

NFPA® 110 Annotated Edition

Standard for Emergency and Standby Power Systems

2010 Edition

Annotated by Christopher D. Coache



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NFPA® 110
Standard for
Emergency and Standby Power Systems
2010 Edition

This edition of NFPA 110, *Standard for Emergency and Standby Power Systems*, was prepared by the Technical Committee on Emergency Power Supplies and released by the Technical Correlating Committee on National Electrical Code®. It was issued by the Standards Council on August 6, 2009, with an effective date of August 26, 2009, and supersedes all previous editions.

A tentative interim amendment (TIA) to 7.13.4.1.3(1) and 7.13.4.3.4 was issued on August 6, 2009. For further information on tentative interim amendments, see Section 5 of the NFPA Regulations Governing Committee Projects available at: <http://www.nfpa.org/assets/files/PDF/CodesStandards/TIAErrataFI/TIAREgs.pdf>

This edition of NFPA 110 was approved as an American National Standard on August 26, 2009.

▲ Origin and Development of NFPA 110

The Technical Committee on Emergency Power Supplies was organized in 1976 by NFPA in recognition of the demand for viable guidelines for the assembly, installation, and performance of electrical power systems to supply critical and essential needs during outages of the primary power source. It was the intent of the committee to establish the necessary equipment requirements to achieve an on-site auxiliary electrical power source suitable to the needs of the applicable requirements and user criteria.

In 1979, the committee's report proposing adoption of NFPA 110 was published but withdrawn because of issues involving the scope of the committee. In 1981, a revised committee report was returned to committee to resolve differences with other NFPA documents. At the 1982 NFPA Fall Meeting, the committee's report was adopted as a tentative standard (NFPA 110T-1983) in order to expose the document to as much public review as possible. NFPA 110 was formally adopted as a standard at the 1984 NFPA Fall Meeting and designated as the 1985 edition. The 1985 edition clarified scope statements, prototype testing, battery and bypass-isolation switch requirements, and revised maintenance requirements.

The requirements of the standard are considered necessary to obtain the minimum level of reliability and performance, particularly where life safety electrical power needs are involved.

The standard does not require the installation of emergency and standby power supply systems. Rather, it is a document that, if followed, results in a system suitable for various situations as required by other codes and standards.

The 1988 edition of NFPA 110 included several new definitions and further clarified transfer switch and installation testing requirements.

The 1993 edition of NFPA 110 revised the document to reflect (1) the adoption by NFPA of a new document on stored electrical energy emergency and standby power systems (NFPA 111, *Standard on Stored Electrical Energy Emergency and Standby Power Systems*), (2) a basic requirement for one-step loading for all prime movers, (3) an update on battery technology, (4) restrictions on unnecessary transferring of loads, and (5) the need for battery maintenance.

The 1996 edition of NFPA 110 included, but was not limited to, the following changes: monthly load testing requirements for generator sets were changed, including taking into consideration wet stacking; definitions were added for various kinds of fuel tanks; types of fuel tanks and spillage considerations were added; restrictions on the types of batteries that can be used were added; the minimum number of cranks, including time-outs, that an engine must be capable of completing was clarified; cooling system requirements were clarified; working space requirements were added; and the issue of timing devices in health care facilities for testing a generator was clarified.

The 1999 edition was changed by the deletion of the testing of generator sets at 50 percent of the emergency power supply system (EPSS) load because the relevant measure is the nameplate rating. That edition also deleted the exception for wet stacking. Exhaust temperature monitoring was added, because it is an acceptable performance measure of proper emergency power supply (EPS) loading.

The 2002 edition included format and technical revisions. The 2000 edition of the *Manual of Style for NFPA Technical Committee Documents* was applied in this document's restructure and format. Introductory material in Chapter 1 was formatted for consistency among all NFPA documents. Referenced publications that apply to the document were relocated from the last chapter to Chapter 2, resulting in the renumbering of chapters. Informational references remained in the last annex. Appendices were designated as annexes. Definitions in Chapter 3 were reviewed for consistency with definitions in other NFPA documents, systematically aligned, and individually numbered. Paragraph structuring was revised with the intent of one mandatory requirement per section, subsection, or paragraph. Information that often accompanied many of the requirements was moved to Annex A, Explanatory Material. Exceptions were deleted or rephrased in mandatory text, unless the exception represented an allowance or required an alternate procedure to a general rule when limited specified conditions existed. The format appearance and structure provided continuity among NFPA documents, clarity of mandatory text, and greater ease in locating specific mandatory text.

Changes in the 2002 edition of NFPA 110 included definitive and broad-based requirements regarding electrical installations in accordance with NFPA 70, *National Electrical Code*[®]; additional EPS controls and safeguards, such as alerting staff of impending failure of the EPS to start; access and working space around the generator set; ventilation; energy converters; and EPSS testing requirements.

Changes in the 2005 edition of NFPA 110 included electrical installations in accordance with NFPA 70, *National Electrical Code*[®]; revised clearance distances between transfer switches and service equipment; revision of the definitions for both lead-acid (flooded) and valve-regulated lead-acid (VRLA) batteries; and changes in the testing and maintenance section to include testing for spark-ignited engines that parallels those for diesel. Changes for the 2005 edition also included new annex material for diesel fuel testing and maintenance procedures, as well as transfer switches.

Significant revisions to the 2010 edition include the following:

- (1) Clarification that the standard is intended to apply to those EPSSs classed as either Level 1 or Level 2 systems. Applying the requirements of this standard to systems classed as optional standby is not mandatory.
- (2) Revision of the application section to indicate that the operation testing and routine maintenance requirements of Chapter 8 cover new and existing EPSSs.
- (3) Revisions to the definitions of Automatic Transfer Switch (ATS) and Nonautomatic Transfer Switch for consistency with NFPA 111, *Standard on Stored Electrical Energy Emergency and Standby Power Systems*, and for correlation with relevant product standards covering the construction of transfer switches.
- (4) Revisions to the requirements of Chapter 7 for acceptance testing that distinguish what is required for new and unoccupied buildings and facilities versus the requirements for existing occupied buildings and facilities. In addition, requirements for test duration, step-testing intervals, and required documentation have been modified.
- (5) Revisions to the requirements of Chapter 8 on operational test durations for diesel and spark-ignited prime movers. In addition, the 36-month test requirement has been revised to clarify the maximum duration, the minimum acceptable EPS loading or operating condition, and the method of test initiation.



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NFPA 110

Standard for

Emergency and Standby Power Systems

2010 Edition

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Information on referenced publications can be found in Chapter 2 and Annex C.

▲ Chapter 1 Administration

▲ **1.1 Scope.** This standard covers performance requirements for emergency and standby power systems providing an alternate source of electrical power to loads in buildings and facilities in the event that the primary power source fails.

▲ **1.1.1** Power systems covered in this standard include power sources, transfer equipment, controls, supervisory equipment, and all related electrical and mechanical auxiliary and accessory equipment needed to supply electrical power to the load terminals of the transfer equipment.

1.1.2 This standard covers installation, maintenance, operation, and testing requirements as they pertain to the performance of the emergency power supply system (EPSS).

1.1.3 This standard does not cover the following:

- (1) Application of the EPSS
- (2) Emergency lighting unit equipment
- (3) Distribution wiring
- (4) Utility service when such service is permitted as the EPSS
- (5) Parameters for stored energy devices
- ▲ (6) The equipment of systems that are not classed as Level 1 or Level 2 systems in accordance with Chapter 4 of this standard

1.1.4* This standard does not establish criteria for stored energy systems.

1.1.5 The selection of any of the following is not within the scope of this standard:

- (1) Specific buildings or facilities, or both, requiring an EPSS
- (2) Specific loads to be served by the EPSS
- (3)*Assignment of type, class, or level to any specific load

1.2 Purpose. This standard contains performance requirements for an EPSS.

1.2.1 It is the role of other NFPA standards to specify which occupancies require an EPSS and the applicable level, type, and class. This standard does not specify where an EPSS is required.

1.2.2 This standard also is intended to provide guidance for inspectors, designers, installers, manufacturers, and users of EPSSs and to serve as a vehicle for communication between the parties involved. It is not intended as a design manual.

1.2.3 Compliance with this standard is not intended to exempt the parties involved from their respective responsibilities for the design, installation, maintenance, performance, or compliance with other applicable standards and codes.

▲ **1.3 Application.** This document applies to new installations of EPSSs, except that the requirements of Chapter 8 shall apply to new and existing systems. Existing systems shall not be required to be modified to conform, except where the authority having jurisdiction determines that nonconformity presents a distinct hazard to life.

▲ **1.4 Equivalency.** Nothing in this standard is intended to prevent the use of systems, methods, or devices of equivalent or superior quality, strength, fire resistance, effectiveness, durability, and safety to those prescribed by this standard.

1.4.1 Technical documentation shall be submitted to the authority having jurisdiction to demonstrate equivalency.

1.4.2 The system, method, or device shall be approved for the intended purpose by the authority having jurisdiction.

▲ Chapter 2 Referenced Publications

2.1 General. The documents or portions thereof listed in this chapter are referenced within this standard and shall be considered part of the requirements of this document.

2.2 NFPA Publications. National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471.

NFPA 30, *Flammable and Combustible Liquids Code*, 2008 edition.

NFPA 37, *Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines*, 2006 edition.

NFPA 54, *National Fuel Gas Code*, 2009 edition.

NFPA 58, *Liquefied Petroleum Gas Code*, 2008 edition.

NFPA 70®, *National Electrical Code®*, 2008 edition.

NFPA 72®, *National Fire Alarm and Signaling Code*, 2010 edition.

NFPA 99, *Standard for Health Care Facilities*, 2005 edition.

NFPA 780, *Standard for the Installation of Lightning Protection Systems*, 2008 edition.

2.3 Other Publications.

2.3.1 ASCE Publications. American Society of Civil Engineers, 1801 Alexander Bell Drive, Reston, VA 20191.

ASCE 7, *Minimum Design Loads for Buildings and Other Structures*, 2002.

2.3.2 Other Publications.

Merriam-Webster's Collegiate Dictionary, 11th edition, Merriam-Webster, Inc., Springfield, MA, 2003.

2.4 References for Extracts in Mandatory Sections. (Reserved)



▲ Chapter 3 Definitions

▲ **3.1 General.** The definitions contained in this chapter shall apply to the terms used in this standard. Where terms are not defined in this chapter or within another chapter, they shall be defined using their ordinarily accepted meanings within the context in which they are used. *Merriam-Webster's Collegiate Dictionary*, 11th edition, shall be the source for the ordinarily accepted meaning.

▲ 3.2 NFPA Official Definitions.

3.2.1* Approved. Acceptable to the authority having jurisdiction.

▲ **3.2.2* Authority Having Jurisdiction (AHJ).** An organization, office, or individual responsible for enforcing the requirements of a code or standard, or for approving equipment, materials, an installation, or a procedure.

3.2.3 Labeled. Equipment or materials to which has been attached a label, symbol, or other identifying mark of an organization that is acceptable to the authority having jurisdiction and concerned with product evaluation, that maintains periodic inspection of production of labeled equipment or materials, and by whose labeling the manufacturer indicates compliance with appropriate standards or performance in a specified manner.

▲ **3.2.4* Listed.** Equipment, materials, or services included in a list published by an organization that is acceptable to the authority having jurisdiction and concerned with evaluation of products or services, that maintains periodic inspection of production of listed equipment or materials or periodic evaluation of services, and whose listing states that either the equipment, material, or service meets appropriate designated standards or has been tested and found suitable for a specified purpose.

3.2.5 Shall. Indicates a mandatory requirement.

3.2.6 Should. Indicates a recommendation or that which is advised but not required.

3.2.7 Standard. A document, the main text of which contains only mandatory provisions using the word "shall" to indicate requirements and which is in a form generally suitable for mandatory reference by another standard or code or for adoption into law. Nonmandatory provisions shall be located in an appendix or annex, footnote, or fine-print note and are not to be considered a part of the requirements of a standard.

▲ 3.3 General Definitions.

3.3.1* Battery Certification. The certification by a battery manufacturer that a battery is built to industry standards.

3.3.2 Battery, Lead-Acid.

3.3.2.1 Valve-Regulated (VRLA). A lead-acid battery consisting of sealed cells furnished with a valve that opens to vent the battery whenever the internal pressure of the battery exceeds the ambient pressure by a set amount. In VRLA batteries, the liquid electrolyte in the cells is immobilized in an absorptive glass mat (AGM cells or batteries) or by the addition of a gelling agent (gel cells or gelled batteries).

3.3.2.2 Vented (Flooded). A lead-acid battery consisting of cells that have electrodes immersed in liquid electrolyte. Flooded lead-acid batteries may have a provision for the

user to add water to the cell and are equipped with a flame-arresting vent which permits the escape of hydrogen and oxygen gas from the cell in a diffused manner such that a spark, or other ignition source, outside the cell will not ignite the gases inside the cell.

3.3.3 Black Start. Where the stored energy system has the capability to start the prime mover without using energy from another source.

3.3.4* Emergency Power Supply (EPS). The source of electric power of the required capacity and quality for an emergency power supply system (EPSS).

▲ **3.3.5* Emergency Power Supply System (EPSS).** A complete functioning EPS system coupled to a system of conductors, disconnecting means and overcurrent protective devices, transfer switches, and all control, supervisory, and support devices up to and including the load terminals of the transfer equipment needed for the system to operate as a safe and reliable source of electric power.

3.3.6 Fuel Tank.

3.3.6.1 Day Fuel Tank. A fuel tank, located inside a structure, that provides fuel to the engine.

3.3.6.2 Enclosed Fuel Tank. A fuel tank located within a separate room, separated from other equipment.

3.3.6.3 Integral Fuel Tank in EPS Systems. A fuel tank furnished by the EPS supplier and mounted on the engine or under as a subbase.

3.3.6.4 Main Fuel Tank. A separate, main fuel tank for supplying fuel to the engine or a day tank.

3.3.7 Lamp. An illuminating indicator.

3.3.8 Occupancy Category. See ASCE 7, *Minimum Design Loads for Buildings and Other Structures*, Section 9, 2002 edition.

3.3.9 Switch.

3.3.9.1 Automatic Transfer Switch (ATS). Self-acting equipment for transferring the connected load from one power source to another power source.

3.3.9.2 Bypass-Isolation Switch. A manually operated device used in conjunction with an automatic transfer switch to provide a means of directly connecting load conductors to a power source and disconnecting the automatic transfer switch.

3.3.9.3 Nonautomatic Transfer Switch. A device, operated manually by a physical action or electrically by either a local or remote control, for transferring a common load between a normal and alternate supply.

▲ Chapter 4 Classification of Emergency Power Supply Systems (EPSSs)

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).

▲ **4.2* Class.** The class defines the minimum time, in hours, for which the EPSS is designed to operate at its rated load without being refueled or recharged. [See Table 4.1(a).]

Table 4.1(a) Classification of EPSSs

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) Types of EPSSs

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

▲ **4.3 Type.** The type defines the maximum time, in seconds, that the EPSS will permit the load terminals of the transfer switch to be without acceptable electrical power. Table 4.1(b) provides the types defined by this standard.

▲ **4.4* Level.** This standard recognizes two levels of equipment installation, performance, and maintenance.

▲ **4.4.1* Level 1** systems shall be installed where failure of the equipment to perform could result in loss of human life or serious injuries.

▲ **4.4.2* Level 2** systems shall be installed where failure of the EPSS to perform is less critical to human life and safety.

▲ **4.4.3** All equipment shall be permanently installed.

4.4.4* Level 1 and Level 2 systems shall ensure that all loads served by the EPSS are supplied with alternate power that meets all the following criteria:

- (1) Of a quality within the operating limits of the load
- (2) For a duration specified for the class as defined in Table 4.1(a)
- (3) Within the time specified for the type as defined in Table 4.1(b)

▲ Chapter 5 Emergency Power Supply (EPS): Energy Sources, Converters, and Accessories

5.1 Energy Sources.

5.1.1* The following energy sources shall be permitted to be used for the emergency power supply (EPS):

- ▲ (1)*Liquid petroleum products at atmospheric pressure
- (2) Liquefied petroleum gas (liquid or vapor withdrawal)
- (3) Natural or synthetic gas

▲ *Exception: For Level 1 installations in locations where the probability of interruption of off-site fuel supplies is high, on-site storage of an alternate energy source sufficient to allow full output of the EPSS to be delivered for the class specified shall be required, with the provision for automatic transfer from the primary energy source to the alternate energy source.*

▲ **5.1.2** Seismic design category C, D, E, or F, as determined in accordance with ASCE 7, shall require a Level 1 EPSS Class X (minimum of 96 hours of fuel supply).

▲ **5.1.3** The energy sources listed in 5.1.1 shall be permitted to be used for the EPS where the primary source of power is by means of on-site energy conversion, provided that there is separately dedicated energy conversion equipment on-site with a capacity equal to the power needs of the EPSS.

▲ **5.1.4*** A public electric utility that has a demonstrated reliability shall be permitted to be used as the EPS where the primary source is by means of on-site energy conversion.

▲ 5.2 Energy Converters — General.

▲ **5.2.1** Energy converters shall consist only of rotating equipment as indicated in 5.2.4.

5.2.1.1 Level 1 energy converters shall be representative products built from components that have proven compatibility and reliability and are coordinated to operate as a unit.

▲ **5.2.1.2** The capability of the energy converter, with its controls and accessories, to survive without damage from common and abnormal disturbances in actual load circuits shall be demonstrable by tests on separate prototype models, or by acceptable tests on the system components as performed by the component suppliers, or by tests performed in the listing process for the assembly.

5.2.1.3 A separate prototype unit shall be permitted to be utilized in a Level 1 or Level 2 installation, provided that all prototype tests produce no deleterious effects on the unit, and the authority having jurisdiction, the owner, and the user are informed that the unit is the prototype test unit.

5.2.2* The rotating equipment prototype unit shall be tested with all typical prime mover accessories that affect its power output in place and operating. These accessories include, but shall not be limited to, the following:

- (1) Battery-charging alternator
- (2) Water pump
- (3) Radiator fan for unit-mounted radiators or oil coolers (or comparable load)
- (4) Fuel pump and fuel filter(s)
- (5) Air filter(s)
- (6) Exhaust mufflers or restriction simulating the maximum backpressure recommended by the prime mover manufacturer

5.2.3 The energy converter for Level 1 systems shall be specifically designed, assembled, and tested to ensure system operation under the following conditions:

- (1) Short circuits
- (2) Load surges due to motor starting
- (3) Elevator operations
- (4) Silicon controlled rectifier (SCR) controllers
- (5) X-ray equipment
- (6) Overspeed, overtemperature, or overload
- (7) Adverse environmental conditions



- ▲ **5.2.4** Rotating equipment shall consist of a generator driven by one of the following prime mover types:

- (1) Otto cycle (spark ignited)
- (2) Diesel cycle
- (3) Gas turbine cycle

- ▲ **5.2.4.1** Other types of prime movers and their associated equipment meeting the applicable performance requirements of this standard shall be permitted, if acceptable to the authority having jurisdiction.

5.2.4.2 Where used for Level 1 applications, the prime mover shall not mechanically drive any equipment other than its operating accessories and its generator.

5.2.5 The EPS shall be installed in accordance with *NFPA 70, National Electrical Code*.

5.3 Energy Converters — Temperature.

- ▲ **5.3.1** The EPS shall be heated as necessary to maintain the water jacket and battery temperature determined by the EPS manufacturer for cold start and load acceptance for the type of EPSS.

5.3.2 All prime mover heaters shall be automatically deactivated while the prime mover is running. (*For combustion turbines, see 7.7.6.*)

5.3.2.1 Air-cooled prime movers shall be permitted to employ a heater to maintain lubricating oil temperature as recommended by the prime mover manufacturer.

5.3.3 Antifreeze protection shall be provided according to the manufacturer's recommendations.

5.3.4 Ether-type starting aids shall not be permitted.

5.4* Energy Converters — Capacity. The energy converters shall have the required capacity and response to pick up and carry the load within the time specified in Table 4.1(b) after loss of primary power.

5.5 Energy Converters — Fuel Supply.

5.5.1 The fuel supplies specified in 5.1.1(1) and 5.1.1(2) for energy converters intended for Level 1 use shall not be used for any other purpose. (*For fuel system requirements, see Section 7.9.*)

- ▲ **5.5.1.1** Enclosed fuel tanks shall be permitted to be used for supplying fuel for other equipment, provided that the draw-down level always guarantees the quantity needed for the EPSS.

5.5.1.2 Vapor-withdrawal LP-Gas systems shall have a dedicated fuel supply.

5.5.2* A low-fuel sensing switch shall be provided for the main fuel supply tank(s) using the energy sources listed in 5.1.1(1) and 5.1.1(2) to indicate when less than the minimum fuel necessary for full load running, as required by the specified class in Table 4.1(a), remains in the main fuel tank.

- ▲ **5.5.3*** The main fuel tank shall have a minimum capacity of at least 133 percent of either the low-fuel sensor quantity specified in 5.5.2 or that specified in Table 4.1(a) (class).

5.6 Rotating Equipment.

- ▲ **5.6.1 General.** Prime movers and accessories shall comply with NFPA 37, *Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines*, except as modified in this standard.

- ▲ **5.6.2 Prime Mover Ratings.** Proper derating factors, such as altitudes, ambient temperature, fuel energy content, accessory losses, and site conditions as recommended by the manufacturer of the generator set shall be used in determining whether or not brake power meets the connected load requirements.

5.6.3 Prime Mover Accessories.

5.6.3.1 Governors shall maintain a bandwidth of rated frequency for any constant load (steady-state condition) that is compatible with the load.

5.6.3.1.1 The frequency droop between no load and full load shall be within the range for the load.

- ▲ **5.6.3.1.2** The frequency dip upon one-step application of the full load shall not be outside the range for the load, with a return to steady-state conditions occurring within the requirements of the load.

- ▲ **5.6.3.2** Solenoid valves, where used, both in the fuel line from the supply or day tank closest to the generator set and in the water-cooling lines, shall operate from battery voltage.

5.6.3.2.1 Solenoid valves shall have a manual (nonelectric) operation, or a manual bypass valve shall be provided.

5.6.3.2.1.1 The manual bypass valve shall be visible and accessible and its purpose identified.

- ▲ **5.6.3.2.1.2** The fuel bypass valve shall not be the valve used for malfunction or emergency shutdown.

5.6.3.3 The prime mover shall be provided with the following instruments:

- (1) Oil pressure gauge to indicate lubricating oil pressure. Engines with splash-lubricated systems shall not require this gauge.
- (2) Temperature gauge to indicate cooling medium temperature. Air-cooled engines shall not require this gauge.
- (3) Hour meter to indicate actual total running time.
- (4) Battery-charging meter indicating performance of prime mover-driven battery charging means.
- (5) Other instruments as recommended or provided by the prime mover manufacturer where required for maintenance.

5.6.3.4 The instruments required in 5.6.3.3(1) through 5.6.3.3(4) shall be placed on an enclosed panel, located in proximity to or on the energy converter, in a location that allows maintenance personnel to observe them readily. The enclosed panel shall be mounted by means of antishock vibration mountings if mounted on the energy converter.

5.6.3.5 All wiring for connection to the control panel shall be harnessed or flexibly enclosed, shall be securely mounted on the prime mover to prevent chafing and vibration damage, and shall terminate at the control panel in an enclosed box or panel. (*For control panel requirements, see 5.6.5.*)

5.6.3.6 The generator set shall be fitted with an integral accessory battery charger, driven by the prime mover and automatic voltage regulator, and capable of charging and maintaining the starting battery unit (and control battery, where used) in a fully charged condition during a running condition.

5.6.3.6.1 A battery charger driven by the prime mover shall not be required, provided the automatic battery charger has a high-low rate capable of fully charging the starting battery during running conditions as specified in 5.6.3.6.

▲ 5.6.4 Prime Mover Starting Equipment.

5.6.4.1 Starting Systems. Starting shall be accomplished using either an electric starter or a stored energy starting system.

