**General Electrical Requirements for Healthcare Facilities**

In the previous topic, [**Electrical Design Philosophy for Major Types of Buildings**](http://alihassanelashmawy.blogspot.com/2011/12/electrical-design-philosophy-for-major.html), We talk about the different types of buildings and how the building type (function) influences its electrical design.   
  
  
This was very clear in our previous discussions for the electrical design requirements of both industrial and commercial buildings which were included in the following topics:   
  
**1- Industrial buildings:**

* [**Electrical Design Requirements for Industrial Building**](http://alihassanelashmawy.blogspot.com/2011/12/electrical-design-requirements-for.html)
* [**Specific Electrical Design Requirements for Industrial Buildings – Part One**](http://alihassanelashmawy.blogspot.com/2012/01/specific-electrical-design-requirements.html)
* [**Specific Electrical Design Requirements for Industrial Buildings – Part Two**](http://alihassanelashmawy.blogspot.com/2012/01/specific-electrical-requirements-for.html)

**2- Commercial buildings:**

* [**General Electrical Design Requirements for Commercial Buildings**](http://alihassanelashmawy.blogspot.com/2012/02/electrical-design-requirements-for.html)
* [**Specific Electrical Design Requirements for Commercial Buildings**](http://alihassanelashmawy.blogspot.com/2012/02/specific-electrical-design-requirements.html)
* [**Power system architectures for the commercial buildings – Part One**](http://alihassanelashmawy.blogspot.com/2012/02/power-system-architectures-for.html)
* [**Power system architectures for the commercial buildings – Part Two**](http://alihassanelashmawy.blogspot.com/2012/02/power-system-architectures-for_15.html)
* [**Power system architectures for the commercial buildings – Part Three**](http://alihassanelashmawy.blogspot.com/2012/02/power-system-architectures-for_16.html)
* [**Power system architectures for the commercial buildings – Part Four**](http://alihassanelashmawy.blogspot.com/2012/02/power-system-architectures-for_17.html)
* [**Power System Architectures for the Commercial Buildings – Part Five**](http://alihassanelashmawy.blogspot.com/2012/02/power-system-architectures-for_18.html)
* [**Comparison between Power system architectures for the commercial buildings**](http://alihassanelashmawy.blogspot.com/2012/02/comparison-between-power-system.html)

Today, I will explain the third type of buildings which is Healthcare buildings although these type of buildings generally categorized under the commercial buildings but as they were important type of buildings, we will assign special topics for clarifying the electrical requirements of this type of buildings.   
  
  
**Health care facility definition:**



Health or personal care facility refers to buildings or parts of buildings that contain, but are not limited to, hospitals, nursing homes, limited care facilities, clinics, medical and dental offices, and ambulatory care centers, whether permanent of movable and such other health care occupancies where patients who may be unable to provide for their own needs and safety without the assistance of another person are treated.   
  
  
**Health care facility famous types:**

**1- Hospital (General Medical and Surgical)**

Hospitals are Buildings used as diagnostic and treatment facilities for inpatient care. it applies to a general medical and surgical hospital that is either a stand-alone building or a campus of buildings.   
  
These facilities provide acute care services including emergency medical care, physician's office services, diagnostic care, ambulatory care, surgical care, and limited specialty services such as rehabilitation and cancer care.   
  
The definition of Hospital accounts for all space types that are located within the Hospital building/campus, such as medical offices, administrative offices, and skilled nursing. The total floor area should include the aggregate floor area of all buildings on the campus as well as all supporting functions such as: stairways, connecting corridors between buildings, medical offices, exam rooms, laboratories, lobbies, atria, cafeterias, storage areas, elevator shafts, and any space affiliated with emergency medical care, or diagnostic care.   
  
  
**2- Medical Office/ clinic**

Medical Office applies to facility space used to provide diagnosis and treatment for medical, dental, or psychiatric outpatient care where patients are not regularly kept as bed patients for twenty-four hours or more. The total gross floor area should include all supporting functions such as kitchens used by staff, laboratories, lobbies, atria, conference rooms and auditoria, fitness areas for staff, storage areas, stairways, elevator shafts, etc.  
  
  
  
**3- "Nursing home," "nursing home unit" or "long-term care unit"**

It refers to buildings having a group of beds for the accommodation of patients who, because of chronic illness or physical infirmities, require skilled nursing care and related medical services but are not acutely ill and not in need of the highly technical or specialized services ordinarily a part of hospital care.   
  
  
**4- "Ambulatory surgical facility” or “Ambulatory Health Care Center”**

It refers to a facility, not a part of a hospital, providing surgical treatment to patients not requiring inpatient care in a hospital.   
  
  
**Preliminary design phase (planning) for health care facilities**

During this phase, preliminary design data is gathered from administrators and staff of the health care facility, the local utility, and authorities having jurisdiction over electrical construction. All relevant national, state, and local codes, and facility design guidelines, should be reviewed.   
  
Two national codes having a major affect on health care power distribution design are

* The National Electrical Code (NEC) (NFPA 70-1996).
* NFPA 99-1996, Health Care Facilities.

