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NFPA 111 Stored Electrical Energy Emergency and Standby Power Systems 1993 Edition

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There is a concern that the growing use of synthetic materials may produce more or additional toxic products of combustion in a fire environment. The Board has, therefore, asked all NFPA technical committees to review the documents for which they are responsible to be sure that the documents respond to this current concern. To assist the committees in meeting this request, the Board has appointed an advisory committee to provide specific guidance to the technical committees on questions relating to assessing the hazards of the products of combustion.

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NFPA 111

Standard on

Stored Electrical Energy Emergency and Standby Power Systems

1993 Edition

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 Fall Meeting held November 16-18, 1992, in Dallas, TX. It was issued by the Standards Council on January 15, 1993, with an effective date of February 12, 1993, and supersedes all previous editions. (NFPA 111 was formerly designated NFPA 110A.)

The 1993 edition of this document has been approved by the American National Standards Institute.

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.

Origin and Development of NFPA 111

The Technical Committee on Emergency Power Supplies, organized in 1976 by the NFPA in recognition of the demand for guidelines for the assembly, installation, and performance of electrical power systems to supply critical and essential needs during outages of the normal power source, developed a base standard (NFPA 110) 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 required 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 called Stored Energy Emergency and Standby Power Systems (designating it NFPA 110A) into the 1989 Annual Meeting cycle. It was approved at the 1989 Annual Meeting.

NFPA 110A (now NFPA 111) 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 may be required by other codes and standards.

The detail in the standard is 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.

This second edition of NFPA 110A (now NFPA 111) makes only minor changes from the previous 1989 edition.

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This list represents the membership at the time the Committee was balloted on the text of this edition. Since that time, changes in the membership may have occurred.

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 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 shall also be responsible for criteria on the maintenance and testing of the system. The Committee shall not be responsible for requirements for the application of emergency power systems, self-contained emergency lighting units and the electrical wiring except that wiring that is an integral part of the system up to the load side of the transfer switch(es).

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NFPA 111

Standard on

Stored Electrical Energy Emergency and Standby Power Systems

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

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. For emergency power systems supplied by emergency generators, see NFPA 110, *Standard on 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 performance of the Stored Emergency Power Supply System (SEPSS).

1-1.4 Exclusions.

1-1.4.1 This standard does not cover:

(a) The application of the SEPSS

(b) Distribution wiring

(c) Systems having total outputs less than 500VA or less than 24v or for less than Class .033

(d) Emergency lighting unit equipment

(e) Nuclear sources, fuel cells, and solar and wind stored-energy systems are excluded from the scope of this document.

1-1.4.2 The selection of any of the following is not within the scope of this standard:

(a) Specific buildings or facilities or both requiring a Stored Emergency Power Supply System (SEPSS)

(b) Specific loads to be served by the SEPSS

(c) Assignment of type, class, or level to any specific load (*see Section 2-2*).

1-2 Purpose.

1-2.1 This standard contains performance requirements for SEPSS and may also be used in conjunction with other standards. It is the role of other NFPA standards to specify which occupancies require a SEPSS and the applicability level, type, and class. This standard does not specify where SEPSS's are required. (*See 1-1.4.2.*)

1-2.2 This standard is also intended to provide guidance for inspectors, designers, installers, manufacturers, and users of SEPSS, and to serve as a basis for communication between 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 of design, installation, maintenance, and performance or compliance with other applicable standards and codes.

1-2.3 The installation of 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 for a given length of time to loads within a specified time after loss, failure, or disruption of the normal supply. SEPSS shall include a means to recharge the stored energy system.

Chapter 2 Definitions and Classification

2-1 NFPA Definitions.

Approved. Acceptable to the "authority having jurisdiction."

NOTE: 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 or 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 concerned with product evaluations which is in a position to determine compliance with appropriate standards for the current production of listed items.

Authority Having Jurisdiction. The "authority having jurisdiction" is the organization, office or individual responsible for "approving" equipment, an installation or a procedure.

NOTE: 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, 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 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."

Labeled. Equipment or materials to which has been attached a label, symbol or other identifying mark of an organization 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.

Listed. Equipment or materials included in a list published by an organization acceptable to the "authority having jurisdiction" and concerned with product evaluation, that maintains periodic inspection of production of listed equipment or materials and whose listing states either that the equipment or material meets appropriate standards or has been tested and found suitable for use in a specified manner.

