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NFPA 110 Emergency and Standby Power Systems 1993 Edition

NFPA®

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The Board of Directors reaffirms that the National Fire Protection Association recognizes that the toxicity of the products of combustion is an important factor in the loss of life from fire. NFPA has dealt with that subject in its technical committee documents for many years.

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 110

Standard for

Emergency and Standby Power Systems

1993 Edition

This edition of NFPA 110, *Standard for 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.

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 110

The Emergency Power Supplies Committee was organized in 1976 by the Association in recognition of the demand for viable guidelines for the assembly, installation, and performance of electrical power systems to supply critical and essential needs during outages of the normal power source.

It was the intent of the committee to establish the necessary equipment requirements to achieve an on-site auxiliary electrical power source suitable to the needs of the applicable requirements and user criteria.

In 1979, the Committee's report, proposing adoption of NFPA 110, was published but withdrawn because of issues involving the scope of the Committee.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

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

Particular power sources not specifically addressed within the current standard will be considered for inclusion by the Committee as appropriate equipment detail and performance parameters are made available.

The standard does not require the installation of emergency and standby power supply 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 1988 edition of NFPA 110 added several new definitions and further clarified transfer switch and installation testing requirements.

This 1993 edition of NFPA 110 revised the document to reflect: 1) the adoption by NFPA of a new document on stored electrical energy emergency and standby power systems (NFPA 111), 2) a basic requirement for one-step loading for all prime movers, 3) an updating on battery technology, 4) restrictions on unnecessary transferring of loads (4-2.4.9), and 5) the need to maintain batteries (6-3.6).

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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 which is an integral part of the system up to the load side of the transfer switch(es).

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NFPA 110

Standard for

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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 C.

Chapter 1 General

1-1 Scope.

1-1.1 This standard covers performance requirements for power systems providing an alternate source of electrical power to loads in buildings and facilities in the event that the normal power source fails.

1-1.2 Power systems covered in this standard include power sources, transfer equipment, controls, supervisory equipment, and all related electrical and mechanical auxiliary and accessory equipment needed to supply electrical power to the load terminals of the transfer equipment.

1-1.3 This standard covers installation, maintenance, operation, and testing requirements, as they pertain to performance of the emergency power supply system (EPSS).

1-1.4 Exclusions.

1-1.4.1 This standard does not cover: the application of emergency power supply systems, emergency lighting unit equipment, distribution wiring, utility service when such service is permitted as the emergency power supply system, or parameters for stored energy devices.

1-1.4.2* This standard does not establish criteria for stored energy systems. (*See NFPA 111, Standard on Stored Electrical Energy Emergency and Standby Power Systems.*)

1-1.4.3 The selection of any of the following is not within the scope of the standard:

(a) Specific buildings or facilities or both requiring an EPSS.

(b) Specific loads to be served by the EPSS.

(c) Assignment of type, class, or level to any specific load (*see Section 2-3*).

1-2 Purpose.

1-2.1 This standard contains performance requirements for EPSS and may also be used in conjunction with other standards. It is the role of other NFPA standards to specify which occupancies require an EPSS and the applicable level, type, and class. This standard does not specify where EPSSs are required (*see 1-1.4*).

1-2.2 This standard is also intended to provide guidance for inspectors, designers, installers, manufacturers, and users of EPSSs and to serve as a vehicle for communication between parties involved. It is not intended as a design manual. Compliance with this 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.

1-3 Application. This document shall apply to new installations of 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.

Chapter 2 Definitions

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 of Terms 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.

Battery Certification. The certification by a battery manufacturer that a battery was built to industry standards, such as that of the American Association of Battery Manufacturers.

Bypass-Isolation Switch. A manually operated device used in conjunction with an automatic transfer switch to provide a means of (1) directly connecting load conductors to a power source, and (2) disconnecting the automatic transfer switch.

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).

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.

NOTE: See Appendix B for diagrams of typical systems.

Lamp. An illuminating indicator.

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.

Valve-Regulated (Sealed) Battery. A battery that is not provided with a means for replacing the evolved products of electrolysis.

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

2-3.1 General. The function of the EPSS 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 or failure of the normal supply.

This standard defines requirements for the EPSS as a complete functioning system in terms of types, classes, and levels. It is not the intent of this standard to recommend which EPSS is most suitable for any given application.

NOTE: 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, 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.

2-3.2 Type. The type defines the maximum time, in seconds, that the EPSS will permit the load terminals of the transfer switch to be without acceptable electrical power. Only the following types are defined by this standard:

Type U	[Basically uninterruptible (UPS systems)]
Type 10	(10 seconds)
Type 60	(60 seconds)
Type 120	(120 seconds)
Type M	(Manual stationary or nonautomatic—no time limit).

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

Class 0.083	(0.083 hours—5 minutes)
Class 0.25	(0.25 hours)
Class 2	(2 hours)
Class 6	(6 hours)
Class 48	(48 hours)
Class X	(Other time, in hours, as required by the application, code, or user).

2-3.4 Level. It is recognized that EPSSs 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, maintenance, and testing.

2-3.4.1* 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 serious injuries or loss of human life . All Level 1 equipment shall be permanently installed.

2-3.4.2* Level 2 defines equipment performance requirements for applications where failure of the EPSS 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.

2-3.4.3* It is the intent of Levels 1 and 2 to ensure that loads provided with EPSSs are supplied with alternate power of a quality essentially equal to commercial power or acceptable for the load, within the time defined in the type and for a duration defined in the class. (*See ANSI C84.1, Standard for Voltage Ratings for Electrical Power Systems and Equipment.*)

2-3.4.4 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 in Level 3 in this standard. Nowhere else in this document is Level 3 addressed.

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

3-1 Energy Sources.

3-1.1 The following energy sources are acceptable for use for the emergency power supply (EPS):

(a)* Liquid petroleum products at atmospheric pressure.

(b) Liquefied petroleum gas (liquid or vapor withdrawal).

(c) Natural or synthetic gas.

Exception: For Level 1 installations in locations where the probability of interruption of off-site fuel supplies is high (i.e., due to earthquake, flood damage, or a demonstrated utility unreliability), on-site storage of an alternate energy source sufficient to allow full output of the emergency power supply system (EPSS) to be delivered for the class specified shall be required, with provision for automatic transfer from the primary energy source to the alternate energy source.

(d) Electric storage batteries.

3-1.2* The performance of Level 1 EPSSs in seismic risk areas shall be based on the EPS equipment operating a minimum of 96 hours without refueling if the need for an emergency power supply persists for this period of time.

3-1.3 The energy sources of 3-1.1 are acceptable for use for the emergency power supply when the normal source of power is by on-site energy conversion under the specific condition that there be separately dedicated energy conversion equipment on-site of capacity equal to the power needs of the EPSS.

3-1.4 A public electric utility that has a demonstrated reliability shall be permitted to be used as the EPS where the normal source is by on-site energy conversion.

3-2 Energy Converters — General.

3-2.1 Energy converters shall consist only of rotating equipment or stored energy sources or both as indicated in 3-2.2 and 3-2.3. Level 1 energy converters shall be a representative product built from components that have proven compatibility, reliability, and are coordinated to operate as a unit. The capability of the energy converter, with its controls and accessories, to survive without damage from common and abnormal disturbances in actual load circuits must be demonstrable by tests on separate prototype models or by acceptable tests on the system components as performed by the component suppliers.

Exception: The separate prototype unit may be utilized in a Level 1 or Level 2 installation only if all of the prototype tests had no deleterious effects on the unit and provided that the authority having jurisdiction, the owner, and the user are informed that the unit was the prototype test unit.

3-2.1.1 The rotating equipment prototype unit shall be tested with all typical prime mover accessories that affect its power output in place and operating. These accessories include, but are not limited to, battery-charging alternator, water pump, radiator fan for unit-mounted radiators or oil coolers (or comparable load), fuel pump and fuel filter(s), air filter(s), and exhaust mufflers or restriction simulating the maximum backpressure recommended by the prime mover manufacturer.

3-2.1.2 The energy converter for Level 1 shall be specifically designed, assembled, and tested to assure that such conditions as short circuit, load surges due to motor starting, elevator operations, SCR controllers, and X-ray equipment or overspeed, overtemperature, overload, and adverse environmental conditions are not likely to render the system inoperative.