In addition, the architectural plans and existing site conditions should be examined from an electrical system perspective to determine potential problems and needs. The following issues should be addressed during the system planning phase of the design:   
  
**1- Reliability:**  
Alternative power systems may be authorized, but are limited to serving certain essential loads for critical, hospital, and other special facilities and loads as identified therein. The designer shall consider the location and space for essential electrical system components in order to limit interruptions caused by localized natural conditions, such as floods and earthquakes. Essential systems will be designed to function after seismic events occur. Non-essential systems may be inoperable, but components will be constrained to avoid personnel injury, or damage to other building components.   
  
**2- Durability:**  
Installed electrical systems and electrical equipment will have a minimum rating for continuous full design load, except where other criteria mandate greater, to meet the reliability requirements for the design life of the facility.   
  
**3- Maintainability**  
The design and construction for facilities will provide a means to remove and maintain equipment, and field installed wiring without interruption to mission critical loads.   
  
**4- Efficiency**  
The efficiency of the facility electrical system, measured at the utilization transformer secondary and the alternative power source, will have a power factor (PF) not less than 0.90 at nominal voltage for balanced three phase loading (phase unbalance will not exceed 5 percent between A, B, and C phase). Where required power factor correction shall be used to assure a minimum PF of 0.90.   
  
**5- Economy**  
Evaluate alternative system configurations, and component types and sizing for economic value, consistent with other criteria factors above.   
  
  
Once the system planning phase is complete, the designer will have the necessary information to begin the actual design of the electrical distribution system for the health care facility.   
  
  
  
**Load requirements for healthcare facilities**  
  
The major loads to be served by the electrical system in health care facilities will be divided into two types; lighting and power loads as follows:   
  
**1- Lighting loads**  
Lighting loads may be divided into the following broad categories

* Internal lighting loads.
* Special lighting loads.
* Outdoor lighting loads.

**2- Power loads**  
Power loads may be divided into the following broad categories:   
  
**1- Building equipment:**

* Heating, ventilating, air conditioning and refrigeration (HVAC&R).
* Transportation (elevators, escalators, trolleys).
* Auxiliary pumps (fire, sump, clinical air and vacuum, pneumatic tube).

**2- Functional equipment:**

* Kitchen.
* Data processing.
* Communication systems.
* Business machines.
* Laundry.

**3- Medical equipment:**

* **X-ray and imaging systems**
* Radiation therapy.
* Laboratory.
* Surgery.
* Intensive care, recovery, emergency.
* Physical and occupational therapy.
* Inhalation therapy.
* Pharmacy.
* Materials management.
* Medical records.

**NOTE**: Major loads occur in the first two categories (building & functional equipment) and these loads are similar to those in other types of commercial buildings. The third category (medical equipment) is unique to health care.   
  
  
  
In the next Topic, I will continue explaining **the general electrical requirements for Healthcare facilities**. So, please keep following.

**Electrical Design Requirements for Health Care Facilities – Part Two**

In the previous topic, [**the Electrical Design Requirements for Health Care Facilities – Part One**](http://alihassanelashmawy.blogspot.com/2012/02/general-electrical-requirements-for.html), We talk about Health care facility definition, types, preliminary design consideration and electrical load types.   
  
Today, we will talk about the power sources, Voltage considerations and electrical distribution system for health care facilities as follows.   
  
  
**Power sources in health care facilities:**

Generally, the power sources that can be used in the electrical networks of health care facilities are as follows: (**see fig.1**)

1. The normal power source.
2. The alternate power source.

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| [http://4.bp.blogspot.com/-OvIbD95kvls/T0U6mKrZgoI/AAAAAAAABMI/JRmglLBi0Bw/s400/1.JPG](http://4.bp.blogspot.com/-OvIbD95kvls/T0U6mKrZgoI/AAAAAAAABMI/JRmglLBi0Bw/s1600/1.JPG) |
| **Fig (1)** |

**1- The normal power source**

The normal power source which may be one of the following:

1. The electric utility power.
2. On-site power generator(s) and in this case the alternate power source required can be another power generator unit or the electric utility.

**2- The Alternate Power Source**

Alternate power source Definition:

1. 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.
2. Alternate power source by an on-site power source such as:
3. Generator set(s) driven by some form of prime mover(s) and located on the premises.
4. Another generating unit(s) where the normal source consists of a generating unit(s) located on the premises.
5. An external utility service when the normal source consists of a generating unit(s) located on the premises.
6. Uninterruptible power supply (UPS) (which can be applied as the principal alternate for large computing centers or other critical, sensitive loads).
7. battery/inverter system ( which can be applied as the principal alternate for nursing homes, residential custodial care facilities, and other health care facilities provided they meet the conditions outlined in NFPA 99-1996).

Typically, the alternate sources of power are supplied to the loads through a series of automatic and/or manual transfer switches. The transfer switches can be non-delayed automatic, delayed automatic or manual transfer depending on the requirements of the specific branch of the EES (Essential Electrical System) that they are feeding.   
  
It is permissible to feed multiple branches or systems of the EES from a single automatic transfer switch provided that the maximum demand on the EES does not exceed 150 kVA. This configuration called as (Radial – Generator) is typically seen in smaller health care facilities that must meet ESS Type 1 requirements.   
  