NOTE: The means for identifying listed equipment may vary for each organization concerned with product evaluation, some of which 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.

Shall. Indicates a mandatory requirement.

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

2-2 Definitions Used in this Standard.

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.

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.

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.

Non-Automatic Transfer Switch. A non-automatic transfer switch is a device, operated by direct manpower or electrical remote manual control, for transferring one or more conductor connections from one power source to another.

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.

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.

NOTE: The UPS usually monitors and tracks the voltage and frequency of the normal source. It may be the preferred or alternate source of power to the load.

2-3 Classification of Stored Emergency Power Supply Systems (SEPSS).

2-3.1 General. This standard defines 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 recommend which SEPSS is most suitable for any given application.

NOTE 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 defines the installation, performance, maintenance, and test requirements in terms of Types, Classes, Categories, and Levels, any one of the terms listed above may be appropriate to describe the application or use depending on the need and the preference of the parties involved.

NOTE 2: For optional standby systems, see Article 702 of NFPA 70, *National Electrical Code*.®

2-3.2 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. Only the following types are defined by this standard:

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)

2-3.3* Class. The class defines the minimum time in hours the SEPSS is designed to operate its rated load without being refueled or recharged.

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)

2-3.4 Category. Two categories are defined by this standard:

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

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

2-3.5 Level. It is recognized that SEPSS's are utilized in many different places and for many different purposes, and that the requirement in one application may not be appropriate in other applications. This standard therefore recognizes two levels of equipment installation, performance, and maintenance.

2-3.5.1* Level 1 defines equipment performance requirements for applications where the requirements are most stringent and 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.

2-3.5.2* 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 allow a higher degree of flexibility than under Level 1. All Level 2 equipment shall be permanently installed.

2-3.5.3* It is the intent of Levels 1 and 2 to ensure that loads provided with SEPSS are supplied with alternate power of a quality that is satisfactory to ensure adequate operation or acceptable for the load, within the time defined in the Type and for a duration defined in the Class.

NOTE: See ANSI C84.1, *Standard for Electric Power Systems and Equipment - Voltage Ratings (60 Hz).*

2-3.5.4 Level 3 defines all other equipment and applications, including optional standby systems, not defined in Levels 1 and 2. There are no requirements for performance for Level 3 in this standard. Nowhere else in this document is Level 3 addressed.

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

3-1 Energy Sources.

3-1.1 The following energy sources are acceptable for use for the Emergency Power Supply (EPS):

3-1.1.1 Electrical Storage Battery.

(a) Secondary lead-acid batteries having construction and chemical composition suitable for standby, float service operation. They may have free or immobilized electrolyte and may be of valve-regulated (sealed) or unsealed construction.

(b) Nickel-cadmium batteries having construction and chemical composition suitable for standby, float service operation. They may be of valve-regulated (sealed) or unsealed construction.

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

(c) 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 Emergency Power Supply (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:

(a) Open rack type

(b) Console or package style

(c) A combination of (a) and (b).

NOTE: Unit equipment — self-contained batteries are excluded from the scope of this document [*see 1-1.4.1(d)*].

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 and/or inertia devices, with related control, conversion, and accessory items.

3-2.2 ECE shall be limited to:

(a) Uninterruptible Power Supply (UPS) systems

(b) Standby power supply systems (central battery systems).

3-2.3 ECE for Level 1 shall be of proven design and components, whose performance and reliability has 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 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 shall be over a range of 50°F (10°C) to 104°F (40°C). For outdoor units, or units in areas having no temperature control, the range shall be -30°F (-34°C) to 122°F (50°C).

3-2.7* Humidity. The ECE shall be designed to function in an atmosphere having a relative humidity that may 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 The ECE shall be automatically capable of resupplying the full rated load and duration within 48 hours, and 60 percent of duration at full rated load within 24 hours, following a full duration power outage.

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:

(a) Inverter/converter carrying load

(b) Battery voltage

(c) Battery current, charge or discharge

(d) System output voltage, each leg

(e) System output frequency (if applicable)

(f) System output current, each leg.