▲ **5.6.4.1.1** Electric starter systems shall start using a positive shift solenoid to engage the starter motor and to crank the prime mover for the period specified in 5.6.4.2 without overheating, at a speed at least equal to that recommended by the manufacturer of the prime mover and at the lowest ambient temperature anticipated at the installation site.

▲ **5.6.4.1.2** Other types of stored energy starting systems (except pyrotechnic) shall be permitted to be used where recommended by the manufacturer of the prime mover and subject to approval of the authority having jurisdiction, under the following conditions:

- (1) Where two complete periods of cranking cycles are completed without replacement of the stored energy
- (2) Where a means for automatic restoration from the emergency source of the stored energy is provided
- (3) Where the stored energy system has the cranking capacity specified in 5.6.4.2.1
- (4) Where the stored energy system has a “black start” capability in addition to normal discharge capability

5.6.4.2* Otto or Diesel Cycle Prime Movers. For otto or diesel cycle prime movers, the type and duration of the cranking cycle shall be as specified in Table 5.6.4.2.

5.6.4.2.1 A complete cranking cycle shall consist of an automatic crank period of approximately 15 seconds followed by a rest period of approximately 15 seconds. Upon starting and running the prime mover, further cranking shall cease.

▲ **5.6.4.2.2** Two means of cranking termination shall be utilized so that one serves as backup to prevent inadvertent starter engagement.

5.6.4.2.3 Otto cycle prime movers of 15 kW and lower and all diesel prime movers shall be permitted to use continuous cranking methods.

5.6.4.3* Number of Batteries. Each prime mover shall be provided with both of the following:

- (1) Storage battery units as specified in Table 5.6.4.2
- (2) A storage rack for each battery or battery unit

Table 5.6.4.2 Starting Equipment Requirements

Starting Equipment Requirements	Level 1	Level 2
(a) Battery unit	X	X
(b) Battery certification	X	NA
(c) Cycle cranking	X or 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
1. dc ammeter	X	X
2. dc voltmeter	X	X
(f) Recharge time	24 hr	36 hr
(g) Low battery voltage alarm contacts	X	X

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

▲ **5.6.4.4* Size of Batteries.** The battery unit shall have the capacity to maintain the cranking speed recommended by the prime mover manufacturer through two complete periods of cranking limiter time-outs as specified in Table 5.6.4.2, item (d).

▲ **5.6.4.5 Type of Battery.** The battery shall be of the nickel-cadmium or lead-acid type.

5.6.4.5.1* Lead-acid batteries shall be furnished as charged when wet. Drain-dry batteries or dry-charged lead-acid batteries shall be permitted.

5.6.4.5.2 When furnished, vented nickel-cadmium batteries shall be filled and charged and shall have listed flip-top, flame arrester vent caps.

5.6.4.5.3 The manufacturer shall provide installation, operation, and maintenance instructions and for batteries shipped dry, electrolyte mixing instructions.

5.6.4.5.4 Batteries shall not be installed until the battery charger is in service.

5.6.4.5.5 All batteries used in this service shall have been designed for this duty and shall have demonstrable characteristics of performance and reliability acceptable to the authority having jurisdiction.

5.6.4.5.6 Batteries shall be prepared for use according to the battery manufacturer’s instructions.

5.6.4.6* Automatic Battery Charger. In addition to the prime mover– (engine–) driven charger required in 5.6.3.6.1, a battery charger(s) as required in Table 5.6.4.2 shall be supplied for recharging or maintaining a charge, or both, on the starting or control battery unit, or both.

5.6.4.7 All chargers shall include the following characteristics, which are to be accomplished without manual intervention (i.e., manual switch or manual tap changing):

- (1) At its rated voltage, the charger shall be capable of delivering energy into a fully discharged battery unit without damaging the battery.
- (2) The charger shall be capable of returning the fully discharged battery to 100 percent of its ampere-hour rating within the time specified in Table 5.6.4.2, item (f).
- (3) As specified in Table 5.6.4.2, item (e), meters with an accuracy within 5 percent of range shall be furnished.
- (4) The charger shall be permanently marked with the following:
 - (a) Allowable range of battery unit capacity
 - (b) Nominal output current and voltage
 - (c) Sufficient battery-type data to allow replacement batteries to be obtained
- (5) The battery charger output and performance shall be compatible with the batteries furnished.

▲ 5.6.5 Control Functions.

5.6.5.1 A control panel shall be provided and shall contain the following:

- (1) Automatic remote start capability
- (2) “Run-off-automatic” switch
- (3) Shutdowns as required by 5.6.5.2(3)
- (4) Alarms as required by 5.6.5.2(4)
- (5) Controls as required by 5.6.5.2(5)

5.6.5.2 Where a control panel is mounted on the energy converter, it shall be mounted by means of antivibration shock mounts, if required, to maximize reliability. An automatic control and safety panel shall be a part of the EPS containing the following equipment or possess the following characteristics, or both:

- (1) Cranking control equipment to provide the complete cranking cycle described in 5.6.4.2 and required by Table 5.6.4.2
- (2) Panel-mounted control switch(es) marked “run–off–automatic” to perform the following functions:
 - (a) Run: Manually initiate, start, and run prime mover
 - (b) Off: Stop prime mover or reset safeties, or both
 - (c) Automatic: Allow prime mover to start by closing a remote contact and stop by opening the remote contact
- (3) Controls to shut down and lock out the prime mover under any of the following conditions:
 - (a) Failing to start after specified cranking time
 - (b) Overspeed

- (c) Low lubricating-oil pressure
- (d) High engine temperature (An automatic engine shutdown device for high lubricating-oil temperature shall not be required.)
- (e) Operation of remote manual stop station
- (4) Individual alarm indication to annunciate any of the conditions listed in Table 5.6.5.2 and with the following characteristics:
 - (a) Battery powered
 - (b) Visually indicated
 - (c) Have additional contacts or circuits for a common audible alarm that signals locally and remotely when any of the itemized conditions occurs
 - (d) Have a lamp test switch(es) to test the operation of all alarm lamps
- (5) Controls to shut down the prime mover upon removal of the initiating signal or manual emergency shutdown
- (6) The ac instruments listed in 5.6.9.9

Table 5.6.5.2 Safety Indications and Shutdowns

Indicator Function (at Battery Voltage)	Level 1			Level 2		
	CV	S	RA	CV	S	RA
(a) Overcrank	X	X	X	X	X	O
(b) Low water temperature	X	NA	X	X	NA	O
(c) High engine temperature pre-alarm	X	NA	X	O	NA	NA
(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	NA	X	O	NA	O
(h) Low coolant level	X	O	X	X	O	X
(i) EPS supplying load	X	NA	NA	O	NA	NA
(j) Control switch not in automatic position	X	NA	X	X	NA	X
(k) High battery voltage	X	NA	NA	O	NA	NA
(l) Low cranking voltage	X	NA	X	O	NA	O
(m) Low voltage in battery	X	NA	NA	O	NA	NA
(n) Battery charger ac failure	X	NA	NA	O	NA	NA
(o) Lamp test	X	NA	NA	X	NA	NA
(p) Contacts for local and remote common alarm	X	NA	X	X	NA	X
(q) Audible alarm silencing switch	NA	NA	X	NA	NA	O
(r) Low starting air pressure	X	NA	NA	O	NA	NA
(s) Low starting hydraulic pressure	X	NA	NA	O	NA	NA
(t) Air shutdown damper when used	X	X	X	X	X	O
(u) Remote emergency stop	NA	X	NA	NA	X	NA

CV: Control panel-mounted visual. S: Shutdown of EPS indication. RA: Remote audible. X: Required.

O: Optional. NA: 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.

5.6.5.3 Engines equipped with a maintaining shutdown device (air shutdown damper) shall have a set of contacts that monitor the position of this device, with local alarm indication and remote annunciation in accordance with Table 5.6.5.2.

5.6.5.4 The control panel in 5.6.5.2(4) shall be specifically approved for either a Level 1 or a Level 2 EPS consistent with the installation.

5.6.5.5 The cranking cycle shall be capable of being initiated by any of the following:

- (1) Manual start initiation as specified in 5.6.5.2(2)(a).
- (2) Loss of normal power at any automatic transfer switch (ATS) considered a part of the EPSS. Prime mover shall start upon closing of a remote switch or contacts and shall stop, after appropriate time delays, when switch or contacts are opened.
- (3) Clock exerciser located in an ATS or in the control panel.
- (4) Manually operated (test) switch located in each ATS that simulates a loss of power and causes automatic starting and operation until this switch is reset, to cause the engine circuit to duplicate its functions in the same manner commercial power is restored after a true commercial power failure.

▲ **5.6.5.6*** All installations shall have a remote manual stop station of a type to prevent inadvertent or unintentional operation located outside the room housing the prime mover, where so installed, or elsewhere on the premises where the prime mover is located outside the building.

5.6.5.6.1 The remote manual stop station shall be labeled.

▲ **5.6.6 Remote Controls and Alarms.** A remote, common audible alarm shall be provided as specified in 5.6.5.2(4) that is powered by the storage battery and located outside of the EPS service room at a work site observable by personnel.

5.6.6.1 An alarm-silencing means shall be provided, and the panel shall include repetitive alarm circuitry so that, after the audible alarm has been silenced, it reactivates after the fault condition has been cleared and has to be restored to its normal position to be silenced again.

5.6.6.2 In lieu of the requirement in 5.6.6.1, a manual alarm-silencing means shall be permitted that silences the audible alarm after the occurrence of the alarm condition, provided such means do not inhibit any subsequent alarms from sounding the audible alarm again without further manual action.

5.6.7 Prime Mover Cooling Systems. Cooling systems for prime movers shall be either forced-air or natural convection, liquid-cooled, or a combination thereof.

5.6.7.1 Forced-air-cooled diesel or otto cycle engines shall have an integral fan selected to cool the prime mover under full load conditions.

5.6.7.2 Ventilation shall be provided for the evacuation of hot air from the EPS service room or the enclosure housing the unit.

5.6.7.3 Liquid-cooled prime movers for Level 1 applications shall be arranged for closed-loop cooling and consist of one of the following types as required in Section 7.8:

- (1) Unit-mounted radiator and fan
- (2) Remote radiator
- (3) Heat exchanger (liquid-to-liquid)

5.6.7.4 Cooling systems shall prevent overheating of prime movers under conditions of highest anticipated ambient tem-

perature at the installed elevation (above sea level) when fully loaded.

▲ **5.6.7.5** Power for fans and pumps on remote radiators and heat exchangers shall be supplied from a tap at the EPS output terminals or ahead of the first load circuit overcurrent protective device.

▲ **5.6.7.6** The secondary side of heat exchangers shall be a closed-loop cycle, that is, one that recycles the cooling agent.

5.6.8 Prime Mover Exhaust Piping. Where applicable, the exhaust system shall include a muffler or silencer sized for the unit and a flexible exhaust section.

5.6.9 Generators, Exciters, and Voltage Regulators. Generators shall comply with Article 445 of *NFPA 70, National Electrical Code*, and with the requirements of 5.6.9.1 through 5.6.9.9.

5.6.9.1* The generator shall be of dripproof construction and have amortisseur windings.

5.6.9.2 The generator shall be suitable for the environmental conditions at the installation location.

5.6.9.3 The generator systems shall be factory tested as a unit to ensure operational integrity of all of the following:

- (1) Generator
- (2) Exciter
- (3) Voltage regulator

5.6.9.4 EPS voltage output, or the output of the transformer immediately down-line from the EPS, at full load shall match the nominal voltage of the normal source at the transfer switch(es).

5.6.9.5 Exciters, where furnished, shall be of either the rotating type or the static type.

5.6.9.6 Voltage regulators shall be capable of responding to load changes to meet the system stability requirements of 5.6.9.8.

5.6.9.7 If the system stability requirements of 5.6.9.8 cannot be accomplished, anti-hunt provisions shall be included.

5.6.9.8 Generator system performance (i.e., prime mover, generator, exciter, and voltage regulator, as applicable when prototype tested as specified in 5.2.1.2) shall be as follows:

- (1) Stable voltage and frequency at all loads shall be provided to full-rated loads.
- (2) Values consistent with the user's needs for frequency droop and voltage droop shall be maintained.
- (3) Voltage dip at the generator terminals for the maximum anticipated load change shall not cause disruption or relay dropout in the load.
- (4) Frequency dip and restoration to steady state for any sudden load change shall not exceed the user's specified need.

5.6.9.9 The generator instrument panel for Level 1 applications shall contain the following:

- (1) An ac voltmeter(s) for each phase or a phase selector switch
- (2) An ac ammeter(s) for each phase or a phase selector switch
- (3) A frequency meter
- (4) A voltage-adjusting rheostat to allow +5 percent voltage adjustment

5.6.10 Miscellaneous Requirements.

5.6.10.1 Where applicable, the prime mover and generator shall be factory mounted on a common base, rigid enough to maintain the dynamic alignment of the rotating element of the system prior to shipment to the installation site.



5.6.10.2 A certification shall be supplied with the unit that verifies the torsional vibration compatibility of the rotating element of the prime mover and generator for the intended use of the energy converter.

5.6.10.3* Vibration isolators shall be furnished where necessary to minimize vibration transmission to the permanent structure.

5.6.10.4 The manufacturer of the EPS shall submit complete schematic, wiring, and interconnection diagrams showing all terminal and destination markings for all EPS equipment, as well as the functional relationship between all electrical components.

5.6.10.5 The energy converter supplier shall stipulate compliance and performance with this standard for the entire unit when installed.

5.6.10.6 Where requested, the short circuit current capability at the generator output terminals shall be furnished.

▲ Chapter 6 Transfer Switch Equipment

6.1 General.

6.1.1* Switches shall transfer electric loads from one power source to another.

6.1.2* The electrical rating shall be sized for the total load that is designed to be connected.

6.1.3 Each switch shall be in a separate enclosure or compartment.

6.1.4 The switch, including all load current-carrying components, shall be listed for all load types to be served.

6.1.5 The switch, including all load current-carrying components, shall be designed to withstand the effects of available fault currents.

6.1.6* Where available, each switch shall be listed for emergency service as a completely factory-assembled and factory-tested apparatus.

6.2 ATS Features.

6.2.1* General. Automatic transfer switches shall be capable of all of the following:

- (1) Electrical operation and mechanical holding
- (2) Transfer and retransfer of the load automatically
- (3) Visual annunciation when “not-in-automatic”

6.2.2 Source Monitoring.

6.2.2.1* Undervoltage-sensing devices shall be provided to monitor all ungrounded lines of the primary source of power as follows:

- (1) When the voltage on any phase falls below the minimum operating voltage of any load to be served, the transfer switch shall automatically initiate engine start and the process of transfer to the EPS.
- (2)*When the voltage on all phases of the primary source returns to within specified limits for a designated period of time, the process of transfer back to primary power shall be initiated.

6.2.2.2 Both voltage-sensing and frequency-sensing equipment shall be provided to monitor one ungrounded line of the EPS.

6.2.2.3 Transfer to the EPS shall be inhibited until the voltage and frequency are within a specified range to handle loads to be served.

6.2.2.3.1 Sensing equipment shall not be required in the transfer switch, provided it is included with the engine control panel.

6.2.2.3.2 Frequency-sensing equipment shall not be required for monitoring the public utility source where used as an EPS, as permitted by 5.1.4.

6.2.3 Interlocking. Mechanical interlocking or an approved alternate method shall prevent the inadvertent interconnection of the primary power supply and the EPS, or any two separate sources of power.

6.2.4* Manual Operation. Instruction and equipment shall be provided for safe manual nonelectric transfer in the event the transfer switch malfunctions.

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.

▲ **6.2.6 Time Delay at Engine Control Panel.** Time delays shall be permitted to be located at the engine control panel in lieu of in the transfer switches.

6.2.7 Time Delay on Transfer to EPS. An adjustable time-delay device shall be provided to delay transfer and sequence load transfer to the EPS to avoid excessive voltage drop when the transfer switch is installed for Level 1 use.

6.2.7.1 Time Delay Commencement. The time delay shall commence when proper EPS voltage and frequency are achieved.

6.2.7.2 Time Delay at Engine Control Panel. Time delays shall be permitted to be located at the engine control panel in lieu of in the transfer switches.

6.2.8* Time Delay on Retransfer to Primary Source. An adjustable time-delay device with automatic bypass shall be provided to delay retransfer from the EPS to the primary source of power and to allow the primary source to stabilize before retransfer of the load.

6.2.9 Time Delay Bypass If EPS Fails. The time delay shall be automatically bypassed if the EPS fails.

6.2.9.1 The transfer switch shall be permitted to be programmed for a manually initiated retransfer to the primary source to provide for a planned momentary interruption of the load.

6.2.9.2 If used, the arrangement in 6.2.9.1 shall be provided with a bypass feature to allow automatic retransfer in the event that the EPS fails and the primary source is available.

6.2.10 Time Delay on Engine Shutdown. A minimum time delay of 5 minutes shall be provided for unloaded running of the EPS prior to shutdown to allow for engine cooldown.

6.2.10.1 The minimum 5-minute delay shall not be required on small (15 kW or less) air-cooled prime movers.

6.2.10.2 A time-delay device shall not be required, provided it is included with the engine control panel, or if a utility feeder is used as an EPS.

6.2.11 Engine Generator Exercising Timer. A program timing device shall be provided to exercise the EPS as described in Chapter 8.

- ▲ **6.2.11.1** Transfer switches shall transfer the connected load to the EPS and immediately return to primary power automatically in case of an EPS failure.

6.2.11.2 Exercising timers shall be permitted to be located at the engine control panel in lieu of in the transfer switches.

- ▲ **6.2.11.3** A program timing device shall not be required in health care facilities that provide scheduled testing in accordance with NFPA 99, *Health Care Facilities Code*.

6.2.12 Test Switch. A test means shall be provided on each ATS that simulates failure of the primary power source and then transfers the load to the EPS.

6.2.13* Indication of Transfer Switch Position. Two pilot lights with identification nameplates or other approved position indicators shall be provided to indicate the transfer switch position.

6.2.14 Motor Load Transfer. Provisions shall be included to reduce currents resulting from motor load transfer if such currents could damage EPSS equipment or cause nuisance tripping of EPSS overcurrent protective devices.

6.2.15* Isolation of Neutral Conductors. Provisions shall be included for ensuring continuity, transfer, and isolation of the primary and the EPS neutral conductors wherever they are separately grounded to achieve ground-fault sensing.

6.2.16* Nonautomatic Transfer Switch Features. Switching devices shall be mechanically held and shall be operated by direct manual or electrical remote manual control.

6.2.16.1 Interlocking. Reliable mechanical interlocking or an approved alternate method shall prevent the inadvertent interconnection of the primary power source and the EPS.

6.2.16.2 Indication of Transfer Switch Position. Two pilot lights with identification nameplates or other approved position indicators shall be provided to indicate the switch position.

6.3 Load Switching (Load Shedding). When two or more engine generator sets are paralleled for emergency power, the paralleled system shall be arranged to inhibit connection of EPS-damaging loads.

6.3.1 Each transfer switch shall have a continuous current rating and interrupting rating for all classes of loads to be served.

6.3.2 The transfer switch shall be capable of withstanding the available fault current at the point of installation.

6.3.3 The transfer of loads to the EPS shall be sequenced as follows:

- (1) First-priority loads shall be switched to the emergency bus upon sensing the availability of emergency power on the bus.
- (2) Each time an additional engine generator set is connected to the bus, a remaining load shall be connected in order of priority until all emergency loads are connected to the bus.
- (3) The system shall be designed so that, upon failure of one or more engine generator sets, the load is automatically reduced, starting with the load of least priority and proceeding in ascending priority, so that the last load affected is the highest-priority load.

6.4 Bypass-Isolation Switches.

- ▲ **6.4.1 Bypassing and Isolating Transfer Switches.** Bypass-isolation switches shall be permitted for bypassing and isolating the transfer switch and shall be installed in accordance with 6.4.2, 6.4.3, and 6.4.4.

6.4.2 Bypass-Isolation Switch Rating. The bypass-isolation switch shall have a continuous current rating and a current rating compatible with that of the associated transfer switch.

6.4.3* Bypass-Isolation Switch Classification. Each bypass-isolation switch shall be listed for emergency electrical service as a completely factory-assembled and factory-tested apparatus.

6.4.4* Operation. With the transfer switch isolated or disconnected, the bypass-isolation switch shall be designed so it can function as an independent nonautomatic transfer switch and allow the load to be connected to either power source.

6.4.5 Reconnection of Transfer Switch. Reconnection of the transfer switch shall be possible without a load interruption greater than the maximum time, in seconds, specified by the type of system.

6.5 Protection.

6.5.1* General. The overcurrent protective devices in the EPSS shall be coordinated to optimize selective tripping of the circuit overcurrent protective devices when a short circuit occurs.

6.5.2 Short Circuit Current. The maximum available short circuit current from both the utility source and the emergency energy source shall be evaluated for the ability to satisfy this coordination capability.

6.5.3* Overcurrent Protective Device Rating. The overcurrent protective device shall have an interrupting rating equal to or greater than the maximum available short circuit current at its location.

6.5.4 Accessibility. Overcurrent devices in EPSS circuits shall be accessible to authorized persons only.

▲ Chapter 7 Installation and Environmental Considerations

7.1 General.

7.1.1* This chapter shall establish minimum requirements and considerations relative to the installation and environmental conditions that have an effect on the performance of the EPSS equipment such as the following:

- (1) Geographic location
- (2) Building type
- (3) Classification of occupancy
- (4) Hazard of contents

- ▲ **7.1.2*** Minimizing the probability of equipment or cable failure within the EPSS shall be a design consideration to reduce the disruption of loads served by the EPSS.

- ▲ **7.1.3** The EPSS equipment shall be installed as required to meet the user's needs and to be in accordance with all of the following:

- (1) This standard
- (2) The manufacturer's specifications
- (3) The authority having jurisdiction



7.1.4 EPSS equipment installed for the various levels of service defined in this standard shall be designed and assembled for such service.

- ▲ **7.1.5** When the normal power source is not available, the EPS shall be permitted to serve optional loads other than system loads, provided that the EPS has adequate capacity or automatic selective load pickup and load shedding are provided as needed to ensure adequate power to (1) the Level 1 loads, (2) the Level 2 loads, and (3) the optional loads, in that order of priority. When normal power is available, the EPS shall be permitted to be used for other purposes such as peak load shaving, internal voltage control, load relief for the utility providing normal power, or co-generation.

7.2 Location.

- ▲ **7.2.1** The EPS shall be installed in a separate room for Level 1 installations. EPSS equipment shall be permitted to be installed in this room.

- ▲ **7.2.1.1** The room shall have a minimum 2-hour fire rating or be located in an adequate enclosure located outside the building capable of resisting the entrance of snow or rain at a maximum wind velocity required by local building codes.

7.2.1.2 No other equipment, including architectural appurtenances, except those that serve this space, shall be permitted in this room.

- ▲ **7.2.2*** Level 1 EPSS equipment shall not be installed in the same room with the normal service equipment, where the service equipment is rated over 150 volts to ground and equal to or greater than 1000 amperes.

- ▲ **7.2.3*** The rooms, shelters, or separate buildings housing Level 1 or Level 2 EPSS equipment shall be designed and located to minimize the damage from flooding, including that caused by the following:

- (1) Flooding resulting from fire fighting
- (2) Sewer water backup
- (3) Similar disasters or occurrences

- ▲ **7.2.4*** Minimizing the possibility of damage resulting from interruptions of the emergency source shall be a design consideration for EPSS equipment.

- ▲ **7.2.5** The EPS equipment shall be installed in a location that permits ready accessibility and a minimum of 0.9 m (36 in.) from the skid rails' outermost point in the direction of access for inspection, repair, maintenance, cleaning, or replacement. This requirement shall not apply to units in outdoor housings.

7.2.6 Design considerations shall minimize the effect of the failure of one energy converter on the continued operation of other units.