  
**Health care Facilities voltage classification:**

Health care Facilities are primarily people- and public-oriented and because of their different sizes and types, they can need electrical supply with different voltage classes , for examples simple medical office /clinic will need an electrical supply with low voltage class (under 1000 V) from public Low Voltage grid while a large hospital will need an electrical supply with medium voltage class (UP to 20KV) Via public or in-house MV substations, for more information about different voltage classes , please review the following links:

[**Course EE-1 : Voltage Ranges -Part One**](http://alihassanelashmawy.blogspot.com/2011/11/course-ee-1-voltage-ranges.html)

[**EE-1 Course: Voltage Ranges - Part Two**](http://alihassanelashmawy.blogspot.com/2011/11/ee-1-course-voltage-ranges-part-two.html)

For more information about [**Electrical System Configurations**](http://alihassanelashmawy.blogspot.com/2011/01/beginners-design-courseelectrical.html) press on the link

**Special voltage considerations for health care facilities:**

* The proper selection, regulation, and quality of utilization voltages is extremely important because of the extensive use of sensitive medical equipment that is available in many different voltage ratings.
* The voltage levels selected will depend on the utility voltage available, the size of the health care facility, the loads served, expansion requirements, the building layout, voltage regulation requirements, and cost.
* Typically, a large health care facility will be supplied power at a medium voltage level from the utility and it will be stepped-down to either 480Y/277 V or 208Y/120 V for utilization.
* Either 480 V or 208 V can be used to supply mechanical equipment (chillers, fans, pumps, etc.), medical equipment (radiology, medical air pumps, etc.), and other support equipment such as laboratory equipment and kitchen equipment.
* If 480 V is present, however, it is preferred. From initial cost considerations, ongoing operating cost reasons, and isolation from sensitive 120 loads, the 480 V level is the better choice for these equipment.
* The use of 277 V lighting in lieu of 120 V in large health care facilities is common. The application of 277 V lighting in hospitals, however, differs from other commercial facilities because of the requirement for the four divisions of the electrical system (normal, critical branch, life safety branch, and the equipment system). Depending on other equipment requirements, applying 277 V lighting may increase the number of 480Y/277V panels on each floor and/or in each electrical room.
* There is no general rule on when to apply 277 V lighting. Each individual application should be analyzed to determine its feasibility. Typical benefits of 277 V lighting include reduced system losses, reduced number of branch circuits for lighting, reduced sizes of power conductors, reduced heat gains on the air conditioning system due to power losses, and segregation of the harmonics of the electronic ballasts in luminaires from the medical equipment operating at 208Y/120 V.
* Once the nominal utilization voltages have been selected, the voltage of all medical equipment to be installed in the facility should be carefully checked to assure proper application.
* If the equipment is new, it should be ordered to one of the planned utilization voltages. If this is not possible, then buck/boost autotransformer, or standard two-winding transformers should be considered to supply rated voltage to the equipment.
* A common misapplication includes the use of nominally rated 230 V motors installed on a 208 V system.

**Electrical Distribution systems in health care facilities:**

We will study the Electrical Distribution systems for the following health care facilities:

1. Hospitals.
2. Nursing homes and residential custodial care facilities.
3. Other health care facilities (excluding hospitals, nursing homes, and residential custodial care facilities where the facility administers inhalation anesthetics or requires electromechanical life support devices).

**1- Electrical Distribution Systems for Hospitals**

Electrical Distribution Systems for Hospitals is basically divided into two sub-systems as follows:

1. The normal electrical system (non-essential).
2. The essential electrical system.

**Note**: Both systems are supplied by the normal power source; however, the essential electrical system can be transferred to the alternate power supply whenever the normal power source experiences a power failure.   
  
  
in the next Topic, I will continue explaining **the  Electrical Distribution Systems for Hospitals**. so, please keep following

# Essential Electrical Systems at Health Care Facilities

What happened to the word emergency?

[Krista McDonald Biason, P.E.](http://www.ecmweb.com/author/krista-mcdonald-biason-pe) | Sep 22, 2014

Emergency is emergency is emergency, right? If it is from the generator distribution system, then it must all constitute as emergency power. Well, no. I cannot tell you how many times I have walked into an existing health care facility and seen the dreaded “E” power. “E” power constitutes all things generator supplied — together with no separation of systems. Unfortunately, there is still confusion regarding the code-required separation of systems in a health care facility. It is different from other types of occupancies.

To confuse matters from the start, the 2014 Edition of NFPA 70 (National Electrical Code) now refers to the three branches of generator power as “essential systems.” The term “emergency” is no longer referenced as a defining quantification in Art. 517. However, other sections of the NEC still reference “emergency” power.

The essential systems in a health care occupancy consist of life safety branch, critical branch, and equipment branch. Life safety branch is what it sounds

like; it is the power required to safely egress the building and includes egress lighting, exit signs, powered doors in the path of egress, and the fire alarm system. To add confusion to the limitations of this branch of power, the NEC also includes elevator controls and lights, generator set accessories, medical gas alarms, and other communications and notification systems required to egress the building. This does not include elevator power, medical gas pumps, or the public address system that plays the lullaby when a baby is born in the hospital.

