Power Generation for Healthcare Facilities

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INTRODUCTION

When it comes to backup power within the health care industry, there is an extraordinary amount of detail and complexity in the design, inspection, and installation of electrical systems. Equally challenging is ensuring that these designs and installations meet a significant number of codes and regulations.

This white paper will discuss key elements related to backup power system design to meet such requirements.

NATIONAL FIRE PROTECTION AGENCY

Some of the more commonly known requirements fall within the National Fire Protection Agency (NFPA). The purpose of this document will be to provide clarification and interpretation of three specific NFPA standards – (NFPA 99, NFPA 110, and NFPA 70).

- NFPA 99 – Health Care Facilities Code
- NFPA 70 – National Electrical Code (NEC)
- NFPA110 – Standard for Emergency and Standby Power Systems

There are also many local regulations and codes that health care installations must meet. So, it is important to work with your local inspectors and authorities having jurisdiction to ensure compliance standards are being followed. However, the goal is to break down each of the above standards most referenced within healthcare installations, and more specifically, alternative power generation requirements within them

SCOPE AND APPLICATION

These codes reference one another heavily while sticking within their respective scope, and adoption of the most recent code varies by state. Because there are many similarities between the standards, the goal will be to highlight the specific scope and applications of each standard individually and summarize the references between them.

IMPORTANT TERMINOLOGY

First let us talk about what "Essential Electrical Systems" and "Emergency Power Supply Systems" (interchangeable with Emergency Power System) are:

- **Essential Electrical System (EES)**
  Series of circuits/electrical branches that are critical to life safety. These include but are not limited to emergency egress lighting, power for surgery units, and intensive care units (ICU) power
- **Emergency Power Supply Systems/Emergency Power System (EPSS/EPS)**
  A system designed to retain electrical systems to a building. A stationary engine driven generator is one example. Battery cells or solar panels may be classified as EPS's as well. Keep in mind that EPSS and EPS's are interchangeable. However, definitions vary depending on location/jurisdiction.

  Some may view the EPS as a stationary engine driven generator or some other source of electrical power generation. While the EPSS encapsulates the EPS, but also includes the switchgear or automatic transfer switch systems.

NFPA 99 HEALTHCARE FACILITIES CODE

NFPA 99, Healthcare Facilities Code, covers a wide range of requirements from plumbing, gas and vacuum systems, and even emergency preparedness plans. Our focus within this standard will primarily be within chapter 6 – Electrical Systems. However, some terms to understand will include verbiage such as "type," and "category."

RISK CATEGORIES

Much of Chapter 6 will include requirements based on category. NFPA 99 is categorized in 4 levels as shown in *Figure 1*.

Figure 1

NFPA CATEGORY LEVELS

CATEGORY OF RISK	
Category 1 Major Injury or Death	Failure of systems and activities can cause major injury and/or loss of life.
Category 2 Minor Injury	Failure of systems and activities may cause minor injuries.
Category 3 Not Likely to Cause Injury	Failure of systems and activities unlikely to cause minor injuries (still possibility of minor injury).
Category 4 No Impact on Patient Care	Failure of systems and activities will have no impact on patient care.

These categories are not all inclusive, and a facility has the right to design their systems to a higher risk category. Category space and electrical system requirements are dictated by these category levels and separated out accordingly within the chapter. From here, we will dive into EES.

NFPA 99 HEALTHCARE FACILITIES CODE (CONT.)

EES requirements from NFPA 99 pull many references directly from NFPA 110 Standard for emergency and Standby Power Systems. NFPA 110 will be discussed a bit later, but each category number will require a "type" requirement of the EES. The below table *Figure 2* summarizes the type requirements based on category.

Figure 2

Essential Electrical Systems Categories

Category 1	Category 2	Category 3	Category 4
Type 1 EES	Type 1 or Type 2 EES	No EES required	No EES required

NFPA 99 DEFINES TYPE 1 AND TYPE 2

NFPA 99 defines Type 1 and Type 2 EES's through subsections within chapter 6. Both Type 1 and Type 2 EES's require two independent power sources (e.g. utility and back-up generator). The next table shown in *Figure 3*, highlights some of the key differences between Type 1 and Type 2 requirements.

