NFPA 111

Standard on Stored Electrical Energy Emergency and Standby Power Systems

2001 Edition

NFPA, 1 Batterymarch Park, PO Box 9101, Quincy, MA 02269-9101
An International Codes and Standards Organization

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Stored Electrical Energy Emergency and Standby Power Systems

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This edition of NFPA 111, *Standard on Stored Electrical Energy Emergency and Standby Power Systems*, was prepared by the Technical Committee on Emergency Power Supplies and acted on by the National Fire Protection Association, Inc., at its November Meeting held November 12–15, 2000, in Orlando, FL. It was issued by the Standards Council on January 13, 2001, with an effective date of February 9, 2001, and supersedes all previous editions.

This edition of NFPA 111 was approved as an American National Standard on February 9, 2001.

Origin and Development of NFPA 111

The Technical Committee on Emergency Power Supplies was organized in 1976 by NFPA in recognition of the demand for guidelines on the assembly, installation, and performance of electrical power systems to supply critical and essential needs during outages of the normal power source. The committee developed a base standard, NFPA 110, *Standard for Emergency and Standby Power Systems*. During the process of developing NFPA 110, it was determined that several power sources were available for emergency and standby power systems, each of which presented unique characteristics. The committee determined that sufficient differences existed between these sources to justify a multidocument presentation, with each document providing clearly defined specifics. Each document would follow the basic format of NFPA 110 to provide a consistent basis for comparison and usage and would remain under the jurisdiction of the Technical Committee on Emergency Power Supplies.

However, because of the unique knowledge necessary to provide an authoritative document, it was determined that a subcommittee should be established to prepare each document.

The technical committee, late in 1982, authorized a subcommittee to begin preparation of a draft document on systems using stored energy sources. Actual drafting began in 1984. In 1986, the technical committee authorized the entry of a document tentatively titled NFPA 110A, *Stored Energy Emergency and Standby Power Systems*, for adoption at the 1989 NFPA Annual Meeting.

Now designated as NFPA 111, this document addresses the performance of stored energy systems with appropriate equipment detail. It does not require the installation of stored energy systems. Rather, it is a document that, if followed, will result in a system suitable for various situations as required by other codes and standards.

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, and to achieve an on-site stored energy auxiliary electrical power source suitable to the needs of the applicable requirements.

The second edition of NFPA 111, the first under its new designation, contained only minor changes from the 1989 edition.

For the 1996 edition, the major change was the addition of Section 1.5, which covered the acceptability of systems, methods, and devices other than those listed in the document.

This 2001 edition contains two changes: moving informational text to the appendix, and expanded operational testing requirements in Section 6.3.

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This list represents the membership at the time the Committee was balloted on the final text of this edition. Since that time, changes in the membership may have occurred. A key to classifications is found at the back of the document.

NOTE: Membership on a committee shall not in and of itself constitute an endorsement of the Association or any document developed by the committee on which the member serves.

Committee Scope: This Committee shall have primary responsibility for documents on performance criteria for the selection and assembly of the components for emergency and standby power systems in buildings and facilities, including categories of power supplies, transfer equipment, controls, supervisory equipment, and all related electrical and mechanical auxiliary or accessory equipment needed to supply emergency or standby power to the utilization equipment. The Committee also shall be responsible for criteria on the maintenance and testing of the system. This Committee does not cover requirements for the application of emergency power systems, self-contained emergency lighting units, and electrical wiring, except that wiring that is an integral part of the system up to the load side of the transfer switch(es).

Contents

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Stored Electrical Energy Emergency and Standby Power Systems

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NOTICE: An asterisk (*) following the number or letter designating a paragraph indicates that explanatory material on the paragraph can be found in Appendix A.

Changes other than editorial are indicated by a vertical rule in the margin of the pages on which they appear. These lines are included as an aid to the user in identifying changes from the previous edition.

Information on referenced publications can be found in Chapter 7 and Appendix B.

Chapter 1 General

1.1 Scope.

1.1.1 This standard covers performance requirements for stored electrical energy systems providing an alternate source of electrical power in buildings and facilities in the event that the normal electrical power source fails.

NOTE: For emergency power systems supplied by emergency generators, see NFPA 110, *Standard for Emergency and Standby Power Systems.*

1.1.2 Systems covered in this standard include power sources, transfer equipment, controls, supervisory equipment, and accessory equipment, including integral accessory equipment, needed to supply electrical power to the selected circuits.

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

1.1.4 Exclusions.

1.1.4.1 This standard does not cover the following:

(1) The application of the SEPSS
(2) Distribution wiring
(3) Systems having total outputs less than 500 VA or less than 24 V or systems less than Class 0.033
(4) Emergency lighting unit equipment
(5) Nuclear sources, fuel cells, solar systems, and wind stored-energy systems are not covered by the scope of this document.