The critical branch is more straightforward with its requirements, but also leaves some room for interpretation. The intent is power for “direct patient care.” If it directly affects the wellbeing of a patient, it is on critical branch. The basic definition is receptacles and lighting in patient care areas. There is also a “catch all” section of the NEC [517.33(A)(9)] that allows “additional task illumination, receptacles, and selected power circuits needed for effective hospital operation.” The code does not provide any additional guidance regarding this section.  As electrical designers, we need to use our judgment on what this specific part of the NEC constitutes that is not already indicated in the previous eight subparts of Sec. 517.33(A). Be mindful that other portions of the Code require normal branch, or an alternate critical branch, source of power in most locations that require critical power. You cannot only serve patient care areas with a single source of critical branch power.

The final choice for the essential systems is equipment branch power. This, again, is rather intuitive regarding what is required on this source of power. This is where our medical gas equipment and other mechanical systems reside. The items required to be either on automatic or delayed equipment branch power include systems such as operating room HVAC, heating for patient rooms, or cooling for data rooms. But fear not, those items that are not in the “required” equipment branch power list still have the opportunity to receive generator power. They are permitted to be on the “optional” branch of power. Often we see radiology equipment, non-patient care HVAC units, and chillers on this branch of power.

Each system is required to be separated from other sources with a few exceptions. Even after all the years I’ve been designing electrical health care infrastructures, I still find myself going back to Art. 517 to confirm the current requirements for the more unique systems in the facility. It is always best to refer back first to the word of the Code and then the intent of the Code to assure a compliant essential systems distribution.

TAGS: [Construction](http://www.ecmweb.com/construction) [Maintenance, Repair & Operations](http://www.ecmweb.com/maintenance-repair-operations)



[**content**](http://www.ecmweb.com/content)

# NFPA 99 and the NEC: The Basis for a Healthy Electrical System

Let's face it. The electric utility grid isn't 100% reliable. That's why the National Fire Protection Association (NFPA) and Code-enforcing authorities require alternate (emergency) sources of power to serve certain portions of electrical distribution systems in hospitals. In addition to appearing in Part III of Art. 517 of the 2002 NEC, requirements for essential electrical systems can be found in

[Steven Owen](http://www.ecmweb.com/author/steven-owen) | Sep 01, 2004

Let's face it. The electric utility grid isn't 100% reliable. That's why the National Fire Protection Association (NFPA) and Code-enforcing authorities require alternate (emergency) sources of power to serve certain portions of electrical distribution systems in hospitals.

In addition to appearing in Part III of Art. 517 of the 2002 NEC, requirements for essential electrical systems can be found in Chapter 4 of NFPA 99-2002, Standard for Health Care Facilities, and other applicable federal, state, and local requirements.

According to 517.25, which applies to clinics, medical and dental offices, outpatient facilities, nursing homes, limited-care facilities, hospitals, and other health-care facilities that serve patients, essential electrical systems must be able to supply at least enough light and power for life safety in the event that normal electrical service is interrupted.

The branches of the emergency system shall be installed and connected to the alternate power source so that all functions

specified for the emergency system shall be automatically restored to operation within 10 seconds of interruption of the normal source.

**General considerations.** Essential electrical systems for hospitals must consist of an emergency system and an equipment system. The emergency system only consists of circuits essential to life safety and critical patient care. The equipment system is dedicated to major electrical equipment necessary for patient care and basic hospital operation.

The number of transfer switches to be used shall be based on reliability, design, and load considerations. Each branch of the emergency system and each equipment system shall have one or more transfer switches. One transfer switch shall be permitted to serve one or more branches or systems in a facility with a maximum demand on the essential electrical system of 150kVA.

Other loads served by the generating equipment not specifically named in Art. 517 shall be served by their own transfer switches. These loads shall not be transferred if the transfer will overload the generating equipment. In addition, these loads shall be automatically shed upon generating equipment overloading. Hospital power sources and alternate power sources shall be permitted to serve the essential electrical systems of contiguous or same-site facilities. [NFPA 99, 3.4.2.2.1, 12.3.3.2].

On the wiring front, it's critical that you keep the life safety branch and critical branch circuits of the emergency system entirely independent of all other wiring and equipment. Don't place them in the same raceways, boxes, or cabinets with each other or other wiring (Photo on page 79). This rule is very similar to those found in 700.9(B) for emergency systems.

When installing isolated power systems in critical care areas that use anesthetizing gases, you must power task illumination fixtures, selected receptacles, and fixed equipment via an individual circuit that serves no other load. You must limit the number of receptacles placed on a single branch circuit for the items mentioned above to limit the effects of a branch circuit outage. Branch-circuit overcurrent devices shall be made readily accessible to nursing and other authorized personnel.