3-2.2* Rotating equipment shall consist of a generator driven by a prime mover. The prime mover shall be otto cycle (spark ignited), diesel cycle, or gas turbine cycle. Other types of prime movers and their associated equipment meeting the applicable performance criteria of this standard shall be permitted, if acceptable to the authority having jurisdiction. The prime mover shall not mechanically drive any equipment other than its operating accessories and its generator when used for Level 1 applications.

3-2.3 Stored energy systems shall be powered by electric storage batteries located on-site and shall be limited to:

(a) Central battery systems.

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

(b) Inverter or uninterruptible power supply systems (UPS systems).

(c) Unit equipment — self-contained battery lights. [*See Section 700-12(f), NFPA 70, National Electrical Code.*®]

3-3 Energy Converters — Temperature.

3-3.1 Energy Converter Temperature. Provision shall be made to maintain the energy converter room temperature containing Level 1 rotating equipment as specified in 5-7.6. When an engine water jacket heater is required, it shall maintain the jacket water temperature at not less than 90°F (32°C). Outdoor housed units shall have an automatically

controlled heater to keep the jacket water temperature at not less than 90°F (32°C). Provision shall be made for outdoor housed units to maintain the energy converter enclosure at not less than 32°F (0°C), or battery heaters shall be provided to maintain battery temperature at a minimum of 50°F (10°C) and shall automatically shut off when the battery temperature attains 90°F (32°C). All prime mover heaters shall be automatically deactivated while the prime mover is running.

Exception No. 1: Air-cooled prime movers shall be permitted to employ a heater to maintain lubricating oil temperature as recommended by the prime mover manufacturer.

Exception No. 2: For combustion turbines, see 5-7.6.

3-3.2 Adequate antifreeze protection shall be provided. Ether-type starting aids shall not be permitted.

3-4 Energy Converters — Capacity.

3-4.1* The energy converters shall have sufficient capacity and response to pick up and carry the load and to stabilize frequency and voltage within the time specified in 2-3.1 after loss of normal power.

3-4.2 Fuel Supply.

3-4.2.1 The fuel supply for energy converters of 3-1.1(a) and (b) intended for Level 1 use shall not be used for any other purpose.[1] (*See Section 5-9.*)

Exception: Enclosed tanks may be used for supplying fuel for other equipment provided that the draw-down level will always guarantee the quantity needed for the EPSS. Vapor withdrawal LPG systems require a dedicated fuel supply.

3-4.2.2 A low-fuel sensing switch shall be provided for the main fuel supply tank(s) to indicate when less than the minimum fuel necessary for full load running as required by the specified class (*see 2-3.2*) remains in the main fuel tank. This low-fuel sensor shall apply only to 3-1.1(a) and (b). Low-fuel alarm point for liquid fueled engines is defined as the point when the main fuel tank contains insufficient fuel to meet the required full load operating hours and shall signal this condition.

3-4.2.3* The main fuel reservoir shall have a minimum capacity of at least 133 percent of either the low-fuel sensor quantity specified in 3-4.2.2 or that specified in 2-3.3 (class).

3-5 Rotating Equipment.

3-5.1 General. Prime movers and accessories shall comply with NFPA 37, *Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines*, except as modified in this standard.

3-5.2 Prime Mover Ratings. Proper derating factors, such as altitudes, ambient temperature, fuel energy content, accessory losses, and site conditions, recommended by the manufacturer of the generator set shall be used in determining whether net brake power is sufficient to meet load requirements.

3-5.3 Prime Mover Accessories.

3-5.3.1 Governors shall maintain a band width of rated frequency, for any constant load (steady-state condition), acceptable for the load. Frequency droop between no load and full load shall be acceptable for the load. Frequency dip upon one-step application of full load shall not be excessive with return to steady-state conditions occurring within the requirements of the load.

3-5.3.2 When used, solenoid valves, both in the fuel line from the supply tank(s) to the generator set and in the water cooling lines, shall operate from battery voltage. Means shall be provided for manual (nonelectric) operation of these solenoid valves, or a manual bypass valve shall be provided. The manual bypass shall be visible and accessible and its purpose identified. This fuel valve shall not be the valve used for malfunction or emergency shutdown.

3-5.3.3 Instrument Panel. The instruments required in 3-5.3.4(a), (b), (c), and (d) shall be placed on an enclosed panel located in the proximity of or on the energy converter, in such a location that will allow maintenance personnel to readily observe them without changing position from a logical maintenance work position at the energy converter. The enclosed panel shall be mounted by means of antishock vibration mountings if mounted on the energy converter.

3-5.3.4 Instruments. The prime mover shall be provided with the following instruments:

(a) Oil pressure gage to indicate lubricating oil pressure.

Exception: Engines with splash-lubricated systems.

(b) Temperature gauge to indicate cooling medium temperature.

Exception: Air-cooled engines.

(c) Hour meter to indicate actual total running time.

(d) Battery charging meter to indicate satisfactory performance of prime mover-driven battery charging means.

(e) Other instruments as recommended or provided by the prime mover manufacturer when required for proper maintenance.

3-5.3.5 Prime Mover to Control Panel Wiring. (*See 3-5.5.*) All wiring for connection to the control panel shall be harnessed or flexibly enclosed, shall be securely mounted on the prime mover to prevent chafing and vibration damage, and shall terminate at the control panel in an enclosed box or panel.

3-5.3.6 Battery Charger. The generator set shall be fitted with an integral accessory battery charger driven by the prime mover and automatic voltage regulator capable of charging and maintaining the starting battery unit (and control battery, when used) in a fully charged condition during a running condition.

Exception: A battery charger driven by the prime mover shall not be required if the automatic battery charger (see 3-5.4.6) has a high-low rate capable of fully charging the starting battery during running conditions.

3-5.4 Prime Mover Starting Equipment.

3-5.4.1 Starting shall be accomplished using an adequately sized electric starter system with a positive shift solenoid to engage the starter motor and to crank the prime mover for the period specified in 3-5.4.2 without overheating, at a speed at least equal to that recommended by the manufacturer of the prime mover, and at the lowest ambient temperature anticipated at the installation site.

Exception: Other types of stored energy starting systems (except pyrotechnic) may be used when recommended by the manufacturer of the prime mover, subject to approval of the authority having jurisdiction, provided two complete periods of cranking cycles are completed without replacement of the stored energy. A means for automatic restoration from the emergency source of the stored energy shall be provided. The stored energy system shall have the cranking capacity specified in 3-5.4.4 and shall have "black start" capability in addition to normal discharge capability.

3-5.4.2 For Otto or Diesel Cycle Prime Movers. The type and duration of the cranking cycle shall be as specified in Table 3-5.4.

A complete cranking cycle shall consist of an automatic crank period of approximately 15 seconds duration followed by a rest period of approximately 15 seconds duration. Upon starting and running of the prime mover, further cranking shall cease. Two means of cranking termination shall be utilized so that one will act as backup to the other to prevent inadvertent starter engagement. Fifteen kW and smaller otto cycle and all diesel prime movers shall be permitted to use continuous cranking methods.

Table 3-5.4 Starting Equipment

	Level 1	Level 2
(a) Battery Unit	X	X
(b) Battery Certification	X	
(c) Cycle Cranking	X or O	O
(d) Cranking Limiter Time (sec)		
cycle crank	75	75
continuous crank	45	45
(e) Float-type Battery Charger	X	X
1. DC Ammeter	X	X
2. DC Voltmeter	X	X
(f) Recharge Time (hr)	24	36
(g) Low Battery Voltage Alarm Contracts	X	X

X Required O Optional

3-5.4.3 Number of Batteries. Each prime mover shall be provided with the storage battery units as specified in Table 3-5.4. Each battery or battery unit shall be provided with an adequate storage rack. A battery unit is one or more batteries or a group of cells, series, or series parallel connected to provide the required battery unit voltage and capacity.

3-5.4.4* Size of Batteries. The battery unit shall have the capacity to maintain the cranking speed recommended by the prime mover manufacturer through two complete periods of cranking cycles specified in Table 3-5.4.

3-5.4.5 Type of Battery. The battery shall be nickel-cadmium or lead-acid. Lead-acid batteries shall be furnished as charged when wet or valve regulated (sealed). Drain-dry batteries or dry-charged lead-acid batteries shall be permitted. Vented nickel-cadmium batteries shall be furnished filled and charged, with listed flip-top, flame arrestor vent caps. The manufacturer shall provide installation, operation, and maintenance instructions, and, when shipped dry, electrolyte mixing instructions. Batteries shall not be installed until the battery charger is in service.