3-3.2 Alarms. Individual visual indicators and a common audible annunciator shall be provided for the following:

(a) High/low battery voltage

(b) Output circuit breaker open

(c) High temperature

(d) ECE in bypass mode

(e) 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:

(a) Transfer an electrical load from one power source to another

(b) Perform load switching or shedding functions on any electrical load

(c) Bypass, isolate, and test any transfer or isolation switch in that static system

(d) Isolate any faulted component inside the static system so that it ceases to be connected to the output load terminals

(e) Bypass the energy conversion equipment (ECE).

4-1.2 Protection, as used in this chapter, refers to either electronic sensing or inherent overload protective devices (such as fuses and/or automatic breakers) 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 provided, suitable for transferring the connected loads between the energy converter and the building electrical service. Transfer switches may be electrical or electronic or a hybrid combination of the two. 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). These switches may be separate devices within their own enclosures or be an integral part of the energy converter (ECE).

4-2.1.1 The capacity and endurance rating of these 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 failure of the switch will 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 integral current-carrying components shall withstand the effects of available fault currents. (*See ANSI/UL 924, Emergency Lighting and Power Equipment, and ANSI/UL 1008, Automatic Transfer Switches.*)

4-2.3 Transfer Switch Classification. Each transfer switch shall be listed for emergency service as a completely factory-assembled and tested apparatus.

Exception: Switches, electronic or electromechanical, that constitute an integral part of the ECE may be accepted if 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 automatic 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, and may be monitored for frequency and/or quality of waveform. The ECE and the utility shall be monitored for unacceptable conditions. If a condition is sensed as out of tolerance, the transfer switch shall automatically switch to the alternate source(s) of power, providing that the alternate source(s) of power is/are themselves within tolerance. If the alternate source(s) of power is/are not within tolerance, then switching to the alternate source may be inhibited.

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. Provision for retransfer to the preferred source shall also be available under manual command, provided the preferred source is within tolerance. Retransfer may 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: When interconnection is inherent in the system design, the sources of power, preferred and alternate(s), shall not be connected together for any longer than it shall take to transfer the preferred source of power, without disturbance to the electrical loads connected, provided that such interconnection can be sustained by the two connected sources of incoming power without causing internal current protection features to be invoked.

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 should malfunction.

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 alternate source to preferred source of power. The time delay shall be automatically bypassed if the ECE or EPS fails.

NOTE: The timer is intended to permit the preferred source to stabilize before retransfer of the load.

4-2.4.6 Test Switch. A test switch shall be provided on each automatic transfer switch (ATS) that will simulate failure of the preferred power source. ATS shall then perform its intended function.

4-2.5 Non-Automatic Transfer Switch Features.

4-2.5.1 General. Switching devices shall operate by direct manual or remote input. Once operated, the device shall switch to its alternate state and the device shall remain in that state, and upon release of the input 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. 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. When two or more static systems are paralleled, the paralleled system shall be controlled so that excessive loading (beyond the intended capacity of the paralleled system) shall be inhibited or the ECE shall go 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.

Should any static power module connected to the emergency bus be isolated from that bus by reason of internal failure, the total loading on the emergency bus shall also be diminished by switching off the loads in the inverse priority order, in proportion to the lost power capacity of the isolated module, if 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 Rating. The bypass switch shall have a continuous current rating and withstand current rating compatible with that of the associated transfer switch.

4-4.3 Classification. Each bypass switch shall be designed for emergency electrical service as a completely factory-assembled and tested apparatus.

4-5 Protection.

4-5.1* General. The overcurrent protective devices in the Emergency Power Supply System 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 satisfy this coordination ability.

4-5.2 Overcurrent Protective Device Rating. The rating of integral devices (fuses, 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 will 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 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 relative to the installation and environmental conditions that could adversely affect the performance of the SEPSS.

5-1.2 Consideration shall be given, when evaluating the location of the SEPSS, to 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 as recommended by the manufacturer and acceptable to the authority having jurisdiction.

5-1.4 When normal power is available, the EPS shall serve Level 1 and Level 2 system loads and may serve other additional loads provided that, on failure of the normal power, these additional loads are automatically dropped to ensure the EPS has sufficient capacity to serve the Level 1 and 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 shall be met.

NOTE: Separate rooms may be required for battery banks due to corrosion and/or ventilation requirements for hazardous gas accumulations or for service requirements.