7.3 Lighting.

- ▲ **7.3.1** The Level 1 or Level 2 EPS equipment location(s) shall be provided with battery-powered emergency lighting. This requirement shall not apply to units located outdoors in enclosures that do not include walk-in access.

7.3.2 The emergency lighting charging system and the normal service room lighting shall be supplied from the load side of the transfer switch.

7.3.3* The intensity of illumination in the separate building or room housing the EPS equipment for Level 1 shall be 32.3 lux

(3.0 ft-candles), unless otherwise specified by a requirement recognized by the authority having jurisdiction.

7.4 Mounting.

7.4.1 Rotating energy converters shall be installed on solid foundations to prohibit sagging of fuel, exhaust, or lubricating-oil piping and damage to parts resulting in leakage at joints.

7.4.1.1 Such foundations or structural bases shall raise the engine at least 150 mm (6 in.) above the floor or grade level and be of sufficient elevation to facilitate lubricating-oil drainage and ease of maintenance.

7.4.2 Foundations shall be of the size (mass) and type recommended by the energy converter manufacturer.

7.4.3 Where required to prevent transmission of vibration during operation, the foundation shall be isolated from the surrounding floor or other foundations, or both, in accordance with the manufacturer's recommendations and accepted structural engineering practices.

7.4.4 The EPS shall be mounted on a fabricated metal skid base of the type that shall resist damage during shipping and handling. After installation, the base shall maintain alignment of the unit during operation.

7.5* Vibration. Vibration isolators, as recommended by the manufacturer of the EPS, shall be installed either between the rotating equipment and its skid base or between the skid base and the foundation or inertia base.

7.6* Noise. Design shall include consideration of noise control regulations.

7.7 Heating, Cooling, and Ventilating.

- ▲ **7.7.1*** With the EPS running at rated load, ventilation air flow shall be provided to limit the maximum air temperature in the EPS room to the maximum ambient air temperature required by the EPS manufacturer.

7.7.1.1 Consideration shall be given to all the heat emitted to the EPS equipment room by the energy converter, uninsulated or insulated exhaust pipes, and other heat-producing equipment.

7.7.2 Air shall be supplied to the EPS equipment for combustion.

- ▲ **7.7.2.1** For EPS supplying Level 1 EPSS, ventilation air shall be supplied directly from a source outside the building by an exterior wall opening or from a source outside the building by a 2-hour fire-rated air transfer system.

7.7.2.2 For EPS supplying Level 1 EPSS, discharge air shall be directed outside the building by an exterior wall opening or to an exterior opening by a 2-hour fire-rated air transfer system.

- ▲ **7.7.2.3** Fire dampers, shutters, or other self-closing devices shall not be permitted in ventilation openings or ductwork for supply or return/discharge air to EPS equipment for Level 1 EPSS.

- ▲ **7.7.3** Ventilation air supply shall be from outdoors or from a source outside the building by an exterior wall opening or from a source outside the building by a 2-hour fire-rated air transfer system.

7.7.4 Ventilation air shall be provided to supply and discharge cooling air for radiator cooling of the EPS when running at rated load.

7.7.4.1 Ventilation air supply and discharge for radiator-cooled EPS shall have a maximum static restriction of 125 Pa (0.5 in. of water column) in the discharge duct at the radiator outlet.

7.7.4.2 Radiator air discharge shall be ducted outdoors or to an exterior opening by a 2-hour rated air transfer system.

7.7.5 Motor-operated dampers, when used, shall be spring operated to open and motor closed. Fire dampers, shutters, or other self-closing devices shall not be permitted in ventilation openings or ductwork for supply or return/discharge air to EPS equipment for Level 1 EPSS.

▲ **7.7.6** The ambient air temperature in the EPS equipment room or outdoor housing containing Level 1 rotating equipment shall be not less than 4.5°C (40°F).

▲ **7.7.7** Units housed outdoors shall be heated as specified in 5.3.1.

7.7.8 Design of the heating, cooling, and ventilation system for the EPS equipment room shall include provision for factors including, but not limited to, the following:

- (1) Heat
- (2) Cold
- (3) Dust
- (4) Humidity
- (5) Snow and ice accumulations around housings
- (6) Louvers
- (7) Remote radiator fans
- (8) Prevailing winds blowing against radiator fan discharge air

7.8 Installed EPS Cooling System.

7.8.1 The installed EPS cooling system shall be designed to cool the prime mover at full rated load while operating in the particular installation circumstances of each EPS.

7.8.1.1 A full load on-site test shall not result in activation of high-temperature pre-alarm or high-temperature shutdown.

▲ **7.8.2*** For EPSS cooling systems requiring intermittent or continuous waterflow, pressure, or both, a utility, city, or other water supply service shall not be used.

7.8.2.1 The EPSS cooling system shall be permitted to use utility or city water for filling or makeup water.

7.8.3 Makeup water hose bibs and floor drains, where required by other codes and standards, shall be installed in EPS equipment rooms.

7.8.4 Where duct connections are used between the prime mover radiator and air-out louvers, the ducts shall be connected to the prime movers by means of flexible sections.

7.8.5 Design of the EPS cooling system shall consider the following factors:

- (1) Remote radiator or heat exchanger sizing
- (2) Pipe sizing
- (3) Pump sizing
- (4) Sufficient shutoffs to isolate equipment to facilitate maintenance
- (5) The need for and sizing of de-aeration and surge tanks
- (6) Drain valves for cleaning and flushing the cooling system
- (7) Type of flexible hoses between the prime mover and the cooling system piping

7.9 Fuel System.

7.9.1 Fuel tanks shall be sized to accommodate the specific EPS class.

7.9.1.1 All fuel tanks and systems shall be installed and maintained in accordance with NFPA 30, *Flammable and Combustible Liquids Code*, NFPA 37, *Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines*, NFPA 54, *National Fuel Gas Code*, and NFPA 58, *Liquefied Petroleum Gas Code*.

▲ **7.9.1.2*** Fuel system design shall provide for a supply of clean fuel to the prime mover.

▲ **7.9.1.3** Tanks shall be sized so that the fuel is consumed within the storage life, or provision shall be made to replace stale fuel with clean fuel.

▲ **7.9.2** Fuel tanks shall be close enough to the prime mover for the fuel lift (suction head) of the prime mover fuel pump to meet the fuel system requirements, or a fuel transfer pump and day tank shall be provided.

▲ **7.9.2.1** If the engine manufacturer's fuel pump static head pressure limits are exceeded when the level of fuel in the tank is at a maximum, a day tank shall be utilized.

7.9.3 Fuel piping shall be of compatible metal to minimize electrolysis and shall be properly sized, with vent and fill pipes located to prevent entry of groundwater or rain into the tank.

▲ **7.9.3.1** Galvanized fuel lines shall not be used.

7.9.3.2 Approved flexible fuel lines shall be used between the prime mover and the fuel piping.

▲ **7.9.4** Day tanks on diesel systems shall be installed below the engine fuel return elevation.

7.9.4.1 The return line to the day tank shall be below the fuel return elevation.

7.9.4.2 Gravity fuel oil return lines between the day tank and the main supply tank shall be sized to handle the potential fuel flow and shall be free of traps so that fuel can flow freely to the main tank.

▲ **7.9.5** Integral tanks of the following capacities shall be permitted inside or on roofs of structures, or as approved by the authority having jurisdiction:

- (1) Maximum of 2498 L (660 gal) diesel fuel
- (2) Maximum of 95 L (25 gal) gasoline fuel

7.9.6* The fuel supply for gas-fueled and liquid-fueled prime movers shall be installed in accordance with applicable standards.

▲ **7.9.7*** Where the gas supply is connected to the building gas supply system, it shall be connected on the supply side of the main gas shutoff valve and marked as supplying an emergency generator.

7.9.8 The building's main gas shutoff valve shall be marked or tagged to indicate the existence of the separate EPS shutoff valve.

7.9.9 The fuel supply for gas-fueled and liquid-fueled prime movers shall be designed to meet the demands of the prime mover for all of the following factors:

- (1) Sizing of fuel lines
- (2) Valves, including manual shutoff
- (3) Battery-powered fuel solenoids
- (4) Gas regulators
- (5) Regulator vent piping
- (6) Flexible fuel line section
- (7) Fuel line filters
- (8) Fuel vaporizers (LP-Gas)
- (9) Ambient temperature effect of fuel tank vaporization rates of LP-Gas where applicable



7.9.10 The fuel storage and supply lines for an EPSS shall be in accordance with this standard or with the specific authority having jurisdiction, or both.

7.9.11 All manual fuel system valves shall be of the indicating type.

- ▲ **7.9.12** Listed generator subbase secondary containment fuel tanks of 2498 L (660 gal) capacity and below shall be permitted to be installed outdoors or indoors without diking or remote impounding.

7.9.12.1 A minimum clearance of 0.9 m (36 in.) shall be maintained on all sides.

7.10 Exhaust System.

7.10.1 The exhaust system equipment and installation, including piping, muffler, and related accessories, shall be in accordance with NFPA 37, *Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines*, and other applicable standards.

7.10.2 Exhaust system installation shall be gastight to prevent exhaust gas fumes from entering inhabited rooms or buildings and terminate in such a manner that toxic fumes cannot reenter a building or structure, particularly through windows, air ventilation inlets, or the engine air-intake system.

7.10.3* Exhaust piping shall be connected to the prime mover by means of a flexible connector and shall be independently supported thereafter so that no damaging weight or stress is applied to the engine exhaust manifold or turbocharger.

- ▲ **7.10.3.1** A condensate trap and drain valve shall be provided at the low point(s) of the piping unless the piping is self-draining.

7.10.3.2 Design consideration shall be given to thermal expansion and the resultant movement of the piping.

7.10.3.3 For reciprocating engines, mufflers shall be placed as close as practicable to the engine, in a horizontal position if possible.

7.10.3.4 An approved thimble(s) shall be used where exhaust piping passes through combustible walls or partitions.

7.10.3.5 For reciprocating engines, the piping shall terminate in any of the following:

- (1) Rain cap
- (2) Tee
- (3) Ell, pointing downwind from the prevailing wind
- (4) Vertically upward-oriented stack with suitable provisions for trapping and draining rain and snow water

7.10.3.6 Design consideration shall be given to the potential heat effect due to proximity to all of the following:

- (1) Conduit runs
- (2) Fuel piping
- (3) Lighting fixtures

7.10.3.7 Design consideration shall be given to insulating the engine exhaust systems in buildings after the flexible section.

7.10.4 For maximum efficiency, operation economy, and prevention of engine damage, the exhaust system shall be designed to eliminate excessive backpressure on the engine by properly selecting, routing, and installing the piping size, connections, and muffler.

7.10.4.1 Exhaust systems shall be installed to ensure satisfactory EPS operation and meet the requirements of the manufacturer.

7.11 Protection.

- ▲ **7.11.1** The room in which the EPS equipment is located shall not be used for other purposes that are not directly related to the EPS. Parts, tools, and manuals for routine maintenance and repair shall be permitted to be stored in the EPS room.

- ▲ **7.11.2*** Where fire suppression systems are installed in EPS equipment rooms or separate buildings, the following systems shall not be used:

- (1) Carbon dioxide or halon systems, unless prime mover combustion air is taken from outside the structure
- (2) An automatic dry chemical system, unless the manufacturers of the EPS certify that the dry chemical system cannot damage the EPS system, hinder its operation, or reduce its output

- ▲ **7.11.3** Where the EPS rooms or separate buildings are equipped with fire detection systems, the installation shall be in accordance with NFPA 72, *National Fire Alarm and Signaling Code*.

- ▲ **7.11.4** Where outdoor and/or rooftop Level 1 EPS installations are required to be protected from lightning, the lightning protection system(s) shall be installed in accordance with NFPA 780, *Standard for the Installation of Lightning Protection Systems*.

7.11.5* In recognized seismic risk areas, EPS and EPSS components, such as electrical distribution lines, water distribution lines, fuel distribution lines, and other components that serve the EPS, shall be designed to minimize damage from earthquakes and to facilitate repairs if an earthquake occurs.

7.11.6* For systems in seismic risk areas, the EPS, transfer switches, distribution panels, circuit breakers, and associated controls shall be capable of performing their intended function during and after being subjected to the anticipated seismic shock.

7.12 Distribution.

7.12.1 The distribution and wiring systems within EPSS shall be installed in accordance with NFPA 70, *National Electrical Code*.

7.12.2 When EPSSs are installed in health care facilities, the installation of the EPSS shall also be in compliance with NFPA 99, *Health Care Facilities Code*.

7.12.3 The wiring between the EPS output terminals and the first distribution overcurrent protective device terminals within the EPSS shall be located at a minimal distance to ensure system reliability and safety.

7.12.4 If the conduit's point of attachment to the EPS is on the forcing function side of the EPS vibration isolation system, a flexible conduit section(s) shall be installed between the EPS unit(s) and any of the following, so attached:

- (1) The transfer switch
- (2) The control and annunciator wiring
- (3) Any accessory supply wiring such as jacket water heaters

7.12.4.1 Stranded wire of adequate size shall be used to minimize breakage due to vibration.

7.12.4.2 Bushings shall be installed to protect wiring from abrasion with conduit terminations.

- ▲ **7.12.5** All ac-powered support and accessory equipment necessary to the operation of the EPS shall be supplied from the load side of the ATSS, or the output terminals of the EPS, ahead of the main EPS overcurrent protection to ensure continuity of the EPSS operation and performance.

7.12.6 The starting battery units shall be located next to the prime mover starter to minimize voltage drop.

7.12.6.1 Battery cables shall be sized to minimize voltage drop in accordance with the manufacturer's recommendations and accepted engineering practices.

▲ **7.12.6.2** Battery charger output wiring shall be permanently connected to the primary side of the starter solenoid (positive) and the EPS frame (negative), or other grounding location.

▲ **7.13 Installation Acceptance.**

7.13.1 Upon completion of the installation of the EPSS, the EPS shall be tested to ensure conformity to the requirements of the standard with respect to both power output and function.

7.13.2 An on-site acceptance test shall be conducted as a final approval test for all EPSSs.

7.13.2.1 For new Level 1 installations, the EPSS shall not be considered as meeting this standard until the acceptance tests have been conducted and test requirements met.

7.13.2.2 The test shall be conducted after completion of the installation with all EPSS accessory and support equipment in place and operating.

▲ **7.13.3** The authority having jurisdiction shall be given advance notification of the time at which the acceptance test is to be performed so that the authority can witness the test.

7.13.4 The EPSS shall perform within the limits specified in this standard.

▲ **7.13.4.1** The on-site installation acceptance test shall be conducted in accordance with 7.13.4.1.1 through 7.13.4.1.3.

7.13.4.1.1* In a new and unoccupied building or facility, with the prime mover in a cold start condition and the emergency load at operating level, a normal power failure shall be initiated by opening all switches or circuit breakers supplying the normal power to the building or facility.

7.13.4.1.2* In an existing occupied building or facility, with the prime mover in a cold start condition and the emergency load at operating level, a normal power failure shall be simulated by operating at least one transfer switch test function or initiated by opening all switches or breakers supplying normal power to all ATSS that are part of the EPSS being commissioned by this initial acceptance test.

7.13.4.1.3 The tests conducted in accordance with 7.13.4.1.1 and 7.13.4.1.2 shall be performed in accordance with (1) through (12).

- (1) When the EPSS consists of paralleled EPSs, the quantity of EPSs intended to be operated simultaneously shall be tested simultaneously with building load for the test period identified in 7.13.4.1.3(10).

Subsection 7.13.4.1.3(1) was revised by a tentative interim amendment (TIA). See page 1.

- (2) The test load shall be all loads that are served by the EPSS. There is no minimum loading requirement for this portion of the test.
- (3) The time delay on start shall be observed and recorded.
- (4) The cranking time until the prime mover starts and runs shall be observed and recorded.
- (5) The time taken to reach operating speed shall be observed and recorded.

(6)*The engine start function shall be confirmed by verifying operation of the initiating circuit of all transfer switches supplying EPSS loads.

(7) The time taken to achieve a steady-state condition with all switches transferred to the emergency position shall be observed and recorded.

(8) The voltage, frequency, and amperes shall be recorded.

(9) Where applicable, the prime mover oil pressure and water temperature shall be recorded.

▲ (10) The load test with building load, or other loads that simulate the intended load as specified in Section 5.4, shall be continued for not less than 1.5 hours, and the run time shall be recorded.

(11) When normal power is restored to the building or facility, the time delay on retransfer to normal power for each switch with a minimum setting of 5 minutes shall be recorded.

(12) The time delay on the prime mover cooldown period and shutdown shall be recorded.

7.13.4.2 After completion of the test performed in 7.13.4.1, the prime mover shall be allowed to cool for not less than 5 minutes.

7.13.4.3* A load shall be applied for a 2-hour, full-load test. The building load shall be permitted to serve as part or all of the load, supplemented by a load bank of sufficient size to provide a load equal to 100 percent of the nameplate kW rating of the EPS, less applicable derating factors for site conditions.

▲ **7.13.4.3.1** This full-load test shall be initiated after the test specified in 7.13.4.1.3 by any method that starts the prime mover and, upon reaching rated rpm, picks up not less than 30 percent of the nameplate kW rating for the first 30 minutes, not less than 50 percent of the nameplate kW rating for the next 30 minutes, and 100 percent of the nameplate kW rating for the next 60 minutes, less applicable derating factors for site conditions.

7.13.4.3.2 A unity power factor shall be permitted for on-site testing, provided that rated load tests at the rated power factor have been performed by the manufacturer of the EPS prior to shipment.

▲ **7.13.4.3.3** Where the EPS is a paralleled multi-unit EPS, each unit shall be permitted to be tested individually at its rating.

7.13.4.3.4 The data specified in 7.13.4.1.3(4), (5), (7), (8), and (9) shall be recorded at first load acceptance and every 15 minutes thereafter until the completion of the test period identified in 7.13.4.1.3(10).

Subsection 7.13.4.3.4 was revised by a tentative interim amendment (TIA). See page 1.

7.13.4.4 Any method recommended by the manufacturer for the cycle crank test shall be utilized to prevent the prime mover from running.

7.13.4.4.1 The control switch shall be set at "run" to cause the prime mover to crank.

7.13.4.4.2 The complete crank/rest cycle specified in 5.6.4.2 and Table 5.6.4.2 shall be observed.

7.13.4.4.3 The battery charge rate shall be recorded at 5-minute intervals for the first 15 minutes or until charge rate stabilization.

7.13.4.5 All safeties specified in 5.6.5 and 5.6.6 shall be tested on site as recommended by the manufacturer.

Exception: It shall be permitted for the manufacturer to test and document overcrank, high engine temperature, low lube oil pressure and overspeed safeties prior to shipment.



7.13.4.6 Items (1) through (4) shall be made available to the authority having jurisdiction at the time of the acceptance test:

- (1) Evidence of the prototype test as specified in 5.2.1.2 (for Level 1 systems)
- (2) A certified analysis as specified in 5.6.10.2
- (3) A letter of compliance as specified in 5.6.10.5
- (4) A manufacturer's certification of a rated load test at rated power factor with the ambient temperature, altitude, and fuel grade recorded

▲ Chapter 8 Routine Maintenance and Operational Testing

▲ 8.1* General.

8.1.1 The routine maintenance and operational testing program shall be based on all of the following:

- (1) Manufacturer's recommendations
- (2) Instruction manuals
- (3) Minimum requirements of this chapter
- (4) The authority having jurisdiction

8.1.2 Consideration shall be given to temporarily providing a portable or alternate source whenever the emergency generator is out of service.

8.2* Manuals, Special Tools, and Spare Parts.

8.2.1 At least two sets of instruction manuals for all major components of the EPSS shall be supplied by the manufacturer(s) of the EPSS and shall contain the following:

- (1) A detailed explanation of the operation of the system
- (2) Instructions for routine maintenance
- (3) Detailed instructions for repair of the EPS and other major components of the EPSS
- (4) An illustrated parts list and part numbers
- (5) Illustrated and schematic drawings of electrical wiring systems, including operating and safety devices, control panels, instrumentation, and annunciators

8.2.2 For Level 1 systems, instruction manuals shall be kept in a secure, convenient location, one set near the equipment, and the other set in a separate location.

8.2.3 Special tools and testing devices necessary for routine maintenance shall be available for use when needed.

8.2.4 Replacement for parts identified by experience as high mortality items shall be maintained in a secure location(s) on the premises.

8.2.4.1 Consideration shall be given to stocking spare parts as recommended by the manufacturer.

8.3 Maintenance and Operational Testing.

8.3.1* The EPSS shall be maintained to ensure to a reasonable degree that the system is capable of supplying service within the time specified for the type and for the time duration specified for the class.

▲ 8.3.2 A routine maintenance and operational testing program shall be initiated immediately after the EPSS has passed acceptance tests or after completion of repairs that impact the operational reliability of the system.

8.3.2.1 The operational test shall be initiated at an ATS and shall include testing of each EPSS component on which maintenance or repair has been performed, including the transfer of each automatic and manual transfer switch to the alternate power source, for a period of not less than 30 minutes under operating temperature.

8.3.3 A written schedule for routine maintenance and operational testing of the EPSS shall be established.

8.3.4 A permanent record of the EPSS inspections, tests, exercising, operation, and repairs shall be maintained and readily available.

8.3.4.1 The permanent record shall include the following:

- (1) The date of the maintenance report
- (2) Identification of the servicing personnel
- (3) Notation of any unsatisfactory condition and the corrective action taken, including parts replaced
- ▲ (4)** Testing of any repair for the time as recommended by the manufacturer

8.3.5* Transfer switches shall be subjected to a maintenance and testing program that includes all of the following operations:

- (1) Checking of connections
- (2) Inspection or testing for evidence of overheating and excessive contact erosion
- (3) Removal of dust and dirt
- (4) Replacement of contacts when required

8.3.6 Paralleling gear shall be subject to an inspection, testing, and maintenance program that includes all of the following operations:

- (1) Checking of connections
- (2) Inspection or testing for evidence of overheating and excessive contact erosion
- (3) Removal of dust and dirt
- (4) Replacement of contacts when required

▲ 8.3.7* Storage batteries, including electrolyte levels or battery voltage, used in connection with systems shall be inspected weekly and maintained in full compliance with manufacturer's specifications.

8.3.7.1 Maintenance of lead-acid batteries shall include the monthly testing and recording of electrolyte specific gravity. Battery conductance testing shall be permitted in lieu of the testing of specific gravity when applicable or warranted.

▲ 8.3.7.2 Defective batteries shall be replaced immediately upon discovery of defects.

▲ 8.3.8 A fuel quality test shall be performed at least annually using tests approved by ASTM standards.

8.4 Operational Inspection and Testing.

▲ 8.4.1* EPSSs, including all appurtenant components, shall be inspected weekly and exercised under load at least monthly.

8.4.1.1 If the generator set is used for standby power or for peak load shaving, such use shall be recorded and shall be permitted to be substituted for scheduled operations and testing of the generator set, providing the same record as required by 8.3.4.

▲ **8.4.2*** Diesel generator sets in service shall be exercised at least once monthly, for a minimum of 30 minutes, using one of the following methods:

- ▲ (1) Loading that maintains the minimum exhaust gas temperatures as recommended by the manufacturer
- (2) Under operating temperature conditions and at not less than 30 percent of the EPS nameplate kW rating

• **8.4.2.1** The date and time of day for required testing shall be decided by the owner, based on facility operations.

8.4.2.2 Equivalent loads used for testing shall be automatically replaced with the emergency loads in case of failure of the primary source.

▲ **8.4.2.3** Diesel-powered EPS installations that do not meet the requirements of 8.4.2 shall be exercised monthly with the available EPSS load and shall be exercised annually with supplemental loads at not less than 50 percent of the EPS nameplate kW rating for 30 continuous minutes and at not less than 75 percent of the EPS nameplate kW rating for 1 continuous hour for a total test duration of not less than 1.5 continuous hours.