Figure 3

Comparison of Type 1 and Type 2 Essential Electrical Systems

Type 1 EES	Type 2 EES
1. Life Safety 2. Critical 3. Equipment	1. Life Safety 2. Equipment
Life Safety branch limited to life safety circuits.	*One transfer switch permitted to serve multiple branches only if there are continuous loads 150kVA/120kW or less.
Alarms shall be tied to life safety branch OR critical branch.	AC equipment for generator accessories shall be setup for automatic connection to onsite power.
Critical branch may be subdivided (multiple transfer switches).	Equipment critical to emergency power.
Critical branch category ties requirements for category 1 locations.	
These circuits must be kept entirely independent of all other wiring *Direct verbiage is referenced within NFPA 70 (Article 517) for transfer switches.	

DIFFERENT DEFINITIONS FOR TYPE

An emergency power source must meet NFPA 110 Type 10, Class X, level 1 source requirements. The word "Type" has different meanings for NFPA 99 and NFPA 110. NFPA 99 EES "Type" refers to both the level of importance of the space and respective equipment needing power, where the NFPA 110 "Type" refers to just the time to provide power.

NFPA 70 – ARTICLE 517

It is important to note that many NFPA 99 requirements for type 1 and type 2 EES's are referred to directly in NFPA 70 under article 517. NFPA 70 and NFPA 99 often synchronize with each other for what has been covered so far.

Article 517 expands NFPA 99 EES requirements pertaining to the allowed use of energy storage solutions, and microgrids.

Additionally, Article 517 states that optional loads shall be served by their own transfer switches only if the generators are not overloaded by these loads. In other words, optional loads must be within the rating of the power source unless they can be shed to avoid an overload condition.

KEY 517 SECTIONS

In *Figure 4* below the sections within article 517 are noted for important references on EES's.

Figure 4

Key 517 Sections

Essential Electrical Systems (NFPA 70 [NEC article 517]) – NFPA 99 (Chapter 6)		
Life Safety Branch – 517.33	Critical Branch 517.34	Equipment Branch – 517.35
Note emergency automatic connection requires 10 second starts		Delayed transfers (local municipalities vary)

NFPA 110 STANDARD FOR EMERGENCY AND STANDBY POWER

As stated previously, NFPA 99 EES's call out NFPA 110 Emergency Power Supply Systems (EPSS) requirements. NFPA 99 Type 1 and Type 2 require NFPA 110 Type 10, Class X, level 1 EPSS's. Let's break down what this means.

There is the type, class, and level. See below points and tables referenced from NFPA 110 that break down these options within the standard:

- Type–maximum time (seconds) that the EPSS must supply power.
- Class – time (hours) the EPSS must run for.
- Level – indicator for life dependency:
    1. Level 1 = loss of life in event of power loss
    2. Level 2 = power loss less critical to human health and safety

In *Figure 5* below –Type reference per 2022 edition (Table 4.1(a)).

Figure 5

Designation	Power Restoration
Type U	Basically uninterruptible (UPS systems)
Type 10	10 sec
Type 60	60 sec
Type 120	120 sec
Type M	Manual stationary or non-automatic – no time limit

In *Figure 6* below – Class reference per 2022 edition (Table 4.1(b)).

Figure 6

Class	Minimum Time
Class 0.083	0.083 hr (5min)
Class 0.25	0.25 hr (15min)
Class 2	2 hr
Class 6	6 hr
Class 48	48 hr
Class X	Other time, in hours, as required by the application, code, or user

INDOORS

Like location requirements stated within NFPA 99/70, the location of the EPSS under 110 is also important. For example, if the EPSS system is installed indoors, then the room needs to have a 2-hour fire rating. Furthermore, if used for a level 1 system, the EPSS room needs to be completely dedicated.

As shown in *Figure 7* the energy sources from NFPA 110 can be any of the following:

Figure 7

NFPA 110 Level 1 Energy Sources	
Spark ignition engines	Proton exchange membrane (hydrogen)
Diesel engines	Solid oxide
Turbine engines	Molten carbonate
	Phosphoric acid
	Alkaline

ADDITIONAL NOTES

A few other key notes for the emergency power source here are:

- For level 1 systems there may be no other equipment mechanically driven by the power source.
    1. The only exception is if the power source is mechanically driving accessories needed to run normally, and of course the generator (alternator).
- Air temperature for the system (not running, in standby mode), must be kept at a minimum of 40 degrees Fahrenheit (4.5C).
- Fuel tank capacity requires 133% of either low fuel sensor quantity or quantity required by the class.
    1. For example, if the system is a class 6 generating system, the low fuel sensor should annunciate if the fuel level drops below 6 usable hours at full load.

ADDITIONAL NOTES (CONT.)

As shown in *Figure 8* NFPA 110 EPSS Accessories for level 1 and level 2 per 2022 edition (Table 5.6.4.2).