1.1.4.2 The following are not within the scope of this standard:

(1) Specific buildings or facilities, or both, requiring a stored emergency power supply system (SEPSS)
(2) Specific loads to be served by the SEPSS
(3) Type, class, or level to be assigned to any specific load *(See Section 2.1.)*

1.2 Purpose.

1.2.1 This standard provides performance requirements for SEPSS and also can be used in conjunction with other standards. It is the role of other NFPA standards to specify which occupancies require an SEPSS and the applicable level, type, and class. This standard does not specify where an SEPSS is required. *(See 1.1.4.2.)*

1.2.2 This standard also is intended to provide guidance for inspectors, designers, installers, manufacturers, and users of an SEPSS and to serve as a basis for communication between the parties involved. It is not intended as a design manual. Compliance with the standard is not intended to absolve the parties involved of their respective responsibilities for the design, installation, maintenance, performance, or compliance with other applicable standards and codes.

1.2.3 The installation of a stored energy system(s) conforming to this standard will ensure that alternate power is available to minimize life safety hazards resulting from power loss to certain continuous chemical or industrial processes, computer controlled systems, emergency lighting, and the like.

1.3 Application. This document shall apply to new installations of stored emergency power supply 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 Function. The function of the SEPSS is to provide a source of electrical power of required capacity, reliability, and quality to loads for a given length of time within a specified time after loss, failure, or disruption of the normal power supply. An SEPSS shall include a means to recharge the stored energy system.

1.5 Discretionary Powers of the Authority Having Jurisdiction. 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 document, provided:

(1) Technical justification is submitted to the authority having jurisdiction to demonstrate equivalency.
(2) The system, method, or device is approved for the intended use.

Chapter 2 Definitions and Classification

2.1 Definitions.

2.1.1* Approved. Acceptable to the authority having jurisdiction.

2.1.2* Authority Having Jurisdiction. The organization, office, or individual responsible for approving equipment, materials, an installation, or a procedure.

2.1.3 Automatic Transfer Switch. An automatic transfer switch is self-acting equipment for transferring one or more load conductor connections from one power source to another.

2.1.4 Emergency Power Supply (EPS). The source of electric power of the required capacity and quality for an Emergency Power Supply System (EPSS), including 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. For rotary energy converters, components of an EPS include: prime mover, cooling system, generator, excitation system, starting system, control system, fuel system, and lube system (if required).

2.1.5 Emergency Power Supply System (EPSS). A complete functioning system of an EPS coupled to a system that may consist 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.

2.1.6 Energy Conversion Equipment (ECE). A system of either a UPS, a battery bank and battery charger (central battery system), or a rotating motor generator (with or without inertia flywheel), often supplied by a central battery system power source.

2.1.7 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.

2.1.8* 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.

2.1.9 Nonautomatic Transfer Switch. A device, operated by direct manpower or electrical remote manual control, for transferring one or more load conductor connections from one power source to another.

2.1.10 Shall. Indicates a mandatory requirement.

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

2.1.12 Stored Emergency Power Supply System (SEPSS). A system consisting of a UPS, a central battery system, or a motor generator, powered by a stored electrical energy source, together with a transfer switch designed to monitor preferred and alternate load power source and provide desired switching of the load, and all necessary control equipment to make the system functional.

2.1.13* Uninterrupted Power Supply (UPS). A system consisting of a battery source, a converter, an inverter, and control equipment designed to provide a clean, conditioned sinusoidal wave of power for a finite period of time.

2.2 Classification of Stored Emergency Power Supply Systems (SEPSSs).

2.2.1* General. This standard specifies requirements for the SEPSS as a complete functioning system in terms of types, classes, categories, and levels. It is not the intent of this standard to specify the SEPSS most suitable for any given application.

2.2.2 Type. The type defines the maximum time, in seconds, that the SEPSS will permit the load terminals of the transfer switch to be without acceptable electrical power. Table 2.2.2 provides the types defined by this standard.

2.2.3* Class. The class defines the minimum time, in hours, for which the SEPSS is designed to operate at its rated load without being refueled or recharged. *(See Table 2.2.3.)*

Table 2.2.2 Types of SEPSS

Type O	No interruptions — UPS carrying load, 0 seconds
Type U	Basically uninterruptible UPS system with utility as preferred source
Type A	0.25 cycle: 0.0042
Type B	1.0 cycle: 0.0167
Type 10	10 seconds
Type M	Manual stationary or nonautomatic — no time limit

Table 2.2.3 Classes of SEPSS

Class 0.033	0.033 hours (2 minutes)
Class 0.083	0.083 hours (5 minutes)
Class 0.25	0.25 hours (15 minutes)
Class 1.5	1.5 hours (90 minutes)
Class x	Other time, in hours, as required by the application, code, or user

2.2.4 Category. Two categories are defined by this standard as follows:

(1) Category A includes stored energy devices receiving their energy solely from the normal supply.