You must mechanically protect the wiring of the emergency system of a hospital by placing it in nonflexible metal raceways or using Type MI cable. These requirements don't apply to flexible power cords of appliances or other utilization equipment connected to the emergency system or secondary circuits of transformer-powered communications or signaling systems. The Code does allow for a few exceptions. For instance, you can use Schedule 80 rigid nonmetallic conduit for circuits that don't serve patient care areas. You can also use Schedule 40 nonmetallic conduit and electrical nonmetallic conduit, where encased in no less than 2 inches of concrete, to serve these same areas. You can also install flexible metal raceways and cable assemblies where it's necessary to provide for a flexible connection to equipment.

If a receptacle is supplied from the emergency system, it or its cover plate shall have a distinctive color or marking to be readily identifiable. If color is used to identify these receptacles, make sure you use the same one throughout the facility. Red is commonly used for this application. However, orange has been used in some facilities where red was selected for use on the fire alarm circuits.

In general, the components of the essential electrical system, with the exception of the alternate source of supply and transfer switches, are the same as those in the normal distribution system.

**The equipment system.** The equipment system primarily feeds power equipment, including central vacuum and medical gas equipment; pumps, control systems, and alarms required to operate for the safety of essential apparatus; heating equipment for specific designated areas; service for one elevator; supply and exhaust ventilating system for specific areas; and various other selected equipment. The equipment system is arranged so it's connected to the alternate source of power at appropriate time-lag intervals, as described in the Code.

In the case where a hospital has more than one elevator, a manual throw over switch should be installed so that each elevator can be bought to a floor, emptied of passengers, and power transferred to another elevator for the same purpose. After all passengers are removed, all but one elevator will be out of service. Under these circumstances the generator needs to be sized only for one elevator.

**The emergency system.** Those functions of patient care that depend on lighting or appliances connected to the emergency system shall be divided into two mandatory branches: the life safety branch and the critical branch.

The life safety branch of the emergency system shall supply power for the following lighting, receptacles, and equipment:

* Illumination of means of egress
* Exit signs
* Alarm and alerting systems
* Communications systems
* Generator set location
* Elevators
* Automatic doors

No function other than those listed in 517.32(A) through (G) shall be connected to the life safety branch.

The critical branch shall supply power for task illumination, fixed equipment, selected receptacles, and special power circuits that serve the following areas and functions related to patient care:

* Task illumination, selected receptacles, and fixed equipment in critical care areas that use anesthetizing gases
* Isolated power systems in special environments
* Task illumination and selected receptacles in patient care areas
* Additional specialized patient care task illumination and receptacles, where needed
* Nurse call systems
* Blood, bone, and tissue banks
* Telephone equipment rooms and closets
* Task illumination, selected receptacles, and selected power circuits for general care beds (at least one duplex receptacle per patient bedroom), angiographic labs, cardiac catheterization labs, coronary care units, hemodialysis rooms or areas, emergency room treatment areas (selected), human physiolgenerating unit(s) located on the premises, or an external utility service when the normal source consists of a generating unit(s) located on the premises.

The equipment system shall be installed and connected to the alternate power source such that the equipment can be automatically restored to operation at appropriate time-lag intervals following the energizing of the emergency system [517.34(A)] or manually restored to operation [NFPA 99, 3.4.2.2.3(b)].

Equipment that must be arranged for delayed automatic connection to the alternate power source includes the following:

* Central suction systems that serve medical and surgical functions, including controls
* Sump pumps and other equipment required to operate for the safety of a major apparatus, including associated control systems and alarms
* Compressed air systems that serve medical and surgical functions, including controls
* Stair pressurization and smoke control systems, or both
* Kitchen hood supply and exhaust systems or both, if required to operate during a fire in or under the hood [NFPA 99, 3.4.2.2.3(d)]

Equipment that must be arranged for either delayed automatic or manual connection to the alternate power source includes the following:

* Heating equipment that provides heating for operating, delivery, labor, recovery, intensive care, coronary care, nurseries, infection/isolation rooms, emergency treatment spaces, and general patient rooms and pressure maintenance (jockey or make-up) pump(s) for water-based fire protection systems
* An elevator(s) selected to provide service to patient, surgical, obstetrical, and ground floors during interruption of normal power
* Supply, return, and ventilating systems for airborne infectious/isolation rooms, protective environment rooms, exhaust and for laboratory fume hoods, nuclear medicine areas where radioactive material if used, ethylene oxide evacuation, and anesthesia evacuation
* Hyperbaric facilities
* Hypobaric facilities
* Automatically operated doors
* Minimal electrically heated autoclaving equipment shall be permitted to be arranged for either automatic or manual connection to the alternate source
* Controls for equipment listed in 517.34
* Other selected equipment shall be permitted to be served by the equipment system [NFPA 99, 3.4.2.2.3(e)]

The engine-generator set should be equipped with provisions for automatic shutdown, including visible and audible indications (both local and remote) for conditions like low lubricating-oil temperature, high jacket-water temperature, over-speed, or failure to start. An ammeter and voltmeter, each with a phase-selector switch, should also be part of the generator set, together with a frequency meter and means of adjusting output voltage and frequency.

The rules of 700.7 require you to provide audible and visual signals to indicate derangement of the emergency source, the battery is carrying load, the battery charger isn't functioning, and a ground fault has occurred in a solidly grounded wye emergency system of more than 150V to ground and circuit-protective devices rated 1,000A or more.