5-2.2 The rooms or buildings housing the SEPSS shall be located so as to minimize the possibility of damage from flooding, including flooding resulting from fire fighting, sewer water back-up, and similar type disasters or occurrences.

5-2.3 The SEPSS equipment shall be installed in a location that will permit ready accessibility and adequate working space around the unit for inspection, repair, maintenance, cleaning, or replacement. A separate unit emergency lighting system shall be provided at the SEPSS location, if other emergency lighting is not present.

5-3 Heating, Cooling, Ventilating, and Humidity Control.

5-3.1 The SEPSS shall be located in an area 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 specifications. (*See also 3-2.6.*)

5-3.2 Adequate ventilation shall be provided to remove gases generated by vented batteries during charging, or caused by an equipment malfunction. This shall be, as a minimum, two air changes per hour.

5-3.3 For SEPSS equipment using free electrolyte batteries with vents that permit the free evolution of gases, ventilation openings or airflow shall be situated so as to limit the possibility of the build-up of gas pockets.

When 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 or halon systems or other systems acceptable to the authority having jurisdiction shall be used.

5-4.3 Where SEPSS equipment rooms are fitted with fire detection systems, they shall be in accordance with the applicable standards. (*See NFPA 72, Standard for the Installation, Maintenance, and Use of Protective Signaling Systems, and NFPA 72E, Standard on Automatic Fire Detectors.*)

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, both in power output and function.

5-6.2 An on-site acceptance test shall be conducted as a final approval test 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, initiate a normal power failure by opening all switches or breakers supplying the normal power to that load. For an emergency load that is not normally energized, open the breakers to the monitored circuit that requires the emergency load to become energized.

NOTE: The connected emergency load may be provided by equivalent load banks of appropriate specification as determined by the project engineer or authority having jurisdiction.

(b) Observe and record the time delay between initiation of the power failure and the energizing of the load.

(c) Record voltage and current supplied to the emergency load and, where applicable, the frequency, waveform, and transients.

(d) Continue the load test for 15 minutes or rated time (Class), whichever is least, and observe and record: voltage and current to the load, the voltage and current of the battery bank, and, where applicable, the frequency.

(e) Restore the normal power to the monitored circuit. Observe the transfer time.

5-6.2.2 Immediately following the preceding test, allow the SEPSS to 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 can be used instead of the site-connected load provided that it is sized to be equal to the ECE rating. Unity power factor for ac SEPSS is acceptable, provided that rated load tests at 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 Record the data required in 5-6.2.1 (b), (c), and (d) every minute until completion of the test period. After test completion, inspect and repair as necessary the buss bar bolts, and retorque to specification. Replace any batteries and buss bars that have failed, and so note 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:

(a) Factory test data on the completed system

(b) Battery specifications

(c) 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 is dependent on an established program of routine maintenance and operational testing. The routine maintenance and operational testing shall be based on the manufacturer's recommendation, 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:

(a) A detailed explanation of the operation of the system

(b) A schematic wiring diagram

(c) A function block diagram

(d) Battery specification, battery installation, maintenance, and wiring diagram

(e) Instructions for routine maintenance

(f) Suggested spare parts list with part numbers and part sources

(g) 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 so as to provide reasonable assurance that the system will be 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* Routine maintenance and an operational testing program shall be initiated immediately following the acceptance test.

NOTE: For suggested guide, see Table A-6-3.2 and Table A-6-4.2 in Appendix A.

6-3.3 A written record of inspection, tests, and repairs shall be maintained on the premises. (*See Table A-6-3.2 for suggested guidance.*) The record shall include:

(a) Completion of a log

(b) Notification of any unsatisfactory condition and the corrective actions taken, including parts replaced

(c) Identification of the servicing personnel.

6-4 Operational Inspection and Testing.

6-4.1 Level 1 equipment shall be inspected every month and shall be exercised at least quarterly under connected load for a minimum of 5 minutes or Class, whichever is less. (*See Table A-6-4.2 for suggested guide.*)

6-4.2* Inspection of the equipment shall include the following:

(a) Check that the battery and associated charger/control equipment are in a clean and satisfactory condition and that no exceptional environment or other conditions exist that could damage or affect performance.