All batteries used in this service shall have been designed for this duty and shall have demonstrable characteristics of performance and reliability acceptable to the authority having jurisdiction. Batteries shall be prepared for use according to the battery manufacturer's instructions.

Exception: Valve-regulated (sealed-type) batteries shall not be required to be capable of periodic water addition, nor shall they be required to be supplied with a means of determining the state of charge.

3-5.4.6* Automatic Battery Charger. In addition to the prime mover- (engine-) driven charger required in 3-5.3.6, a battery charger(s) as required in Table 3-5.4 shall be supplied for recharging or maintaining a charge or both on the starting or control battery unit or both. All chargers shall have the following characteristics that are to be accomplished without manual intervention, i.e., manual switch or manual tap changing:

(a) At its rated voltage, it shall be capable of delivering energy into a fully discharged battery unit without damaging the unit.

(b) When specified, the charger shall be capable of returning to the fully discharged battery 100 percent of its ampere-hour rating within the time specified.

(c) Meters, as specified, with an accuracy within 5 percent of range shall be furnished to indicate the operation of the charger.

(d) The charger shall be permanently marked with the allowable range of battery unit capacity, nominal output current and voltage, and sufficient battery-type data to allow suitable replacement batteries to be secured.

(e) The battery charger output and performance shall be compatible with the batteries furnished, including the maintenance charge rate.

3-5.5 Control Functions.

3-5.5.1 A control panel shall be provided, containing the following:

(a) Automatic remote start capability.

(b) "Run-Off-Auto" switch.

(c) Shutdowns [3-5.5.2(c)].

(d) Alarms [3-5.5.2(d)].

(e) Controls [3-5.5.2(e)].

3-5.5.2 An automatic control and safety panel shall be a part of the EPS, containing the following equipment and/or possessing the following characteristics:

(a) Cranking control equipment to provide the complete cranking cycle described in 3-5.4.2 and Table 3-5.4.

(b) Panel-mounted control switch(es) marked "Run-Off-Automatic" to perform the following functions:

1. Run: Manually initiate, start, and run prime mover.

2. Off: Stop prime mover or reset safeties or both.

3. Automatic: Allow prime mover to start by closing a remote contact and stop by opening the remote contact.

(c) Controls to shut down and lock out the prime mover under the following conditions: failing to start after specified cranking time, overspeed, low lubricating-oil pressure, high engine temperature, or operation of remote manual stop station. (*See 3-5.5.6.*)

(d) Battery-powered individual alarm indication to annunciate visually at the control panel the occurrence of any of the conditions itemized in Table 3-5.5.2(d); additional contacts or circuits for a common audible alarm signaling locally and remotely of the occurrence of any of the itemized conditions. A lamp test switch(es) shall be provided to test the operation of all alarm lamps listed in Table 3-5.5.2(d).

(e) Controls to shut down the prime mover upon removal of initiating signal or manual emergency shutdown.

(f) The automatic control and safety panel shall also house the AC instruments listed in 3-5.9.7. Where the control panel is mounted on the energy converter, it shall be mounted by means of antivibration shock mounts, if required, to maximize reliability.

3-5.5.3 Engines equipped with a maintaining shutdown device (air shutdown damper) shall have a set of contacts that monitors the position of this device, with local alarm indication and remote annunciation in accordance with Table 3-5.5.2(d).

3-5.5.4 The panel of 3-5.1.2(d) shall be specifically approved for either a Level 1 or a Level 2 EPS consistent with the installation.

3-5.5.5 The cranking cycle shall be capable of being initiated by any of the following:

(a) Manual start initiation of 3-5.5.2(b).

(b) Loss of normal power at any automatic transfer switch considered a part of the EPSS. Prime mover shall start upon closing of a remote switch or contacts and shall stop, after appropriate time delays, when switch or contacts are opened.

(c) A clock exerciser located in an automatic transfer switch or in the control panel.

(d) A manually operated (test) switch located in each automatic transfer switch (ATS) that shall simulate a loss of power and cause automatic starting and running until this test means is reset to cause the engine circuit to duplicate its functions the same as when commercial power is restored after a true commercial power failure.

3-5.5.6 All Level 1 installations shall have a remote manual stop station of a type similar to a break-glass station located outside the room housing the prime mover (when so installed) or elsewhere on the premises when the prime mover is located outside the building.

Table 3-5.5.2(d) Safety Indications and Shutdowns

	Indicator Function (at Battery Voltage)	Level 1 C.V.	Level 1 S	Level 1 R.A.	Level 2 C.V.	Level 2 S	Level 2 R.A.
(a)	Overcrank	X	X	X	X	X	O
(b)	Low Water Temp. < 70° F (21° C)	X		X	X		O
(c)	High Engine Temperature Prealarm	X		X	O		
(d)	High Engine Temperature	X	X	X	X	X	O
(e)	Low Lube Oil Pressure Prealarm	X		X	O		
(f)	Low Lube Oil Pressure	X	X	X	X	X	O
(g)	Overspeed	X	X	X	X	X	O
(h)	Low Fuel Main Tank	X		X	O		O
(i)	EPS Supplying Load	X			O		
(j)	Control Switch Not in Auto. Position	X		X	O		
(k)	Battery Charger Malfunctioning	X			O		
(l)	Low Voltage in Battery	X			O		
(m)	Lamp Test	X			X		
(n)	Contacts for Local and Remote Common Alarm	X		X	X		X
(o)	Audible Alarm Silencing Switch			X			O
(p)	Low Starting Air Pressure	X			O		
(q)	Low Starting Hydraulic Pressure	X			O		
(r)	Air Shutdown Damper when Used	X	X	X	X	X	O
(s)	Remote Emergency Stop		X			X	

Key:
C.V. Control panel-mounted visual indication
R.A. Remote Audible
S Shutdown of EPS
X Required
O Optional

Notes:
1. Item (n) shall be provided, but a separate remote audible signal shall not be required when the regular work site of 3-5.6.1 is manned 24 hours a day.
2. Item (b) is not applicable for combustion turbines.
3. Items (p) or (q) apply only when applicable as a starting method.
4. Item (i) EPS AC Ammeter is acceptable for this function.
5. All required C.V. functions visually annunciated by a remote, common visual indicator. All required functions indicated in Column R.A. also annunciated by a remote, common audible alarm [*see 3-5.5.2(d)*].

3-5.6 Remote Controls and Alarms.

3-5.6.1 A common, remote, audible alarm powered by the storage battery shall be provided as specified in 3-5.5.2(d). This remote alarm shall be located outside of the EPS service room at a work site readily observable by personnel.

3-5.6.2 An alarm-silencing means shall be provided, and the panel shall include repetitive alarm circuitry so that, after the audible alarm is silenced, it will be reactivated after clearing the fault condition and must be restored to normal position to be silenced.

Exception: In lieu of the above, a manual alarm silencing means shall be permitted that silences the audible alarm after the occurrence of the alarm condition if such means do not inhibit any subsequent alarms from again sounding the audible alarm without further manual action.

3-5.7 Prime Mover Cooling Systems.

3-5.7.1 Cooling systems for prime movers shall be either natural or forced-air convection or liquid cooled, or a combination thereof.

3-5.7.2 Forced-air-cooled diesel or otto cycle engines shall have an integral fan of adequate size to effectively cool the prime mover under full-load conditions. Means shall be provided for evacuation of hot air from the EPS service room or the enclosure housing the unit (when so housed).

3-5.7.3 Liquid-cooled prime movers for Level 1 applications shall be arranged for closed-loop cooling consisting of one of the following types (*see Section 5-8*):

(a) Unit-mounted radiator and fan.

(b) Remote radiator.

(c) Heat exchanger (liquid-to-liquid).

Cooling systems shall prevent overheating of prime movers under conditions of highest anticipated ambient temperature at the installed elevation (above sea level) when fully loaded. Power for fans and pumps on remote radiators shall be supplied from a tap at the EPS output terminals or ahead of the first load circuit overcurrent protective device.

The secondary side of heat exchangers shall be a closed-loop cycle (i.e., recycling of cooling agent) with pumps, motors, etc., powered from a tap at the EPS output terminals or ahead of the first load circuit overcurrent protective device.

3-5.8 Prime Mover Exhaust Piping. Where applicable, the exhaust system shall include an adequate muffler or silencer and a flexible exhaust section.

3-5.9 Generators, Exciters, and Voltage Regulators.

