

Understanding NFPA 110:

Managing Emergency Generators



White paper

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Power outages can mean more than lights out. For many facilities, an outage of even a minute can result in the loss of millions of euros—or worse, put human lives at risk. National Fire Protection Association standard 110—the standard for emergency and standby power systems—outlines requirements for the installation and performance of backup power systems in emergency and legally required applications, where an outage would pose a life-safety risk. In this whitepaper, we'll explore what NFPA 110 is and what to consider when implementing and maintaining your facility's emergency power system.

What is NFPA 110: a brief overview

Split into eight chapters and three annexes, the 2016 edition of NFPA 110 is intended to codify the performance—in installation, maintenance, operation and testing—of emergency and standby power systems. Before launching into what NFPA 110 is and how it should—and shouldn't—be used by facility managers, installers, design engineers and manufacturers, we need to address a few key definitions used throughout the standard.

Emergency power supply (EPS)

Essentially, the emergency power supply (EPS) is the source of electrical power (i.e., generator) used in your backup power system (3.3.3). It is independent of your primary source of power, ready to operate in case of power failure. Within the confines of this particular whitepaper, when we refer to an EPS, we are talking about a standby generator.

Emergency power supply system (EPSS)

Your emergency power supply system (EPSS) refers to your functioning backup power system in its entirety. It includes the EPS, transfer switches, load terminals and all the equipment required to provide a safe and reliable alternative source of power for your facility (3.3.4).

Authority having jurisdiction (AHJ)

Authority having jurisdiction (AHJ) is a broad term referring to the agency or agencies responsible for enforcing code compliance in your particular city or region (3.2.2).

Approved

NFPA 110 defines something as approved when it's "acceptable to the AHJ" (3.2.2). This is important: the NFPA doesn't approve any equipment or installations as being "compliant" with NFPA 110 (A.3.2.1). The only way to guarantee your installation, procedures or equipment are compliant is to work with your AHJ to ensure it aligns with all applicable standards, policies and codes, while referencing this standard and your manufacturer's recommendations.

These terms are at the core of NFPA 110. Essentially, the standard provides requirements and best practices for the setup and ongoing performance of EPSSs to ensure they are able to provide prompt and reliable power in the event of the failure of your primary power source, minimizing the risk to human life.

The keys to understanding NFPA 110, class and type

The key to understanding the requirements outlined in NFPA 110 lies in acquainting yourself with the way emergency power supply systems (EPSS) are classified: By Level, Class and Type.

1. Level

Dictates performance standards your system needs to follow.

2. Class

Duration your system must be able to run without refueling.

3. Type

Time your generator has to be operational after a power failure.

These categories dictate decisions including (but not limited to) what equipment to use, where to store the system and how much fuel to keep on site as required by your facility's application, location, proximity to fuel and level of life-safety risk.

1. Level

There are two EPSS levels defined in the standard: Level 1 and Level 2. They're distinguished by the types of loads they carry and have different equipment and installation standards.

Level 1 EPSS systems provide power where failure would result in "loss of human life or serious injuries" (4.4.1). Level 2 EPSS systems carry loads "less critical to human life and safety" (4.4.2).

As you can imagine, Level 1 EPSS systems are subject to stricter design guidelines. Most equipment is designed for Level 1 requirements and can be used for the less strictly regulated Level 2 loads.

It's important to note that NFPA 110 does not state which applications, specifically, qualify as Level 1 or Level 2—that is up to the AHJs interpretation (1.1.5). They do, however, provide some examples of situations where a Level 1 or 2 EPSS might be required.

Possible NFPA 110 Level 1 applications Life safety illumination, public safety communication systems, fire pumps and ventilation equipment (A.4.4.1).

Possible NFPA 110 Level 2 applications Heating and refrigeration systems, sewage disposal and some industrial processes (A.4.4.2).

NFPA 110 only defines systems with a direct impact on life safety—even the failure of a Level 2 system would have significant ramifications for occupants if it failed (1.1.3). Due to the effect of Levels 1 and 2 loads on life safety, NFPA EPSS must be permanently installed to ensure it is available in case of your primary power source's failure.

As you're likely aware, there are certain nonessential applications (i.e., data centers, research facilities) where failure could result in the loss of millions of euros. These types of loads would be served by optional standby generators, which aren't defined in NFPA 110 because they aren't essential to life safety. Facility managers looking for compliance guidance for a necessary (but not legally required) unit should turn to NFPA 70, more commonly referred to as the National Electrical Code®. Article 702 contains helpful information regarding the design and installation of optional standby power systems.

