



NFPA 110 Overview

Part 2: Installation, Environment, and Testing

White Paper 126

Life Is On



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Part 2: Installation, Environment, and Testing

NFPA 110 – Standard for Emergency and Standby Power Systems provides basic requirements for the performance of backup power systems.²⁹ Often referenced by other standards and regulations, an understanding of NFPA 110 is essential for professionals engaged in critical power equipment installation and operation. **Part 1** of this ASCO Power Technologies white paper described key requirements for emergency and standby power systems that are found in Chapters 1 through 6 of NFPA 110.³⁰ This second part summarizes key highlights regarding the environmental requirements for backup power systems as well as acceptance and operational testing, which are found in Chapters 7 and 8 of the standard.

INSTALLATION AND ENVIRONMENTAL CONSIDERATIONS

Environmental Requirements

In NFPA 110, Chapter 7 stipulates that Emergency Power Supply (EPS) equipment must be installed per the requirements of the standard as well as manufacturer and Authority Having Jurisdiction (AHJ) requirements. When normal power is unavailable, EPSs are permitted to serve optional loads, but only if they can first meet the demands of any Level 1 and Level 2 loads. (Defined in Part 1, Level 1 systems are installed where a failure of backup power could result in loss of human life or serious injuries. Level 2 systems serve systems and equipment that are “less critical” to human life and safety.) When normal power is available, EPSs are permitted to serve peak shaving, utility load relief and cogeneration purposes.³¹

For indoor applications, Level 1 EPS equipment must be installed in a dedicated room that is constructed to a two-hour fire resistance rating. Emergency Power Supply System (EPSS) equipment may also be installed there, but no other equipment (other than architectural equipment that serves the space) is permitted in this room.³²

For outdoor locations, an EPS must be installed in an enclosure that can resist rain and snow pursuant to local building codes and minimize damage from flooding, including that from firefighting, sewer back up, and disasters.^{33,34} EPSS equipment may also be installed unless it is rated above 150 volts to ground and 1000 Amps, but no other equipment (other than architectural equipment that serves the space) is permitted.^{35,36} Information regarding enclosure selection can be found in the ASCO document entitled ***Equipment Enclosure Classifications***.³⁷ The ASCO document entitled ***Protecting Transfer Switches from Water-Related Damages*** also presents relevant information.³⁸

²⁹ *NFPA 110 – Standard for Emergency and Standby Power Systems, 2019 Edition*. National Fire Protection Agency. Quincy, Massachusetts, USA. 2018.

³⁰ *NFPA 110 Overview - Part 1: Key Requirements for Emergency and Standby Power Systems*. ASCO Power Technologies, Inc. Florham Park, New Jersey, USA. 2020. <https://www.ascopower.com/us/en/download/document/ASC-TS-WP-125-NFPA110O/>, accessed December 8, 2020.

³¹ Ibid. Article 7.1.5. p. 110-15.

³² Ibid. Article 7.2 *et seq.* p 110-16.

³³ Ibid. Article 7.2.2. p. 110-16.

³⁴ Ibid. Article 7.2.4. p. 110-16.

³⁵ Ibid. Article 7.2.2.2. p. 110-16.

³⁶ Ibid. Article 7.2.2.3. p. 110-16.

³⁷ *Equipment Enclosure Classifications*. ASCO Power Technologies, Inc. Florham Park, New Jersey, USA. 2019. <https://www.ascopower.com/us/en/download/document/TS-WP-EQUIPENCLOSURE/>, accessed December 8, 2020.

³⁸ *Protecting Transfer Switches from Water-Related Damages*. ASCO Power Technologies, Inc. Florham Park, New Jersey, USA. <https://www.ascopower.com/us/en/download/document/ASC-WP-ATS-WTR-DMG/>, accessed December 8, 2020.