3-5.9.1 Generators shall comply with Article 445 of NFPA 70, *National Electrical Code*. Generators shall also comply with the following requirements:

3-5.9.2 The generator shall be of dripproof construction and have amortisseur windings. It shall be suitable for the environmental conditions at the installation location. The generator, exciter, and voltage regulator shall be factory tested as a unit to assure the operational integrity of the generator system. (*See ANSI/NEMA MG1, Standard for Motors and Generators, and ANSI/NEMA MG2, Safety Standard for Construction and Guide for Selection, Installation and Use of Electric Motors and Generators.*)

3-5.9.3 EPSS voltage output at full load shall match the nominal voltage of the normal source at the transfer switch(es).

3-5.9.4 Exciters, where furnished, shall be of either the rotating or static type.

3-5.9.5 Voltage regulators shall be capable of responding to load changes sufficiently fast to meet the system stability requirements of 3-5.9.6. Antihunt provisions shall be included as necessary to accomplish this.

3-5.9.6 Generator system performance (i.e., prime mover, generator, exciter, and voltage regulator, as applicable when prototype tested as specified in 3-2.1) shall be as follows:

(a) Provide stable voltage and frequency at all loads to full rated loads.

(b) Maintain values consistent with the user's needs for frequency droop and voltage droop.

(c) Voltage dip at the generator terminals for the maximum anticipated load change shall not cause disruption or relay dropout in the load.

(d) Frequency dip and restoration to steady state for any sudden load change shall not exceed the user's specified need.

3-5.9.7 Generator instrument panel for Level 1 application shall contain:

(a) AC voltmeter(s) for each phase.

(b) AC ammeter(s) for each phase.

Exception: Phase selector switch for (a) and (b) may be used in lieu of multiple meters.

(c) Frequency meter.

(d) Voltage adjusting rheostat to allow ±5 percent voltage adjustment.

3-5.10 Miscellaneous Considerations.

3-5.10.1 Where applicable, the prime mover and generator shall be factory mounted on a common base of sufficient rigidity to maintain satisfactory dynamic alignment of the rotating element of the system, prior to shipment to the installation site.

3-5.10.2 A certification shall be supplied with the unit verifying torsional vibration compatibility of the rotating element of the prime mover and generator for the intended use of the energy converter.

3-5.10.3 Vibration isolators, as necessary, shall be furnished to minimize vibration transmission to the permanent structure. Where unusual vibration conditions are anticipated, adequate isolation treatment shall be supplied.

3-5.10.4 Electrical Diagrams. The manufacturer of the EPS shall submit complete schematic, wiring, and interconnection diagrams showing all terminal and destination markings for all EPS equipment, as well as the functional relationship between all electrical components.

3-5.10.5 The energy converter supplier shall stipulate compliance with this standard and satisfactory performance of the entire unit when installed. When requested, the short-circuit current capability at the generator output terminals shall be furnished.

Chapter 4 Electrical — Switching and Protection

4-1* General.

4-1.1 Switching, as applied to this chapter, refers to electrical equipment or devices used to do any or all of the following:

(a) Transfer connected electrical loads from one power source to another.

(b) Perform load-switching functions.

(c) Bypass, isolate, and test the transfer switch.

4-1.2 Protection, as applied to this chapter, refers to sensing and overcurrent protective devices used to protect against damage due to fault or overload to conductors and equipment connected to the output of the emergency energy source, up to and including the load terminals of the transfer switch(es).

4-2 Transfer Switches.

4-2.1 General. Transfer switches shall be suitable for transferring electric loads from one power source to another. The electrical rating shall be adequate for the total load that is designed to be connected. Each transfer switch shall be in a separate enclosure or compartment.

4-2.2 Switch Capacity. The capacity of the transfer switch, including all load current-carrying components, 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. (*See ANSI/UL 1008, Standard for Automatic Transfer Switches.*)

4-2.3 Transfer Switch Classification. When available, each transfer switch shall be listed for emergency service as a completely factory-assembled and -tested apparatus. (*See Section 700-6 of NFPA 70, National Electrical Code, and Section 7-8 of NFPA 20, Standard for the Installation of Centrifugal Fire Pumps, for listing and installation requirements for transfer switches used with fire pumps.*)

4-2.4 Automatic Transfer Switch Features.

4-2.4.1* General. Automatic transfer switches shall be electrically operated and mechanically held. The transfer switch shall transfer and retransfer the load automatically.

4-2.4.2 Source Monitoring.

(a)* Undervoltage-sensing devices shall be provided to monitor all ungrounded lines of the normal source of power. When the voltage on any phase falls below the minimum operating voltage of any load to be served, the transfer switch shall automatically initiate engine start and the process of transfer to the EPS. When the voltage on all phases of the normal source returns to within acceptable limits for a designated period of time, the process of transfer back to normal power shall be initiated. (*See 4-2.4.5 and 4-2.4.7.*)

(b) Both voltage- and frequency-sensing equipment shall be provided to monitor one ungrounded line of the EPS power. Transfer to the EPS shall be inhibited until there is adequate voltage and frequency to handle loads to be served.

Exception No. 1: Sensing equipment need not be provided in the transfer switch if included with the engine control panel.

Exception No. 2: Frequency-sensing equipment shall not be required for monitoring public utility source. (When used as an EPS, see 3-1.4.)

4-2.4.3 Interlocking. Reliable mechanical interlocking or an approved alternate method shall prevent the inadvertent interconnection of the normal power supply and the EPS or of any two separate sources of power.

4-2.4.4* Manual Operation. Instruction shall be provided for safe manual nonelectric transfer in the event the transfer switch should malfunction.

4-2.4.5* Time Delay on Starting of EPS. A time delay device shall be provided to delay starting of the EPS. The timer is intended to prevent nuisance starting of the EPS and possible subsequent load transfer in the event of harmless momentary power dips and interruptions of the normal source.

Exception: Time delay need not be provided if included with the engine control panel.

4-2.4.6 Time Delay on Transfer to EPS. An adjustable time delay device shall be provided to delay transfer to the EPS when the transfer switch is installed for Level 1 use and loads must be sequenced to avoid excessive voltage drop. The time delay shall commence when proper EPS voltage and frequency are achieved.

Exception: These time delays may be provided at the engine control panel in lieu of in the transfer switches.

4-2.4.7* Time Delay on Retransfer to Normal Source. An adjustable time delay device with automatic bypass shall be provided to delay retransfer from EPS to normal source of power. The timer is intended to permit the normal source to stabilize before retransfer of the load. The time delay shall be automatically bypassed if the EPS fails.

Exception: It shall be permitted to program the transfer switch for a manually initiated retransfer to the normal source to provide for a planned momentary interruption of the load. If used, this arrangement shall be provided with a bypass feature to permit automatic retransfer in the event that the EPS fails and the normal source is available.

4-2.4.8 Time Delay on Engine Shutdown. A time delay of 5 minutes minimum shall be provided for unloaded running of the EPS prior to shutdown. This delay provides additional engine cooldown. This time delay shall not be required on small (15 kW or less) air-cooled prime movers.

Exception: Time delay need not be provided if included with the engine control panel or if a utility feeder is used as an EPS.

4-2.4.9* Engine Generator Exercising Timer. A program timing device shall be provided to exercise the EPS as described in Chapter 6. Where load is switched, immediate return to normal power shall be automatically accomplished in case of EPS failure. Under such retransfer, no further automatic transfer of load to EPS shall be initiated for the duration of the exercising period unless normal power fails.

Exception: Exercising timer need not be provided if included with the engine control panel.

4-2.4.10 Test Switch. A test switch that will simulate failure of the normal power source shall be provided on each automatic transfer switch (ATS). An ATS shall transfer the load to the EPS.

4-2.4.11* Indication of Switch Position. Two pilot lights with identification nameplates or other approved position indicators shall be provided to indicate the transfer switch position.

4-2.4.12* Motor Load Transfer. Provisions shall be included to reduce excessive currents resulting from motor load transfer if such currents may damage EPSS equipment or cause nuisance tripping of EPSS overcurrent protective devices.

4-2.4.13 Isolation of Neutral Conductors. Provisions shall be included for assuring proper continuity, transfer, and isolation of the normal and the EPS neutral conductors whenever they are separately grounded, if needed, to achieve proper ground-fault sensing. [*See Section 230-95(b) of NFPA 70, National Electrical Code.*]

4-2.5 Nonautomatic Transfer Switch Features.

4-2.5.1* General. Switching devices shall be mechanically held and shall be operated by direct manpower or electrical remote manual control.

