The 10-second start
NFPA 110 Type 10 starting requirements
for generator set applications

White Paper
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The Type 10 start has been a point of pride for quality generator set manufacturers for several years. Touting the ability to start a unit, bring it up to acceptable frequency and voltage, and connect it to a facility suffering from an outage has made engine-based generator sets the standby power system of choice for healthcare and critical power facilities. However, there has been some confusion in the industry regarding what actually is included in those critical 10 seconds and when the clock technically starts and stops for compliance.

History of NFPA 110

The National Fire Protection Agency (NFPA) has served as a committee of technical and nontechnical members that aims to bring fire prevention and public safety to light through its publication of various codes and standards. While the NFPA was established in 1896, the Technical Committee that advocates for Emergency Power Supplies was not formed until 1976. The first standard that comprehensively covered the safety aspects surrounding the application and operation of Emergency Power Systems was published as a 1985 edition under the name of NFPA 110. Since this first release, this standard has undergone numerous revisions, each with contribution from industry technical experts representing manufacturers, installers and end-users.

NFPA 110 is currently on a three-year review cycle, with the most current published revision being released as the 2013 edition. It is important to note that significant changes occur year to year; as such, the particular edition that local jurisdictions reference in their own codes may not be the most current revision. In these cases, the previous edition should be reviewed for compliance to the project in question. Copies of the NFPA 110 standard, as well as other offerings from NFPA, are available directly from the organization.

NFPA 110 and Generator Sets

NFPA 110 references Emergency Power Supply Systems (EPSS) throughout the standard and in many sections, does not
discriminate between the requirements of the various options that facility designers have to provide standby power. One such section is the Classification of EPSS found in Chapter 4 of the 2013 edition. Specifically, this section addresses the terminology used to define different applications.

**NFPA 110 Standard for Emergency and Standby Power Systems**

**4.1 General.** The EPSS shall provide a source of electrical power of required capacity, reliability, and quality to loads for a length of time as specified in Table 4.1(a) and within a specified time following loss or failure of the normal power supply as specified in Table 4.1(b).

<table>
<thead>
<tr>
<th>Class</th>
<th>Minimum Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class 0.083</td>
<td>0.083 hr (5 min)</td>
</tr>
<tr>
<td>Class 0.25</td>
<td>0.25 hr (15 min)</td>
</tr>
<tr>
<td>Class 2</td>
<td>2 hr</td>
</tr>
<tr>
<td>Class 6</td>
<td>6 hr</td>
</tr>
<tr>
<td>Class 48</td>
<td>48 hr</td>
</tr>
<tr>
<td>Class X</td>
<td>Other time, in hours, as required by the application, code, or user</td>
</tr>
</tbody>
</table>

*Table 4.1(a)*

<table>
<thead>
<tr>
<th>Designation</th>
<th>Power Restoration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type U</td>
<td>Basically uninterruptible (UPS systems)</td>
</tr>
<tr>
<td>Type 10</td>
<td>10 sec</td>
</tr>
<tr>
<td>Type 60</td>
<td>60 sec</td>
</tr>
<tr>
<td>Type 120</td>
<td>120 sec</td>
</tr>
<tr>
<td>Type M</td>
<td>Manual stationary or nonautomatic — no time limit</td>
</tr>
</tbody>
</table>

*Table 4.1(b)*

As stated in the excerpt, the Class defines the required run time capability, while the Type dictates the allowable time between a loss of utility power and the restoration of acceptable power to the facilities’ loads. Because the Class determination is self-explanatory, the remainder of this paper will focus on the Type requirements and what it means with respect to equipment manufacturers and the applications where these products are installed.

**Emergency Power Supply System Type Designation**

The NFPA 110 defines the types of Level I and Level II EPSSs, but it leaves various other application codes to define when a specific Type, Class and Level power system needs to be designated for a certain application.

For example, the NFPA 70, otherwise known as the National Electrical Code (NEC), dedicates the entirety of article 700 to Emergency Systems. Two sections of article 700 specifically address the types of loads and the time required for power restoration.

**NFPA 70 National Electrical Code:**

**700.2 Definitions**

Emergency Systems: Those systems legally required and classed as emergency by municipal, state, federal, or other codes, or by any governmental agency having jurisdiction. These systems are intended to automatically supply illumination, 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.

**700.12 General Requirements**

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

As defined above, the NEC clearly states that power and lighting loads which are essential for life safety must be restored within 10 seconds; therefore, these types of loads within a facility are Type 10.

As another example, the NFPA 99, the Healthcare Facilities Code, repeats this requirement in its own text under section 6.4 for Essential Electrical System Requirements. The Healthcare Facilities Code classifies its essential electrical system power sources as Type 10, Class X under NFPA 110.