The sensor for the ground-fault signal devices shall be located at, or ahead of, the main system disconnecting means for the emergency source, and the maximum setting of the signal devices shall be for a ground-fault current of 1,200A. Instruction on the course of action to be taken in the event of indicated ground fault shall be located at or near the sensor locations.

**Transfer switches.** The rating of the transfer switches shall be adequate for switching all classes of loads to be served and for withstanding the effects of available fault currents without contact welding. Each automatic transfer switch shall be approved for emergency electrical service as a complete assembly.

The transfer switch shall transfer and retransfer the load automatically. Non-automatic transfer switching devices shall be mechanically held. Operation shall be by direct manual or electrical remote manual control. Electrically operated switches shall derive their control power from the source to which the load is being transferred. A means for safe manual operation shall be provided.

Bypass-isolation switches shall be permitted for bypassing and isolating the transfer switch.

**Conclusion.** Don't forget to regularly provide maintenance for the essential electrical systems. You must test generator sets and transfer switches under load and operating temperature conditions at least once every 30 days. Permanently record all available instrument readings during the monthly test. Also pay particular attention to your fuel or gas systems, engine cooling system, engine lubricating system, engine electrical starting system, engine compressed air starting system, engine exhaust systems, and transfer switches.

General maintenance includes checking for any unusual condition of vibration, deterioration, leakage, or high surface temperatures or noise. Ensure that maintenance manuals, service logs, basic service tools, jumpers, and supplies are readily available. Check and record the time intervals of the various increments of the automatic start-up and shutdown sequences. Check overall cleanliness of the room. And ensure that there are no unnecessary items in the room.

**Editor's note:** *The references from NFPA 70 National Electrical Code — 2002 Edition displayed as example [NFPA 99, 3.4.2.2.1] are based on the NFPA 99 Standard for Health Care Facilities - 1999 Edition*.

*Owen is the owner and president of National Code Seminars in Pelham, Ala*.

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| |  | | --- | | **Article 517: Healthcare Facilities** | |

by Mike Holt

Prepare for electrical work in the fast growing healthcare sector.

[ **Note:** Graphics are not included in the Newsletter ]

Healthcare is one of the fastest growing sectors of the economy. One reason is demographics. As more baby boomers reach retirement age, demand is increasing for new construction, upgrades, and maintenance in healthcare facilities. These facilities include hospitals, outpatient clinics, dialysis centers, cancer treatment centers, dental offices, and long-term care facilities. The growth of the "over 60 club" isn't the only driver. Many lifestyle issues are fueling demand in treatment for problems ranging from adult onset diabetes in teenagers to sports injuries in their great grandparents.

While demand is growing, so are concerns over patient safety, cost containment, regulatory compliance, and litigation. Consequently, Article 517 is now mainstream.

It can seem daunting to learn all 39 definitions in Part I, but it's worth the effort if you are working with healthcare facilities. The requirements in Parts II and III obviously apply to single-function buildings. But, they also apply to individual rooms or areas-such as a doctor's examining room or patient bed location within a multifunction healthcare facility. Where Parts IV through VII apply is evident in their titles.

Part II provides requirements for wiring and protection in patient care areas (defined in 516.2). It does not apply to:

* Business offices, corridors, waiting rooms or similar areas in clinics, medical and dental offices, and outpatient facilities.
* Nursing home and limited care facility areas used exclusively for patient sleeping.

A major goal of Part II is to prevent electrical shock. In healthcare applications, people's bodies are often in direct contact with energized equipment. Thus, Part II provides extensive grounding and bonding requirements-even for something as ordinary as a receptacle.

Patient Care Area Receptacle Rules

You probably consider wiring a receptacle for a residential, commercial, or industrial application one of the simplest jobs an electrician can do. But, wiring a receptacle in a patient care area poses special requirements [517.13] - and it's not simple. The following rules apply to receptacles in such areas.

You must install all branch circuits so they have a ground path for fault current. This means installation in a metal raceway system or a cable armor or sheath assembly-each of which must qualify as an effective ground-fault current path per 250.118. Examples of such a raceway or cable are EMT or Armored Cable (Type AC cable). See Figure 517-1.

The outer metal sheath of interlocked MC cable is not listed as a suitable ground-fault path in 250.118(10); therefore, you cannot use it to supply these branch circuits (Figure 517-4).

AC cable is listed as a suitable ground-fault path because it contains an internal bonding strip of aluminum in direct contact with the outer metal sheath of AC cable [250.118(8)].

If you use FMC for branch circuit wiring, it is limited to the requirements of 250.118(5) and 517.30(C)(3). See Figure 517-3.

Any receptacle supplied by an emergency circuit must not use Type AC, MC, FMC, or any other flexible cable. Emergency circuits must have a nonflexible metal raceway-or MI cable with an additional insulated copper equipment grounding (bonding) conductor [517.30(C)(3)] (some exceptions apply).

You must use an insulated copper equipment grounding (bonding) conductor to ground the grounding terminals of all receptacles (and all noncurrent-carrying conductive surfaces of fixed electric equipment operating at over 100V), if they are likely to become energized and are subject to personal contact.