4-2.5.2 Interlocking. Reliable mechanical interlocking, or an approved alternate method, shall prevent the inadvertent interconnection of the normal and the EPS.

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. When two or more engine generator sets are paralleled for emergency power, the system shall be arranged to inhibit connection of excessive loads.

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

4-4 Bypass-Isolation Switches.

4-4.1 Bypass-isolation switches shall be permitted for bypassing and isolating the transfer switch, and if installed, they shall be in accordance with 4-4.2, 4-4.3, and 4-4.4.

4-4.2 Bypass-Isolation Switch Rating. The bypass-isolation 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-Isolation Switch Classification. Each bypass-isolation switch shall be listed for emergency electrical service as a completely factory-assembled and -tested apparatus. (*See Section 700-3 of NFPA 70, National Electrical Code.*)

4-4.4* Operation. With the transfer switch isolated or disconnected or both, means shall be provided so the bypass-isolation switch can function as an independent nonautomatic transfer switch and allow the load to be connected to either power source. Reconnection of the transfer switch shall be possible without a load interruption greater than the maximum time in seconds specified by the type of system.

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 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 overcurrent protective device shall have an interrupting rating equal to or greater than the maximum available short-circuit current at its location.

NOTE: See 6-7.4 of NFPA 20, *Standard for Installation of Centrifugal Fire Pumps.*

4-5.3 Accessibility. Overcurrent devices in EPSS circuits shall be accessible to authorized persons only.

Chapter 5 Installation and Environmental Considerations

5-1 General.

5-1.1* This chapter establishes minimum requirements and considerations relative to the installation and environmental conditions that could affect the performance of the EPSS equipment.

5-1.2* Consideration shall be given to the installation requirements and effects of environmental conditions relative to the various conditions that could affect the performance of the EPSS such as geographic location, building type, classification of occupancy, and hazard of contents.

5-1.3 Consideration shall be given to minimize the probability of equipment or cable failure within the EPSS, which could cause disruption of power to loads served by the EPSS.

5-1.4 The EPSS equipment shall be installed as required to meet the user's needs and to be in accordance with these standards, manufacturer's specifications, and the authority having jurisdiction.

5-1.5 EPSS equipment installed for the various levels of service defined in this standard shall be designed and assembled for such service.

5-1.6 When normal power is available, the EPS may serve loads, other than Level 1 and Level 2 systems loads, provided that either:

(a) A single EPS is installed and the EPSS is programmed to power only EPSS loads should the normal source fail, or

(b) Multiple energy converters are installed and, upon the failure of any one energy converter, the remaining energy converters shall have sufficient capacity to serve the Level 1 and 2 Level system loads.

When normal power is not available, the EPS shall serve Level 1 and Level 2 systems loads and may serve additional loads, other than Level 1 and Level 2 systems loads, provided that:

(1) Multiple energy converters are installed, and

(2) Upon failure of any one energy converter, enough load, other than Level 1 and 2 systems loads, is automatically shed when required so that the remaining energy converter(s) have sufficient capacity to serve the Level 1 and Level 2 systems loads.

5-2 Location.

5-2.1 For Level 1 installations, energy converters shall be located in a separate service room dedicated to the EPS, separated from the remainder of the building by fire separations having a minimum two-hour fire rating, or shall be located in an adequate enclosure outside the building capable of preventing the entrance of snow or rain. Rooms for Level 1 shall not be shared with other equipment or electrical service equipment not a part of the EPSS.

5-2.2* The rooms, shelters, or separate buildings housing Level 1 or Level 2 EPSS equipment shall be located to minimize the possibility of damage from flooding, including flooding resulting from fire fighting, sewer water backup, and similar type disasters or occurrences.

5-2.3* Consideration shall be given to the location of the Level 1 and Level 2 EPSS equipment to minimize the possibility of damage resulting from interruptions of emergency power source caused by:

(a) Natural conditions such as storms, floods, earthquakes, tornadoes, hurricanes, lightning, ice storms, wind, and fire.

(b) Man-made conditions such as vandalism, sabotage, and other similar occurrences.

(c) Material and equipment failures.

5-2.4 The EPS 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.

5-2.5 Where an EPS comprises more than one energy converter located in a single area, the arrangement shall minimize the possibility of failure of one energy converter affecting the continued operation of the other units.

5-3 Lighting.

5-3.1 The Level 1 or Level 2 EPS equipment location shall be provided with battery-powered emergency lighting. The emergency lighting charging system and the normal service room lighting shall be supplied from the load side of the transfer switch.

5-3.2* The intensity of illumination in the separate building or room housing the EPS equipment for Level 1 shall be 30 footcandles, unless otherwise specified by a requirement recognized by the authority having jurisdiction.

Exception: This requirement does not apply to outdoor housed units.

5-4 Mounting.

5-4.1 Rotating energy converters shall be installed on solid foundations not likely to permit sagging of fuel, exhaust, or lubricating oil piping and damage to parts resulting in leakage at joints. Such foundations or structural bases shall raise the engine at least 6 in. (150 mm) above the floor or grade level and shall be of sufficient elevation to facilitate lubricating oil drainage and ease of maintenance.

5-4.2 Generally, foundations shall be of the size (mass) and type recommended by the energy converter manufacturer. Where required to prevent transmission of vibration during operation, the foundation shall be isolated from the surrounding floor or other foundations or both in accordance with the manufacturer's recommendations and accepted structural engineering practices.

5-4.3 The EPS shall be mounted on a fabricated metal skid base of sufficient strength to resist damage during shipping and handling and, after installation, shall maintain alignment of the unit during operation.

5-5* Vibration. Vibration isolators, as recommended by the manufacturer of the EPS, shall be installed either between the rotating equipment and its skid base or between the skid base and the foundation or inertia base.

5-6* Noise. Design consideration shall be given to noise control regulations, where applicable.

5-7 Heating, Cooling, and Ventilating.

5-7.1* Consideration shall be given to properly sizing the ventilation or air conditioning systems to remove all the heat rejected to the EPS equipment room by the energy converter, uninsulated or insulated exhaust pipes, and other heat-producing equipment.

5-7.2 Adequate ventilation shall be provided to prevent temperatures or temperature rises in the EPS and related accessory equipment in excess of the recommendations of the manufacturer.

5-7.3 For the EPS equipment room, the ventilation or cooling equipment, or both, shall be sized so that the ambient temperature shall not exceed EPS equipment manufacturer's criteria or allowable maximum temperatures.

5-7.4 Adequate combustion air shall be supplied to the EPS equipment.

5-7.5 Consideration shall be given to properly designing and sizing an air intake louver and air discharge louver system, either gravity or motor operated, as required, to provide the proper pressure control and airflows. Dampers and louver restrictions shall be considered in sizing the room ventilation requirements.

5-7.6 Provision shall be made to maintain the EPS equipment room containing Level 1 rotating equipment at not less than 70°F (21°C), neither less than 40°F (4.5°C) where the engine water jacket temperature is maintained at the levels specified in Chapter 3, nor more than the maximum temperature recommended by the manufacturer or authority having jurisdiction.

5-7.7 Outdoor housed units shall be heated as specified in Chapter 3.

5-7.8 To assure successful installations, consideration shall be given to adverse conditions such as heat; cold; dust; humidity; snow and ice accumulations around housings, louvers, and remote radiator fans; and prevailing winds blowing against radiator fan discharge air.

5-8 Installed EPS Cooling System.

5-8.1 The installed EPS cooling system shall be adequate to cool the prime mover at full-rated load while operating in the particular installation circumstances of each individual EPS. A full load on-site test shall not result in activation of high temperature prealarm or high temperature shutdown.

5-8.2* Typical methods of cooling the energy converters consist of radiator cooling, remote radiator cooling, city water cooling, air cooling, and heat exchangers. On EPSS cooling systems requiring intermittent or continuous water flow, pressure, or both, a utility, city, or other water service shall not be used. Using city water for filling or makeup water to all systems is acceptable.

5-8.3 Makeup water hose bibs and floor drains shall be considered in EPS equipment rooms.

5-8.4 Where duct connections are used between the prime mover radiator and air out louvers, the ducts shall be connected to the prime movers by means of flexible sections.

5-8.5 Design consideration shall be given to remote radiator or heat exchanger sizing, pipe sizing, pump sizing, sufficient shutoffs to isolate equipment to facilitate maintenance, the need for and sizing of deaeration and surge tanks, drain valves for cleaning and flushing the cooling system, and type of flexible hoses between the prime mover and the cooling system piping.