(2) Category B includes all devices not included in Category A and not specifically excluded elsewhere in this standard.

2.2.5 Level. It is recognized that an SEPSS is utilized in many different locations and for many different purposes. The requirement for one application might not be appropriate for other applications. Therefore, this standard recognizes two levels of equipment installation, performance, and maintenance.

2.2.5.1* Level 1 defines the most stringent equipment performance requirements for applications where failure of the equipment to perform could result in loss of human life or serious injuries. All Level 1 equipment shall be permanently installed.

2.2.5.2* Level 2 defines equipment performance requirements for applications where failure of the SEPSS to perform is less critical to human life and safety and where it is expected that the authority having jurisdiction will exercise its option to permit a higher degree of flexibility than provided by Level 1. All Level 2 equipment shall be permanently installed.

2.2.5.3* It is the intent of Levels 1 and 2 to ensure that loads provided with an SEPSS are supplied with alternate power of a quality that is satisfactory to ensure adequate operation or is acceptable for the load, within the time defined in the type and for a duration defined in the class.

2.2.5.4 Level 3 defines all other equipment and applications, including optional standby systems, not defined in Levels 1 and 2. There are no performance requirements for Level 3 in this standard. Level 3 is not addressed in this document.

Chapter 3 Emergency Power Supply: Energy Sources, Converters, Inverters, and Accessories

3.1 Energy Sources. The energy sources listed in this section shall be permitted for use for the emergency power supply (EPS).

3.1.1* Electrical Storage Battery.

(1) Secondary lead–acid batteries having a construction and chemical composition suitable for standby, float service operation. They shall be permitted to have free or immobilized electrolyte and shall be permitted to be of valve-regulated (sealed) or unsealed construction.
(2) Nickel–cadmium batteries having construction and chemical composition suitable for standby, float service operation. They shall be permitted to be of valve-regulated (sealed) or unsealed construction.
(3) Secondary batteries of other couples, designed for standby, float service operation, acceptable to the authority having jurisdiction.

3.1.2 Emergency and Standby Systems.

3.1.2.1 The EPS shall be located on site and shall meet the applicable requirements of NFPA 70, *National Electrical Code®*.

3.1.2.2* Batteries shall be central battery systems, as follows:

(1) Open rack type
(2) Console or package style
(3) A combination of (1) and (2)

3.2 Energy Conversion Equipment (ECE) — General.

3.2.1 Energy conversion equipment as addressed in this standard shall pertain to systems utilizing battery sources or inertia devices, or both, with related control, conversion, and accessory items.

3.2.2 The ECE shall be limited to the following:

(1) Uninterruptible power supply (UPS) systems
(2) Standby power supply systems (central battery systems)

3.2.3 The ECE for Level 1 shall be of proven design and components whose performance and reliability have been listed.

3.2.4 The ECE shall be tested and certified by the manufacturer at full rated load for the specified class.

3.2.5 The output of an ECE shall be dc or ac and of the voltages, waveform, and frequency acceptable for the load.

3.2.6 Temperature. Energy converters shall be designed to operate without failure over the expected environmental temperature range. For indoor units, this range shall be 50°F to 104°F (10°C to 40°C). For outdoor units, or units in areas having no temperature control, the range shall be –30°F to 122°F (–34°C to 50°C).

3.2.7* Humidity. The ECE shall be designed to function in an atmosphere having a relative humidity that can vary from 5 percent to 95 percent.

3.2.8 Capacity.

3.2.8.1 The ECE shall have sufficient capacity to supply the class for which it is rated.

3.2.8.2 Following a full duration power outage, the ECE shall be capable of automatically resupplying the full rated load and duration within 48 hours, and of resupplying 60 percent of duration at full rated load within 24 hours.

3.2.9 Response. The energy converters shall be capable of supplying the load at full voltage, correct frequency, required waveform (where applicable), and within type.