Section 7 further elaborates on requirements for EPS systems such as engine mounting, cooling, fuel, exhaust, and others that are typically the purview of genset specifiers, manufacturers, and installers. Notably, heating, ventilation, and air conditioning requirements for the EPS space are also addressed, where temperatures cannot exceed the maximum recommended by the EPS manufacturer.³⁹ Level 1 systems require heating to maintain ambient temperatures above 4.5°C (40°F).^{40,41}

Level 1 systems require ambient room temperatures above 4.5°C (40°F).^{40,41} Article 7.11 addresses protection for EPS rooms, including prohibitions against certain types of fire suppression systems. Any fire detection systems are referenced to *[NFPA 72- National Fire Alarm and Signaling Code](#)*, and outdoor or rooftop Level 1 EPSs must be protected from lightning in accordance with *[NFPA 780- Standard for the Installation of Lightning Protection Systems](#)*.^{42,43,44} In areas with recognized seismic risks, EPS and EPSS components must be designed to minimize damage from earthquakes, and systems such as transfer switches, panels, breakers, and controls must be capable of functioning following anticipated seismic shock.^{45,46} For additional information about locating backup power equipment in areas with elevated earthquake risk, review the ASCO document entitled *[Seismic Certification and the Consulting Engineer](#)*.⁴⁷

Installation Acceptance Testing

The last section of Chapter 7 addresses installation acceptance testing for all EPSSs, of which the AHJ must be given advance notice “so the authority can witness the test”.⁴⁸ Testing occurs in two parts. For the initial on-site installation acceptance test, any prime movers must be in a cold-start condition, and distinct test initiation procedures are specified for new unoccupied facilities and existing occupied facilities.^{49,50} For paralleled EPSs, any generator paralleling and load shedding functions must be verified.⁵¹ Test loads are the intended EPSS loads, without minimum, and the test must run for at least 1.5 hours.⁵²

³⁹ NFPA 110. Article 7.7.1. p. 110-16.

⁴⁰ Ibid. Article 7.7.6. p. 110-17.

⁴¹ Ibid. Article 5.3.5. p. 110-9.

⁴² *NFPA 72 - National Fire Alarm and Signaling Code, 2016 Edition*. National Fire Protection Agency. Quincy, Massachusetts, USA.

⁴³ *NFPA 780 - Standard for the Installation of Lightning Protection Systems - 2017 Edition*. National Fire Protection Agency. Quincy, Massachusetts, USA.

⁴⁴ Ibid. Article 7.11 *et seq.* p. 110-18.

⁴⁵ Ibid. Article 7.11.5. p. 110-18.

⁴⁶ Ibid. Article 7.11.6. p. 110-18.

⁴⁷ *Seismic Certification and the Consulting Engineer*. ASCO Power Technologies, Inc. Florham Park, New Jersey, USA. 2017. <https://www.ascopower.com/us/en/download/document/TS-WP-SEISMIC/>, accessed December 8, 2020.

⁴⁸ NFPA 110. Article 7.13.3. p. 110-19.

⁴⁹ Ibid. Article 7.13.4.1.1. p. 110-19.

⁵⁰ Ibid. Article 7.13.4.1.2. p. 110-19.

⁵¹ Ibid. Article 7.13.4.1.3. p. 110-19.

⁵² Ibid. Article 7.13.4.1.4 *et seq.* p. 100-19.

A second two-hour test is required. During this test, building load and any necessary supplemental load (such as one or more load banks) is used to exercise the EPS at up to 100% of rated nameplate capacity.⁵³ More specifically, load during this test must not be less than 30% for the first 30 minutes, 50% for the next 30 minutes, and 100% for the next 60 minutes.⁵⁴ During this test, genset cooling temperatures must stabilize for at least 30 minutes. Article 7.13.4.6 lists records that must be made available to the AHJ at the time of test. Table 4 summarizes acceptance test requirements.