▲ **8.4.2.4** Spark-ignited generator sets shall be exercised at least once a month with the available EPSS load for 30 minutes or until the water temperature and the oil pressure have stabilized.

8.4.2.4.1 The date and time of day for required testing shall be decided by the owner, based on facility operations.

8.4.2.4.2 Equivalent loads used for testing shall be automatically replaced with the emergency loads in case of failure of the primary source.

8.4.3 The EPS test shall be initiated by simulating a power outage using the test switch(es) on the ATSS or by opening a normal breaker. Opening a normal breaker shall not be required.

8.4.4 Load tests of generator sets shall include complete cold starts.

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

8.4.6 Transfer switches shall be operated monthly.

▲ **8.4.6.1** The monthly test of a transfer switch shall consist of electrically operating the transfer switch from the standard position to the alternate position and then a return to the standard position.

▲ **8.4.7*** EPSS circuit breakers for Level 1 system usage, including main and feed breakers between the EPS and the transfer switch load terminals, shall be exercised annually with the EPS in the “off” position.

8.4.7.1 Circuit breakers rated in excess of 600 volts for Level 1 system usage shall be exercised every 6 months and shall be tested under simulated overload conditions every 2 years.

▲ **8.4.8** The routine maintenance and operational testing program shall be overseen by a properly instructed individual.

▲ **8.4.9*** Level 1 EPSS shall be tested at least once within every 36 months.

▲ **8.4.9.1** Level 1 EPSS shall be tested continuously for the duration of its assigned class (*see Section 4.2*).

▲ **8.4.9.2** Where the assigned class is greater than 4 hours, it shall be permitted to terminate the test after 4 continuous hours.

8.4.9.3 The test shall be initiated by operating at least one transfer switch test function and then by operating the test function of all remaining ATSS, or initiated by opening all switches or breakers supplying normal power to all ATSS that are part of the EPSS being tested.

8.4.9.4 A power interruption to non-EPSS loads shall not be required.

8.4.9.5 The minimum load for this test shall be as specified in 8.4.9.5.1, 8.4.9.5.2, or 8.4.9.5.3.

▲ **8.4.9.5.1** For a diesel-powered EPS, loading shall be not less than 30 percent of the nameplate kW rating of the EPS. A supplemental load bank shall be permitted to be used to meet or exceed the 30 percent requirement.

▲ **8.4.9.5.2** For a diesel-powered EPS, loading shall be that which maintains the minimum exhaust gas temperatures as recommended by the manufacturer.

▲ **8.4.9.5.3** For spark-ignited EPSs, loading shall be the available EPSS load.

▲ **8.4.9.6** The test required in 8.4.9 shall be permitted to be combined with one of the monthly tests required by 8.4.2 and one of the annual tests required by 8.4.2.3 as a single test.

▲ **8.4.9.7** Where the test required in 8.4.9 is combined with the annual load bank test, the first 3 hours shall be at not less than the minimum loading required by 8.4.9.5 and the remaining hour shall be at not less than 75 percent of the nameplate kW rating of the EPS.

▲ Annex A Explanatory Material

Annex A is not a part of the requirements of this NFPA document but is included for informational purposes only. This annex contains explanatory material, numbered to correspond with the applicable text paragraphs.

A.1.1.4 See NFPA 111, *Standard on Stored Electrical Energy Emergency and Standby Power Systems*.

A.1.1.5(3) See Chapter 4.

A.3.2.1 Approved. The National Fire Protection Association does not approve, inspect, or certify any installations, procedures, equipment, or materials; nor does it approve or evaluate testing laboratories. In determining the acceptability of installations, procedures, equipment, or materials, the authority having jurisdiction may base acceptance on compliance with NFPA or other appropriate standards. In the absence of such standards, said authority may require evidence of proper installation, procedure, or use. The authority having jurisdiction may also refer to the listings or labeling practices of an organization that is concerned with product evaluations and is thus in a position to determine compliance with appropriate standards for the current production of listed items.

A.3.2.2 Authority Having Jurisdiction (AHJ). The phrase “authority having jurisdiction,” or its acronym AHJ, is used in NFPA documents in a broad manner, since jurisdictions and approval agencies vary, as do their responsibilities. Where public safety is primary, the authority having jurisdiction may be a

federal, state, local, or other regional department or individual such as a fire chief; fire marshal; chief of a fire prevention bureau, labor department, or health department; building official; electrical inspector; or others having statutory authority. For insurance purposes, an insurance inspection department, rating bureau, or other insurance company representative may be the authority having jurisdiction. In many circumstances, the property owner or his or her designated agent assumes the role of the authority having jurisdiction; at government installations, the commanding officer or departmental official may be the authority having jurisdiction.

A.3.2.4 Listed. The means for identifying listed equipment may vary for each organization concerned with product evaluation; some organizations do not recognize equipment as listed unless it is also labeled. The authority having jurisdiction should utilize the system employed by the listing organization to identify a listed product.

A.3.3.1 Battery Certification. One such certifier of batteries is the American Association of Battery Manufacturers.

A.3.3.4 Emergency Power Supply (EPS). For rotary energy converters, components of an EPS include the following:

- (1) Prime mover
- (2) Cooling system
- (3) Generator
- (4) Excitation system
- (5) Starting system
- (6) Control system
- (7) Fuel system
- (8) Lube system, if required

The EPS includes all the related electrical and mechanical components of the proper size and/or capacity required for the generation of the required electrical power at the EPS output terminals.

A.3.3.5 Emergency Power Supply System (EPSS). See Annex B for diagrams of typical systems.

A.4.1 This standard specifies requirements for the EPSS as a complete functioning system in terms of types, classes, and levels. It is not the intent of this standard to recommend the EPSS most suitable for any given application. The terms *emergency power supply systems* and *standby power supply systems* as used in this standard include, but are not limited to, such terms as the following:

- (1) Alternate power systems
- (2) Standby power systems
- (3) Legally required standby systems
- (4) Alternate power sources

Since this standard specifies the installation, performance, maintenance, and test requirements in terms of types, classes, and levels, any of these terms might be appropriate for describing the application or use, depending on the need and the preference of the parties involved.

A.4.2 Selection of the class of the EPSS should take into account past outage records and fuel delivery problems due to weather, shortages, and other geographic and environmental conditions. Class "X" is a calculated value that usually represents between 48 and 96 hours of fuel for a Level 1 facility.

A.4.4 It is recognized that EPSSs are utilized in many different locations and for many different purposes. The requirement for one application might not be appropriate for other applications.

A.4.4.1 Typically, Level 1 systems are intended to automatically supply illumination or power, or both, to critical areas and equipment in the event of failure of the primary supply or in the event of danger to elements of a system intended to supply, distribute, and control power and illumination essential for safety to human life. Other NFPA codes and standards, such as NFPA 20, *Standard for the Installation of Stationary Pumps for Fire Protection*, NFPA 99, *Standard for Health Care Facilities*, and NFPA 101, *Life Safety Code*, provide specific requirements on where Level 1 systems are required.

Essential electrical systems can provide power for the following essential functions:

- (1) Life safety illumination
- (2) Fire detection and alarm systems
- (3) Elevators
- (4) Fire pumps
- (5) Public safety communications systems
- (6) Industrial processes where current interruption would produce serious life safety or health hazards
- (7) Essential ventilating and smoke removal systems

A.4.4.2 Typically, Level 2 systems are intended to supply power automatically to selected loads (other than those classed as emergency systems) in the event of failure of the primary source.

Level 2 systems typically are installed to serve loads, such as the following, that, when stopped due to any interruption of the primary electrical supply, could create hazards or hamper rescue or fire-fighting operations:

- (1) Heating and refrigeration systems
- (2) Communications systems
- (3) Ventilation and smoke removal systems
- (4) Sewage disposal
- (5) Lighting
- (6) Industrial processes

A.4.4.4 It is important to recognize that an EPSS might react substantially differently from commercial power during transient and short circuit conditions due to the relatively small capacities of the EPSS compared to the primary commercial power source. (See ANSI C84.1.)

A.5.1.1 Examples of probability of interruption could include the following: earthquake, flood damage, or a demonstrated utility unreliability.

A.5.1.1(1) See A.5.5.3 for shelf-life precautions for fuel supplies. Diesel fuel should be 1D, 2D, or a blend and have a minimum cetane rating of 40.

A.5.1.4 On-site energy conversion is not restricted to rotating-type generating systems. Other types of continuous energy conversion systems can be used, including fuel-cell systems.

A.5.2.2 The following devices are typical of energy converters and energy sources that should be reviewed carefully as part of Level 1 EPSS:

- (1) Motor-generator/engine
- (2) Motor-generator/flywheel
- (3) Steam turbine

Connection to the primary power source ahead of the primary source main service disconnect and a separate service should be excluded as a sole source of EPS.

A.5.4 It is recognized that in some installations, part or all of the output of the EPS might be used for peak shaving or part of the output might be used for driving nonessential loads during loss of the primary power source. Load shedding of these loads when the output of the energy converter is needed is one way of meeting the requirements of Section 5.4. The load should be reviewed to ascertain that load growth has not exceeded EPS capability.

A.5.5.2 The low-fuel alarm point for liquid-fueled engines is defined as the point when the main fuel tank contains insufficient fuel to meet the required full load operating hours and is the point at which this condition is signaled.

A.5.5.3 Consideration should be given to sizing tanks in order to meet minimum fuel supplier delivery requirements, particularly for small tanks. Consideration also should be given to over-sizing tanks, because many fuels have a shelf life and deteriorate with age. Where large tanks are required, it is recommended that fuels be periodically pumped out and used in other services and replaced with fresh fuel. Prudent disaster management could require much larger on-site temporary or permanent fuel storage.

A.5.6.4.2 See Figure A.5.6.4.2 for a diagram of cranking cycles.

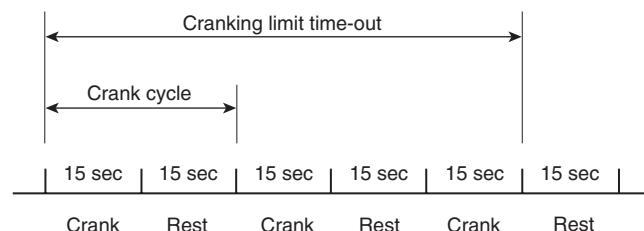


FIGURE A.5.6.4.2 Diagram of Cranking Cycles.

A.5.6.4.3 A battery unit is one or more batteries or a group of cells, a series, or a parallel series connected to provide the required battery unit voltage and capacity.

A.5.6.4.4 Cold-cranking amperes, or cranking performance, are the number of amperes a fully charged battery at -17.8°C (0°F) can continuously deliver for 30 seconds while maintaining 1.2 V per cell.

A.5.6.4.5.1 It is recommended that lead-acid starting batteries be replaced every 24 to 30 months.

A.5.6.4.6 It is intended that the battery charger be factory-built, adjusted, and approved for the specific type, construction, and capacity of the battery. For lead-acid batteries, the battery charger should be tested for the specific gravity, type, and concentration of grid alloys, such as high or low gravity, high or low antimony, calcium, or none.

A.5.6.5.6 For systems located outdoors, the manual shut-down should be located external to the weatherproof enclosure and should be appropriately identified.

A.5.6.9.1 See ANSI/NEMA MG1 and ANSI/NEMA MG2.

A.5.6.10.3 Where unusual vibration conditions are anticipated, adequate isolation treatment should be supplied.

A.6.1.1 Electrical switching is electrical equipment or devices used to do any or all of the following:

- (1) Transfer connected electrical loads from one power source to another
- (2) Perform load-switching functions
- (3) Bypass, isolate, and test the transfer switch

A.6.1.2 Electrical protection equipment is sensing and overcurrent protective devices used to protect against damage due to fault or overload to conductors and equipment connected to the output of the emergency energy source, up to and including the load terminals of the transfer switch(es).

A.6.1.6 See Section 695.10 of *NFPA 70, National Electrical Code*, and Section 10.8 of *NFPA 20, Standard for the Installation of Stationary Pumps for Fire Protection*, for listing and installation requirements for transfer switches used with fire pumps.

A.6.2.1 For most applications in this standard, the automatic transfer switch (ATS) is used to transfer a load from a primary source of supply to an engine generator set.

An ATS might include circuit breakers, contactors, switches, or vacuum and solid-state power devices operating in conjunction with automatic-sensing and logic devices to perform the defined function.

A.6.2.2.1 Where special loads require more rapid detection of power loss, underfrequency monitoring also might be provided. Upon frequency decay below the lower limit necessary for proper operation of the loads, the transfer switch should automatically initiate transfer to the alternate source. (See A.6.2.15.)

A.6.2.2.1(2) See 6.2.5 and 6.2.7.

A.6.2.4 Authorized personnel should be available and familiar with manual operation of the transfer switch and should be capable of determining the adequacy of the alternate source of power prior to manual transfer.

A.6.2.5 For most applications, a nominal delay of 1 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 type classification.

A.6.2.8 It is recommended that the timer for delay on retransfer to the primary source be set for 30 minutes. The 30-minute recommendation is to establish a "normalized" engine temperature when it is beneficial for the engine. *NFPA 70, National Electrical Code*, establishes a minimum time requirement of 15 minutes.

A.6.2.13 For maintenance purposes, consideration should be given to a transfer switch counter.

A.6.2.15 ATSs can be provided with accessory controls that provide a signal to operate remote motor controls that disconnect motors prior to transfer and to reconnect them after transfer when the residual voltage has been substantially reduced. Another method is to provide in-phase monitors within the ATS in order to prevent retransfer to the primary source until both sources are nearly synchronized. A third method is to use a programmed neutral position transfer switch. See Section 230.95 of *NFPA 70, National Electrical Code*.

A.6.2.16 Standards for nonautomatic transfer switches are similar to those for ATSs, as defined in 3.3.9.1 and 3.3.9.3, with the omission of automatic controls.

A.6.4.3 See Section 700.6 of *NFPA 70, National Electrical Code*.

A.6.4.4 Consideration should be given to the effect that load interruption could have on the load during maintenance and service of the transfer switch.

A.6.5.1 It is important that the various overcurrent devices be coordinated, as far as practicable, to isolate faulted circuits and to protect against cascading operation on short circuit faults. In many systems, however, full coordination is not practicable without using equipment that could be prohibitively costly or undesirable for other reasons. Primary consideration also should be given to prevent overloading of equipment by limiting the possibilities of large current inrushes due to instantaneous reestablishment of connections to heavy loads.

A.6.5.3 See 9.6.5 of *NFPA 20, Standard for the Installation of Stationary Pumps for Fire Protection*.

A.7.1.1 The performance of the EPS and the EPSS is dependent on many factors, one of which is correct initial installation, primarily as the installation relates to the location and environmental conditions. Although this standard is not intended to serve as a design standard for EPSS installation and environmental considerations, certain minimum standards are recognized as essential for successful startup and performance, safe operation, and utilization of the EPSS where required.

A.7.1.2 The environmental conditions to be considered in the EPSS design should include, but not be limited to, heating, ventilating, and air-conditioning systems; protection from floods, fire, vandalism, wind, earthquakes, lightning, and other similar or applicable environmental conditions common to geographic locations; and other factors affecting the location of the EPSS equipment.

The probability and frequency of power failures that do or can occur as a result of lightning, wind, and rain produced by thunderstorms, hurricanes, tornadoes, and similar weather conditions associated with the user's geographic location should be considered.

A.7.2.2 The intent of this requirement is to provide maximum fire protection to the most critical, high energy systems. Consideration should be given to the potential fire hazard when locating Level 2 EPSS equipment in the normal electrical service room, or to Level 1 systems below 1000 amperes and 150 volts to ground.

A.7.2.3 EPSS equipment should be located above known previous flooding elevations where possible.

A.7.2.4 When installing the EPSS equipment and related auxiliaries, environmental considerations should be given, particularly with regard to the installation of the fuel tanks and exhaust lines, or the EPS building, or both.

To protect against disruption of power in the facility, it is recommended that the transfer switch be located as close to the load as possible. The following are examples of external influences:

- (1) Natural conditions
 - (a) Storms
 - (b) Floods
 - (c) Earthquakes
 - (d) Tornadoes
 - (e) Hurricanes
 - (f) Lightning
 - (g) Ice storms
 - (h) Wind
 - (i) Fire
- (2) Human-caused conditions
 - (a) Vandalism
 - (b) Sabotage
 - (c) Other similar occurrences
- (3) Material and equipment failures

For natural conditions, EPSS design should consider the "100-year storm" flooding level or the flooding level predicted by the Sea, Lake, and Overland Surges from Hurricanes (SLOSH) models for a Class 4 hurricane.

A.7.3.3 Where units housed outdoors are used, it is recommended that a flashlight or battery-powered light with a flexible cord be maintained in the housing.

A.7.5 Generally, integral rubber vibration isolators are used on the rotating energy converters, and spring-type or pad-type isolators are used on the larger energy converter units. In some cases, high deflection spring-type isolators should be used where a high degree of vibration attenuation is required. The EPS manufacturer should be consulted during consideration of the specific type of vibration control. Inertia bases should be considered where unusual vibration conditions are anticipated.

A.7.6 Generally, exhaust noises can be attenuated by using the proper mufflers. The mufflers used should be in accordance with the EPS manufacturer's recommendations. Depending on the degree of silencing required, the muffler should be rated accordingly for "commercial," "semicritical," and "critical" (high degree of silencing) service. To attenuate other noises, line-of-sight barriers having acoustical treatment or total acoustical enclosures can be used. The EPS should be installed away from critical areas.

A.7.7.1 During operation, EPS and related equipment reject considerable heat that needs to be removed by proper ventilation or air-cooling. In some cases, outdoor installations rely on natural air circulation, but enclosed installations need properly sized, properly positioned ventilation facilities, to prevent recirculation of cooling air. The optimum position of air-supply louvers and radiator air discharge is on opposite walls, both to the outdoors.

A.7.8.2 It should be recognized that the reliability of municipal water-cooling is strictly dependent upon the reliability of the water utility. It should also be recognized that, during such natural disasters as earthquakes and floods, the water supply can be interrupted simultaneously with the primary electric power supply. Methods of cooling the energy converter(s) consist of radiator cooling, either unit-mounted or remote, utility-furnished (city) water-cooling, heat exchangers, and air-cooling.

A.7.9.1.2 Commercial distillate fuel oils used in modern diesel engines are subject to various detrimental effects. The origin of the crude oil, refinement processing techniques, time of year, and geographical consumption location all aid in the determination of fuel blend formulas. Sulfur, naturally occurring gums, waxes, soluble metallic soaps, water, dirt, and temperature all begin to degrade fuel as it is handled and stored. These effects begin at the time of fuel refinement and continue until consumption.

Proper fuel storage is critical to engine start-up, efficiency, and longevity. Storage tanks should be kept water-free and have provisions for drainage on a scheduled basis. Water can contribute to steel tank corrosion and the potential development of microbiological growth where fuel and water interface. Copper and its alloys, along with zinc or zinc coatings, should be avoided in fuel-handling systems. These elements can react with fuel to form certain gels or organic acids, resulting in clogging of filters or further system corrosion. Stable storage temperatures are conducive to fuel health. Tanks that are aboveground and subject to extreme daily temperature variations cause fuel to degrade more rapidly. This is further exacerbated with large aboveground tanks that are less than full. Airspace allows for condensation that can further add to the contaminant levels. Reflective exterior tank coatings reduce but do not eliminate the solar heating effect.

Scheduled fuel maintenance and testing help to reduce or nearly eliminate fuel contamination. Fuel maintenance filtration can remove contaminants and water and return fuel to conditions where it will provide reliability and efficiency for standby generators when called upon in emergency conditions. Fuel maintenance and testing should begin the day of installation and first fill to establish a benchmark guideline for further comparison. Fuel monitoring and testing services are available nationwide from many companies.

A.7.9.6 See NFPA 37, *Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines*; NFPA 54, *National Fuel Gas Code*; and NFPA 58, *Liquefied Petroleum Gas Code*.

A.7.9.7 Valving for natural gas-fueled prime movers should be configured so that the gas supply to the prime mover cannot be inadvertently or intentionally shut off by anyone other than qualified personnel such as the gas supplier. If valves are placed in an isolated area, a secure area or locking the valve(s) open is recommended.

A.7.10.3 Consideration should also be given to utilizing dampening supports where it is necessary to reduce exhaust noise vibration transmission.

A.7.11.2 If a fire suppression system is used in EPS rooms or separate buildings housing EPS equipment, consideration should be given to preaction-type suppression systems.

A.7.11.5 Consideration should be given to the location of the EPS equipment, both as it relates to the building structure and to the effects of an earthquake.

All emergency power equipment support or sub-support systems should be designed and constructed so that they can withstand static or anticipated seismic forces, or both, in any direction, with the minimum force value used being equal to the equipment weight.

Bolts, anchors, hangers, braces, and other restraining devices should be provided to limit earthquake-generated differential movements between the EPS nonstructural equipment and the building structure. However, the degree of isolation required for vibration and acoustical control of the EPS equipment and other equipment should be maintained.

Suspended items such as piping, conduit, ducts, and other auxiliary equipment related to the EPSS should be braced in two directions to resist swaying and excessive movement in earthquake risk areas.

Battery racks for EPS equipment and electrical items or related auxiliaries, or both, should be designed to resist internal damage and damage at the equipment supports resulting from earthquake-generated motion. Battery racks should be capable of withstanding seismic forces equal to the supported weight in any direction. Batteries should be restrained to their support to prevent vibration damage, and electrical interconnections should be provided with adequate slack to accommodate all relative deflections.

Transfer switch enclosures should be mounted so that their anchors and support structures can withstand static forces equal to the anticipated seismic shock in any direction.

Transfer switch components should be of the type that resists malfunction during dynamic excitation and should be designed to resist the anticipated seismic shock.

Where possible, EPS equipment and associated cooling systems and controls should be mounted on a single frame. The frame, in turn, should be rigidly attached to its foundation so that its anchorage can withstand static forces equal to the equipment weight in any direction. Where engine generator sets and associated cooling systems' controls cannot be mounted as an integral unit, each should be secured to meet the floating requirements previously described. Equipment not using the preferred rigid mounting should have vibration isolators with restraints capable of withstanding static forces equal to twice the weight of the supported equipment in any direction. In addition, interconnecting power, fuel, and cooling lines should be provided with adequate flexibility to allow maximum anticipated excursions without damage.

Appendages to the EPS equipment, such as day tanks, should be mounted to withstand static forces equal to the anticipated seismic shock in any direction.

A.7.11.6 Seismic shock should be simulated at the factory or in a testing laboratory on a prototype unit. Simulation should consist of a test(s) approximating actual time-history records of known seismic shocks applied to the equipment under test. Subassemblies of the total equipment could be tested separately where it is neither practical nor feasible to test the complete unit.

A.7.13.4.1.1 Cold start is typical standby condition under normal ambient conditions with coolant heaters functioning normally.

A.7.13.4.1.2 Cold start is typical standby condition under normal ambient conditions with coolant heaters functioning normally.

A.7.13.4.1.3(6) Verification of the engine start function can be accomplished by actual starting of the engine or by testing of the ATS start circuit.

A.7.13.4.3 Connection of the load bank (or a portable generator) is facilitated by providing permanently installed equipment or connection points such as spare circuit breakers or switches.

A.8.1 The continuing reliability and integrity of the EPSS are dependent on an established program of routine maintenance and operational testing.

A.8.2 Where adequately secured from public access, it is desirable to locate an instruction manual, special tools and testing devices, and spare parts in the room in which the EPS is located. The articles should be mounted at a convenient location on a wall and should be enclosed in a metal or other suitable cabinet. The cabinet should accommodate the instruction manual on the inside of the door.

A.8.3.1 The suggested maintenance procedure and frequency should follow those recommended by the manufacturer. In the absence of such recommendations, Figure A.8.3.1(a) and Figure A.8.3.1(b) indicate alternate suggested procedures.

A.8.3.5 Where sealed devices are used, replacement of the complete device might be necessary. Maintenance should be performed according to manufacturer's recommendations. In the absence of such recommendations, the list given in 8.3.5 suggests minimal procedures.