3.3 Instrumentation.

3.3.1 The SEPSS shall be provided with instruments or other approved display means, including remote annunciation capability, to indicate the following:

(1) Inverter/converter carrying load
(2) Battery voltage
(3) Battery current, charge, or discharge
(4) System output voltage, each leg
(5) System output frequency (if applicable)
(6) System output current, each leg

3.3.2 Individual visual indicators and a common audible annunciator shall be provided for the following:

(1) High/low battery voltage
(2) Output circuit breaker open
(3) High temperature
(4) ECE in bypass mode
(5) High battery current

3.3.3 For Level 1 SEPSS, contacts for remote alarm annunciation shall be provided.

Chapter 4 Transfer Switches and Protection

4.1 General.

4.1.1 Switching, as used in this chapter, refers to any electrical or electronic equipment that is used to:

(1) Transfer an electrical load from one power source to another
(2) Perform load-switching or load-shedding functions on any electrical load
(3) Bypass, isolate, and test any transfer or isolation switch in the static system
(4) Isolate any faulted component inside the static system so that it ceases to be connected to the output load terminals
(5) Bypass the ECE

4.1.2 Protection, as used in this chapter, refers either to electronic-sensing or to inherent overload protective devices (such as fuses, automatic breakers, or both) that are used to protect the static system against damage caused by faults or overloads on either the output of the static system in its loads or conductors or on internal faults in the static system.

4.2 Transfer Switches.

4.2.1 General. Transfer switches shall be suitable for transferring the connected loads between the energy converter and the building electrical service. Transfer switches shall be permitted to be electrical or electronic or a hybrid of both. Any transfer switch shall be suitable for transferring all connected electrical loads from one power source to another. Its characteristics shall be suitable for the connected electrical load. It shall provide suitable isolation between the electrical load and the alternate source(s). Transfer switches shall be permitted to be separate devices within their own enclosures or an integral part of the ECE.

4.2.1.1 The capacity and endurance rating of transfer switches shall be adequate for all classes of loads to be served. The transfer switch shall be listed.

4.2.1.2 The method of operation shall ensure that the most likely causes of switch failure result in the loads being connected to the building service.

4.2.1.3 Testing. Means shall be provided to check the operation of the transfer switch.

4.2.2* Switch Capacity. The capacity of the transfer switch, electronic or electromechanical, shall be adequate for all classes of loads to be served. The transfer switch, including all load current–carrying components, shall withstand the effects of available fault currents.

4.2.3 Transfer Switch Classification. Each transfer switch shall be listed for emergency service as a completely factory-assembled and factory-tested apparatus.

Exception: Electronic or electromechanical switches that constitute an integral part of the ECE shall be permitted, provided they form part of a listed equipment.

4.2.4 Automatic Transfer Switch Features.

4.2.4.1 General. Automatic transfer switches shall be electrically or electronically operated. The transfer of the load from one source to another source shall be permitted to be automatic. The retransfer shall be permitted to be automatically or manually initiated.

4.2.4.2* Source Monitoring. The load source shall be monitored for undervoltage and overvoltage on all of its ungrounded input lines. The ECE and the utility shall be monitored for unacceptable conditions. If a condition that is out of tolerance is sensed, the transfer switch shall automatically switch to the alternate source(s) of power, provided that the alternate source(s) of power itself is within tolerance.

When the preferred source of power returns to acceptable tolerance in its sensed parameters as given above, the transfer switch shall initiate an automatic retransfer to the preferred source. Sufficient time shall be allowed to ensure that the preferred source is within its steady-state specification limits before such retransfer is performed. Provision for retransfer to the preferred source also shall be available under manual command, provided the preferred source is within tolerance.

Retransfer shall be permitted to be sequenced if desired to pick up heavy loads without introducing further disturbances.

4.2.4.3 Interlocking. Interlocking shall be provided to prevent inadvertent interconnection of the preferred and alternate power sources.

Exception: Where interconnection is inherent in the system design, the sources of power, both the preferred and the alternate(s), shall not be connected together for any longer than necessary to transfer the preferred source of power, without disturbance to the electrical loads connected to it, provided that such interconnection can be sustained by the two connected sources of incoming power without causing internal current protection features to be initiated.

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

4.2.4.5* Time Delay on Retransfer to Preferred Source. An adjustable time delay device with automatic bypass shall be provided to delay retransfer from the alternate source to the preferred source of power. The time delay shall be automatically bypassed if the ECE or EPS fails.

4.2.4.6 Test Switch. A test switch shall be provided on each automatic transfer switch (ATS) that simulates failure of the preferred power source. The ATS shall then perform its intended function.

4.2.5 Nonautomatic Transfer Switch Features.

4.2.5.1 General. Switching devices shall operate by direct manual or remote input. Once operated, a device shall switch to its alternate state and shall remain in that state. Upon release of the input, the device shall return to its preferred state.

4.2.5.2 Interlocking. Reliable mechanical interlocking, or an approved alternate method, shall prevent the inadvertent interconnection of the preferred power supply and the alternate source or of any two separate sources of power.