You must install the equipment grounding (bonding) conductor (sized per Table 250.122) in a metal raceway system or a cable armor or sheath assembly-each of which must qualify as an effective ground-fault current path per 250.118 [517.13(A)]. See Figure 517-2.

These requirements are just for "ordinary" receptacles in patient care areas. What if you are providing power to a room that will use equipment requiring an isolated ground (IG)? Then, things get a bit more complicated.

Per 517.16, the IG receptacle must have the equipment grounding (bonding) conductor required by 250.146(D), and it must be identified by an orange triangle located on the face of the receptacle [406.2(D)]. See Figure 517-6.

But, 517.16 doesn't tell the whole story. The outer sheath of interlocked-type MC cable presents the same problem here as with patient care areas, so you can't use it to supply an IG receptacle-unless the cable contains two equipment grounding (bonding) conductors. You can use interlocked-type AC cable containing a single insulated equipment grounding (bonding) conductor to supply receptacles, because the armor of type AC cable is listed as an equipment grounding (bonding) conductor [250.118(8)]. See Figure 517-7. If you use the AC cable with two insulated equipment grounding conductors, you must use one grounding conductor for the receptacle and one for the outlet box.

While some designers specify IG circuits as an instant fix for power quality problems, the NEC doesn't recommend this as a first line of defense. In fact, the NEC recommends caution (see the FPN to 517.16). An IG does not benefit functionally from any parallel grounding paths, so there are some trade-offs to this solution. The decision to use IG needs to account for the other problems it might create.

Requirements by use

The last three sections of Part II (517.18, 517.19, and 517.20) provide the requirements for specific types of patient care areas-which are defined by their use. These areas are general care, critical care, and wet locations.

*General care areas* have three requirements:

(A) At least two branch circuits-one from the emergency system and one from the normal system-must supply each patient bed location. All branch circuits from the normal system must originate in the same panelboard (three exceptions apply).

(B) Each "patient bed location" must have a minimum of four hospital grade receptacles. (Figure 517-9).

(C) If you put receptacles in a pediatric ward, use only ones listed as tamper-resistant or ones that employ listed tamper-resistant covers (Figure 517-11).

*Critical care areas* have six requirements [517.9]. Requirements A, B, and D apply to all receptacles, while requirements C, E, and F are for optional configurations. Critical care requirements are more stringent than general care requirements, as you might expect. For example, 517.19(B) requires each patient area to have at least six receptacles-two more than in general care areas.

*Wet locations* require GFCIs if interruption of power under fault conditions can be tolerated. If interruption under fault conditions cannot be tolerated, a wet location can be served by an isolated power system.

Essential Electrical Systems for Hospitals

From 517.2, we know an essential electrical system (EES) has the mission of ensuring continuity of electrical power to specific functions and areas of a healthcare facility. Part III provides requirements for meeting that mission, as stated in the scope [517.25].

Hospitals have specific EES requirements [517.13 through 517.35]. Nursing homes also have specific requirements [517.40 through 517.44]. Part III ends with the requirements for other healthcare facilities [517.45]. The requirements for nursing homes and other healthcare facilities refer back to the requirements for hospitals where similar care is provided or life support equipment is required.

One basic requirement for hospitals is the EES must consist of two separate systems, which must be kept entirely separate from all other wiring and equipment. They can't even share raceways, boxes, or cabinets with other wiring. These two systems are:

* Emergency system. This is limited to circuits essential to life safety and critical patient care.
* Equipment system. This supplies major electrical equipment necessary for patient care and basic hospital operation.

The wiring of the EES must be mechanically protected, per one of the following wiring methods:

(1) Nonflexible metal raceways, Type MI cable, or Schedule 80 rigid nonmetallic conduit.

(2) Schedule 40 rigid nonmetallic conduit or flexible nonmetallic raceways listed for installation in concrete (where encased in not less than 50 mm (2 in.) of concrete).

(3) Flexible metal raceways and metal sheathed cable assemblies as follows:

1. When used in listed prefabricated medical headwalls,
2. When used In listed office furnishings,
3. Where fished into existing walls or ceilings (not otherwise accessible and not subject to physical damage), or
4. Where necessary for flexible connection to equipment.

(4) Flexible power cords of appliances or other utilization equipment connected to the emergency system.

(5) Secondary circuits of Class 2 or Class 3 communication or signaling systems.

In patient care areas, comply with the requirements of 517.13(A) and (B). For example, do not use nonmetallic raceways for branch circuits that supply patient care areas.

Code Red

Part IV addresses inhalation anesthetizing locations, and Part V addresses X-Ray installations. Part VII addresses isolated power systems. Part VI addresses specific types of low voltage wiring. To avoid getting a "Code Red" on your healthcare electrical work, make a point of becoming familiar with all seven Parts of Article 517.

If you read the scope of each Part and think of its main goals, you will find the requirements easier to understand and remember. And that can be very healthy for your bottom line.

* [§ 18-27-517.30 Essential electrical systems for hospitals](https://chicagocode.org/18-27-517.30/)

# § 18-27-517.30

## Essential electrical systems for hospitals

a.

Applicability. The requirements of Part C, Sections 18-27-517.30 through 18-27-517.35, shall apply to hospitals where an essential electrical system is required.

b.