Table 4: Acceptance Test			
Test	Load Requirements	Duration	Reference
Initial Acceptance Test	EPSS loads, without minimum	1.5 Hours	NFPA 110 Article 7.13.4.1
Two-Hour Full-Load Test	30% of nameplate or more	First 30 Minutes	NFPA 110 Article 7.13.4.3
	50% of nameplate or more	Next 30 Minutes	
	100% of nameplate	Next 60 Minutes	

MAINTENANCE AND OPERATIONAL TESTING

After backup power equipment and systems are installed and accepted, they are put into service to provide backup power when needed. Equipment maintenance and testing is necessary to ensure that backup systems remain able to provide power when needed. *Section 8* of NFPA 110 thus requires a written maintenance and testing program that complies with (1) manufacturer’s recommendations, (2) instruction manuals, (3) minimum requirements of the chapter, and (4) the AHJ.^{55,56} This program commences immediately following acceptance or subsequent system repairs.⁵⁷ For transfer switches and paralleling gear, the scope of maintenance includes (1) checking connections, (2) inspecting or testing for overheating and corrosion, (3) removal of dust and dirt, and (4) contact replacement when required.⁵⁸ For paralleling gear, the proper function of controls must also be verified. Articles 8.3.6 and 8.3.7 prescribe maintenance and testing for batteries and fuel. Maintenance must be performed by qualified personnel.⁵⁹

Notably, Article 8.1.2 states, “Consideration shall be given to temporarily providing a portable or alternate source whenever the emergency generator is out of service...” and cannot meet the performance requirements for supplying power to loads. These requirements are referenced in Article 4.3, which is addressed in [Part 1](#) of this paper. Provisions for a temporary or alternate power source are required for some backup power systems by Articles 700, 701, and 708 of the [National Electrical Code®](#). For more information about the related requirements, solutions, and applications, see the ASCO document entitled [National Electrical Code Requirements for Emergency Power Transfer Switching](#), the ASCO Technical Brief entitled [NEC Requirement for Permanent Manual Switching Means](#), and the ASCO video entitled [ASCO SERIES 300 Manual Transfer Switch Solutions](#).^{60,61,62}

Following repairs, operational tests shall be initiated at an ATS and include testing of each repaired EPSS component. During these tests, each transfer switch must be transferred to the alternate power source for a period of not less than 30 minutes.⁶³

⁵³ Ibid. Article 7.13.4.3. p. 110-19.

⁵⁴ Ibid. Article 7.13.4.3.1. p. 110-19.

⁵⁵ Ibid. Article 8.3.3. p. 110-20.

⁵⁶ Ibid. Article 8.1.1. p.110-20.

⁵⁷ Ibid. Article 8.3.2. p. 110-20.

⁵⁸ Ibid. Article 8.3.4 *et seq.* p. 110-20.

⁵⁹ Ibid. Article 8.4.8. p. 110-21.

⁶⁰ *National Electrical Code Requirements for Emergency Power Transfer Switching*. ASCO Power Technologies, Inc. Florham Park, New Jersey, USA. 2017. <https://www.ascopower.com/us/en/download/document/TS-WP-NECREQ/>, accessed December 8, 2020.

⁶¹ *NEC Requirement for Permanent Manual Switching Means*. ASCO Power Technologies, Inc. 2020. <https://www.ascopower.com/us/en/resources/technical-briefs/nec-requirement-for-permanent-manual-switching.jsp>, accessed December 8, 2020.

⁶² *ASCO SERIES 300 Manual Transfer Switch Solutions*. Video. ASCO Power Technologies, Inc. 2018. <https://youtu.be/2H02eoYjPPI>, accessed December 8, 2020.

⁶³ NFPA 110, Article 8.3.2.1. p.110-20.