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

4.3 Load Switching (Load Shedding).

4.3.1 General. Where two or more static systems are paralleled for emergency power, the paralleled systems shall be controlled so that excessive loading (i.e., beyond the intended capacity of the paralleled system) is prevented or so that the ECE goes to bypass mode.

4.3.2 Transfer Switch Rating. Each transfer switch shall have a continuous current rating and interrupting rating adequate for all classes of loads to be served. The transfer switch shall be capable of withstanding the available fault current at the point of installation.

4.3.3 Operation. First priority loads shall be switched to the emergency bus (if not already on that bus) when the emergency source is made available to their switching devices. The remaining lower priority loads shall be switched to the emergency bus thereafter, provided the emergency bus is not overloaded by such switching, until all such emergency loads of lower priority are on the emergency bus.

In the event that any static power module connected to the emergency bus is isolated from that bus due to internal failure, the total loading on the emergency bus also shall be reduced by switching off the loads in inverse priority order, in proportion to the lost power capacity of the isolated module, if the remaining connected power modules cannot serve the total connected load. Switching off shall cease when the load demand matches the connected capacity of the remaining modules.

4.4 Bypass Switches.

4.4.1* Bypass switches, with or without isolation, shall be permitted for bypassing, or bypassing and isolating, the transfer switch, and, if installed, they shall be in accordance with 4.4.2 and 4.4.3.

4.4.2 Bypass Switch Rating. The bypass switch shall have a continuous current rating and shall withstand a current rating compatible with that of the associated transfer switch.

4.4.3 Bypass Switch Classification. Each bypass switch shall be designed for emergency electrical service as a completely factory-assembled and factory-tested apparatus.

4.5 Protection.

4.5.1* General. The overcurrent protective devices in the emergency power supply system (EPSS) shall be coordinated to ensure selective tripping of the circuit overcurrent protective devices when a short-circuit current occurs. The maximum available short-circuit current from both the utility source and the emergency energy source shall be evaluated to verify compliance with this coordination.

4.5.2 Overcurrent Protective Device Rating. The rating of integral devices (e.g., fuses or breakers) shall be coordinated with downstream protective devices, taking into account the prospective short-circuit current available from the connected upstream power sources, such that the downstream devices operate first to eliminate the least critical portion of the connected electrical load. In those cases where electronic protection is incorporated via feedback to limit the current output of the ECE, the internal transfer switch(es) shall operate to switch the connected electrical load to the alternate source.

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

Chapter 5 Installation and Environmental Consideration

5.1 General.

5.1.1 This chapter establishes the minimum requirements and considerations for an SEPSS relative to the installation and environmental conditions that could affect its performance adversely.

5.1.2 When the location of the SEPSS is evaluated, consideration shall be given to the geographic location, building type, classification of occupancy, and hazardous nature of the area.

5.1.3 The equipment shall be installed in a manner and location recommended by the manufacturer and acceptable to the authority having jurisdiction.

5.1.4 Where normal power is available, the EPS shall serve Level 1 and Level 2 system loads and shall be permitted to serve additional loads, provided that, on failure of the normal power, the additional loads are automatically dropped to ensure that the EPS has sufficient capacity to serve the Level 1 and Level 2 loads.

5.2 Location.

5.2.1* The SEPSS shall be permitted to be located in a switch gear room or other electrical service room, provided that the manufacturer's environmental specification is met.

5.2.2 The rooms or buildings housing the SEPSS shall be located to minimize the possibility of damage from flooding, including flooding resulting from fire fighting, sewer water backup, and similar disasters or occurrences.

5.2.3 The SEPSS equipment shall be installed in a location that allows ready accessibility and adequate working space for the inspection, repair, maintenance, cleaning, or replacement of the unit. A separate unit emergency lighting system shall be provided at the SEPSS location if no other emergency lighting is present.

5.3 Heating, Cooling, Ventilating, and Humidity Control.

5.3.1 The SEPSS shall be located in an area provided with sufficient heating and cooling to ensure that, both during the time that normal power is available and during an emergency, the equipment is operated within the manufacturer's ambient temperature specifications. *(See also 3.2.6.)*

5.3.2 Ventilation with a minimum of two air changes per hour shall be provided to remove gases generated by vented batteries during charging or caused by an equipment malfunction.

5.3.3 For SEPSS equipment using free electrolyte batteries with vents that allow the free evolution of gases, ventilation openings or airflow shall be situated to limit the possibility of the buildup of gas pockets.