Transfer switches should be subjected to an annual maintenance program including (one) major maintenance and (three) quarterly inspections. Programs should include all of the following operations. Note: Due to the critical nature of these devices, permission should be gained to perform these tasks since some of the following recommendations could cause disruption of power to the load. The following tasks should be carefully reviewed with facility-management personnel to ensure agreement and plan for contingencies.

Major Maintenance

- (1) Check connections.
 - (a) A thermographic or temperature scan should be done prior to this visit, while the ATS is under normal (peak) load. This thermographic scan should be repeated during the EPSS load test. Results should be available to the maintenance provider so that suspect conditions can be addressed during this activity.
 - (b) With power connected to the normal source, measure and record millivolt drop levels across each pole. Note: Any reading that is greater than 25 percent of the average of all poles should be carefully inspected when the ATS is de-energized.
 - (c) With power connected to the emergency source, measure and record millivolt drop levels across each pole. Note: Any reading that is greater than 25 percent of the average of all poles should be carefully inspected when the ATS is de-energized.
 - (d) If the ATS is equipped with a bypass isolation feature, operate the bypass to the connected source (emergency or normal) and repeat the steps in (a), (b), and (c). Levels should drop to approximately 50 percent of initial levels and be uniform relative to initial readings. This step verifies that the bypass feature is properly connected and that the connected load will not be affected when the automatic portion is isolated for maintenance.
 - (e) With power secured and both the emergency and normal sources properly locked out and tagged out, measure the micro-ohm resistance levels across the following connection points:
 - i. Emergency source cabling lug to bus



- ii. Normal source cabling lug to bus
- iii. Load cabling lug to bus
- iv. Neutral cabling lug to bus
- v. Load connected to normal across each pole
- vi. Load connected to emergency across each pole

Note: If the ATS is equipped with an isolation bypass and the bypass remains energized, perform these tests on the isolated transfer switch unit only. **DO NOT APPLY DIGITAL LOW RESISTANCE OHMMETER (DLRO) TO ENERGIZED CIRCUITS.** Any value greater than 20 percent of the average value of all similar type connections requires further investigation.

- (2) Inspect or test for evidence of overheating or excessive contact corrosion.
 - (a) With power from both sources secured and properly locked out and tagged out, remove all protective pole covers and arc chutes.
 - (b) Carefully inspect main contacts and other current-carrying parts for signs of corrosion or overheating. Note: Observation should correlate with previous results (i.e., thermographic or temperature evidence of higher than normal temperatures or heat migration, abnormal millivolt drop readings as previously noted, or abnormal micro-ohm (DLRO) readings as previously noted).
 - (c) Carefully inspect insulating materials or standoff insulators for signs of contamination (dirt, grime, oil, etc.). The combination of contaminants and possible introduction of high humidity or moisture could lead to insulation breakdown and subsequent destructive faults. Clean contaminated surfaces with a solvent approved for this purpose.
 - (d) Inspect control connection, plugs, and harnesses for signs of corrosion, heat, contamination, and so forth.
 - (e) Using a vacuum, remove all dust and debris from the ATS cabinet, transfer switch mechanism, bus, and so forth. Note: Never use compressed air to blow out dust. Doing so can blow dust and debris into controls and the transfer switch mechanism.
 - (f) Inspect cabinets for proper sealing. Open conduit knockouts or other penetrations should be properly sealed to prevent the introduction of dust, moisture, or other alien matter. Enclosures installed outside should be inspected for proper seal and appropriate gasketing. Ensure that enclosure door securing devices are intact and properly secured.
 - (g) Replace and secure all protective pole covers and chutes. Remove lockout devices and resupply normal power. If the ATS is of the bypass isolation type, reconnect the transfer switch mechanism. Observe proper manufacturer's procedures.
- (3) Verify control and feature setpoints and operation.
 - (a) Measure and record the following data and setpoints:
 - i. Normal source voltage phase to phase, phase to ground, and phase to neutral
 - ii. Engine start time (from crank start to source available light or relay pickup)
 - iii. Emergency source voltage phase to phase, phase to ground, and phase to neutral
 - iv. Load current each phase
 - v. Momentary override normal deviation where provided
 - vi. Transfer time delay where provided
 - vii. Return to normal source time delay where provided
 - viii. Engine cooldown where provided

- (b) If the connection is to a multiple-source EPS, verify the load priority of the ATS being tested and confirm this is correct given the criticality of the connected load.
- (c) Verify proper operation of all indicator lights and meters and controls.
- (d) Return ATS to normal service.

Quarterly Inspections

- (1) Visually inspect the transfer switch control mechanism, control panel, harnesses, and cable connections for signs of moisture, corrosion, or heating.
- (2) Measure and record the following data and setpoints:
 - (a) Normal source voltage phase to phase, phase to ground, and phase to neutral
 - (b) Engine start time (from crank start to source available light or relay pickup)
 - (c) Emergency source voltage phase to phase, phase to ground, and phase to neutral
 - (d) Load current each phase
 - (e) Momentary override normal deviation where provided
 - (f) Transfer time delay where provided
 - (g) Return to normal source time delay where provided
 - (h) Engine cooldown where provided
- (3) If the connection is to a multiple-source EPS, verify the load priority of the ATS being tested and confirm this is correct given the criticality of the connected load.
- (4) Verify proper operation of all indicator lights and meters and controls.
- (5) Inspect cabinets for proper sealing. Open conduit knockouts or other penetrations should be properly sealed to prevent the introduction of dust, moisture, or other alien matter. Enclosures installed outside should be inspected for proper seal and appropriate gasketing. Ensure that enclosure door securing devices are intact and properly secured.
- (6) Perform a load test using the test switch if permitted. Note: This will cause the emergency power source to start and the ATS to transfer. Be sure to gain permission from the facility management prior to performing this test.

A.8.3.7 A battery load test should be performed quarterly.

A.8.4.1 Weekly inspection does not require running of the EPS. Running unloaded generators as part of this weekly inspection can result in long-term problems such as wet stacking. See Figure A.8.4.1 (a) and Figure A.8.4.1 (b).

A.8.4.2 Light loading creates a condition termed *wet stacking*, indicating the presence of unburned fuel or carbon, or both, in the exhaust system. Its presence is readily indicated by the presence of continuous black smoke during engine-run operation. The testing requirements of 8.4.2 are intended to reduce the possibility of wet stacking. If equivalent loads are used for exercising, it is suggested that all essential loads be energized first, with the equivalent load used only to supplement the test. If the normal power were to fail during the exercise period, it would negate the urgency to automatically remove the equivalent load as described in 8.4.2.2.

A.8.4.7 Circuit breakers should be tested under simulated overload conditions every 2 years.

A.8.4.9 The intent of this requirement is to provide reasonable assurance that the EPSS with all of its auxiliary subsystems is capable of running for the duration of its assigned class with its running load. A full facility power outage is not intended for this test but is recommended where a total facility power outage has not occurred within the last 36 months. Supplemental load banks are not required. After the test, the fuel supply should be replenished if necessary.

EPSS Maintenance Schedule							
Component (as applicable)	Procedure X — Action R — Replace, if needed					Frequency W — Weekly S — Semiannually M — Monthly A — Annually Q — Quarterly Nos. indicate hours	
	Visual Inspection	Check	Change	Clean	Test	Level 1	Level 2
1. Fuel							
(a) Main supply tank level		X				W	M
(b) Day tank level	X	X				W	M
(c) Day tank float switch	X				X	W	Q
(d) Supply or transfer pump operation	X				X	W	Q
(e) Solenoid valve operation	X				X	W	Q
(f) Strainer, filter, dirt leg, or combination				X		Q	Q
(g) Water in system		X		X		W	Q
(h) Flexible hose and connectors	X		R			W	M
(i) Tank vents and overflow piping unobstructed		X			X	A	A
(j) Piping	X					A	A
(k) Gasoline in main tank (when used)			R			A	A
2. Lubrication System							
(a) Oil level	X	X				W	M
(b) Oil change			R			50 or A	50 or A
(c) Oil filter(s)			R			50 or A	50 or A
(d) Lube oil heater		X				W	M
(e) Crankcase breather	X		R	X		Q	S
3. Cooling System							
(a) Level	X	X				W	M
(b) Antifreeze protection level					X	S	A
(c) Antifreeze			R			A	A
(d) Adequate cooling water to heat exchanger		X				W	M
(e) Rod out heat exchanger				X		A	A
(f) Adequate fresh air through radiator		X				W	M
(g) Clean exterior of radiator				X		A	A
(h) Fan and alternator belt	X	X				M	Q
(i) Water pump(s)	X					W	Q
(j) Condition of flexible hoses and connection	X	X				W	M
(k) Jacket water heater		X				W	M
(l) Inspect duct work, clean louvers	X	X		X		A	A
(m) Louver motors and controls	X			X	X	A	A
4. Exhaust System							
(a) Leakage	X	X				W	M
(b) Drain condensate trap		X				W	M

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FIGURE A.8.3.1(a) Suggested Maintenance Schedule for Emergency Power Supply Systems (EPSSs).



EPSS Maintenance Schedule *(continued)*

Component (as applicable)	Procedure X — Action R — Replace, if needed					Frequency W — Weekly S — Semiannually M — Monthly A — Annually Q — Quarterly Nos. indicate hours	
	Visual Inspection	Check	Change	Clean	Test	Level 1	Level 2
(c) Insulation and fire hazards	X					Q	Q
(d) Excessive backpressure					X	A	A
(e) Exhaust system hangers and supports	X					A	A
(f) Flexible exhaust section	X					S	S
5. Battery System							
(a) Electrolyte level		X				W	M
(b) Terminals clean and tight	X	X				Q	Q
(c) Remove corrosion, case exterior clean and dry	X			X		M	M
(d) Specific gravity or state of charge					X	M	M
(e) Charger and charge rate	X					M	M
(f) Equalize charge		X				M	M
6. Electrical System							
(a) General inspection	X					W	M
(b) Tighten control and power wiring connections		X				A	A
(c) Wire chafing where subject to movement	X	X				Q	S
(d) Operation of safeties and alarms		X			X	S	S
(e) Boxes, panels, and cabinets				X		S	S
(f) Circuit breakers, fuses Note: Do not break manufacturer's seals or perform internal inspection on these devices.	X	X	R	X	X	M	A
(g) Transfer switch main contacts	X			X		A	A
(h) Calibration of voltage-sensing relays/devices		X			X	A	A
(i) Wire insulation breakdown					X	5/500 ^a	3/500 ^b
7. Prime Mover							
(a) General inspection	X					W	M
(b) Service air cleaner			R	X		S	S
(c) Governor oil level and linkage	X	X				M	M
(d) Governor oil			R			A	A
(e) Ignition system — plugs, points, coil, cap, rotor, secondary wire insulation	X	X	R	X	X	A	A
(f) Choke setting and carburetor adjustment		X				S	S
(g) Injector pump and injectors for flow rate pressure and/or spray pattern					X	A	A
(h) EPS at minimum of 30% nameplate rating					X	3/4 ^c	3/4 ^c

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FIGURE A.8.3.1(a) *Continued*

EPSS Maintenance Schedule *(continued)*

Component (as applicable)	Procedure X — Action R — Replace, if needed					Frequency W — Weekly S — Semiannually M — Monthly A — Annually Q — Quarterly Nos. indicate hours	
	Visual Inspection	Check	Change	Clean	Test	Level 1	Level 2
(i) Valve clearance					X	3/500 ^b	3/500 ^b
(j) Torque bolts					X	3/500 ^b	3/500 ^b
8. Generator							
(a) Brush length, appearance, free to move in holder	X	X		X		S	S
(b) Commutator and slip rings	X			X		A	A
(c) Rotor and stator	X			X		A	A
(d) Bearing(s)	X		R			A	A
(e) Bearing grease		X	R			A	A
(f) Exciter	X	X		X		A	A
(g) Voltage regulator	X	X		X		A	A
(h) Measure and record resistance readings of windings with insulation tester (Megger)					X	A	A
9. (a) General condition of EPSS, any unusual condition of vibration, leakage, noise, temperature, or deterioration	X			X		W	M
(b) Service room or housing house-keeping	X			X		W	M
10. Restore system to automatic operation condition	X					W	M

^a Every 5 years or 500 hours

^b Every 3 years or 500 hours

^c Every 3 years for 4 hours

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FIGURE A.8.3.1(a) *Continued*



EPSS Maintenance Log										Frequency	
										W — Weekly	S — Semiannually
										M — Monthly	A — Annually
										Q — Quarterly	Nos. indicate hours
Performed by											
Component	Service Frequency		Date								
	Level 1	Level 2									
			Fill in Appropriate Readings								
1. Fuel											
(a) Main supply tank level	W	M									
(b) Day tank level	W	M									
(c) Day tank float switch	W	Q									
(d) Supply or transfer pump operation	W	Q									
(e) Solenoid valve operation	W	Q									
(f) Strainer, filter, dirt leg, or combination	Q	Q									
(g) Water in system	W	Q									
(h) Flexible hose and connectors	A	A									
(i) Tank vents and overflow piping unobstructed	A	A									
(j) Piping	A	A									
(k) Gasoline in main tank (when used)	A	A									
2. Lubrication System											
(a) Oil level	W	M									
(b) Oil change	50 or A	50 or A									
(c) Oil filter(s)	50 or A	50 or A									
(d) Lube oil heater	W	M									
(e) Crankcase breather	Q	S									
3. Cooling System											
(a) Level	W	M									
(b) Antifreeze protection level	S	A									
(c) Antifreeze	A	A									
(d) Adequate cooling water to heat exchanger	W	M									
(e) Rod out heat exchanger	A	A									
(f) Adequate fresh air through radiator	W	M									
(g) Clean exterior of radiator	A	A									
(h) Fan and alternator belt	M	Q									
(i) Water pump(s)	W	Q									
(j) Condition of flexible hoses and connection	W	M									
(k) Jacket water heater	W	M									
(l) Inspect duct work, clean louvers	A	A									
(m) Louver motors and controls	A	A									
4. Exhaust System											
(a) Leakage	W	M									
(b) Drain condensate trap	W	M									

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FIGURE A.8.3.1(b) Sample Maintenance Log — Routine Maintenance, Operation, and Testing (RMOT).

EPSS Maintenance Log (continued)													
Component	Service Frequency		Performed by										
	Level 1	Level 2	Date										
			Fill in Appropriate Readings										
(c) Insulation and fire hazards	Q	Q											
(d) Excessive backpressure	A	A											
(e) Exhaust system hangers and supports	A	A											
(f) Flexible exhaust section	S	S											
5. Battery System													
(a) Electrolyte level	W	M											
(b) Terminals clean and tight	Q	Q											
(c) Remove corrosion, case exterior clean and dry	M	M											
(d) Specific gravity or state of charge	M	M											
(e) Charger and charge rate	M	M											
(f) Equalize charge	M	M											
6. Electrical System													
(a) General inspection	W	M											
(b) Tighten control and power wiring connections	A	A											
(c) Wire chafing where subject to movement	Q	S											
(d) Operation of safeties and alarms	S	S											
(e) Boxes, panels, and cabinets	S	S											
(f) Circuit breakers, fuses Note: Do not break manufacturer's seals or perform internal inspection on these devices.	2 or M	2 or A											
(g) Transfer switch main contacts	A	A											
(h) Calibration of voltage-sensing relays/devices	5 or A	5 or A											
(i) Wire insulation breakdown	5/500 ^a	3/500 ^b											
7. Prime Mover													
(a) General inspection	W	M											
(b) Service air cleaner	S	S											
(c) Governor oil level and linkage	M	M											
(d) Governor oil	A	A											
(e) Ignition system — plugs, points, coil, cap, rotor, secondary wire insulation	A	A											
(f) Choke setting and carburetor adjustment	S	S											
(g) Injector pump and injectors for flow rate pressure and/or spray pattern	A	A											
(h) EPS at minimum of 30% nameplate rating	3/4 ^c	3/4 ^c											

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FIGURE A.8.3.1(b) Continued



EPSS Maintenance Log <i>(continued)</i>				Frequency													
				Performed by						W — Weekly S — Semiannually M — Monthly A — Annually Q — Quarterly Nos. indicate hours							
Component	Service Frequency		Date														
	Level 1	Level 2	Fill in Appropriate Readings														
(i) Valve clearance	3/500 ^b	3/500 ^b															
(j) Torque bolts	3/500 ^b	3/500 ^b															
8. Generator																	
(a) Brush length, appearance, free to move in holder	W	M															
(b) Commutator and slip rings	S	S															
(c) Rotor and stator	A	A															
(d) Bearing(s)	A	A															
(e) Bearing grease	A	A															
(f) Exciter	A	A															
(g) Voltage regulator	A	A															
(h) Measure and record resistance readings of windings with insulation tester (Megger)	A	A															
9. (a) General condition of EPSS, any unusual condition of vibration, leakage, noise, temperature, or deterioration	W	M															
(b) Service room or housing house-keeping	W	M															
10. Restore system to automatic operation condition	W	M															

^a Every 5 years or 500 hours
^b Every 3 years or 500 hours
^c Every 3 years for 4 hours

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FIGURE A.8.3.1(b) *Continued*

EPSS Operation and Testing Log																			
	Performed by _____																		
	Date _____																		
Item*	Fill in Appropriate Readings																		
1. Maintenance schedule																			
2. RTM																			
3. Power fail																			
4. T/D start																			
5. Crank time																			
6. Transfer																			
7. (a) ac voltage																			
(b) Hz																			
(c) ac amperage																			
8. (a) Oil pressure																			
(b) dc amperage																			
9. (a) Oil pressure																			
(b) dc amperage																			
(c) W/A temp.																			
10. Restore normal																			
11. (a) Oil pressure																			
(b) dc amperage																			
(c) W/A temp.																			
(d) ac voltage																			
(e) Hz																			
(f) ac amperage																			
12. T/D retransfer																			
13. T/D stop																			
14. Auto mode																			
Comments																			

* See Suggested Operation and Testing Procedures for explanation of items.

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FIGURE A.8.4.1(a) Sample Operation and Testing Log for Rotating Equipment.

Suggested Operation and Testing Procedures

Item*	Procedure	Item*	Procedure
1.	Perform maintenance per Maintenance Schedule	8.	Record initial oil pressure and battery-charging rate.
2.	Record running time meter (RTM) reading at start and end of test.	9.	Record oil pressure, battery-charging rate, and water or air temperature after 15 minutes running time.
3.	Simulate normal power failure from a “cold start” by use of the test switch in automatic transfer switch or by opening normal power supply to EPSS.	10.	Return test switch to normal or reestablish normal power supply at such time to cause a minimum running time of 30 minutes under load.
4.	Observe and record time delay (T/D) on start.	11.	Record prime mover and ac instruments just prior to transfer.
5.	Record cranking time (terminates when engine starts).	12.	Record time delay on retransfer.
6.	Transfer load to EPS.	13.	Record time delay on shutdown for units so equipped.
7.	Record ac voltage, frequency, amperage.	14.	Place unit in automatic operation mode.

*See Operation and Testing Log.

FIGURE A.8.4.1(b) Operation and Testing Procedures Suggested for Rotating Equipment.

▲ Annex B Diagrams of Typical Systems

This annex is not a part of the requirements of this NFPA document but is included for informational purposes only.

B.1 Typical Power Supply Systems. See Figure B.1 (a) through Figure B.1(d) for examples.

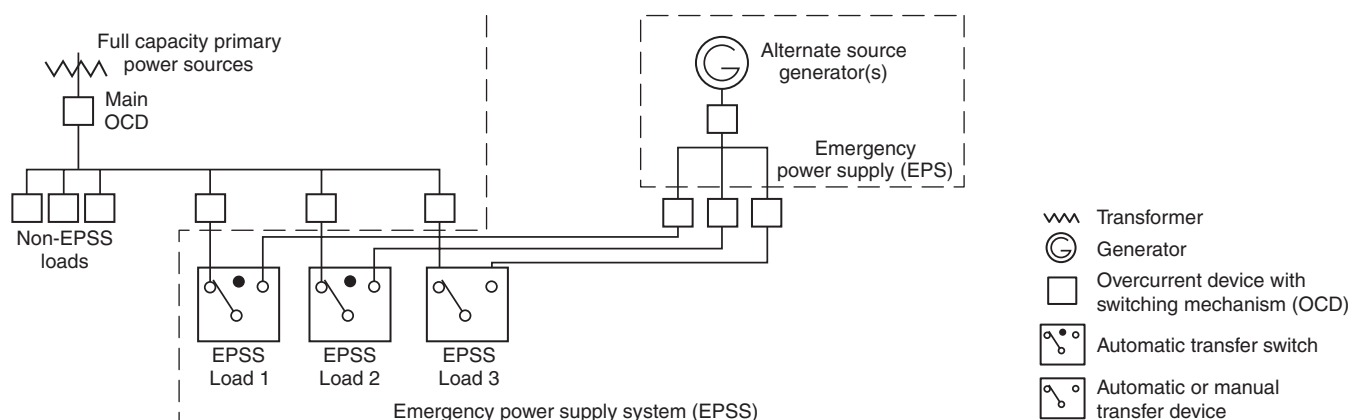


FIGURE B.1(a) Typical Rotating Emergency Power Supply System.

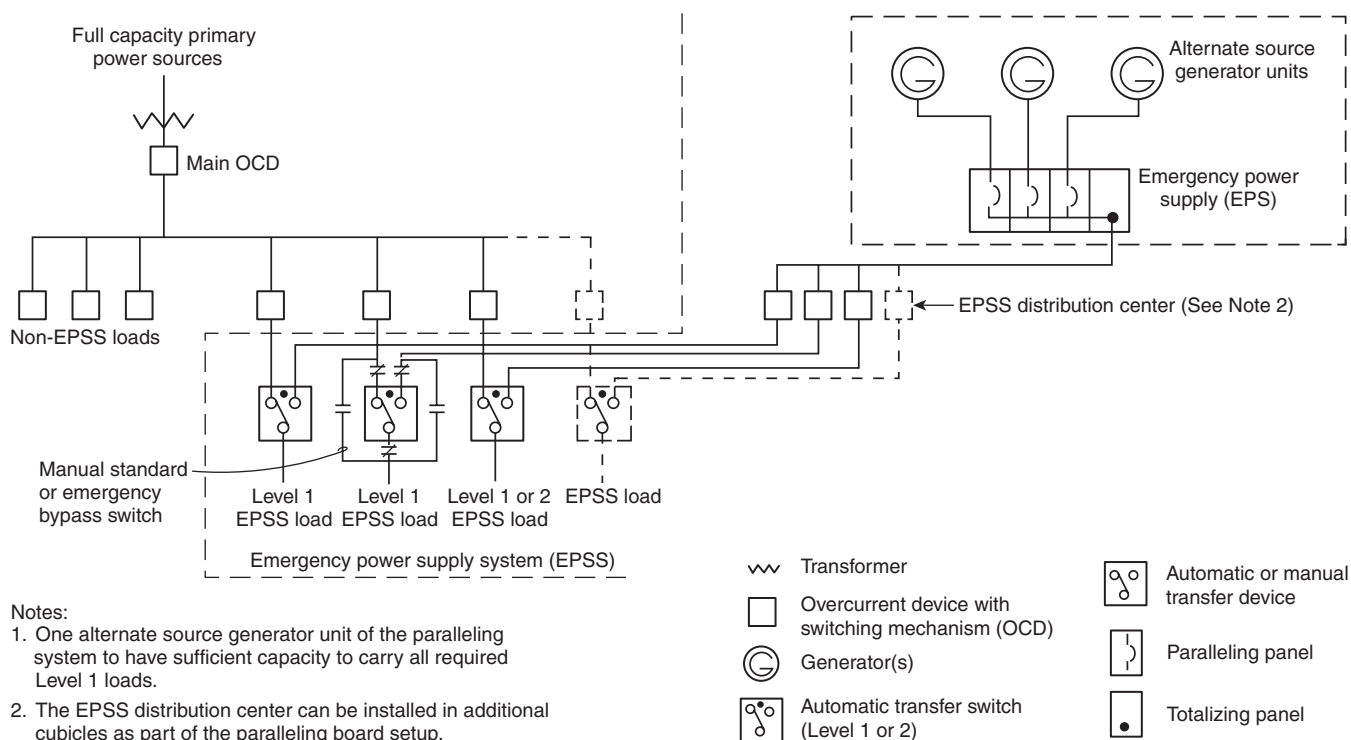


FIGURE B.1(b) Typical Multiple-Unit Emergency Power Supply System.