OPERATIONAL INSPECTION AND TESTING

Weekly Inspection and Monthly Testing

Emergency Power Supply Systems and their associated components require weekly inspection. They must also be tested under load monthly. If the normal power source fails during testing, any supplemental test loads must be replaced with the intended building loads. Tests must proceed for at least 30 minutes under loads that either meet the generator manufacturer's minimum exhaust temperature requirement or 30% of the EPS standby nameplate kW rating. Diesel-powered gensets that do not meet these criteria during monthly tests must also be tested annually. Minimum load levels are 50% of rating for 30 minutes, 75% for one hour, and 100% for 90 minutes.⁶⁴

When used for standby power or for peak load shaving applications, such use can be substituted for compliance testing. Emergency power source tests shall be initiated under cold start conditions with specified time delays by using test switches on the ATs or by opening a normal breaker.^{65,66,67} Additional information about the functions of timing delays are summarized in the ASCO Technical Brief entitled [*Elements of Timing Delays*](#), the ASCO video entitled [*Timing Delays for ATS Transition Modes*](#), and the ASCO [*white paper of the same title*](#).^{68,69,70} Additional information about using backup power event data to satisfy compliance testing requirements can be found in the ASCO document entitled [*The Value of Automated Power Compliance Reporting*](#).

Monthly transfer switch tests require electrically operating the switch from its primary position to the alternate position and back.⁷¹

Other Required Actions

For Level 1 applications, EPSS circuit breakers must be cycled annually with the EPS in the "off" position. Breakers rated in excess of 600 volts must be exercised every 6 months and tested under a simulated overload once every 2 years.⁷²

Level 1 EPSSs shall be tested at least once every 36 months for the duration of its assigned class or up to 4 hours, whichever is less.⁷³ For spark-ignited gensets, the available EPSS load is used. For diesel-powered units, load must equal at least 30 percent of the nameplate kW rating of the EPS. This test can be combined with monthly and annual tests specified in Articles 8.4.2 and 8.4.2.3. Specific loading requirements apply if a load bank is used.

⁶⁴ Ibid. Article 8.4 *et seq.* p.110-20.

⁶⁵ Ibid. Article 8.4.4. p. 110-21.

⁶⁶ Ibid. Article 8.4.5. p. 110-21.

⁶⁷ Ibid. Article 8.4.3. p. 110-21.

⁶⁸ *Elements of Timing Delays*. ASCO Power Technologies, Inc. 2020. <https://www.ascopower.com/us/en/resources/technical-briefs/elements-of-time-delays.jsp>, accessed December 8, 2020.

⁶⁹ *Timing Delays for ATS Transition Modes*. Video. ASCO Power Technologies, Inc. 2020. https://youtu.be/a_hdlayNJPM, accessed December 8, 2020.

⁷⁰ *Timing Delays for ATS Transition Modes*. ASCO Power Technologies, Inc. Florham Park, New Jersey, USA. 2020. https://www.ascopower.com/us/en/download/document/ASC-71_NFPA_110. Article 8.4.6. p. 110-21.

⁷² Ibid. Article 8.4.7 *et seq.* p. 110-21.

⁷³ NFPA 110, Article 8.4.9 *et seq.* p. 110-21.



Key actions required for Level 1 and Level 2 EPSSs are summarized in Table 5.

Table 5: Operational Tests for EPSSs			
Test	Load Requirements	Minimum Duration	Reference
Weekly Inspection	--	--	NFPA 110 Article 8.4.1
Monthly Load Test	Min. Exhaust Gas Temp OR ≥30% of rating	30 Minutes	NFPA 110 Article 8.4.
Diesel Sets Not Meeting Above Criteria - Annually	≥50% of rating	30 Minutes	NFPA 110 Article 8.4.2.3
	≥75% of rating	60 Minutes	
	100% of rating	90 Minutes	
For Level 1 EPSSs			
Triennial Test (1 per 36 months)	EPSS load for spark-ignited gensets	Class Runtime OR 4 Hrs. Max	NFPA 110 Article 8.4.2.3
	≥30% of rating for diesel gensets		

SUMMARY

The second of a two-part series, this document highlights environmental and testing requirements presented in Chapters 7 and 8 of NFPA 110, including selected requirements for environmental conditions and for acceptance and operational testing.

The information in Part 1 and Part 2 of this series is presented for informational purposes. Any evaluation of a compliance strategy should be made only after consulting NFPA 110 directly and/or consulting a qualified professional.



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