, provided the overcurrent protection complies with the requirements of 700.27.*

485

700.10. Wiring, Emergency System

- c. Legally required and optional standby circuits shall not originate from the same vertical switchboard section, panelboard enclosure, or individual disconnect enclosure as emergency circuits.
- d. It shall be permissible to utilize single or multiple feeders to supply distribution equipment between an emergency source and the point where the combination of emergency, legally required, or optional loads are separated.

486

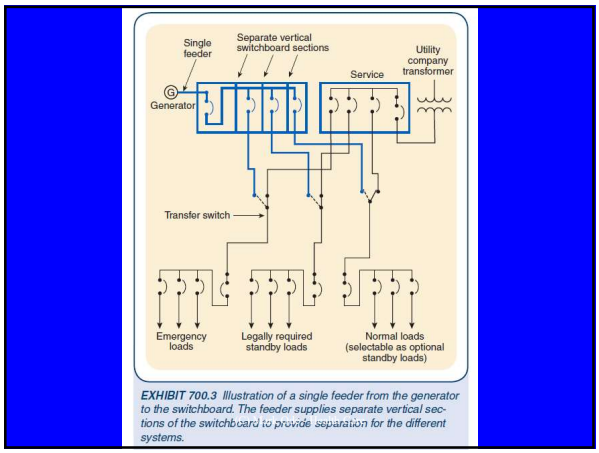


EXHIBIT 700.3 Illustration of a single feeder from the generator to the switchboard. The feeder supplies separate vertical sections of the switchboard to provide separation for the different systems.

487

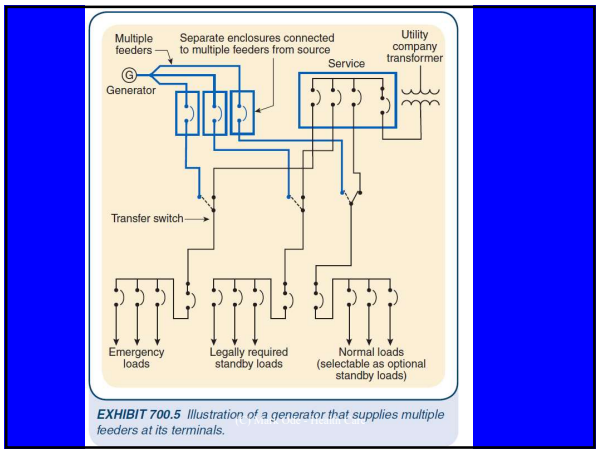


EXHIBIT 700.5 Illustration of a generator that supplies multiple feeders at its terminals.

488

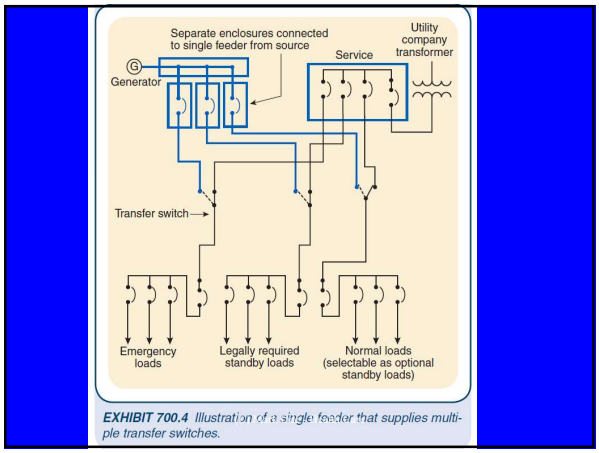


EXHIBIT 700.4 Illustration of a single feeder that supplies multiple transfer switches.

489

C. Sources of Power

- **700.12. General Requirements**
  - **(A) Storage Battery.**
  - **(B) Generator Set**
  - **(C) Uninterruptible Power Supplies**
  - **(D) Separate Service**
  - **(E) Unit Equipment**

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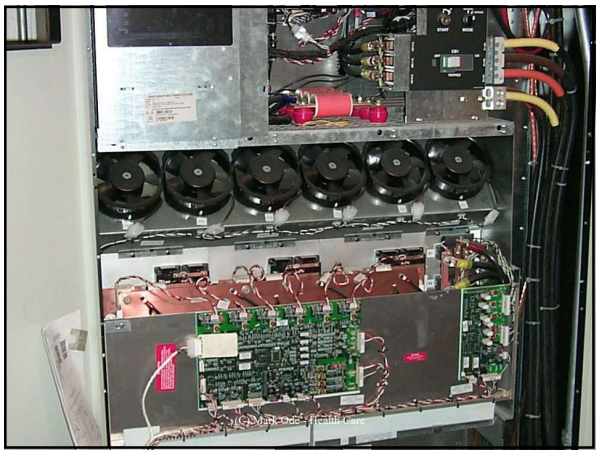
492



493

700.12 General Requirements.

- Current supply shall be such that,
- in the event of failure of the normal supply to, or within, the building or group of buildings concerned,
- emergency lighting, emergency power, or both
- shall be available within the time required for the application but not to exceed 10 seconds.

