10-Second Time to Readiness

NFPA 110 Type 10 starting requirements for generator set applications

White paper by
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The 10-second 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 2017 edition. It is important to note that significant changes may occur with each revision; 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 2016 edition. Specifically, this section addresses the terminology used to define different applications.

TABLE 4.1(A) CLASSIFICATION OF EPSS

Class	Minimum Time
Class 0.083	0.083 hr (5 min)
Class 0.25	0.25 hr (15 min)
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

TABLE 4.1(B) TYPE OF EPSS

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 nonautomatic — no time limit

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

NFPA 110 defines requirements for EPSS, 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 are 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 01: Systems determined to be essential for safety to human life must meet Type 10 requirements as defined under NFPA 110.

10-second time to readiness

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. NFPA 110 permits tailoring of this configurable time delay as determined by power system requirements.

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.

A.6.2.5
For most applications, a nominal delay of one second is adequate. The time delay should be short enough so that the generator can start and be online within the time specified for the type classification.

For most applications, a nominal delay of one second is adequate. The time delay should be short enough so that the generator can start and be on line within the time specified for the application.

This time delay must be accounted for when the EPSS is evaluated for NFPA 110 Type 10 compliance.

In effect, this time delay requires that the generator set achieve ready to load status in less than 10 seconds. The 10-second time to readiness requirement is also inclusive of the signal detection, ATS transfer time and any other intended or unintended power transfer delays.

Key Takeaway 02: Time to readiness includes the time from the loss of power at the load side of the transfer switch until acceptable power is restored to the load side of the transfer switch which includes all time delays associated with sensing and transfer of power, and any other intended or unintended transfer delays.

Acceptable power

NFPA 110 requires 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.

Key Takeaway 03: 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.

Summary

Systems determined to be essential for safety to human life must meet Type 10 requirements as defined under NFPA 110. Type 10 requirements include established time to readiness criteria which includes the time from the loss of power at the load side of the transfer switch until acceptable power is restored to the load side of the transfer switch which includes all time delays associated with sensing and transfer of power, and any other intended or unintended transfer delays. 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. Compliance with these requirements is the responsibility of the specifying engineer to effectively coordinate system design in partnership with key equipment vendors.

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Michael Sanford is a graduate of Minnesota State University, Mankato with a Bachelor's Degree in Automotive Engineering Technologies. He has been in the power generation industry since 2012, joined Cummins Inc. in 2014 and leads Cummins Technical Marketing initiative with previous experience leading the Sales Application Engineering group for North America supporting the Power Systems line of business including diesel generator sets, natural gas generator sets, transfer switches, controls and switchgear. Michael's primary focus includes technical education on topics impacting the power generation industry. He is an active Electrical Generating Systems Association (EGSA) member.

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