Figure 8

NFPA 110 EPSS Accessories for level 1 and level 2 per 2022 edition (Table 5.6.4.2)

Starting Equipment Requirements	Level 1	Level 2
(a) Battery unit	X	X
(b) Battery certification	X	NA
(c) Cycle cranking	O	O
(d) Cranking limiter time-outs		
Cycle crank (3 cycles)	75 sec	75 sec
Continuous crank	45 sec	45 sec
(e) Float-type battery charger	X	X
dc ammeter	X	X
dc voltmeter	X	X
(f) Recharge time	24 hr	36 hr
(e) Low battery voltage alarm contacts	X	X

X: Required. O: Optional. NA: Not applicable.

NFPA 110 CONTROL AND ANNUNCIATION FUNCTIONS

For either conventional systems, or alternative solutions for emergency power, both must have the required control function and annunciations applicable to meet the intent of NFPA 110.

These include, but may not be limited to the following:

- Auto start capable
- "Run-off-automatic" switching/ modes
- Shutdowns and lockouts for a prime mover under fail to start within cranking cycles, overspeed, low oil, high temperature, use of remote emergency stops.
- Alarms to indicate the above shutdown conditions, along with being battery powered, visually indicated, needs to be audible in both onsite and remote locations if applicable, and needs a test button/light that tests the operability of all alarm indicating lights.

NFPA 110 CONTROL AND ANNUNCIATION FUNCTIONS–CONT.

As shown in *Figure 9* NFPA 110 Annunciation per 2022 edition for level 1 and level 2 systems (Table 5.6.5.4)

Figure 9

NFPA 110 Annunciation per 2022 edition for level 1 and level 2 systems (Table 5.6.5.4)

	Level 1			Level 2		
Starting Equipment Requirements	CV	S	RA	CV	S	RA
(a) Overcrank	X	X	X	X	X	O
(b) Low water temperature	X	N/A	X	X	N/A	O
(c) High engine temperature prealarm	X	N/A	X	O	N/A	N/A
(d) High engine temperature	X	X	X	X	X	O
(e) Low lube-oil pressure	X	X	X	X	X	O
(f) Overspeed	X	X	X	X	X	O
(g) Low fuel main tank	X	N/A	X	O	N/A	O
(h) Low coolant level	X	O	X	X	O	X
(i) EPS supplying load	X	N/A	N/A	O	N/A	N/A
(j) Control switch not in automatic position	X	N/A	X	X	N/A	X
(k) High battery voltage	X	N/A	N/A	O	N/A	N/A
(l) Low cranking voltage	X	N/A	X	O	N/A	O
(m) Low voltage in battery	X	N/A	N/A	O	N/A	N/A
(n) Battery charger ac failure	X	N/A	N/A	O	N/A	N/A
(o) Lamp test	X	N/A	N/A	X	N/A	N/A
(p) Contacts for local and remote common alarm	X	N/A	X	X	N/A	X
(q) Audible alarm silencing switch	N/A	N/A	X	NA	N/A	O
(r) Low starting air pressure	X	N/A	N/A	O	N/A	N/A
(s) Low starting hydraulic pressure	X	N/A	N/A	O	N/A	N/A
(t) Air shutdown damper when used	X	X	X	X	X	O
(u) Remote emergency stop	N/A	X	N/A	N/A	X	N/A
(v) Overload alarm/load shed contact	X	N/A	X	N/A	N/A	N/A

CV: Control-panel-mounted visual. S: Shutdown of EPS. RA: Remote audible. X: Required. O: Optional. N/A: Not applicable.

Notes:

(1) Item (p) shall be provided, but a separate remote audible signal shall not be required when the regular work site in 5.6.6 is staffed 24 hours a day.

(2) Item (b) is not required for combustion turbines.

(3) Item (r) or (s) shall apply only where used as a starting method.

(4) Item (i) EPS ac ammeter shall be permitted for this function.

(5) All required CV functions shall be visually annunciated by a remote, common visual indicator

(6) All required functions indicated in the RA column shall be annunciated by a remote, common audible alarm as required in 5.6.5.2(4)

(7) Item (g) on gaseous systems shall require a low gas pressure alarm.

(8) Item (b) shall be set at 11°C (20°F) below the regulated temperature determined by the EPS manufacturer as required in 5.3.1.

NFPA 110 TESTING AND OTHER REQUIREMENTS

There are monthly and annual testing requirements that are designed for healthcare facilities. Additionally, coordination studies for transfer equipment may be needed depending on your local authorities. The emergency power source ambient temperatures need to maintain a minimum of 40 degrees Fahrenheit (4.5 degrees Celsius).