5-9 Fuel System.

5-9.1* Fuel tanks shall be sized to accommodate the specific EPS class.

5-9.2 Fuel tanks shall be placed as close as practical to the prime mover. Fuel lift (suction head) of the prime mover fuel pump shall be adequate for the fuel system or a fuel transfer pump and day tank shall be utilized. Gravity feed of fuel to the prime mover shall not be allowed except from an integral tank (*see NFPA 37, Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines*).

5-9.3 Fuel piping shall be of compatible metal to minimize electrolysis, properly sized, with vent and fill pipes located to prevent entry of ground water or rain into the tank. Galvanized fuel lines shall not be used. Approved flexible fuel lines shall be used between the prime mover and the fuel piping.

5-9.4 Day tanks on diesel systems shall be installed below the engine fuel return elevation, and the return line to the day tank shall be below the fuel return elevation. Gravity fuel oil return lines between the day tank and the main supply tank shall be sized to handle the potential fuel flow and shall be free of traps so that fuel will flow freely to the main tank.

5-9.5 Integral tanks of 60 gal (230 L) diesel fuel or 25 gal (95 L) gasoline fuel or less capacity of liquid fuels shall be allowed inside or on roofs of structures, or as approved by the authority having jurisdiction. Quantities of all types of fuels stored in buildings shall meet the approval of the authority having jurisdiction.

5-9.6 Fuel supply for gas- and liquid-fueled prime movers shall be installed in accordance with applicable standards. (*See NFPA 37, Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines; NFPA 54, National Fuel Gas Code; and NFPA 58, Standard for the Storage and Handling of Liquefied Petroleum Gases.*)

5-9.7 The fuel supply for gas- and liquid-fueled prime movers shall be adequate for the demands of the prime mover in all respects including sizing of fuel lines, valves including manual shutoff, battery-powered fuel solenoids, gas regulators, regulator vent piping, flexible fuel line section, fuel line filters, fuel vaporizers (LPG) and ambient temperature effect of fuel tank vaporization rates of LPG where applicable.

5-9.8 The fuel storage and supply lines for EPSS shall be in accordance with this standard or with the specific authority having jurisdiction, or both.

5-9.9 All manual fuel system valves shall be the indicating type.

5-10 Exhaust System.

5-10.1 The exhaust system equipment and installation, including piping, muffler, and related accessories, shall be in accordance with applicable standards. (*See NFPA 37, Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines.*)

5-10.2 Exhaust system installation shall be gastight to prevent exhaust gas fumes from entering inhabited rooms or buildings and shall terminate in such a manner that toxic fumes will not reenter a building or structure, particularly through windows, air ventilation inlets, or the engine air-intake system.

5-10.3* Exhaust piping shall be connected to the prime mover by means of a flexible connector and shall be independently supported thereafter so no damaging weight or stress is applied to the engine exhaust manifold or turbocharger. A condensate trap and drain valve shall be provided where necessary at the low point of the piping. Consideration shall be given to thermal expansion and resultant movement of the piping. For reciprocating engines, mufflers shall be placed as close as practical to the engine, in a horizontal position where possible. An approved thimble(s) shall be used where exhaust piping passes through combustible walls or partitions. For reciprocating engines, the piping shall terminate in a rain cap, tee, or ell, pointing downwind from the prevailing wind. Consideration shall be given to potential heat effect due to proximity to conduit runs, fuel piping, and lighting fixtures. Consideration shall be given to insulating the engine exhaust systems in buildings after the flexible section.

5-10.4 For maximum efficiency, operation economy, and prevention of engine damage, the exhaust system shall be designed so it does not create excessive backpressure on the engine. The piping size, connections, and muffler shall be properly selected and installed to ensure satisfactory EPS operation and shall meet the requirements of the manufacturer.

5-10.5 The exhaust system shall not pass near any flammable material. Consideration shall be given to a fire-resistive, high temperature rated, insulative material wrapped around the exhaust system covered with a metal retainer to reduce heat radiation and exhaust noise.

5-11 Protection.

5-11.1 The room in which the EPS equipment is located shall not be used for storage purposes.

5-11.2* Where EPS equipment rooms or separate buildings are equipped with fire suppression systems, carbon dioxide or halon systems shall not be used unless prime mover combustion air is taken from outside the structure. An automatic dry chemical system shall not be used unless the manufacturers of the EPS certify that the dry chemical system will not damage the EPS system or hinder its operation or reduce its output. Where sprinkler protection is provided in the EPS equipment rooms or separate buildings, hoods or shields of noncombustible materials shall be installed to protect the critical equipment.

5-11.3 Where the EPS rooms or separate buildings are equipped with fire detection systems, the installation shall be in accordance with applicable standards. (*See NFPA 72, Standard for the Installation, Maintenance, and Use of Protective Signaling Systems, and NFPA 72E, Standard on Automatic Fire Detectors.*)

5-11.4 The EPS equipment shall be adequately protected from damage due to lightning.

5-11.5* In recognized seismic risk areas, EPS and EPSS components such as electrical distribution lines, water distribution lines, fuel distribution lines, and others that serve the EPS shall be designed to minimize damage from earthquakes and to facilitate repairs should an earthquake occur.

5-11.6* In seismic-prone areas for Level 1 and Level 2 systems, EPSs, transfer switches, distribution panels, circuit breakers, and associated controls must be capable of performing their intended functional operation during and after being subjected to the anticipated seismic shock.

5-12 Distribution.

5-12.1 The distribution and wiring systems within EPSSs shall be installed in accordance with applicable standards. (*See NFPA 70, National Electrical Code.*)

5-12.2 Where applicable, in addition to the requirements of 5-12.1, distribution and wiring systems of Level 1 EPSSs shall be installed in accordance with applicable standards. (*See Chapter 3, Electrical Systems, of NFPA 99, Standard for Health Care Facilities.*)

5-12.3 The wiring between the EPS output terminals and the first distribution overcurrent protective device terminals within the EPSS shall be located at a minimum distance to enhance system reliability and safety.

5-12.4 If the conduit attaching point to the EPS is on the forcing function side of the EPS's vibration isolation system, flexible conduit section(s) shall be installed between the EPS unit(s) and any of the following so attached:

(a) The transfer switch.

(b) The control and annunciator wiring.

(c) Any accessory supply wiring such as jacket water heaters.

Stranded wire of adequate size shall be used to minimize breakage due to vibration. Bushings shall be installed to protect wiring from abrasion with conduit terminations.

5-12.5 All AC-powered support and accessory equipment necessary to the operation of the EPS shall be supplied from the load side of the automatic transfer switch(es), or the output terminals of the EPS, ahead of the main EPS overcurrent protection, as necessary to assure continuity of the EPSS operation and performance.

5-12.6 The starting battery units shall be located as close as practicable to the prime mover starter to minimize voltage drop. Battery cables shall be sized to minimize voltage drop in accordance with the manufacturer's recommendations and accepted engineering practices.

5-12.7 The electrical distribution system of the EPSS shall be complete with properly sized overcurrent and fault current protective equipment. (*See NFPA 70, National Electrical Code.*)

5-13 Installation Acceptance.

5-13.1 Upon completion of the installation of the EPSS, the EPS shall be tested to ensure conformity to the requirements of the standard, both in power output and in function. The authority having jurisdiction shall be given advance notification of the time the final test will be performed in order that the authority may witness these tests.

5-13.2 An on-site acceptance test shall be conducted as a final approval test for all Emergency Power Supply Systems. For new Level 1 installations, the EPSS shall not be construed to meet this standard until the acceptance tests have been conducted and test requirements met.

5-13.2.1 The test shall be conducted after completion of the installation with all EPSS accessory and support equipment in place and operating.

5-13.2.2 Test Results. The EPSS shall perform within the limits specified in this standard.

5-13.2.3 The on-site installation test shall be conducted in the following manner:

(a) With prime mover in a "cold start" condition and emergency load at normal operating level, initiate a normal power failure by opening all switches or breakers supplying the normal power to the building or facility. Test load shall be that load that is served by the EPSS.

(b) Observe and record the time delay on start.

(c) Observe and record the cranking time until the prime mover starts and runs.

(d) Observe and record the time required to come up to operating speed.

(e) Record voltage and frequency overshoot.

(f) Observe and record time required to achieve steady-state condition with all switches transferred to the emergency position.