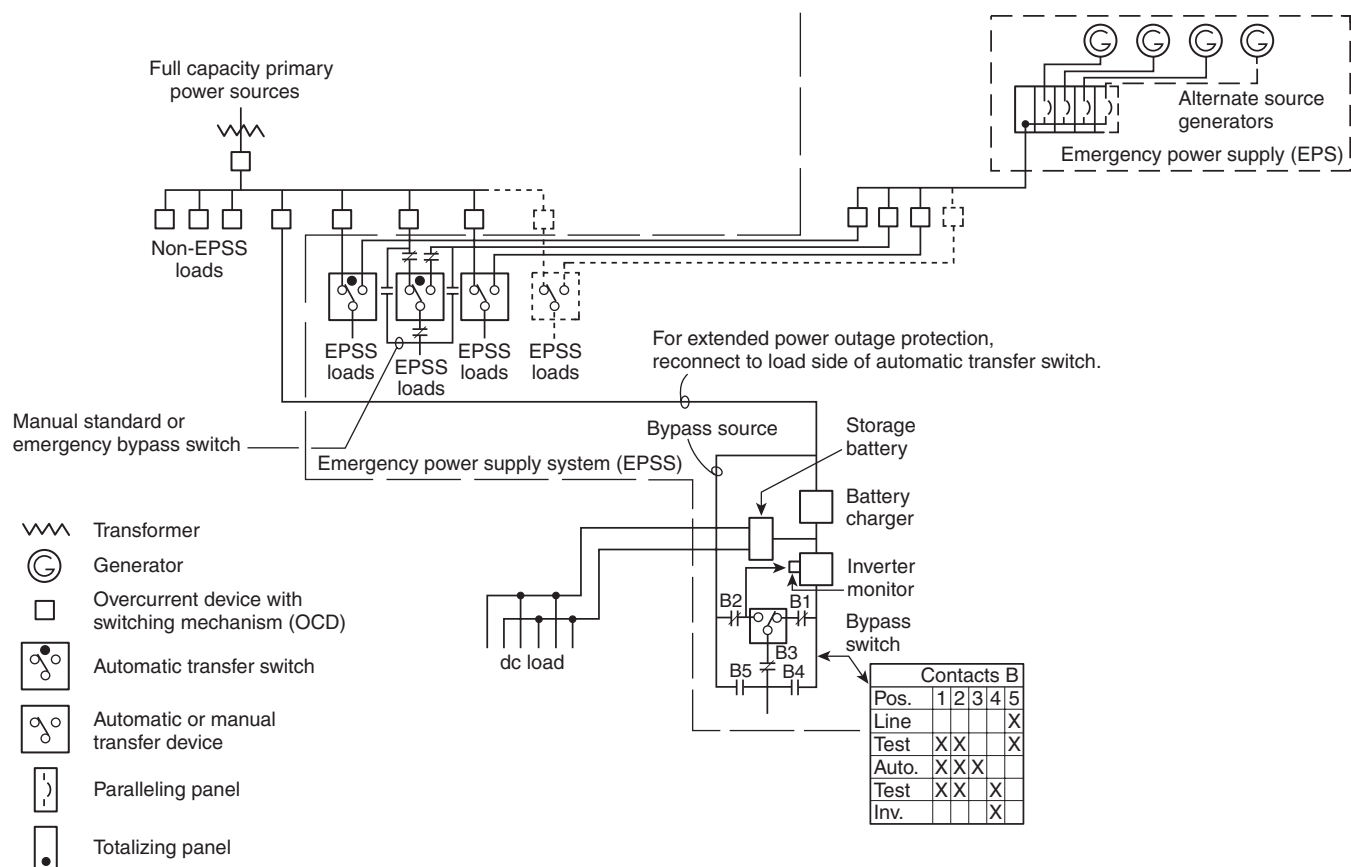


FIGURE B.1(c) Typical Composite Emergency Power Supply System.

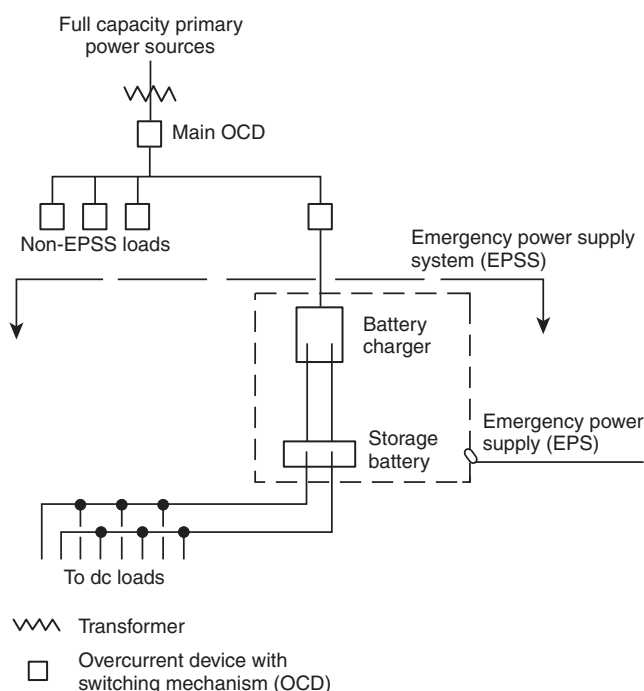


FIGURE B.1(d) Typical Uninterruptible Power Supply (UPS) System.

▲ Annex C Informational References

C.1 Referenced Publications. The documents or portions thereof listed in this annex are referenced within the informational sections of this standard and are not part of the requirements of this document unless also listed in Chapter 2 for other reasons.

C.1.1 NFPA Publications. National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471.

NFPA 20, *Standard for the Installation of Stationary Pumps for Fire Protection*, 2010 edition.

NFPA 37, *Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines*, 2006 edition.

NFPA 54, *National Fuel Gas Code*, 2009 edition.

NFPA 58, *Liquefied Petroleum Gas Code*, 2008 edition.

NFPA 70®, *National Electrical Code®*, 2008 edition.

NFPA 99, *Standard for Health Care Facilities*, 2005 edition.

NFPA 101®, *Life Safety Code®*, 2009 edition.

NFPA 111, *Standard on Stored Electrical Energy Emergency and Standby Power Systems*, 2010 edition.

C.1.2 Other Publications.

C.1.2.1 ANSI Publications. American National Standards Institute, Inc., 25 West 43rd Street, 4th Floor, New York, NY 10036.

ANSI C84.1, *Standard for Electric Power Systems and Equipment Voltage Ratings*, 1995.

ANSI/NEMA MG1, *Standard for Motors and Generators*, 1998.

ANSI/NEMA MG2, *Safety Standard for Construction and Guide for Selection, Installation and Use of Electric Motors and Generators*, 1989.

C.2 Informational References. The following documents or portions thereof are listed here as informational resources only. They are not a part of the requirements of this document.

C.2.1 NFPA Publications. National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471.

NFPA 70B, *Recommended Practice for Electrical Equipment Maintenance*, 2006 edition.

NFPA 72®, *National Fire Alarm and Signaling Code*, 2010 edition.

C.3 References for Extracts in Informational Sections. (Reserved)

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Sequence of Events Leading to Issuance of an NFPA Committee Document

Step 1: Call for Proposals

- Proposed new Document or new edition of an existing Document is entered into one of two yearly revision cycles, and a Call for Proposals is published.

Step 2: Report on Proposals (ROP)

- Committee meets to act on Proposals, to develop its own Proposals, and to prepare its Report.
- Committee votes by written ballot on Proposals. If two-thirds approve, Report goes forward. Lacking two-thirds approval, Report returns to Committee.
- Report on Proposals (ROP) is published for public review and comment.

Step 3: Report on Comments (ROC)

- Committee meets to act on Public Comments to develop its own Comments, and to prepare its report.
- Committee votes by written ballot on Comments. If two-thirds approve, Report goes forward. Lacking two-thirds approval, Report returns to Committee.
- Report on Comments (ROC) is published for public review.

Step 4: Technical Report Session

- “Notices of intent to make a motion” are filed, are reviewed, and valid motions are certified for presentation at the Technical Report Session. (“Consent Documents” that have no certified motions bypass the Technical Report Session and proceed to the Standards Council for issuance.)
- NFPA membership meets each June at the Annual Meeting Technical Report Session and acts on Technical Committee Reports (ROP and ROC) for Documents with “certified amending motions.”
- Committee(s) vote on any amendments to Report approved at NFPA Annual Membership Meeting.

Step 5: Standards Council Issuance

- Notification of intent to file an appeal to the Standards Council on Association action must be filed within 20 days of the NFPA Annual Membership Meeting.
- Standards Council decides, based on all evidence, whether or not to issue Document or to take other action, including hearing any appeals.

Committee Membership Classifications

The following classifications apply to Technical Committee members and represent their principal interest in the activity of the committee.

- M *Manufacturer:* A representative of a maker or marketer of a product, assembly, or system, or portion thereof, that is affected by the standard.
- U *User:* A representative of an entity that is subject to the provisions of the standard or that voluntarily uses the standard.
- I/M *Installer/Maintainer:* A representative of an entity that is in the business of installing or maintaining a product, assembly, or system affected by the standard.
- L *Labor:* A labor representative or employee concerned with safety in the workplace.
- R/T *Applied Research/Testing Laboratory:* A representative of an independent testing laboratory or independent applied research organization that promulgates and/or enforces standards.
- E *Enforcing Authority:* A representative of an agency or an organization that promulgates and/or enforces standards.
- I *Insurance:* A representative of an insurance company, broker, agent, bureau, or inspection agency.
- C *Consumer:* A person who is, or represents, the ultimate purchaser of a product, system, or service affected by the standard, but who is not included in the *User* classification.
- SE *Special Expert:* A person not representing any of the previous classifications, but who has a special expertise in the scope of the standard or portion thereof.

NOTES;

1. “Standard” connotes code, standard, recommended practice, or guide.
2. A representative includes an employee.
3. While these classifications will be used by the Standards Council to achieve a balance for Technical Committees, the Standards Council may determine that new classifications of members or unique interests need representation in order to foster the best possible committee deliberations on any project. In this connection, the Standards Council may make appointments as it deems appropriate in the public interest, such as the classification of “Utilities” in the National Electrical Code Committee.
4. Representatives of subsidiaries of any group are generally considered to have the same classification as the parent organization.

NFPA Document Proposal Form

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1. (a) NFPA Document Title National Fuel Gas Code NFPA No. & Year 54, 200X Edition

(b) Section/Paragraph 3.3

2. Proposal Recommends (check one): ☐ new text ☒ revised text ☐ deleted text

3. Proposal (include proposed new or revised wording, or identification of wording to be deleted): [Note: Proposed text should be in legislative format; i.e., use underscore to denote wording to be inserted (inserted wording) and strike-through to denote wording to be deleted (~~deleted wording~~).]

Revise definition of effective ground-fault current path to read:

3.3.78 Effective Ground-Fault Current Path. An intentionally constructed, permanent, low impedance electrically conductive path designed and intended to carry underground electric fault current ~~conditions~~ from the point of a ground fault on a wiring system to the electrical supply source.

4. Statement of Problem and Substantiation for Proposal: (Note: State the problem that would be resolved by your recommendation; give the specific reason for your Proposal, including copies of tests, research papers, fire experience, etc. If more than 200 words, it may be abstracted for publication.)

Change uses proper electrical terms.

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ANNOTATIONS

Origin and Development

The development of NFPA 110 began in 1976 with the formation of a technical committee to establish requirements for power sources used at a facility when the primary power source fails. Having a system installed is only half the battle; having a system that will function when called upon is the other half. Many codes and standards require such a system, but NFPA 110 fills a void by providing the criteria for an acceptable minimum performance level.

The committee worked on a draft standard over several years, which required resolving differences between other codes and standards. Finally, in 1983, NFPA 110T was available as a tentative standard. This subjected the standard to public review and generated input for clarifying the scope and many requirements for testing and maintenance. The revised document was formally adopted as NFPA 110, *Emergency and Standby Systems*, 1985 edition.

Over time technical revisions to the standard addressed many performance, testing, and maintenance aspects of these systems. Testing frequencies, durations, methods, and requirements are common areas to undergo revision, then and now. Routine maintenance requirements necessary to keep a system functional are also frequently revised as technology has changed and equipment itself has become more reliable.

Considerable thought went into the title of NFPA 110. As a performance standard, it should apply not only to required emergency and standby power systems but could be applied to voluntarily installed systems as well. Determining whether the system is “required” or “legally required” is not within the scope of NFPA 110, and the title conveys that fact.

The overall intent of NFPA 110 is to ensure a safe and reliable source of electrical power. To achieve this, the requirements are divided into eight chapters to guide the user through specific concerns regarding the performance of a standby power system. The first three chapters detail the administration of the standard, other applicable documents necessary for installation, and definitions of terms. The classification of the system is defined in Chapter 4, which then allows for determination of the applicable requirements. The physical equipment is covered in Chapter 5 (equipment that generates the electrical power) and Chapter 6 (equipment that switches between the primary electrical source and the standby system). Chapter 7 covers installation requirements that impact the system performance, and Chapter 8 covers the continued testing and maintenance of the system.

Chapter 1

The information found in Chapter 1 is essential for establishing a framework for using and applying the standard. The authority having jurisdiction (AHJ) needs to understand the boundaries of the document in order to administer the provisions and to avoid conflicts and overlaps with other codes or standards that may have been adopted. Chapter 1 includes the following administrative topics:

- Scope (Section 1.1)
- Purpose (Section 1.2)
- Application (Section 1.3)
- Equivalency (Section 1.4)

These sections lay the ground rules by which the standard is enforced. These rules are necessary in order to achieve uniformity in enforcement between jurisdictions, which assists the users of the standard in complying with its provisions.

Chapter 1 is the starting point of the standard. The user of any standard must first determine its applicability to his or her situation. Without concern for the document’s scope or purpose, it is impossible to determine proper compliance. Chapter 1 provides the necessary information to determine whether the standard applies to an installation.

1.1

The document scope describes in general terms what the document covers and includes sufficient details to explain the range or limits of what is covered. NFPA 110 is a standard addressing the reliable performance of a standby power system. Its requirements cover only installation and testing. Other codes and standards contain additional information for the need, type, installation, and use of such a system. For example, *NFPA 70®*, *National Electrical Code®* (NEC®), covers the installation of the conductors, while NFPA 37, *Standard for the Installation and Use of Stationary Combustible Engines and Gas Turbines*, covers the general installation of the diesel generator.

ANNOTATIONS

1.1.1

The scope of NFPA 110 extends to the load terminals of the transfer switch since that is the limit of the performance aspect of the power source. The requirements within NFPA 110 are based on this criterion. Delivering the reliable power to other systems is a distribution concern not covered by this standard. See Exhibit 1.

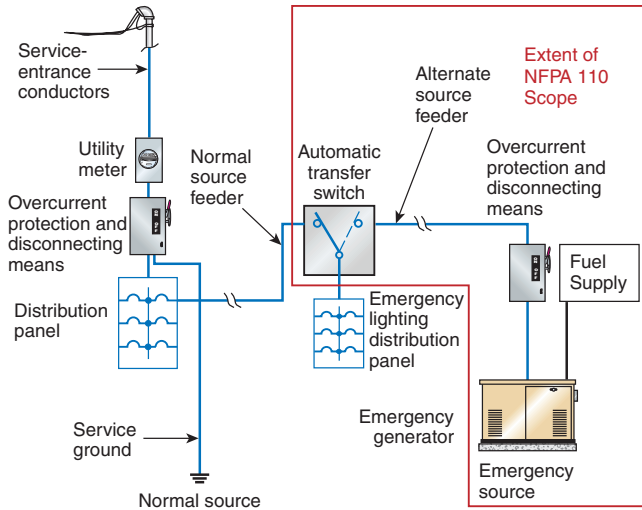


Exhibit 1. Extent of NFPA 110 Scope.

1.1.3(6)

The requirements of NFPA 110 are not intended to apply to a standby system unless it is an emergency power supply system (EPSS) designated as either Level 1 or Level 2. Early editions of NFPA 110 included a Level 3 to cover other types of systems, but minimum requirements for systems with no impact on life or safety are difficult to define because of their almost limitless applications, and the referenced Level 3 was removed from the standard. Furthermore, it is not intended that NFPA 110 apply only to required standby systems; however, until a requirement specifically includes all emergency, legally required standby, and optional standby EPSSs, its application to voluntary systems is optional. When a system (that is not required) is installed at the discretion of the owner, the choice to apply the requirements of NFPA 110 is also at the discretion of the owner. For voluntary use, the system needs to be designated as either Level 1 or Level 2 and all applicable requirements for the selected level will apply.

There is the possibility that a code or standard may not designate an EPSS level, in which case the responsibility of the authority having jurisdiction (AHJ) is to either designate the EPSS level or approve a design/installation that assigns the EPSS level.

1.3

Although the installation requirements of this standard do not apply to existing emergency power supply systems, the routine maintenance and testing (Chapter 8) provisions do apply to these systems. Proper maintenance of a system is not dependent on its installation date. Conducting operational tests ensures that the existing system is functional when needed.

ANNOTATIONS

1.4

Although it is often easier to comply with this standard by installing systems exactly as prescribed, it is not mandatory nor always possible. There could be installations, methods, pieces of equipment, and so on, that are equivalent to or superior than the requirements set forth in NFPA 110. The standard recognizes this fact and allows system designers to utilize alternate means with the approval of the authority having jurisdiction (AHJ).

Chapter 2

This chapter lists the mandatory publications referenced within NFPA 110, while Annex C lists non-mandatory publications referenced within informational sections of the standard. By locating the information immediately after Chapter 1, Administration, the user is presented with the complete list of publications needed for effective use of the standard before reading the specific requirements.

Chapter 3

Chapter 3 contains official NFPA definitions and “General Definitions,” which are technical terms whose definitions are considered crucial to the proper understanding of NFPA 110.

For both the user and the authority having jurisdiction (AHJ) to speak the same language when discussing a requirement, they must know the intended meaning of a word. Although these terms may be used or defined differently in another standard, these definitions are the only ones that apply within the scope of this standard.

3.1

This section provides general information about the definitions used in this document. It also advises the user that should a term not be defined in this chapter, then the common definition found in *Merriam-Webster's Collegiate Dictionary* will apply.

3.2

Official NFPA definitions are the same in all NFPA documents. Many NFPA documents rely on or cross-reference each other, and thus having official definitions facilitates the consistency of the documents.

3.2.2

Although NFPA is responsible for creating the standards that are adopted into law, it is the authority having jurisdiction (AHJ) that makes the final decision as to what installation complies with the requirements found within the standard. Within their jurisdictions, the AHJs provide the official interpretation and determine the equivalency of a requirement. Any given project may have an assortment of jurisdictions with interests or authority.

3.2.4

All methods, systems, and devices under the scope of NFPA 110 are required to be approved. Listing is specified if necessary to comply with a requirement. Although a standard may not require the use of listed equipment, many authorities having jurisdiction (AHJs) will require listing of equipment in order to speed the approval process. Even when listing is not required, manufacturers often will have their equipment listed to facilitate its installation and approval.

3.3

The definitions in Section 3.3 are technical terms that are considered crucial to the proper understanding of this document. These definitions are applicable only within this specific standard. Although these terms may be used or defined differently in another standard, these definitions are the only ones that apply within the scope of this standard.

ANNOTATIONS

3.3.5

The scope of NFPA 110 extends to the load terminals of the transfer switch since that is the limit of the performance aspect of the power source. With the fuel system, power source, and transfer equipment functioning properly, the capability of the distribution system to reliably deliver the emergency power to critical loads is covered by the applicable standard. Essential electrical system distribution equipment on the load side of a transfer switch is not part of the emergency power supply system (EPSS) in accordance with the definition of EPSS. The requirements within NFPA 110 are based on this criterion. Refer to Exhibit 1.

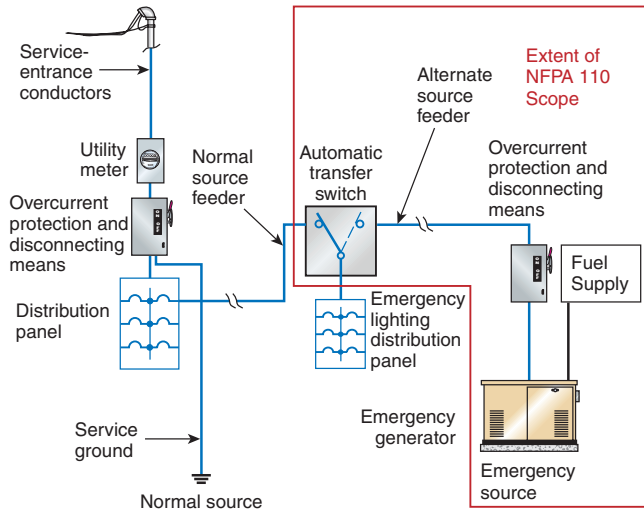


Exhibit 1. Extent of NFPA 110 Scope.

Chapter 4

Many codes and standards refer to the class and type of emergency power supply system (EPSS) as defined in NFPA 110. NFPA 110 recognizes that EPSSs are utilized at many different occupancies for many different purposes. Requirements for one situation may not be appropriate in another situation; therefore, NFPA 110 recognizes two levels of classification. Once the system is identified as either critical to life and safety (Level 1) or less critical (Level 2), the user will be able to determine which requirements apply to that system.

This standard uses the term *emergency power supply systems (EPSSs)*. Other standards may use another term, but the level, class, and type are as referenced in NFPA 110. The terms from other standards could include *alternate*, *standby*, *legally required*, or *backup* power systems—just to name a few.

4.2

NFPA 110 does not require the installation of an emergency power supply system (EPSS) nor does it require a specific class of system for any given occupancy. Its purpose is to provide the performance requirements to ensure a reliable source of alternate power. The classes specified give common ground for the designation of a system required by another code. It is recognized that it is necessary to provide systems that do not conform to the preset designations. Therefore, Class X allows for variation where a specific application may require a system to function for a different period of time. If the class designation is anything other than 0.083, 0.25, 2, 6, or 48, then that system's class is a component of Class X designation.

For example, NFPA 101®, *Life Safety Code*®, requires that new emergency power systems for emergency lighting be at least Type 10, Class 1.5, Level 1, and NFPA 99, *Health Care Facilities Code*, requires that essential electrical system power sources be classified as Type 1, Class X, Level 1. Each code refers the classifications to NFPA 110, which then provides the performance criteria.

ANNOTATIONS

4.3

NFPA 110 does not require the installation of an emergency power supply system (EPSS) nor does it require a specific system type for any given occupancy. Its purpose is to provide the performance requirements to ensure a reliable source of alternate power. The types specified give common ground for the designation of a system required by another code.

The need for an immediate transfer (uninterruptable power supply) to a manual transfer is governed by another code or standard. For example, NFPA 101, *Life Safety Code*, requires that new emergency power systems for emergency lighting be at least Type 10, Class 1.5, Level 1, and for ventilation systems of smokeproof enclosures be classified as Type 60, Class 2, Level 2.

4.4

NFPA 70, *National Electrical Code (NEC)*, describes three types of standby power systems: *emergency* (Article 700), *legally required* (Article 701), and *optional* (Article 702). The scopes of Articles 700 and 701 correlate well with a Level 1 emergency power supply system (EPSS) and a Level 2 EPSS, respectively. However, there is no corresponding level of EPSS in NFPA 110 for an Article 702 optional standby system. Optional standby systems are neither a Level 1 nor a Level 2 EPSS per NFPA 110 but may be voluntarily classified as either for application of the NFPA 110 requirements.