The emergency system itself needs to be tested under loads. In some cases, this may be cost prohibitive which is why coordination reviews may be required. Otherwise, the site may require onsite or rented load banks to assure the power system is loaded at 100% per the recommended schedule.

Also, keep in mind that there may be additional local requirements for the EPSS, so it is important to discuss with local authorities having jurisdiction to remain in compliance.

TRANSFER SWITCH REQUIREMENTS

Transfer switch systems have their own additional list of key requirements to ensure proper operation of the EPSS. Transfer systems must be electrically operated and mechanically held, transfer loads automatically back and forth, and visually indicate when it is not in an automatic setting.

NFPA 99 again calls out requirements for transfer switches from NFPA 110. Source monitoring requirements are similar, however, the source monitoring does not need to be tied into the transfer switch if it is included already on the EPSS's control panel.

HEALTHCARE ORGANIZATIONS

There may be other codes and standards required for overall health care building requirements. For educational and resource purposes, it is important to at least mention a few governing bodies to research. The Facilities Guidelines Institute (FGI), and the Joint Commission (JC) are two such bodies. FGI develops guidelines and best practices for designing, planning, and overall construction of hospitals, outpatient facilities, and more.

The JC additionally provides standards and evaluates/inspects these types of buildings and facilities to ensure compliance with applicable standards and ensure effective care is done safely. More information is included in the links below for readers.

SUMMARY

Emergency power supply systems ensure healthcare facilities and other critical care type locations have the redundancies needed for reliable power to keep people safe and equipment stable.

NFPA 99 Healthcare Facilities Code is a national installation guideline for healthcare facilities that refers to other NFPA installation standards like NFPA 70 and 110 which are used for all power system applications.

It is recommended to read the codes and standards in full to assure proper installation and compliance according to the authority having jurisdiction..

REHLKO ADVANTAGES

Rehlko designs our power systems to meet the NFPA standards, as well as local requirements including 72/96-hour sub base tanks for diesel generators, 10 seconds or less to start our generators, hurricane rated and corrosion resistant enclosures for coastal regions, and control systems that meet the NFPA 110 annunciation requirements.

Rehlko designs products (generators, paralleling switchgear, ATS, and controls) with total system integration in mind so that everything works as expected when it gets installed.

ASSOCIATED LINKS/ RESOURCES

NFPA

www.nfpa.org/Codes-and-Standards/All-Codes-and-Standards/List-of-Codes-and-Standards

NFPA 70 Adoption by State

www.iaei.org/page/nec-code-adoption

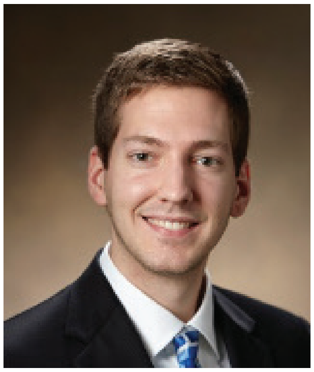
Facilities Guidelines Institute:

www.shop.fgiguidelines.org/

Joint Commission

www.jointcommission.org/resources/

ABOUT THE AUTHOR



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Brady is a member of the Standard Technical Panel (STP) for UL 2200, UL 2200A, and UL 6200. He is also a Technical Committee board member for NFPA 37. He consults with many driving authorities within the industry to understand and provide feedback on the ever-changing world of standards and regulations.

ABOUT POWER SYSTEMS

Power Systems, Rehlko's largest division, delivers worldwide energy solutions designed to ensure resilience for mission-critical applications of all sizes. Building on more than a century of expertise and dedication, the company offers complete power systems, including industrial backup generators (HVO, diesel, gaseous), enclosures, hydrogen fuel cells systems, automatic transfer switches, switchgear, monitoring controls, genuine parts and end-to-end services. As a global company with service partners in every country, Power Systems provides reliable, cutting-edge technology to keep industries and businesses running. www.powersystems.rehlko.com

ABOUT REHLKO

A global leader in energy resilience, Rehlko delivers innovative energy solutions critical to sustain and improve life across home energy, industrial energy systems, and powertrain technologies, by delivering control, resilience and innovation. Leveraging the strength of its portfolio of businesses – Power Systems, Home Energy, Uninterruptible Power, Clarke Energy, Heila Technologies, Curtis Instruments, and Engines, and more than a century of industry leadership, Rehlko builds resilience where and when the grid cannot, and goes beyond functional, individual recovery to create better lives and communities, and a more durable and reliable energy future.