**Key Takeaway #1: Systems determined to be essential for safety to human life are assigned as Type 10 under NFPA 110.**

**“Ten” Second Start**

Provide a source of electrical power of required capacity, reliability, and quality to loads within 10 seconds following loss or failure of the normal power supply. This is the breakdown of NFPA 110 section 4.1 as it applies to life safety loads. This alludes to the distinction of two components in the standard: time and load.

Let’s examine the time aspect first. In most applications for standby power, the life safety loads that require on-site power generation will have an engine-driven generator set serving as its secondary source. Because the engine requires time, fuel and stored energy to start, nuisance starts—where the generator set is not truly needed but is called to start due to a momentary lapse in the utility’s power quality—should be avoided as much as possible. With this in mind, NFPA 110 requires a delay for the starting signal of the unit.
NFPA 110 Standard for Emergency and Standby Power Systems

6.2.5 Time Delay on Starting of EPS. A time-delay device shall be provided to delay starting of the EPS. The timer shall prevent nuisance starting of the EPS and possible subsequent load transfer in the event of harmless momentary power dips and interruptions of the primary source.

8.4.5. Time delays shall be set as follows:
(1) Time delay on start:
   (a) 1 second minimum
   (b) 0.5 second minimum for gas turbine units
(2) Time delay on transfer to emergency: no minimum required
(3) Time delay on restoration to normal: 5 minutes minimum
(4) Time delay on shutdown: 5 minutes minimum

The one-second minimum must be accounted for when generator set manufacturers evaluate the performance of their products with NFPA 110 Type 10 compliance. In effect, this leaves only nine seconds from the start signal to the generator set to the life safety loads connected to the load side of the transfer switch. This is inclusive of the signal detection and ATS transfer time, which can reasonably be assumed to be about 0.5 seconds.

It should be noted that there is a controlled minimum ambient condition of 40 degrees Fahrenheit for Level 1 installations utilizing rotating equipment. This temperature allows generator set manufacturers to accurately plan for the required amount of engine block heating that will be needed to allow large engines to come up to speed in the required time. The minimum allowable temperature also limits the exposure of starting batteries to cold cycling, which may impact the life expectancy and performance.

Key Takeaway #2: The generator set starting sequence includes a one-second minimum time delay upon starting, followed by up to nine seconds of generator set start-up time to acceptable power and switch transfer time to have the load connected within 10 seconds.

Acceptable Power

NFPA 110 references that the power must be of acceptable quality within the time limitation. The transfer device itself has the control capability to recognize an acceptable power source and connect loads to it, hence the name automatic transfer switch. The voltage and frequency pick-up settings in most industrial transfer switches can be adjusted to best suit each installation (typically 90% voltage and 90% frequency). While the pick-up settings can be adjusted for each application, the published NFPA 110 Type 10 compliance is based around using the typical pick-up settings (above) for voltage and frequency as acceptable power. While manufacturers can test their equipment to start and energize within the required time, the subsequent voltage and frequency dip will depend on the application. However, it is important to understand that the generator set and load recovery time is not included in the 10-second start requirement.

Another point to consider relevant to the transient performance of the system is the time in which the Emergency Power Supply (EPS) will require to recover from the voltage and frequency excursions due to the connecting of the emergency loads by the transfer switch. This will depend on the connected loads and the EPS capacity to support those loads. Selection of the proper EPS is required to ensure that load-protective devices will not disconnect the loads.

Key Takeaway #3: Power is deemed as “acceptable” so long as it falls within the acceptable load pick-up parameters of the transfer device and it does not cause the load's protective functions to disconnect it from the EPS.

What to Look For

With clarification brought to the two key components for developing a Type 10 compliant system—time and power quality—how does one go about specifying an EPS that needs to meet the NFPA 110 requirement? There is a critical evaluation criterion for each of the requirements. In order to qualify that the generator set will indeed meet the 10-second start requirement, it is important to verify that generator set is capable of meeting the requirements as stated by NFPA 110. Such a statement can typically be found on the manufacturer's specification sheet, referenced under a common section with other industry code-compliance and certification information.

Summary

The Type 10 requirement encompasses three key aspects that relate to the applicability of the requirement, what is actually required to occur during those 10 seconds and what qualifies as acceptable power from the perspective of the load. At the end of the day, both manufacturers and system owners are reaching toward a common goal: restoring power as quickly as possible to facilities that need it the most. However, due to the differences in every application, compliance with the requirements laid out by NFPA 110 to start and transfer an emergency power system to the load bus serves as a common ground that allows manufacturers to test and certify their equipment while providing peace of mind to facility owners.
About the authors

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