(g) Record voltage, frequency, and amperes.

(h) Record prime mover oil pressure, water temperature where applicable, and battery charge rate at 5-minute intervals for the first 15 minutes, and at 15-minute intervals thereafter.

(i) Continue load test with building load, or other loads that simulate the intended load as defined in 3-4.1, for the minimum time as required by 2-3.2 class, or two hours maximum, observing and recording load changes and the resultant effect on voltage and frequency.

(j) Return normal power to the building or facility, record the time delay on retransfer to normal for each switch (minimum setting: 5 minutes), and the time delay on prime mover cooldown period and shutdown.

NOTE: See A-4-2.4.7.

5-13.2.4 After completion of the test performed in 5-13.2.3, the prime mover shall be allowed to cool for 5 minutes.

5-13.2.5 Full-Load Test. A load shall be applied for a two-hour, full-load test. The building load can serve as part or all of the load, supplemented by a load bank of sufficient size to provide a load equal to 100 percent of the nameplate kW rating of the EPS, less applicable derating factors for site conditions. Unity power factor is acceptable for on-site testing, provided that rated load tests at rated power factor have been performed by the manufacturer of the EPSS prior to shipment.

5-13.2.6 A full-load test shall be initiated immediately after the cooling time allowed in 5-13.2.4 by any method that will start the prime mover and, immediately upon reaching rated rpm, pick up 100 percent of nameplate kW rating on one step, less applicable derating factors for site conditions.

5-13.2.7 Record the data listed in 5-13.2.3(c), (d), (e), (f), (g), and (h) at first load acceptance and every 15 minutes thereafter until the completion of the two-hour test period.

5-13.2.8 Cycle Crank Test. Utilize any method recommended by the manufacturer to prevent the prime mover from running. Put the control switch into "run" to cause the prime mover to crank. Observe the complete crank/rest cycle specified in 3-5.4.2 and Table 3-5.4.

5-13.2.9 Test all safeties specified in 3-5.5 and 3-5.6 as recommended by the manufacturer.

5-13.3 The following shall be made available to the authority having jurisdiction at the time of the acceptance test:

(a) Evidence of the prototype test of 3-2.1 (for Level 1).

(b) Certified analysis of 3-5.10.2.

(c) A letter of compliance specified in 3-5.10.5.

(d) A manufacturer's certification of a rated-load test at rated power factor with the ambient, altitude, and fuel grade recorded.

Chapter 6 Routine Maintenance and Operational Testing

6-1 General.

6-1.1 The continuing reliability and integrity of the EPSS is dependent on an established program of routine maintenance and operational testing. The routine maintenance and operational testing program shall be based on the manufacturer's recommendations, instruction manuals, and the minimum requirements of this chapter and the authority having jurisdiction.

6-1.2 Consideration shall be given to temporarily providing a portable or temporary alternate source whenever the emergency generator is out of service.

6-2* Manuals, Special Tools, and Spare Parts.

6-2.1 At least two sets of an instruction manual(s) for all major components of the EPSS shall be supplied by the manufacturer(s) of the EPSS and shall contain:

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

(b) Instructions for routine maintenance.

(c) Detailed instructions for repair of the EPS and other major components of the EPSS.

(d) Pictorial parts list and part numbers.

(e) Pictorial and schematic electrical drawings of wiring systems, including operating and safety devices, control panels, instrumentation, and annunciators.

6-2.2 For Level 1, one set of the instruction manual shall be kept in a secure, convenient location near the equipment. The other set shall be kept in a different source location.

6-2.3 Special tools and testing devices required for routine maintenance shall be available for use when needed.

6-2.4 Replacement for parts identified by experience as high mortality items shall be maintained in a secure location(s) on the premises. Consideration shall be given to stocking spare parts as recommended by the manufacturer.

6-3 Maintenance and Operational Testing.

6-3.1* The EPSS shall be so maintained as to provide reasonable assurance that the system will be capable of supplying service within the time specified in type and for the time duration specified in class.

6-3.2 A routine maintenance and operational testing program shall be initiated immediately after the EPSS has passed acceptance tests.

6-3.3 A written schedule for routine maintenance and operational testing of the EPSS shall be established.

6-3.4 A written record of inspections, tests, exercising, operation, and repairs of the EPSS shall be maintained on the premises. The written record shall include:

(a) The date of the maintenance report.

(b) Identification of the servicing personnel.

(c) Notation of any unsatisfactory condition and the corrective action taken, including parts replaced.

6-3.5 Transfer switches shall be subjected to a maintenance program including connections, inspection or testing for evidence of overheating and excessive contact erosion, removal of dust and dirt, and replacement of contacts when required.

NOTE: Where sealed devices are used, replacement of the complete device may be necessary.

6-3.6 Storage batteries, including electrolyte levels, used in connection with Level 1 systems shall be inspected at intervals of not more than 7 days and shall be maintained in full compliance with manufacturer's specifications. Defective batteries shall be repaired or replaced immediately upon discovery of defects. [*See NFPA 70, National Electrical Code, Section 700-2(d)(4).*]

6-4 Operational Inspection and Testing.

6-4.1* Level 1 EPSS, including all appurtenant components, shall be inspected weekly and shall be exercised under load at intervals of not more than 30 days.

Exception: If the generator set is used for standby power or for peak load shaving, these uses shall be entered in the written record and may be substituted for scheduled operations and testing of the generator set if the appropriate data are recorded.

6-4.2 Generator sets in Level 1 service shall be exercised under operating temperature conditions and at a capacity not less than fifty percent of the total connected EPSS load (not less than thirty percent of EPS nameplate rating and preferably at least fifty percent of EPS nameplate rating) at least once monthly for a minimum of thirty minutes. Consideration shall be given to more stringent conditions as recommended by the individual energy converter manufacturer.

6-4.2.1 Equivalent loads used for testing shall be automatically replaced with the emergency loads in case of failure of the primary source.

6-4.3 Load tests of generator sets shall include complete cold starts.

6-4.4 Time delays shall be set as follows:

(a) Time delay on start: Minimum 1 second.

Exception: Gas turbine cycle: 0.5 second minimum.

(b) Time delay on transfer to emergency: no minimum required.

(c) Time delay on restoration to normal: 5 minutes minimum. (*See A-4-2.4.7.*)

(d) Time delay on shutdown: 5 minutes minimum.

6-4.5 The monthly test of a transfer switch shall consist of electrically operating the transfer switch from normal position to alternate position and return.

6-4.6* EPSS circuit breakers for Level 1 usage, including main and feed breakers between EPS and the transfer switch load terminals, shall be exercised annually.

Exception: Medium and high voltage circuit breakers for Level 1 usage shall be exercised every six months and tested under simulated overload conditions every two years.

6-4.7 The routine maintenance and operational testing program shall be overseen by a properly instructed individual.

Chapter 7 Referenced Publications

7-1 The following documents or portions thereof are referenced within this standard 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 37, *Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines*, 1990 edition

NFPA 70, *National Electrical Code*, 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-1-1.4.2 Criteria for stored energy systems are being developed for inclusion within this standard or for a separate standard.

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

A-2-3.4.1 Typically, Level 1 systems are intended to automatically supply illumination or power or both to critical areas and equipment in the event of failure of the 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 buildings subject to occupancy by large numbers of persons.

Emergency systems may also provide power for such functions as ventilation when essential to maintain life, fire detection and alarm systems, elevators, fire pumps, 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-2-3.4.2 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-2-3.4.3 It is important to recognize that EPSSs may react substantially differently than commercial power during transient and short-circuit conditions due to the relatively small capacities of the EPSS compared to the normal commercial power source.

A-3-1.1(a) See A-3-4.2.3 on shelf-life precautions for fuel supplies.

A-3-1.2 The seismic risk areas that should be specifically addressed are those designated as Zones 3 and 4 of the *Uniform Building Code* as modified by the authorities having jurisdiction.

A-3-2.2 The following devices are typical of energy converters and energy sources that should be carefully reviewed as part of Level 1 emergency power supplies: motor-generator/engine, motor-generator/flywheel, or steam turbine. Connection to the normal power source ahead of the normal source main service disconnect and a separate service should be excluded as a sole source of EPS.

A-3-4.1 It is recognized that in some installations part or all of the output of the EPS might be used for peak shaving or that part of the output might be used for driving nonessential loads during loss of normal power source. Load shedding of these loads when the output of the energy converter is needed is one way of meeting the requirements of 3-4.1.