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700.12 General Requirements.

- Equipment shall be designed and located to minimize the hazards that might cause complete failure due to flooding, fires, icing, and vandalism.

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700.12(C) Uninterruptible Power Supplies.

- Uninterruptible power supplies used to provide power for emergency systems shall comply with the applicable provisions of 700.12(A) and (B).

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700.12(A) Storage Battery.

- Storage batteries used as a source of power for emergency systems shall be of suitable rating and capacity to supply and maintain the total load for a period of 11/2 hours minimum,
- without the voltage applied to the load falling below 871/2 percent of normal.

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700.12(A) Storage Battery.

- Batteries,
  - whether of the acid or alkali type,
- shall be designed and constructed to meet the requirements of emergency service and
- shall be compatible with the charger for that particular installation.

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700.12(A) Storage Battery.

- For a sealed battery, the container shall not be required to be transparent.
- However, for the lead acid battery that requires water additions, transparent or translucent jars shall be furnished. Automotive-type batteries shall not be used.
- An automatic battery charging means shall be provided.

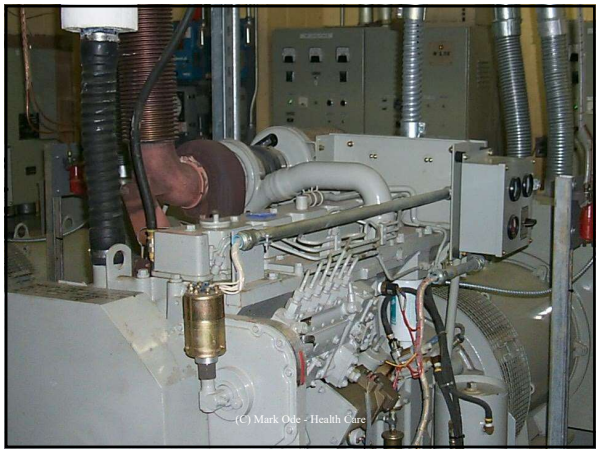
499

500

700.12(B) Generator Set.

- (1) Prime Mover-Driven.
- For a generator set driven by a prime mover acceptable to the authority having jurisdiction and sized in accordance with 700.5, means
- shall be provided for automatically starting the prime mover on failure of the normal service and
- for automatic transfer and operation of all required electrical circuits.

501



502

700.12(B)(1) Prime Mover-Driven.

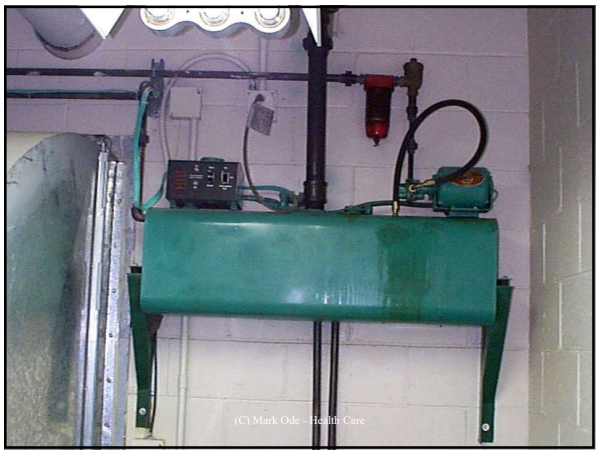
- A time-delay feature permitting a 15-minute setting shall be provided to avoid retransfer in case of short-time reestablishment of the normal source.

503

700.12(B)(2) Internal Combustion as Prime Movers.

- Where internal combustion engines are used as the prime mover, an on-site fuel supply shall be provided with an on-premise fuel supply sufficient for not less than 2 hours' full-demand operation of the system.

504



505

506

700.12(B)(2) Internal Combustion as Prime Movers.

- **Where power is needed for the operation of the fuel transfer pumps to deliver fuel to a generator set day tank,**
- **this pump shall be connected to the emergency power** system.

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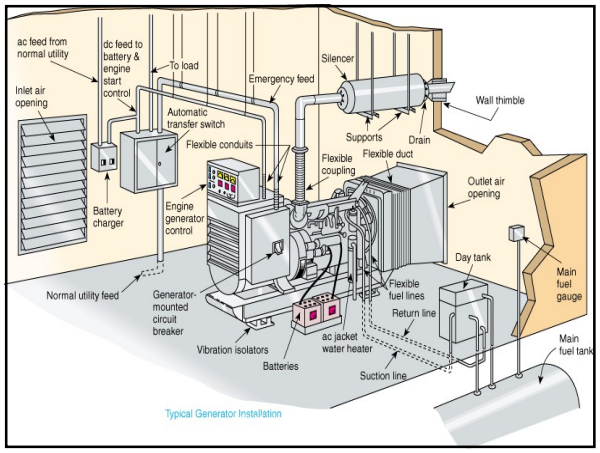
507



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