Where needed, fans used to circulate and exhaust air shall use explosion-proof motors designed for the application. *(See Article 480, NFPA 70, National Electrical Code.)*

5.4 Protection.

5.4.1 The room in which the EPS equipment is located shall not be used for storage purposes.

5.4.2 Where SEPSS equipment rooms or separate buildings are equipped with fire suppression systems, carbon dioxide systems, halon systems, or other systems acceptable to the authority having jurisdiction shall be used.

5.4.3 Where SEPSS equipment rooms are equipped with fire detection systems, the installation shall be in accordance with applicable standards. *(See NFPA 72, National Fire Alarm Code®.)*

5.4.4 The SEPSS equipment shall be adequately protected from voltage transients due to lightning.

5.4.5* In recognized seismic risk areas, the equipment shall be designed to reduce the risk of failure caused by the anticipated seismic shock. The batteries shall be restrained in position and the cables braced to limit the chance of spillage or cable breakage due to the anticipated seismic shock.

5.5 Distribution.

5.5.1 The grounding, distribution, and wiring systems within the EPS shall be installed in accordance with applicable standards. *(See NFPA 70, National Electrical Code.)*

5.5.2 The electrical distribution system within the SEPSS shall be complete with properly sized overcurrent and fault current protective equipment.

5.5.3 Storage batteries used to power the SEPSS shall be located as close to the SEPSS as practical, and shall be connected using cable sized to reduce the voltage drop to acceptable levels, as determined by the manufacturer's specifications.

5.6 Installation Acceptance.

5.6.1 Upon completion of the installation of the SEPSS, the system shall be tested to ensure conformity with the requirements of the standard with respect to both power output and function.

5.6.2 An on-site acceptance test shall be conducted to determine final approval for all SEPSS.

5.6.2.1 For battery-based systems, the on-site test shall be conducted in the following manner.

(a)* With the batteries fully charged and with a connected emergency load at rated value, a normal power failure shall be initiated by opening all switches or breakers supplying the nor-

mal power to that load. For an emergency load that is not normally energized, the breakers to the monitored circuit that energizes the emergency load shall be opened.

(b) The time delay between initiation of the power failure and the energizing of the load shall be observed and recorded.

(c) The voltage and current supplied to the emergency load and, where applicable, the frequency, waveform, and transients shall be recorded.

(d) The load test shall be continued for 15 minutes or the rated time (class), whichever is shorter, and the following shall be observed and recorded: the voltage and current to the load, the voltage and current of the battery bank, and, where applicable, the frequency.

(e) The normal power shall be restored to the monitored circuit. The transfer time shall be observed.

5.6.2.2 Immediately following the test specified in 5.6.2.1, the SEPSS shall be connected to the normal power for 24 hours. *(See 3.2.8.2.)*

5.6.2.3 Full Load Test. A load test shall be initiated immediately following the 24-hour recharge period permitted in 5.6.2.2. A load bank shall be permitted to be used instead of the site-connected load, provided that it is sized to be equal to the ECE rating. The unity power factor for an ac SEPSS shall be permitted, provided that rated load tests at the rated power factor have been performed by the manufacturer of the SEPSS prior to shipment. The duration of the load test shall be 60 percent of the class for which the SEPSS is rated.

5.6.3 The data specified in 5.6.2.1(b), (c), and (d) shall be recorded each minute until the completion of the test. After test completion, the bus bar bolts shall be inspected and repaired as necessary, and retorqued to specification. Any batteries and bus bars that have failed shall be replaced and so noted on test reports/records.

5.6.4 The following shall be made available to the authority having jurisdiction at the time of the acceptance test:

(1) Factory test data on the completed system
(2) Battery specifications
(3) Vendor's certificate of compliance to the specification

Chapter 6 Routine Maintenance and Operational Testing

6.1 General. The continuing reliability and integrity of the SEPSS are dependent on an established program of routine maintenance and operational testing. The routine maintenance and operational testing shall be based on the manufacturer's recommendations, instruction manuals, and the minimum requirements of this chapter and the authority having jurisdiction.

6.2 Manuals, Special Tools, and Spare Parts.

6.2.1 At least two sets of instruction manuals for the SEPSS shall be supplied by the manufacturer of the SEPSS and shall contain the following:

(1) A detailed explanation of the operation of the system
(2) A schematic wiring diagram
(3) A function block diagram
(4) The battery specification, battery installation, battery maintenance, and battery wiring diagram
(5) Instructions for routine maintenance
(6) Recommended spare parts list with part numbers and part sources
(7) Routine troubleshooting procedures

6.2.2 For Level 1, one set of the instructions shall be kept with the equipment. The other set shall be kept in another secure location.