(b) Check battery electrolyte levels, where applicable, and refill as necessary. Clean and re-grease terminals and inter-cell connectors, if necessary, and clean cell tops.

(c) Check and record individual cell voltages where practical.

(d) Check and record specific gravity of pilot cells, where applicable.

(e) For free-electrolyte lead acid batteries in transparent containers, note conditions of plates and sediment.

(f) Perform load test and record at the beginning and end of test for each battery set: output voltage, battery voltage, and duration of test.

(g) Check that all indicator lamps, meters, and controls are operating correctly.

(h) Check load value to ensure that it is within the equipment rating.

6-4.3 Once per year, the SEPSS shall be checked at full load for the full duration for its Class.

6-4.4 A written record of all tests in 6-4.2 shall be maintained and shall be accessible to the authority having jurisdiction. (*See Table A-6-4.2 for suggested test log.*)

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 document and shall be considered part of the requirements of this document. The edition indicated for each reference is the current edition as of the date of the NFPA issuance of this document.

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*, 1993 edition

NFPA 110, *Standard for Emergency and Standby Power Systems*, 1993 edition

Appendix A

This Appendix is not a part of the requirements of this NFPA document, but is included for information purposes only.

A-2-3.3 Selection of the Class of the EPS should take into account past outage records and problems due to weather and other geographic/environmental conditions.

A-2-3.5.1 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 accident to elements of a system intended to supply, distribute, and control power and illumination essential for safety to human life.

Level 1 is generally installed in places of assembly where artificial illumination is required for safe exiting and for panic control in building subject to occupancy by large numbers of persons.

Emergency systems may also provide power for such functions as uninterruptible power supplies, ventilation when 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, "Electrical Systems," of NFPA 99, Standard for Health Care Facilities.)*

A-2-3.5.2 Typically, Level 2 systems are intended to automatically supply power to selected loads (other than those classed as emergency systems) in the event of failure of the normal source.

Level 2 is typically 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 during any interruption of the normal electrical supply, could create hazards or hamper rescue or fire fighting operations.

A-2-3.5.3 It is important to recognize that SEPSS may react substantially differently from commercial power during transient and short circuit conditions due to the relatively small capacities of the SEPSS compared to the normal commercial power source.

A-3-2.7 If the ambient temperature in the location falls below 68°F (20°C), anti-condensation measures should be considered.

A-4-2.4.4 Authorized, trained personnel should be available and familiar with manual operation of the transfer switch, and be capable of determining adequacy of the alternate source of power prior to manual transfer.

A-4-4.1 Consideration should be given to the effect that load interruption may 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 should also be given to prevent overloading of equipment by limiting the possibilities of large current inrushes due to instantaneous re-establishment of connections to heavy loads.

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 required 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 so as to prevent vibration damage, and electrical interconnections should be provided with adequate slack to accommodate all relative deflections.

Table A-6-3.2 Solid State Emergency Power Supply Systems Suggested Maintenance Schedule

Item Component (as applicable)	Procedure					Frequency
The suggested maintenance procedure and frequency should follow those recommended by the manufacturer. In the absence of such recommendations, the table below indicates suggested procedures. X Indicates Action R Indicates Replacement If Needed	Visual inspection	Check	Change	Clean	Test	W - Weekly M - Monthly Q - Quarterly S - Semi-Annually A - Annually
1. 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
2. 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
3. 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
4. Load						
— Load Current		X				Q
— Panel Meters	X					M
5. Transfer Switch						
— Contacts	X					A
— Test Switch					X	S

Table A-6-4.2 Stored Energy System Operation and Suggested Testing Log

Item	Action	Performed by: / Date:				
1. Table A-6-3.2	Review All Actions					
2. AC Input Failure Test	Remove AC Supply					
3. Output AC Volts Frequency Load	Measure and Record: v.a.c. Record (if metered): Hz Measure: amps					
4. 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.					
5. Battery Wet Lead-Acid	For Each Battery: Measure Gravity Check Electrolyte Level					
6. Charge Current Prior to AC Fail 5 Min. After	 Measure: A.d.c. Measure: A.d.c.					
7. Meters Panel Lamps Load Circuit Breakers	Check Functioning Check Functioning Check Close					
8. Buss bars/cables of battery systems	Torque/Barring					

Appendix B Referenced Publications

B-1 The following documents or portions thereof are referenced within this standard for informational purposes only and thus are not considered part of the requirements of this document. The edition indicated for each reference is the current edition as of the date of the NFPA issuance of this document.