4.4.1

NFPA 110 does not determine which occupancies require a Level 1 system or which of its loads are critical to life safety. Level 1 is the appropriate classification where the system operation has a direct impact on life safety and failure of the system will compromise the necessary level of safety. In contrast, Level 2 (see 4.4.2) is the appropriate classification where the operation of the system is less critical to life safety because contingencies for continued operation of a facility or function without a power supply are part of an established procedure.

Again, NFPA 110 is not the standard that requires a Level 1 system for any occupancy. Other codes and standards (e.g., NFPA 101, *Life Safety Code*, and NFPA 99, *Health Care Facilities Code*) will dictate the appropriate level for a given occupancy. The installation of a Level 1 system is also not limited to loss of human life at health care facilities with patients on life support systems. The annex material provides some general examples of what is typically connected to a Level 1 system. It is not an all-inclusive list but provides an idea of functions necessary for life safety (compare to 4.4.2). The specific code, not NFPA 110, will dictate what is to be connected. The following essential functions are typically connected to a Level 1 system:

1. Life safety illumination (commonly referred to as emergency lights)
2. Fire detection and alarm systems
3. Elevators
4. Fire pumps
5. Public safety communications systems
6. Industrial processes where current interruption would produce serious life safety or health hazards
7. Essential ventilating and smoke removal systems

ANNOTATIONS

4.4.2

NFPA 110 does not determine which occupancies require a Level 2 system or which of its loads are less critical to life safety. Level 2 is the appropriate classification where the system operation does not directly impact life safety. In contrast, Level 1 (see 4.4.1) is the appropriate classification where the system operation has a direct impact on life safety.

Again, NFPA 110 is not the standard that requires a Level 2 system for any occupancy. Other codes and standards (e.g., NFPA 101, *Life Safety Code*, and NFPA 99, *Health Care Facilities Code*) will dictate the appropriate level for a given occupancy. The annex material provides some general examples of what is typically connected to a Level 2 system. It is not an all-inclusive list but provides an idea of functions that, although not directly necessary for life safety, may assist in rescue or fire-fighting operations (compare to 4.4.1). The specific code, not NFPA 110, will dictate what is required to be connected. The following functions are often connected to a Level 2 system:

1. Heating and refrigeration systems
2. Communications systems
3. Ventilation and smoke removal systems
4. Sewage disposal
5. Lighting
6. Industrial processes

4.4.3

Because NFPA 110 is directed at an emergency power supply system (EPSS) that has some level of impact on life safety, the system is required to be permanently installed. Even with a manually operated system, which may have a long transfer time, it is not expected that a supply has to be moved into position in order to restore power. See Exhibit 2.



Exhibit 2. A Trailer (Vehicle) Mounted Portable Generator (Not Permitted as an EPS). *(Courtesy of the International Association of Electrical Inspectors)*

ANNOTATIONS

Chapter 5

Chapter 5 provides the user with the requirements for the core of an emergency system and specifies what is acceptable as a power supply. The emergency power supply (EPS) is the source of the electrical power and includes everything necessary to generate the power. The fuel supply (energy source) and the equipment used to convert the fuel to electrical energy (energy converter) are covered in this chapter. The accessories (starting system, batteries, etc.) necessary for this action to occur are also covered. See Exhibit 3.

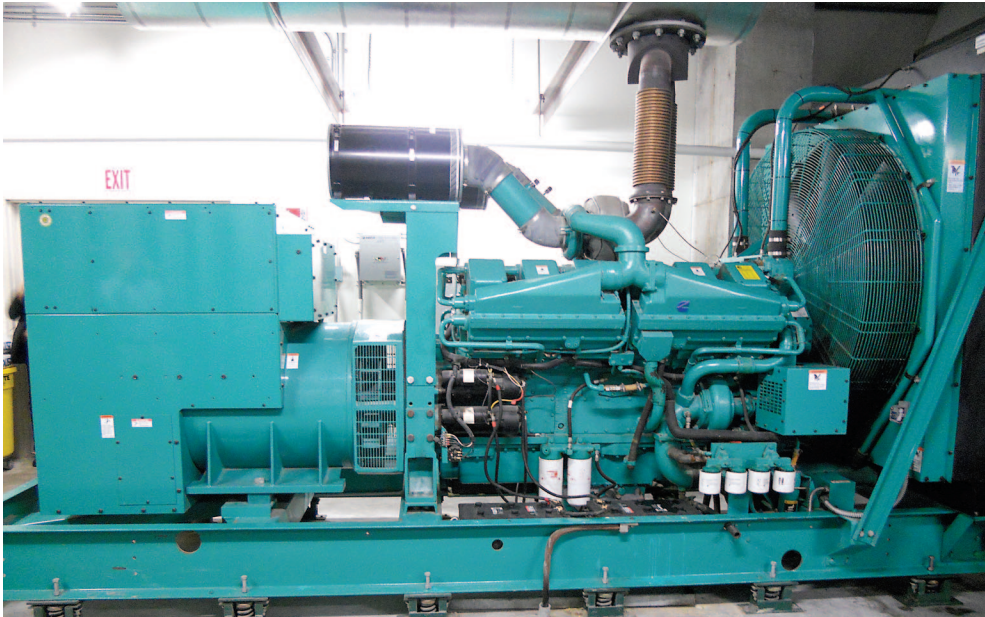


Exhibit 3. Example of an Emergency Generator.

5.1.1(1)

NFPA 110 does not specify a grade of fuel because one grade will not fulfill every need. The grade of diesel fuel selected for use in a prime mover should be based on recommendations of the diesel engine manufacturer. If diesel fuel is stored outside for long-term storage, it may be necessary to use a winter or arctic grade of diesel fuel.

5.1.1 *Exception*

The intent of the requirement is that an on-site fuel source be provided, which is the norm when using diesel or liquefied petroleum gas. The supply should be sufficient for the emergency power supply (EPS) to operate, for the duration of its class, at its rated load without refueling. Natural gas is often piped in, and the exception for a Level 1 EPS is intended to permit this method unless there is high probability that the supply will be interrupted. It still allows the use of the off-site supply but requires a transfer to the on-site supply if interrupted. When the exception to 5.1.1 is applied, it is expected that the on-site supply will have sufficient fuel to operate the EPS for the duration of its class.

Although on-site storage is common, NFPA 110 does not directly require that the requisite amount of fuel be stored on-site. Approval of an off-site fuel source is a matter that can only be addressed by the authority having jurisdiction (AHJ).

ANNOTATIONS

5.1.2

It is not within the scope of NFPA 110 to determine the loads requiring connection to the emergency power supply system (EPSS), which in turn determines the fuel capacity necessary for the required class. What loads are connected and for how long are determined by another standard. NFPA 110 requires that the emergency power supply (EPS) and its fuel supply be sufficient to supply the loads served by the EPSS for its specified time (class of service) without having to refuel. In seismic areas, the intent is for the EPS fuel supply to be enough for 96 hours of operation.

Even though a fire pump is often connected to a Level 1 system, it is not intended that the fuel supply for the generator be large enough to operate the fire pump for 96 hours of full operation. A fire pump is not expected to start just because there is a power outage. What is expected is that if a fire occurs during an outage, the generator will be able to carry the load and run the fire pump for the duration and with the fuel supply specified in NFPA 20, *Standard for the Installation of Stationary Pumps for Fire Protection*. The intent is for the fire pump to be able to run for its maximum duration if a fire occurs some time during the 96 hours and then have enough fuel left in the tank to run the fire pump again in case another incident occurs.

5.1.3

There are locations that do not operate on utility power and the primary power is generated on-site. NFPA 110 is concerned with the loss of primary power, whether generated off-site or on-site. Loss of on-site power has the same effect as loss of off-site power; therefore, a backup system is required. It is not intended that an on-site primary system also act as the emergency power supply (EPS) for the facility. A separate EPS is necessary to provide a backup to the primary system.

Although NFPA 110 limits the type of equipment permitted for Level 1 and Level 2 systems, it does not limit an on-site primary system solely to rotating equipment. Other systems (fuel cells, photovoltaics, hydro, etc.) may be used for an on-site primary generation system.

5.1.4

When on-site energy conversion is used for primary power, it is not intended that the on-site primary system also act as the emergency power supply (EPS). Loss of on-site power has the same effect on the facility as the loss of off-site power; therefore, a backup system is required. It is permitted to use a reliable electric utility as the EPS upon loss of the on-site primary system. However, when primary power is provided by the electric utility, NFPA 110 does not recognize the use of another electric utility source as the EPS.

While NFPA 110 limits the type of equipment permitted for Level 1 and Level 2 systems, it does not limit an on-site primary system solely to rotating equipment. Other systems (fuel cells, photovoltaics, hydro, etc.) may be used for the on-site primary generation system.

5.2

Energy converters are systems that convert fuel energy into electrical energy. They are rotating equipment consisting of the prime mover (engine) and rotating machinery (generator).

5.2.1

For application of the requirements of NFPA 110, the energy converter is required to be a generator (rotating equipment) with a prime mover. Fuel cells and stored energy systems are not to be utilized for Level 1 or Level 2 systems under the scope of NFPA 110. See NFPA 111, *Standard on Stored Electrical Energy Emergency and Standby Power Systems*, for the use of those systems as standby power sources.

5.2.1.2

All methods, systems, and devices under the scope of NFPA 110 are required to be approved. Although this standard does not require the use of a listed generator set, many authorities having jurisdiction (AHJs) will require listing of equipment in order to speed the approval process. Even when listing is not required, manufacturers often will have their equipment listed to facilitate its installation and approval.

Many emergency standby systems are assembled from components to meet a specific need. In the case of NFPA 110, the listing process may provide a convenient means of demonstrating compliance without the additional tests; but to allow flexibility, two alternatives are provided to evaluate generator sets that are not listed.

ANNOTATIONS

5.2.4

The prime movers are the engines that transfer the fuel energy into mechanical energy.

5.2.4.1

NFPA 110 recognizes that it may be necessary or advantageous to use a method other than otto cycle (commonly 4-cycle), diesel cycle, or gas turbine cycle to convert the energy source. This allowance does not alter the requirement to provide a generator, but only the means (prime mover) of driving the generator.

5.3.1

Energy converters are installed indoors and outdoors, and it is necessary to ensure that the system will be at the proper temperature in order to be operational when called upon. A frozen water jacket or battery chilled below its ability to start an engine must be avoided. Heating these components allows the equipment to perform—that is, start and accept load—from a cold start.

This subsection specifically addresses the temperature of the water jacket and battery. The requirement is independent of the room temperature addressed in 7.7.6. It may not be necessary to heat the entire room to a temperature for the battery to function, for example. Heating the battery may be sufficient, as long as the remainder of the equipment is capable of functioning at the room ambient temperature.

5.5.1.1

Subsection 5.5.1 applies only to the supply of fuel for a Level 1 emergency power supply (EPS). Paragraph 5.5.1.1 amends the requirement by allowing the use of the Level 1 system's fuel tank for other purposes, including to supply non-emergency power supply system (non-EPSS) equipment, as long as the required amount of fuel for the Level 1 EPS is ensured. NFPA 110 does not specify the method of ensuring that the draw-down level does not go below what is necessary to supply the assigned class of the Level 1 system. The method chosen is a design consideration.

5.5.3

This capacity requirement applies to the main fuel tank and does not intend that the required fuel supply capacity be shared between the main fuel tank and any provided day tank.

5.6.1

Since NFPA 110 is primarily a performance document, it is expected that the installation of the prime mover (combustion engine, gas turbine, etc.) follow the general requirements of NFPA 37, *Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines*, for other aspects of the emergency power supply (EPS) installation. The requirements in NFPA 110 modify those general requirements where performance of the emergency system needs to be ensured.

5.6.2

This subsection underscores that the ratings on the unit, which often are determined at the reference conditions set by the manufacturer, may not be appropriate for the actual on-site operating conditions. Without comparing the reference test conditions to the on-site conditions and applying any required derating, an installed unit may not be sufficient for the expected load. Alternately, a manufacturer may test a specifically designed system at the prevailing installation site conditions, in which case additional derating may not be necessary.

5.6.3.1.2

Emergency situations may require an emergency power supply (EPS) to accept the entire emergency load (including inrush current) in one step. When a power outage occurs, it is not possible to know what emergency loads will be operating, and there could be situations where all loads are operating at the time of the outage.

ANNOTATIONS

5.6.3.2

The requirements of 5.6.3.2 apply to any solenoid valve installed in the fuel supply line between the generator and the closest fuel tank or day tank. This battery power requirement applies only to solenoid valves in the fuel line closest to the generator set.

Solenoid valves between the engine fuel pump and the closest fuel supply tank, whether a day tank or a supply tank, must use battery voltage to ensure that the engine will start and run. Connection to the battery ensures that these valves will have a power source to provide an initial fuel supply to start the emergency power supply (EPS). Other solenoid valves are permitted to operate at battery voltage or use AC voltage from the generator set output because once the system is operational, these valves will function either way.

5.6.3.2.1.2

This requirement refers to any valve the user may elect to install between the fuel supply and the engine generator set. It is not intended to suggest installing a bypass around the emergency or malfunction shutdown device.

5.6.4

Routine maintenance and testing ensure the performance of the battery and charging system. A single system is sufficient; this subsection does not require a redundant starting battery or redundant battery charger for the starting battery.

5.6.4.1.1

Paragraph 5.6.4.1.1 simply describes the minimum performance requirements for the prime mover starting equipment. Paragraph 5.6.4.2 provides the specific time requirements for the starting equipment. Neither of these paragraphs intends that field-testing be conducted to verify compliance with these performance requirements.

5.6.4.1.2

Paragraph 5.6.4.2 provides the specific time requirements for the starting equipment. Paragraph 5.6.4.1.1 describes the minimum performance requirements for the prime mover starting equipment. Neither of these paragraphs intends that field-testing be conducted to verify compliance with these performance requirements. Note that the acceptance test in Chapter 7 does not consider operating the starter for the full duration of the cranking cycle given in Table 5.6.4.2.

5.6.4.2.2

Two cranking terminations are required because field experience indicated that this is a common failure point, whereas the other safety devices do not experience a high failure rate and do not need redundancy.

5.6.4.4

This requirement ensures that sufficient battery capacity remains to allow a second cranking limit time-out after repairing a fault.

5.6.4.5

NFPA 110 requires that batteries for starting the prime mover be either lead-acid or nickel-cadmium type but does not provide any other specific requirements on the battery construction. It does not prohibit the use of valve-regulated lead-acid or other type of “low maintenance” or “maintenance free” batteries for prime mover starting, provided all requirements in 5.6.4 are met.

5.6.5

There are multiple controls on a multiple generator system that will prevent the system from operating properly. It is the responsibility of the owner/operator to protect and ensure that these controls are kept in the appropriate setting. Only authorized persons should have access to the control panel.

Table 5.6.5.2 Item (8)

The purpose of the low coolant temperature alarm is to signal that the water jacket heaters have stopped working, possibly rendering the emergency power supply (EPS) inoperable. The setpoint for the alarm is below the temperature determined by the EPS manufacturer to be sufficient for cold start and load acceptance.

ANNOTATIONS

5.6.5.6

The function of this device is to shut down the prime mover (engine) of the emergency power supply (EPS) without the need to enter the room. The standard does not specify the exact location for the emergency stop control for an outside generator installation, but it should be located external to the weatherproof enclosure and clearly identified for its purpose. Ultimately, the location of the emergency shutdown switch is a design consideration, which often takes into account the concerns of emergency responders, and which is subject to the approval of the authority having jurisdiction (AHJ).

The security of the remote stop station is a paramount consideration when selecting its location. While the remote annunciator panel is not required to be in a secure location, NFPA 110 also does not prohibit a remote stop station from being installed at the remote annunciator panel.

5.6.6

The remote alarm is required to be in a location that is observable by personnel in order for them to react to any potential or actual malfunction as quickly as possible. If the remote alarm is powered by the standby system and the standby system fails, personnel would not receive a remote alarm. The remote alarm is required to be battery powered to provide indication when the standby system has failed or is out of service.

A single remote common audible trouble alarm is acceptable because individually identifying each specific condition remotely as well as at the control panel is unnecessary. The exact trouble condition can be determined from the control panel annunciator upon arriving at the site.

5.6.7.5

Since the radiator is an integral part of the emergency power supply (EPS), even if located remotely, its pumps and fans are powered from the line side of the EPS overcurrent devices so the EPS can run and cool regardless of problems that may occur with any overcurrent device.

5.6.7.6

The secondary side of a heat exchanger needs to be closed-loop because of the unreliability of external cooling sources.

Chapter 6

The systems covered by NFPA 110 are used as backups to a primary power source. In order to switch from one source to the other during a power outage, a transfer switch is necessary. This chapter covers the performance requirements for these switches. See Exhibit 4.



Exhibit 4. An Emergency System Transfer Switch. (Courtesy of the International Association of Electrical Inspectors)

ANNOTATIONS

6.2.6

The circuit intelligence can be either in the transfer switch or in the engine control panel. With proper circuitry, reliability is not lessened by the circuit location. It is easier, however, to reschedule sequencing of loads if time delays are located at only one place.

6.2.11.1

Many automatic transfer switch (ATS) controls are equipped with a two-position control switch so that the exercise period called for by the automatic timer will be either with or without the load transferred. Many emergency systems are installed where one transfer switch serves emergency, standby, and optional loads. Often the control switch is set to “without load” to not interrupt power to optional loads even during transfer to the emergency power supply (EPS). With the setting in this position, the generator is run by the automatic timer under no load. Engines operated this way may not be reliable sources of emergency power; therefore, NFPA 110 requires the load to be connected to the EPS during the automatic tests.

6.2.11.3

An automatic timer can cause a problem in hospitals if the system is switched at an inopportune time. A health care facility, with a test program conforming to NFPA 99, *Health Care Facilities Code*, is manually performing monthly load tests. When tests are scheduled, the facility staff is notified in advance of the starting of the generator system due to the many hazardous situations that may occur in a health care setting.

6.4.1

The bypass-isolation feature is a redundant switch whose primary purpose is to allow the safe and orderly maintenance of the automatic transfer switch (ATS) and to ensure continuity of power to critical loads without any loss of power. See Exhibit 5.

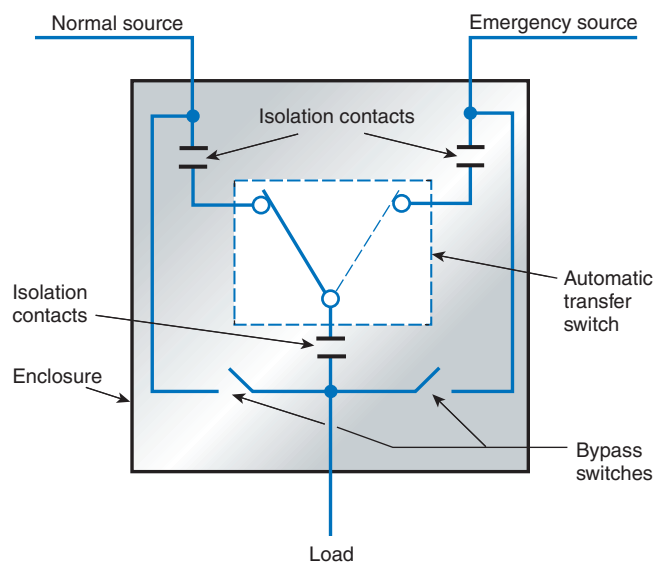


Exhibit 5. Schematic of Bypass-Isolation Transfer Switches.

ANNOTATIONS

Chapter 7

When performance is a concern, issues not typically addressed by a safety or installation standard arise. Chapter 7 is set apart to make users aware of conditions that have an effect on the performance of the emergency system. It is beneficial to know the installed system will actually perform as expected without waiting for the initial operation to occur during the first power outage. Therefore, an acceptance test is necessary to confirm that the system will perform as required.

7.1.2

Equipment or cable failure may occur anywhere between the incoming normal service and the load. For this reason, consideration should be given to the location of the transfer switch. Greater protection is usually provided by locating the transfer switch close to the utilization point, although NFPA 110 leaves selection of the actual location up to designer.

7.1.3

NFPA 110 sets the minimum performance requirements governing the installation of emergency power supply system (EPSS) equipment. All systems are not created equal, and not only must NFPA 110 be followed but also the manufacturer's specifications, the authority having jurisdiction (AHJ) recommendations, and any listing requirements. The standard requirements are not intended to allow installations contradictory to the manufacturer's requirements.

7.1.5

This subsection ensures that the generator (emergency power supply [EPS]) is not overloaded. It is assumed that other system elements meet proper sizing. Other properly sized system elements are allowed to connect to the EPS, as long as the EPS is not overloaded. Occasionally, it is advantageous to use the standby system even when primary power is available. The EPS may also be used for other purposes when primary power is available if it is capable of picking up the Level 1 and/or Level 2 loads upon loss of primary power.

7.2.1

The intent is to provide the emergency power supply (EPS) with a protective envelope. A Level 1 EPS installed indoors must be separated from the rest of the building using 2-hour fire resistance rated construction. The types of loads served by Level 1 systems are critical to life safety, and the room is a key component in ensuring reliability of the emergency power supply system (EPSS) during a building emergency such as a fire.

This provision excludes installation of everything other than that necessary for the performance of the EPS in the room. It also permits, but does not require, the emergency power supply system (EPSS) (transfer switch, etc.) to be installed within the EPS room or the EPSS itself to be provided with a 2-hour rated room. Lastly, this provision does not require a separate room for a Level 2 system.

7.2.1.1

The emergency power supply (EPS) is required to be located in a room that has a 2-hour fire rating or in a suitable outdoor housing. The 2-hour rating applies to the complete envelope, including all walls, floors, and ceilings. The fire rating is to protect the EPS from external fire exposure and therefore is not required for an outdoor housing.

7.2.1.1

Having other equipment in the emergency power supply (EPS) room could affect the EPS performance or operation. It is not permitted to have any other equipment (other than EPSS, see 7.2.1) located within this room. This does not prohibit other equipment from being installed in a room with EPSS equipment.

ANNOTATIONS

7.2.2

Catastrophic events in the service switchboard equipment may interrupt the emergency power supply system (EPSS) equipment, rendering both inoperable. Regardless of the equipment orientation, it is the intent to separate the Level 1 EPSS equipment from the normal service equipment to achieve a higher degree of reliability and protection from fire hazards.

This applies only where the system voltage to ground exceeds 150 volts at 1000 amps or more; therefore, the requirement does not apply to equipment supplied, for example, by a 208Y/120 volt system. It also applies only to service equipment. The location of other electrical distribution equipment, such as a panelboard supplied by the EPSS, is not covered by the requirements of NFPA 110, whose scope extends to the load terminals of transfer equipment.

Although the requirement applies to specific Level 1 systems, all Level 1 and Level 2 systems may benefit from consideration of potential fire hazards when installed with other electrical equipment.

7.2.3

The intent is to ensure that the location of the emergency power supply system (EPSS) equipment will not be subject to flooding from natural causes or from accumulations of water due to fire fighting, sprinkler operation, or a building system malfunction. Not all basements are subject to flooding, and installation in a basement is permitted provided an assessment of potential flooding conditions has been made. Locating EPSS equipment above lower levels in a building or above previous flood elevations, or installing adequate floor drains, are examples of meeting this requirement. This requirement does not preclude installation of fire suppression systems in the room containing the EPSS.

7.2.4

NFPA 110 does not attempt to define every possible scenario of emergency power supply system (EPSS) interruption. Reliability and continuity of electrical power to emergency loads are the paramount objectives of NFPA 110, and minimizing the interruption through design considerations is a major factor for the installation of the EPSS. Consideration for natural conditions, human-caused conditions, and equipment failure each may need to be addressed, but NFPA 110 allows for system designers to determine a suitable method for the hazards present.