Actually, there is quite a bit of overlap between the NEC® and NFPA 110. NFPA Level 1 roughly equates to Article 700 for “emergency systems,” and Level 2 to Article 701 for “legally required standby systems.”

2. Class

Your EPSS Class is the duration (in hours) your system must be able to run at its full-rated output without refueling (4.2).

Class 2 requires your generator run for 2 hours without adding fuel, Class 48 requires 48 hours and so on. Although some AHJs define “Class X” differently, it generally translates to 96 hours of rated output.

Table 4.1(a) Classification of EPSSs

| Class | Minimum time |
|-------------|--|
| Class 0.083 | 0.083 h (5 minutes) |
| Class 0.25 | 0.25 h (15 minutes) |
| Class 2 | 2 h |
| Class 6 | 6 h |
| Class 48 | 48 h |
| Class X | Other time, in hours, as required by the application, code or user |

Source: NFPA 110

Higher classes pose a challenge for system designers—especially designers of larger systems—as you must have enough fuel stored on site to satisfy your generator’s fuel consumption for the duration as defined by your Class. Let’s say you require 68 220 L of fuel to run your EPS for 96 hours because you have a Class X EPSS installation. In accordance with NFPA 110, the main fuel tanks have a minimum capacity of 133%, meaning you need to store almost 90 960 L on-site.

You’ll need to carefully size your fuel tanks and perform regular fuel maintenance to ensure compliance (7.9). You should also consider fuel supplier delivery logistics—if you’re in a rural area where it may take more time to get fuel if you run out, you might consider oversizing your tank even further.

You should work closely with your generator manufacturer to come up with a fuel storage and maintenance plan that complies with this standard and all applicable codes, without being cost prohibitive.

3. Type

Type refers to the time in seconds that all Level 1 and Level 2 loads are supplied with alternate power. For emergency power—defined as Level 1 in NFPA 110, 10 seconds is the standard.

That means all Level 1 loads need to be transferred to your EPSS in 10 seconds, no matter how large or small your system is.

To prevent nuisance starts, there’s usually a time delay of about 1 to 3 seconds on the transfer, leaving even less time to move the load. With bigger units, the time delay is sometimes reduced to buy more time for the transfer. For instance, a time delay of 3 seconds gives 7 seconds for the transfer. Reducing the delay to 1 second gives 2 more seconds to transfer the load, which could be critical for larger applications.

You need your EPSS to be available within a reasonable time frame after power failure—and you need it to fulfill your load requirements in full until your primary power source comes back on.

And that’s what NFPA 110’s classification method was designed to do: Ensure your EPSS system will provide a “source of electrical power of required capacity, reliability and quality” for the timeframe your application requires (4.1).

Table 4.1(b) Types of EPSSs

| Designation | Power restoration |
|-------------|--|
| Type U | Basically uninterruptible (UPS system) |
| Type 10 | 10 s |
| Type 60 | 60 s |
| Type 120 | 120 s |
| Type M | Manual stationary or non automatic—no time limit |

Source: NFPA 110

A few important caveats about NFPA 110

While it provides guidance to design engineers, manufacturers and governing agencies, NFPA 110 is not an all-encompassing manual for the design and implementation of emergency power systems. In fact, NFPA 110 dedicates a whole chapter to listing out referenced publications and standards “considered part of the requirements of [the] document.”

The following publications listed below might be useful in your continued research regarding compliance for your emergency power systems for your facility.

- NFPA 1—Fire code
- NFPA 30—Flammable and combustible liquids code
- NFPA 54—National fuel gas code
- NFPA 37—Standard for the installation and use of stationary combustion engines and gas turbines
- NFPA 58—Liquefied petroleum gas code
- NFPA 70®—National electrical code®
- NFPA 72®—National fire alarm and signaling code
- NFPA 99 (if applicable)—Health care facilities code
- NFPA 780—Standard for the installation of lightning protection systems
- ASCE / SEI 7—Minimum design loads for buildings and other structures

To ensure your system is compliant, you'll need to reference all applicable codes and standards in your area and work closely with all AHJs.

By familiarizing yourself with the necessary codes—and working with the appropriate state and federal authorities to certify your emergency power system—you can be sure your backup emergency power will be available when you need it most.