6.2.3 Special tools and testing devices required for routine maintenance shall be available for use when needed.

6.3 Maintenance and Operational Testing.

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

6.3.2* A routine maintenance and operational testing program shall be initiated immediately following the acceptance test, or any repair or component replacement, including batteries. *(See Tables A.6.3.2 and A.6.4.2 for guidance.)*

6.3.3 A written record of inspection, tests, and repairs shall be maintained on the premises *(see Table A.6.3.2)*. The record shall include the following:

(1) Completion of a log
(2) Notification of any unsatisfactory condition and the corrective actions taken, including parts replaced
(3) Identification of the servicing personnel
(4) Documentation of a satisfactory test of the SEPSS according to 6.4.1 immediately following any repair or battery replacement

6.4 Operational Inspection and Testing.

6.4.1 Level 1 equipment shall be inspected monthly and shall be exercised at least quarterly under connected load for a minimum of 5 minutes or as specified for the class, whichever is less. *(See Table A.6.4.2 for guidance.)*

6.4.2* Inspection of the equipment shall include the following:

(1) The battery and associated charger/control equipment shall be checked to verify that they are in a clean and satisfactory condition and that no exceptional environment or other conditions exist that could damage or affect performance.
(2) Battery electrolyte levels shall be checked, where applicable, and refilled as necessary. Terminals and intercell connectors shall be cleaned and regreased, if necessary, and cell tops shall be cleaned.
(3) Individual cell voltages shall be checked and recorded where practical.
(4) The specific gravity of pilot cells shall be checked and recorded, where applicable.
(5) The conditions of the plates and sediment of free-electrolyte, lead–acid batteries in transparent containers shall be noted.
(6) A load test shall be performed and the output voltage, the battery voltage, and the duration of the test shall be recorded at the beginning and end of the test for each battery set.
(7) All indicator lamps, meters, and controls shall be checked to verify that they are operating correctly.
(8) The load value shall be checked to ensure that it is within the equipment rating.

6.4.3 The SEPSS shall be checked annually at full load for the full duration for its class.

6.4.4 A written record of all checks and tests in 6.4.2 shall be maintained and shall be accessible to the authority having jurisdiction. *(See Table A.6.4.2.)*

6.4.5 The routine maintenance and operational testing program shall be performed by a properly trained individual.

Chapter 7 Referenced Publications

7.1 The following documents or portions thereof are referenced within this standard as mandatory requirements and shall be considered part of the requirements of this standard. The edition indicated for each referenced mandatory document is the current edition as of the date of the NFPA issuance of this standard. Some of these mandatory documents might also be referenced in this standard for specific informational purposes and, therefore, are also listed in Appendix B.

7.1.1 NFPA Publications. National Fire Protection Association, 1 Batterymarch Park, P.O. Box 9101, Quincy, MA 02269-9101.

NFPA 70, *National Electrical Code®*, 1999 edition.

NFPA 72, *National Fire Alarm Code®*, 1999 edition.

NFPA 110, *Standard for Emergency and Standby Power Systems*, 1999 edition.

Appendix A Explanatory Material

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

A.2.1.1 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.2.1.2 Authority Having Jurisdiction. The phrase "authority having jurisdiction" 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.2.1.8 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.2.1.13 Uninterrupted Power Supply (UPS). The UPS usually monitors and tracks the voltage and frequency of the normal source. It could be the preferred or alternate source of power to the load.

A.2.2.1 The terms *emergency power supply systems* and *standby power supply systems*, as used in this standard, include such other terms as *alternate power systems, standby power systems, legally required standby systems, alternate power sources*, and other similar terms. Since this standard specifies the installation, performance, maintenance, and test requirements in terms of types, classes, categories, and levels, any one of the terms listed above might be appropriate to describe the application or use, depending on the need and the preference of the parties involved.

For optional standby systems, see Article 702 of NFPA 70, *National Electrical Code*.

A.2.2.3 Selection of the EPS Class should take into account past outage records and fuel delivery problems due to weather and other geographic/environmental conditions.

A.2.2.5.1 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 normal supply or in the event of damage to elements of a system intended to supply, distribute, and control power and illumination essential for safety to human life.

Level 1 systems generally are installed in places of assembly where artificial illumination is necessary for safe exiting and for panic control in buildings subject to occupancy by large numbers of people.

Emergency systems also can provide power for such functions as uninterruptible power supplies, ventilation where essential to maintain life, fire detection and alarm systems, public safety communications systems, industrial processes where current interruption would produce serious life safety or health hazards, and similar functions. *(See NFPA 101®, Life Safety Code®, and Chapter 3 of NFPA 99, Standard for Health Care Facilities.)*

A.2.2.5.2 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 normal source.