7.2.5

The need for a 36 in. clearance from the outermost projection from the generator set is to allow access for functions such as inspection and maintenance. Clearances for other reasons (cooling, combustible materials, etc.) are specific to a generator, and NFPA 110 does not specify these other distances. For example, NFPA 37, *Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines*, specifies a 5 ft clearance from buildings of combustible construction and from building windows. In addition, manufacturer installation instructions for a specific generator may require other clearances.

ANNOTATIONS

7.3.1

Maintenance personnel at the emergency power supply (EPS) will be in the dark if primary power is disrupted and the EPS requires attention. A battery-powered light source at the EPS when the normal service fails and the generator is down will allow maintenance of the system to continue. See Exhibit 6.

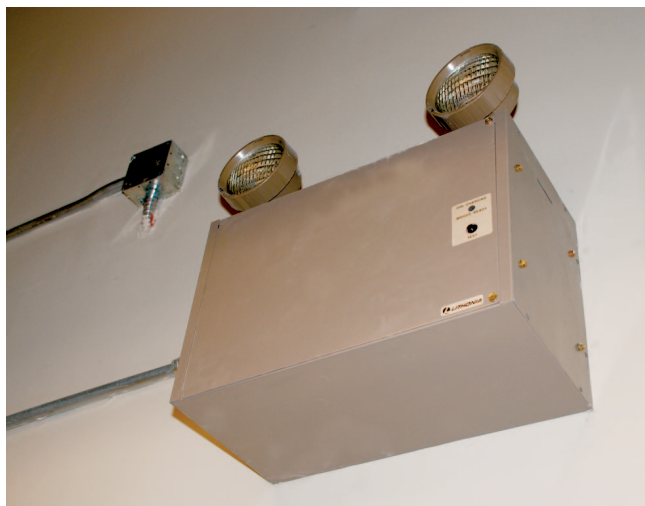


Exhibit 6. Self-Contained, Fully Automatic Unit Equipment.
(Courtesy of the International Association of Electrical Inspectors)

ANNOTATIONS

7.7.1

This requirement addresses the heat generated by the emergency power supply (EPS) while functioning. An EPS operating in an enclosed room could raise the ambient temperature above the operating temperature of the equipment, and therefore proper ventilation is necessary.

7.7.2.1

See Exhibits 7 and 8.

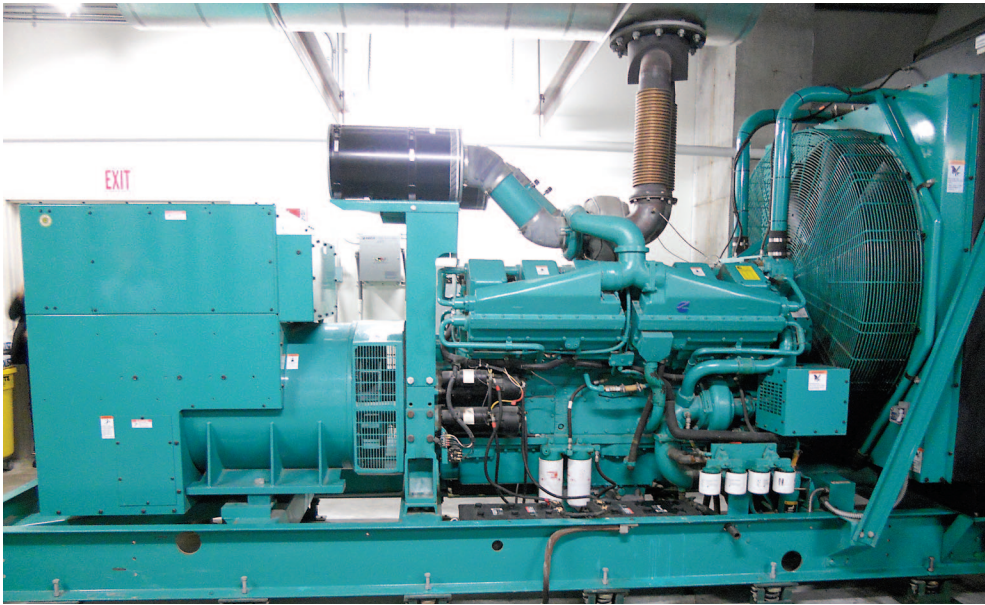


Exhibit 7. Example of an Emergency Generator with Direct External Air Supply.



Exhibit 8. Ventilation Air Supplied Directly from a Source Outside of a Building Through an Opening in an Exterior Wall.

ANNOTATIONS

7.7.2.3

Combustion engines require a supply of air to operate. Prohibiting the use of fire dampers, shutters, or similar self-closing devices is necessary to ensure that the performance of a Level 1 emergency power supply (EPS) is not compromised due to an insufficient supply and exchange of combustion air.

7.7.3

The requirement for the room containing the emergency power supply (EPS) to have a 2-hour fire rating is accomplished by addressing the discharge and ventilation air systems. The EPS will be supplying critical emergency equipment, and impeding exhaust or intake air because of automatically closing dampers is counterproductive to the safety function of the EPS. Therefore, the requirement for either a direct outside discharge/intake or the use of a 2-hour rated air transfer system maintains the fire rating of the EPS room.

7.7.6

This provision applies to all generators supplying a Level 1 emergency power supply system (EPSS) and requires that the inside of a room or outdoor enclosure be maintained at a temperature of not less than 40°F. See Exhibit 9.



Exhibit 9. EPS Located in Heated and Secured Outdoor Enclosure. Note that the area is not subject to flooding. (*Courtesy of the International Association of Electrical Inspectors*)

7.7.7

Energy converters installed outdoors need to be operational when called upon. A frozen water jacket or battery chilled below its ability to start an engine must be avoided. Heating these components allows the equipment to perform—that is, start and accept load—from a cold start.

7.8.2

The reliability of the water utility is the same concern as for an electric utility. The same disaster that disrupts the electric utility might also disrupt the water utility, rendering the emergency power supply (EPS) inoperable if relying on the water supply for cooling.

7.9.1.2

Fuel quality and fuel management are a concern since many generator failures are attributed to poor fuel quality, contamination, and other fuel system problems. Regularly scheduled examination of the fuel allows the operator to evaluate the condition of the fuel. From this examination, a decision regarding the quality of the fuel can be made and in turn ensure the reliable operation of the prime mover.

ANNOTATIONS

7.9.1.3

Power interruptions can often be accompanied by the interruption of fuel delivery systems (snow levels, blocked roads, etc.). Prudent disaster management may require larger on-site temporary or permanent fuel storage, but consideration should be given before utilizing oversized tanks since many fuels have a shelf life. Fuel quality is a concern since many generator failures are attributed to poor fuel quality or contamination. Regularly scheduled examination of the fuel will assist in evaluating the condition of the fuel.

7.9.2

The location of the main fuel tank is not specified nor does NFPA 110 prohibit overhead fuel supplies. The tank distance from the prime mover (engine), without the use of a fuel transfer pump and day tank, is limited by the ability to deliver enough fuel to meet the system's fuel requirements. This allows flexibility in the design and installation of the system.

There is no general requirement to provide a day tank. A remote main tank may not supply the demand of the emergency power supply (EPS), and a day tank may be necessary to meet the EPS fuel system requirements. A minimum capacity is not specified for the day tank. See Exhibit 10.



Exhibit 10. Example of a Day Tank.

7.9.2.1

There is no general requirement to provide a day tank. A large main tank may place an excessive pressure on the fuel system, and a day tank is necessary if the fuel pump static head pressure is exceeded. A minimum capacity is not specified for the day tank.

7.9.3.1

The reaction between the sulfur in the diesel fuel and galvanizing on the interior of piping may adversely affect diesel engine performance. The fuel stands in the pipes for long periods, allowing for a sustained reaction between the fuel and galvanizing. Prohibiting the use of galvanized pipe reflects the need to provide a highly reliable fuel delivery system.

ANNOTATIONS

7.9.4

The intent is to allow the fuel from the prime mover to return to the day tank without the use of a fuel pump. The use of gravity return for the unburned fuel is considered a more dependable method than a pump, which is subject to potential failure. The requirement also eliminates any pressures on the engine fuel return apparatus and fittings that could result in leaks.

7.9.5

This subsection only limits the capacity of an integral tank. NFPA 110 does not require the use of integral tanks for generators installed on roofs and installed in basements. For both of these generator locations, an external fuel tank may be used.

7.9.7

When fire fighters respond to a fire, they shut off the main gas supply to a building. Shutting off the main valve would inadvertently turn off the fuel supply to the emergency generator, leaving the emergency power supply (EPS) without fuel. For this reason, the EPS fuel system connects to the supply side of the main shutoff valve. If it becomes necessary to remove all fuel supplies to the building, the tag at the main supply will indicate that the additional valve requires closing.

7.9.12

This provision allows the use of listed generator subbase secondary containment fuel tanks with a capacity of 660 gallons or less without a dike. For all other fuel tanks or where the subbase tank capacity exceeds 660 gallons, the need for a containment system is addressed in other documents. The tank installation requirements are in NFPA 30, *Flammable and Combustible Liquids Code*; NFPA 37, *Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines*; NFPA 54, *National Fuel Gas Code*; and NFPA 58, *Liquefied Petroleum Gas Code*.

7.10.3.1

It is possible to install piping that has no low points in the system that could trap any condensate. If this condition exists, there is no reason to install a condensate trap and drain valve in a self-draining system.

7.11.1

This subsection prohibits use of the room for all other activities unless they are directly related to the operation of the emergency power supply (EPS). For example, setting up small offices in an EPS room would violate this requirement. The list of items that may be stored in the EPS room clarifies the requirement.

7.11.2

NFPA 110 does not mandate the use of a fire suppression system in the emergency power supply (EPS) room. Other codes and standards determine the need for such a system. The fire rating of the room addresses the performance aspect of the EPS. NFPA 110 provides requirements addressing the type of suppression systems not permitted in the EPS room without additional consideration.

NFPA 110 does not prohibit the use of water-based fire protection systems for fire suppression within the EPS equipment room. It is not plausible to expect an EPS manufacturer to certify that a water-based fire protection system will not damage the EPS, hinder its operation, or reduce its output.

7.11.3

NFPA 110 does not address whether it is permissible to install smoke or heat detection in lieu of a fire suppression system. NFPA 110 provides a mandatory reference to NFPA 72, *National Fire Alarm and Signaling Code*, when a fire detection system is installed. The decision on whether detection can be used as an alternative to a sprinkler system in the emergency power supply (EPS) room is the responsibility of the authority having jurisdiction (AHJ) based on the applicable building/life safety codes that have been adopted in that jurisdiction.

7.11.4

NFPA 110 does not require the installation of a lightning protection system but does require that NFPA 780, *Standard for the Installation of Lightning Protection Systems*, be followed for the installation of a system.

ANNOTATIONS

7.12.5

Some support equipment must be connected to both normal and emergency power in order for the system to function. This equipment connects to the load side of the transfer switch to ensure system reliability. The equipment could include such items as fuel transfer pumps, battery chargers, and jacket water cooling pumps.

7.12.6.2

A permanent connection away from the battery terminals is necessary to remove the corrosion problem that may occur at the battery terminals.

7.13

These installation acceptance tests are applied to the new components of an emergency power supply system (EPSS) whether installed for a new or existing system. For example, an acceptance test is needed for a new generator [emergency power supply (EPS)] being integrated into an existing EPSS. An acceptance test is also needed for the initial EPSS for a new and unoccupied building.

7.13.3

The authority having jurisdiction (AHJ) is the only independent, unbiased party present at the time of testing. It is in the best interest of all parties, especially the user and consumer, that a viewed test be made available to the AHJ. Any given project may have an assortment of jurisdictions with interests or authority.

7.13.4.1

It is beneficial to know the installed system will actually perform as expected without waiting for the initial operation to occur during the first power outage. This paragraph provides guidelines for acceptance testing of a new emergency power supply system (EPSS) in a new and unoccupied building and acceptance testing for a new EPSS at an existing facility. The test is performed on the completely installed EPSS with the test load supplied through the load terminals of the transfer equipment. This requirement applies to the entire EPSS whether supplied by single or multiple emergency power supplies.

7.13.4.1.3(10)

Often at new installations, the actual building load is not available at the time of the test. It is permitted to use other loads that simulate the intended load of the system.

7.13.4.3.1

The requirements are the minimum benchmarks to ensure proper operation of the emergency power supply (EPS). The incremental test provision allows for step-loading of the EPS where there is a concern over ignition of residue in the exhaust stack. If this concern is not inherent to a specific installation, loading to not less than the minimum step-loading levels during the duration of the test is acceptable. Loading the EPS to any level above the minimum step levels is considered to exceed the minimum requirement. It is the operation of the generator at minimum levels for the prescribed time period and not adherence to the exact load levels that is the objective of this paragraph.

7.13.4.3.3

Where the emergency power supply (EPS) is multiple units in parallel, the summed nameplate kW rating of the entire system may be greater than locally available load banks. Running the entire system at one time is acceptable, but it is permitted to test each EPS individually.

Chapter 8

Chapter 8 contains the requirements for routine maintenance and operational testing of the emergency system. Regular verification that an installed system is functional is necessary to ensure that standby power will be available when called upon at a loss of primary power. All components of the system, from fuel quality up to the operation of the transfer switch, are addressed in this chapter, since each relies on the other. The operational testing requirements of NFPA 110 are considered to be the minimum benchmarks to ensure proper operation of the emergency power supply (EPS).

ANNOTATIONS

8.1

Random inspection and testing are not a basis for maintaining the dependability of the emergency power supply system (EPSS). The continued reliability of the EPSS is dependent on an established program of routine maintenance and operational testing.

8.3.2

When components of an emergency power supply system (EPSS) are repaired or replaced, the operation of the system must be ensured. Such repairs do not invoke the initial acceptance tests described in Section 7.13. In addition to being a mandatory requirement for existing EPSS installations, a routine maintenance and operational test is necessary when any part of the EPSS has had repairs that impact the reliability of the system.

8.3.4.1(4)

The manufacturer may provide guidance on testing of their equipment upon repair. Some repairs, such as a coolant hose change, need to be tested for a period of time necessary to pressurize the coolant system so that leaks can be detected.

8.3.7

A major problem of starting generator sets is the lack of battery maintenance. Properly maintaining batteries is important since the system requires a battery in order to start. It is permissible to go beyond the standard requirements. For example, a load test on the starting battery may predict the failure of the battery, or may detect the presence of other conditions that could prevent an emergency power supply (EPS) from starting. See Exhibit 11.



Exhibit 11. Detail of Batteries Used for Starting Engine Used for Emergency Power. Note the clean contacts.

8.3.7.2

Although batteries are required to be lead-acid or nickel-cadmium (NiCad), battery design and chemical composition affect their longevity. There is no time frame specified for battery replacement, which is to be performed in accordance with the battery manufacturer's instructions/recommendations.

ANNOTATIONS

8.3.8

Fuel quality and fuel management are a concern since many generator failures are attributed to poor fuel quality, contamination, and other fuel system problems. Regularly scheduled examination of the fuel allows the operator to evaluate the condition of the fuel. It is advisable to sample the bottom of the storage tank to verify that the stored fuel is as clean and dry as practicable, and that water, sediment, or microbial growth on the tank bottom is minimized.

NFPA 110 does not cite the specific ASTM standard to be used for the fuel quality test. The ASTM standard may vary for different fuels, it may have a revision cycle different from that of NFPA 110, or the jurisdiction may use a different edition. Therefore, the authority having jurisdiction (AHJ) is responsible for acceptance of the fuel quality standard and means of assessment to be used.

Applicable and appropriate ASTM standard test methods are recommended to ascertain the long-term storage capability of existing stored fuels. Limited fuel quality testing performed annually using appropriate ASTM standard test methods is recommended as a means to determine that existing fuel inventories are suitable for continued long-term storage. ASTM D-975 contains test methods for existing diesel fuel.

8.4.1

A weekly inspection procedure may be provided for a specific generator. In lieu of that, there are weekly inspection items for emergency power supply system (EPSS) installations identified in Figure A.8.3.1(a). There are also inspection items for monthly, quarterly, semi-annual, or annual intervals.

It is not intended that the weekly inspection include exercising the generator. However, NFPA 110 specifies minimum requirements, and a manufacturer may have recommendations that exceed those requirements.

8.4.2

Once a system has been commissioned, operational tests are necessary to adequately test the performance of the generator. The monthly test for diesel-powered generator sets provides two test methods. Where neither of the methods can be achieved, 8.4.2.3 provides the alternate monthly test, which is then augmented by an annual test. If one of these test parameters can be met, the alternative monthly/annual test in 8.4.2.3 is not required to be implemented.

Many facilities install oversized generators for future expansion. The loading percentage is based on the generator nameplate kW rating, not on the actual load of the building. A test that uses 100 percent of the existing emergency power supply system (EPSS) load may not meet 30 percent of the generator nameplate kW rating.

8.4.2(1)

There is no load percentage required for this test. The load needs to be sufficient to achieve the exhaust temperature recommended by the manufacturer. Exhaust temperature monitoring is a method of measuring proper emergency power supply (EPS) loading.

ANNOTATIONS

8.4.2.3

This alternative monthly/annual test is not required to be implemented if a test parameter in either 8.4.2(1) or (2) can be met. There are installations where the generator capacity greatly exceeds the total emergency power supply system (EPSS) load, thus making the test parameters in 8.4.2(1) and (2) unachievable. A two-part alternative test method is provided for these systems. Applying the EPSS load to the generator during the monthly test, even if that load does not meet the requirements of 8.4.2(1) and (2), is the first part. The monthly test is conducted with the EPSS load that is running at the time of the test. It does not require that additional loads be turned on for this test. For example, it does not require that a fire pump on the system be run for any portion of the test.

The second part is an additional annual test using load banks [or other building loads that are permitted to be supplied by the emergency power supply (EPS)] to meet the specified loading requirements. The annual load bank test supplements the required monthly test and applies only to diesel-powered generators that supply Level 1 and Level 2 EPSSs.

The incremental test allows the exhaust stack temperature to gradually rise in order to prevent backpressure or stack fires that may occur due to wet-stacking (incomplete combustion) because the EPS is lightly loaded. The percentages are minimum loading requirements to offset operational problems associated with lightly loaded generators, and loading that exceeds these minimum parameters is acceptable as long as tests are conducted for a total of 1½ continuous hours. It is the operation of the generator at minimum levels for the prescribed time period and not adherence to the exact load levels that is the objective of this paragraph. For example, 80 percent loading of the EPS for not less than 1½ hours exceeds the minimum requirement.

Many facilities install oversized generators for future expansion. The loading percentages are based on the generator nameplate kW rating, not on the actual load of the building. A test that uses 100 percent of the existing EPSS load may not meet 50 percent or 75 percent of the generator nameplate kW rating.

8.4.2.4

Spark-ignited engines ignite an air-fuel mixture in the combustion chamber by an electrical spark. Natural gas, propane, and gasoline engines are examples of spark-ignited engines. Diesel engines are typically compression ignition engines.

This paragraph specifies that spark-ignited units are to be tested with the available load either for 30 minutes or until water temperature and oil pressure have stabilized. There are no annual exercising provisions for spark-ignited generators similar to that found in 8.4.2.3 for diesel-powered generators. These spark-ignited units are not subject to the same concerns as diesel units when run under a light load.

This test is conducted with the EPSS load that is running at the time of the test. It does not require that all other EPSS loads be turned on for this test.

8.4.5(3)

With an emergency system not designed to carry the entire primary power load, retransfer to primary power may be advantageous to occur in 5 minutes. For example, in a bank of elevators only one elevator may be on the emergency system. During repair, the primary power may experience momentary interruptions and retransfer should not occur. When uninterrupted primary power is available for 5 minutes, the system's return to primary power will bring other elevators online without extended delays. There is no maximum retransfer delay as this a design consideration.

8.4.6.1

This test is not the manual operation of an automatic transfer switch (ATS). This is an electrically operated transfer from the standard or normal source position to an alternate source position and then back to the standard source position. Although not required to be conducted together, monthly operation of the transfer switch may be conducted in conjunction with the monthly test of the generator.

8.4.7

It is not intended that the circuit breakers be exercised under load.

ANNOTATIONS

8.4.8

Reliable operation of the emergency power supply system (EPSS) is highly dependent on the skill set of those performing maintenance and testing of the EPSS equipment. Those performing these tasks should have skills and knowledge related to the operation, maintenance, repair, and testing of the EPSS equipment and installations.

8.4.9

This requirement applies to all generator types if they supply a Level 1 emergency power supply system (EPSS). The intent is to ensure that the EPSS with all its auxiliary systems is capable of running with load for the duration of its assigned class. It is not intended that a full facility power outage be conducted as part of these tests. This 36 month test is not a requirement for a Level 2 EPSS.

8.4.9.1

Level 1 emergency power supply systems (EPSSs) are tested for the duration of their assigned class if less than 4 hours. See 8.4.9.2 for an assigned class that exceeds 4 hours.

8.4.9.2

The intent is to require a minimum, rather than a maximum, test duration within a reasonable period. Level 1 emergency power supply systems (EPSSs) are not required to be tested for the duration of their assigned class if the class exceeds 4 hours. The test may be terminated at 4 hours, although this is not mandatory. See 8.4.9.1 for an assigned class that is less than 4 hours.

8.4.9.5.1

Many facilities install oversized generators for future expansion. The loading percentages are based on the generator nameplate kW rating, not on the actual load of the building. A test that uses 100 percent of the existing emergency power supply system (EPSS) load may not meet 30 percent of the generator nameplate kW rating.

8.4.9.5.2

There is no load percentage required for this test. The load needs to be sufficient to achieve the exhaust temperature recommended by the manufacturer. Exhaust temperature monitoring is a method of measuring proper emergency power supply (EPS) loading.

8.4.9.5.3

The 36 month test for other than a diesel emergency power supply (EPS) is conducted with the emergency power supply system (EPSS) load that is running at the time of the test. It does not require connection of all other EPSS loads or require that additional loads be turned on for this test. For example, it does not require that a fire pump on the system be run for any portion of the test.

8.4.9.6

A single test may combine one monthly test, one annual test, and the 36 month test. The monthly test for diesel generators uses either a minimum load to maintain the exhaust temperature [8.4.2(1)], a 30 percent minimum load [8.4.2(2)], or no minimum load (8.4.2.3). The minimum loading requirements for a combined monthly and 36 month test are found in 8.4.9.5, and a test that exceeds the minimum loading requirement is acceptable. See 8.4.9.7 for combined annual and 36 month tests.

8.4.9.7

A single test may combine one monthly test, one annual test, and the 36 month test. The minimum loading requirements for a single test are found in 8.4.9.5 for the first 3 hours and 75 percent of the nameplate rating for the last hour. A test that exceeds the minimum loading requirement is acceptable.

Many facilities install oversized generators for future expansion. The loading percentages are based on the generator nameplate kW rating, not on the actual load of the building. A test that uses 100 percent of the existing emergency power supply system (EPSS) load may not meet 75 percent or even 30 percent of the generator nameplate kW rating.

ANNOTATIONS

Annex A

Annex A is included solely to help the user of the document understand the intent of the requirements in the body of the standard by providing further explanatory text, figures, and tables. While the provisions in the body of the standard are mandatory, Annex A is nonmandatory material prepared and voted on by the technical committee. Although the information is processed the same way as mandatory requirements, the annex material is not enforceable. The committee generates this information to provide additional guidance not capable of being included within the mandatory requirements.

Annex B

The one-line diagrams in Annex B illustrate four typical system installations. They are not intended to be all-inclusive nor are they intended to be an approved design for any given system.

Annex C

This annex lists publications that are referenced within the standard's non-mandatory annexes. Chapter 2 lists publications that are mandatory to the extent referenced within the mandatory body of the code. The publications in this annex are NOT mandatory but do contain information that can assist with the installation of emergency and standby power systems. This list is neither an exhaustive list nor an endorsement of the materials mentioned.