Achieving NFPA compliance – what you need to know

Emergency power systems aren't called upon in ideal situations. And your EPSS needs to be designed to operate in flood, earthquake, fire and storm conditions (a.5.1.1).

NFPA 110 outlines ways to prevent the disruption of life-safety critical loads in case of emergency and outlines the tests required to prove compliance with your AHJ. But your EPSS will ultimately be installed, tested and maintained by your generator manufacturer's distributor and "approved" by your AHJ. And because your particular AHJ will vary depending on your location, there's no cut-and-paste way to achieve compliance.

You'll need to carefully read NFPA 110 and talk with your AHJ to make sure your EPSS installation is compliant with all applicable standards and codes.

Installation acceptance testing

Your EPSS is not considered compliant upon installation—you must prove its function and ability to carry all emergency loads (7.13.1) through a series of on-site installation acceptance tests and a two-hour load test (7.13.4.3).

Along with assistance from your generator manufacturer, you'll test your EPSS installation and ensure it both follows NFPA guidelines and is acceptable to your AHJ. After passing the tests, your equipment will be warranted and commissioned by your AHJ for use as an emergency power system.



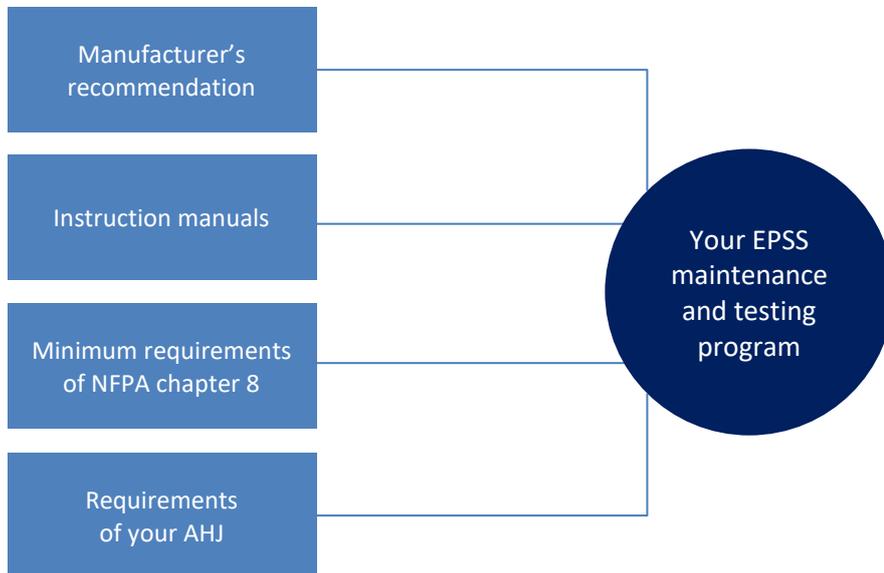
Routine maintenance according to NFPA 110, chapter 8

Your EPSS must provide reliable power at a moment's notice. And since you can't predict when you'll need to call upon your emergency power system, routine maintenance and testing is the only way to make sure the system is functioning and readily available at all times.

NFPA 110 Chapter 8 suggests you follow your manufacturer's maintenance recommendations, but outlines an alternate maintenance program if no manufacturer-given guidelines are available (A.8.3.1).

Their alternative recommendations are helpful in visualizing the weekly, quarterly, monthly and annual inspection / maintenance items you'll have to perform. However, it isn't necessarily an exact replica of what your plan will look like. And following it won't guarantee compliance— the NFPA only provides the sample plan for informational purposes. Your particular system's maintenance program will depend largely on your manufacturer's recommendations and your AHJ's requirements.

Core elements of an EPSS maintenance program



Ongoing emergency power system testing

You'll need to perform a weekly inspection and a monthly load test on your EPSS (8.4.1). And every 36 months, you'll need to run Level 1 EPSS for the amount of time specified in your application's class up to four hours of runtime (8.4.9.1-2).

The purpose of these tests is to periodically verify the function of the system against the standard. To achieve compliance, however, you'll need to consult your AHJ and manufacturer to develop an acceptable testing program for your system.

If you're trying to achieve compliance for your facility's emergency power system, closely reading NFPA 110 is a good place to start. From there, you'll need to work with the governmental agencies responsible for code enforcement in your area. And, along the way, your generator manufacturer should be able to answer any questions you might have about the installation, maintenance, operation and testing of a compliant NFPA EPSS.

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