Level 2 systems typically are installed to serve loads such as heating and refrigeration systems, communication systems, ventilation and smoke removal systems, sewerage disposal, lighting, and industrial processes that, when stopped due to any interruption of the normal electrical supply, could create hazards or hamper rescue or fire-fighting operations.

A.2.2.5.3 It is important to recognize that an SEPSS can react in a manner substantially different from commercial power during transient and short-circuit conditions due to the relatively small capacities of the SEPSS as compared to a commercial power source.

See ANSI C84.1, *Electric Power Systems and Equipment — Voltage Ratings (60 Hertz)*.

A.3.1.1 A valve-regulated (sealed) battery is a battery that is not provided with a means for replacing the evolved products of electrolysis.

A.3.1.2.2 Unit equipment, such as self-contained batteries, are not within the scope of this document. *[See 1.1.4.1(4).]*

A.3.2.7 If the ambient temperature in the location falls below 68°F (20°C), anticondensation measures should be considered.

A.4.2.2 See ANSI/UL 924, *Standard for Safety Emergency Lighting and Power Equipment*, and ANSI/UL 1008, *Standard for Safety Transfer Switch Equipment.*

A.4.2.4.2 The load source should be monitored for frequency or quality of waveform, or both.

A.4.2.4.4 Authorized, trained 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.4.2.4.5 The timer is intended to allow the preferred source to stabilize before retransfer of the load.

A.4.4.1 Consideration should be given to the effect that load interruption could have on the load during maintenance and service of the transfer switch.

A.4.5.1 It is extremely important that the various overcurrent devices be coordinated to protect against cascading operation on short-circuit faults. 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.5.2.1 Separate rooms might be necessary for battery banks due to corrosion, for ventilation requirements for hazardous gas accumulations, or for service requirements.

A.5.4.5 Consideration should be given to the location of the ECE equipment, both as it relates to the building structure and to the effects of an earthquake.

All emergency power equipment support or subsupport 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 ECE nonstructural equipment and the building structure. However, the degree of isolation necessary for vibration and acoustical control of the ECE 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-prone areas.

Battery racks for ECE 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 in any direction equal to the supported weight. 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.

A.5.6.2.1(a) The connected emergency load might be provided by equivalent load banks.

A.6.3.2 Maintenance procedure and frequency should follow those recommended by the manufacturer. In the absence of such recommendations, Table A.6.3.2 indicates suggested procedures.

A.6.4.2 Table A.6.4.2 provides guidance for operation and testing.

Table A.6.3.2 Suggested Maintenance Schedule for Solid-State Emergency Power Supply Systems

Item Component (as applicable)	Procedure					Frequency
	Visual Inspection	Check	Change	Clean	Test	W — Weekly M — Monthly Q — Quarterly S — Semiannually A — Annually
Battery						
Float voltage		X				M
Cable connections		X				S
Terminals				X		Q
Electrolyte gravity					X	Q
Electrolyte level	X					M
Replace cell or battery			X			See mfr.'s instructions
ECE						
Power supply voltage		X				M
Terminals		X				S
Panel meters	X					M
Panel lamps	X					M
Circuit breakers, fuses	X	X	R	X		Every 2 years

(Sheet 1 of 2)

Table A.6.3.2 Suggested Maintenance Schedule for Solid-State Emergency Power Supply Systems *(Continued)*

Item Component (as applicable)	Procedure					Frequency
	Visual Inspection	Check	Change	Clean	Test	W — Weekly M — Monthly Q — Quarterly S — Semiannually A — Annually
Battery charger						
Output terminal volts		X				M
Fuses	X	X	R	X		Every 2 years
Charge current		X			X	Q
Equalize voltage		X				Q
Panel meters	X					M
Panel lamps	X					M
Load						
Load current		X				Q
Panel meters	X					M
Transfer switch						
Contacts	X					A
Test switch					X	S

(Sheet 2 of 2)

Note: X indicates action; R indicates replacement, if needed.

Table A.6.4.2 Stored Energy System Operation and Suggested Testing Log

Item	Action	Performed by: Date:
Table A.6.3.2	Review all actions	
AC input failure test	Remove ac supply	
Output ac volts Frequency Load	Measure and record: v.a.c. Record (if metered): Hz Measure: amps	
DC voltage Prior to ac fail 1 min. after ac fail 5 min. after restoring ac input	 Measure: v.d.c Measure: v.d.c. Measure: v.d.c.	
Battery wet lead–acid	For each battery: Measure gravity Check electrolyte level	
Charge current Prior to ac fail 5 min. after fail	 Measure: a.d.c. Measure: a.d.c.	
Meters Panel lamps Load circuit breakers	Check functioning Check functioning Check close	
Bus bars/cables of battery systems	Torque/barring	