General.

x(1) Essential electrical systems for hospitals shall be comprised of two separate systems capable of supplying a limited amount of lighting and power service, which is considered essential for life safety and effective hospital operation during the time the normal electrical service is interrupted for any reason. These two systems shall be the emergency system and the equipment system.

x(2) The emergency system shall be limited to circuits essential to life safety and critical patient care. These are designated the life safety branch and the critical branch.

x(3) The equipment system shall supply major electric equipment necessary for patient care and basic hospital operation.

4.

The number of transfer switches to be used shall be based upon design and load considerations. Each branch of the essential electrical system shall be served by one or more transfer switches as shown in Figures 18-27-517.30(a). With special permission, facilities with a maximum demand on the essential electrical system of 150 kVA will be permitted to have one transfer switch serving the emergency branches as in Figure 18-27-517.30(b).

5.

Other Loads. Loads served by the generating equipment not specifically named in Sections 18-27-517.33 and 18-27-517.34 shall be served by their own transfer switches such that these loads

a.

Shall not be transferred if the transfer will overload the generating equipment, and

b.

Shall be automatically shed upon generating equipment overloading.

6.

Hospital power sources and alternate power sources shall be permitted to serve the essential systems of contiguous or same site facilities.

c.

Wiring Requirements.

1.

Separation from Other Circuits. The life safety branch and critical branch of the emergency 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.

Exception: Service switchboard and transfer switch equipment.

2.

Isolated Power Systems. Where isolated power systems are installed in any of the areas in Sections 18-27-517.33(a)(1) and (a)(2), each system shall be supplied by an individual circuit serving no other load.

3.

Mechanical Protection of the Emergency System. The wiring of the emergency system of a hospital shall be mechanically protected by installation in non-flexible metal raceways, or shall be wired with Type MI cable. Where installed as branch circuit conductors serving patient care areas, the installation shall comply with the requirements of Section 18-27-517.13.

Exception: Flexible power cords of appliances, or other utilization equipment, connected to the emergency system shall not be required to be enclosed in raceways.

FPN: See Section 18-27-517.13(b) for additional grounding requirements in patient care areas.

d.

Capacity of Systems. 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 system and branch.

Feeders shall be sized in accordance with Articles 215 and 220. The generator set(s) shall have sufficient capacity and proper rating to meet the demand produced by the load of the essential electrical system(s) at any one time.

Demand calculations for sizing of the generator set(s) shall be based upon the following:

1.

Prudent demand factors and historical data, or

2.

Connected load, or

3.

Feeder calculation procedures described in Article 220, or

4.

Any combination of the above.

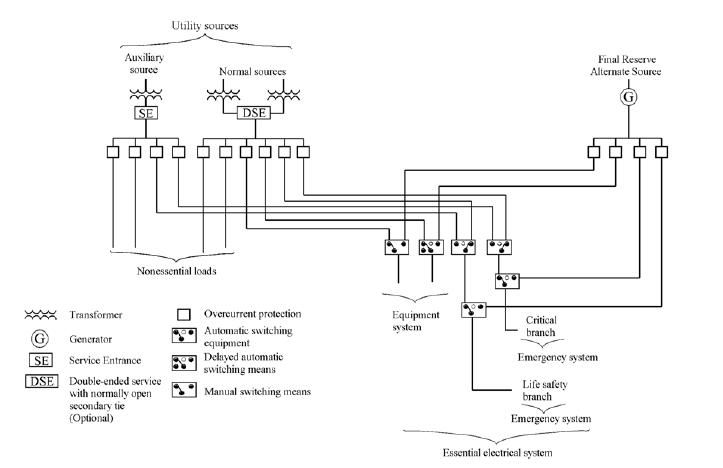
[](https://chicagocode.org/downloads/2015-11-18/images/0-0-0-336.jpg)

Figure 18-27-517.30(a)Essential Electrical System for Hospitals

For a printer-friendly PDF version of Figures 18-27-517.30(a) and (b), please click here.

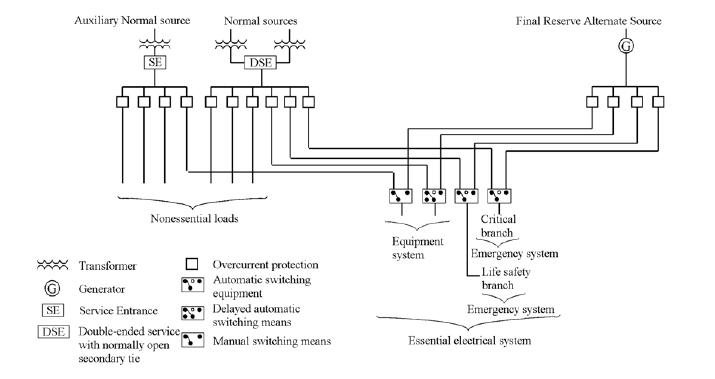
[](https://chicagocode.org/downloads/2015-11-18/images/0-0-0-341.jpg)

Figure 18-27-517.30(b)Hospital with Maximum Essential Electrical System Demand of 150 kVA