B-1.1 NFPA Publications. National Fire Protection Association, 1 Batterymarch Park, P.O. Box 9101, Quincy, MA 02269-9101.

NFPA 70, *National Electrical Code*, 1993 edition

NFPA 70B, *Recommended Practice for Electrical Equipment Maintenance*, 1990 edition

NFPA 72, *Standard for the Installation, Maintenance, and Use of Protective Signaling Systems*, 1990 edition

NFPA 72E, *Standard on Automatic Fire Detectors*, 1990 edition

NFPA 99, *Standard for Health Care Facilities*, 1993 edition

NFPA *101*, *Life Safety Code*, 1991 edition

B-1.2 Other Publications.

B-1.2.1 ANSI Publication. American National Standards Institute, Inc., 1430 Broadway, New York, NY 10018.

ANSI C84.1-1989, *Standard for Electric Power Systems and Equipment - Voltage Ratings (60 Hz)*

B-1.2.2 IEEE Publications. Institute of Electrical and Electronic Engineers, 345 East 47th St., New York, NY 10017-2394.

ANSI/IEEE 446-1987, *Recommended Practice for Emergency and Standby Power Systems for Industrial and Commercial Applications*

ANSI/IEEE 450-1987, *Recommended Practice for Maintenance, Testing, and Replacement of Large Lead Storage Batteries for Generating Stations and Substations*

ANSI/IEEE 484-1987, *Recommended Practice for Installation Design and Installation of Large Lead Storage Batteries for Generating Stations and Substations*

ANSI/IEEE 485-1983, *Recommended Practice for Sizing Large Lead Storage Batteries for Generating Stations and Substations*

ANSI/IEEE 944-1986, *Recommended Practice for the Application and Testing of Uninterruptible Power Supplies for Power Generating Systems*

IEEE 1106-1987, *Recommended Practice for Maintenance, Testing, and Replacement of Nickel-Cadmium Storage Batteries for Generating Stations and Substations*

B-1.2.3 UL Publications. Underwriters Laboratories Inc., 333 Pfingsten Rd, Northbrook, IL 60062.

ANSI/UL 924-1983, *Emergency Lighting and Power Equipment*

ANSI/UL 1008-1987, *Automatic Transfer Switches*

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SUBMITTING PROPOSALS ON NFPA TECHNICAL COMMITTEE DOCUMENTS

Contact NFPA Standards Administration for final date for receipt of proposals on a specific document.

Note: All proposals must be received by 5:00 p.m. E.S.T./E.D.S.T. on the published proposal closing date.

INSTRUCTIONS

Use a separate proposal form for submitting each proposed amendment.

1. Type or print legibly in black ink.

2. Indicate the number, edition year, and title of the document. Also indicate the specific section or paragraph that the proposed amendment applies to.

3. Check the appropriate box to indicate whether this proposal recommends adding new text, revising existing text, or deleting text.

4. In the space identified as "Proposal" indicate the exact wording you propose as new or revised text, or the text you propose be deleted.

5. In the space titled "Statement of Problem and Substantiation for Proposal" state the problem which will be resolved by your recommendation and give the specific reason for your proposal. Include copies of test results, research papers, fire experience, or other materials that substantiate your recommendation.

6. Check the appropriate box to indicate whether or not this proposal is original material, and if it is not, indicate the source of the material.

7. Sign the proposal.

If supplementary material (photographs, diagrams, reports, etc.) is included, you may be required to submit sufficient copies for all members and alternates of the technical committee. The technical committee is authorized to abstract the "Statement of Problem and Substantiation for Proposal" if it exceeds 200 words for publication in the Technical Committee Reports.

NOTE: The NFPA Regulations Governing Committee Projects in Paragraph 10-10 state: Each proposal shall be submitted to the Council Secretary and shall include:

(a) identification of the submitter and his affiliation (Committee, organization, company) where appropriate, and

(b) identification of the document, paragraph of the document to which the proposal is directed, and

(c) a statement of the problem and substantiation for the proposal, and

(d) proposed text of proposal, including the wording to be added, revised (and how revised), or deleted.