A-3-4.2.3 Consideration should be given to tank sizing to meet minimum fuel supplier delivery requirements, particularly in small tanks. Consideration should also be given in regard to oversizing tanks, since many fuels have a "shelf life" and will deteriorate with age. Where large tanks are required, it is recommended that fuels be periodically pumped out and used in other service and replaced with fresh fuel.

A-3-5.4.4 Cold cranking amperes, or cranking performance, is the number of amperes a fully charged battery at 0°F (–17.8°C) can continuously deliver for 30 seconds and maintain a voltage of 1.2 volts per cell.

A-3-5.4.6 It is intended that the battery charger be factory built, adjusted, and approved for the specific type, construction, and capacity of the battery; and for lead-acid batteries, for the specific gravity, type, and concentration of grid alloys (such as high or low gravity, high or low antimony, calcium, or none).

A-4-1 For summary tabulation showing equipment variation as a function of required level of performance, see Table A-4-1.

Table A-4-1 Equipment Variation as a Function of Required Level of Performance

Paragraph	Description	Level 1	Level 2
4-2.4.1	Mechanically held construction.	Yes	Yes
4-2.4.5	Time delay on starting of alternate power source.	Yes	Yes
4-2.4.6	Time delay on transfer to alternate source.	Yes	No
4-2.4.7	Time delay on retransfer to normal source.	Yes	Yes
4-2.4.8	Time delay on engine shutdown.	Yes	Yes
4-2.4.11	Indication of transfer switch position.	Yes	Yes
4-2.4.12	Provision for minimizing motor inrush currents.	Yes	No
4-2.4.13	Isolation of neutral contacts.	Yes	Yes
4-5.3	Overcurrent devices accessible to authorized persons only.	Yes	Yes

A-4-2.4.1 For most applications within this standard, the automatic transfer switch will be used to transfer a load from a normal source of supply to an engine generator set.

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

A-4-2.4.2(a) Where special loads require more rapid detection of power loss, underfrequency monitoring may also be provided. Upon frequency decay to below the lower limit of frequency necessary for proper operation of the loads, the transfer switch should automatically initiate transfer to the alternate source. (*See A-4-2.4.12.*)

A-4-2.4.4 Authorized 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-4-2.4.5 For most applications a nominal delay of one second is adequate. The time delay should be short enough so that the generator can start and be on the line within the time specified for the type classification.

A-4-2.4.7 It is recommended that the timer for delay on retransfer to normal source be set for 30 minutes. This is an appendix item and thus is not mandatory. The 30-minute recommendation is to establish a "normalized" engine temperature, when it is beneficial for the engine. The NFPA 70 requirement of 15 minutes establishes the minimum time.

A-4-2.4.9 The timer may run the generator only, may run the generator and transfer the load to emergency power, or may be provided with a switch for optional operation.

A-4-2.4.11 For maintenance purposes, consideration should be given to a transfer switch counter.

A-4-2.4.12 Automatic transfer switches can be provided with accessory controls that provide a signal that may operate remote motor controls that disconnect motors prior to transfer, and reconnect them after transfer when the residual voltage has been substantially reduced. Another method is to provide in-phase monitors within the automatic transfer switch to prevent retransfer to the normal source until both sources are nearly synchronized. A third method is to use a programmed neutral position transfer switch.

A-4-2.5.1 Standards for nonautomatic transfer switches are similar to those for automatic transfer switches, as defined in Chapter 2, with the omission of automatic controls.

A-4-4.4 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 reestablishment of connections to heavy loads.

A-5-1.1 The performance of the emergency power supply (EPS) and emergency power supply system (EPSS) is dependent on many factors, one of which is correct initial installation, primarily as the installation relates to the location and environmental conditions. While this standard is not intended to serve as a design standard for EPSS installation and environmental considerations, certain minimum standards are recognized as essential for successful start-up and performance, safe operation, and utilization of the EPSS when required.

A-5-1.2 The environmental conditions to be considered in the EPSS design should include but not be limited to heating, ventilating, and air conditioning systems, protection from floods, fire, vandalism, wind, earthquakes, lightning, and other similar or applicable environmental conditions common to the geographic and other factors affecting the location of the EPSS equipment.

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

A-5-2.2 EPSS equipment should be located above known previous flooding elevations where possible.

A-5-2.3 When installing the EPSS equipment and related auxiliaries, environmental considerations should be given, particularly relating to installation of the fuel tanks and exhaust lines, or EPS building, or both.

To protect against disruption of power in the facility, it is recommended that the transfer switch be located as close to the load as possible.

A-5-3.2 Where outdoor housed units are used, it is recommended that a flashlight or battery-powered light with flexible cord be maintained in the housing.

A-5-5 Generally, integral rubber vibration isolators are used on the rotating energy converters and spring-type or pad-type isolators are used on the larger energy converter units. In some cases high deflection spring-type isolators should be used where a high degree of vibration attenuation is required. The EPS manufacturer should be consulted when considering the specific type of vibration control. Inertia bases should be considered where unusual vibration conditions are anticipated.

A-5-6 Generally, exhaust noises can be attenuated by using the proper mufflers. The mufflers used should be in accordance with the EPS manufacturer's recommendations. Depending on the degree of silencing required, the muffler should be rated accordingly for "commercial," "semi-critical," and "critical" (high degree of silencing) service. To attenuate other noises, line-of-sight barriers having acoustical treatment or total acoustical enclosures can be used. The EPS should be installed away from critical areas.

A-5-7.1 During operation, the EPS and related equipment reject considerable heat that must be removed by proper ventilation or air cooling. In some cases outdoor

installations rely on natural air circulation, but enclosed installations need properly sized, properly positioned ventilation facilities or air conditioning equipment or both.

A-5-8.2 It should be recognized that the reliability of city water cooling is strictly dependent upon the reliability of the water utility. It should also be recognized that during such natural disasters as earthquakes, flooding, etc., the water supply can simultaneously be interrupted with the normal electric power supply.

A-5-9.1 Fuel system design consideration should be given to safely provide an adequate supply of clean, fresh fuel to the prime mover. Diesel fuel has a storage life of approximately one and one-half to two years and gasoline has a storage life of approximately six months. Tanks should be sized such that the fuel will be consumed within the storage life or provision made to remove stale fuel and replace it with fresh fuel.

A-5-10.3 Consideration should also be given to utilizing dampening supports where it is necessary to reduce exhaust noise vibration transmission.

A-5-11.2 If a fire suppression system is used in EPS rooms or separate buildings housing EPS equipment, consideration should be given to preaction-type suppression systems.

A-5-11.5 Consideration should be given to the location of the EPS equipment, both as it relates to the building structure and to the effects of an earthquake.

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

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

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

Battery racks for EPS equipment and electrical items or related auxiliaries or both should be designed to resist internal damage and damage at the equipment supports resulting from earthquake-generated motion.

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

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

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

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

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-5-11.6 Seismic shock should be simulated at the factory or in a testing laboratory on a prototype unit. Simulation should consist of a test(s) approximating actual time-history records of known seismic shocks applied to the equipment under test. Subassemblies of the total equipment may be tested separately when it is neither practical nor feasible to test the complete unit.

A-6-2 When adequately secured from public access, it is desirable to locate an instruction manual, special tools and testing devices, and spare parts in the room in which the emergency power supply is located. The articles should be mounted at a convenient location on a wall and should be enclosed in a metal or other suitable cabinet. The cabinet should be made to accommodate the instruction manual on the inside of the door.

A-6-3.1 See Tables A-6-3.1(a) and A-6-3.1(b).

A-6-4.1 See Tables A-6-4.1(a), A-6-4.1(b), and A-6-4.1(c).

A-6-4.6 Circuit breakers should be tested under simulated overload conditions every two years.

Table A-6-3.1(a) Level 1 and 2 Emergency Power Supply Systems Suggested Maintenance Schedule

Item No.		Component (as applicable) The suggested maintenance procedure and frequency should follow those recommended by the manufacturer. In the absence of such recommendations, the table below indicates alternate suggested procedures. X indicates action R indicates replacement, if needed	Procedure: Visual Inspection	Check	Change	Clean	Test	Frequency: W—Weekly M—Monthly Q—Quarterly S—Semiannually A—Annually No. indicates hours Level I	Level 2
1.	(a)	Fuel — Main supply tank level		X				W	M
	(b)	Day tank level	X	X				W	M
	(c)	Day tank float switch	X				X	W	Q
	(d)	Supply or transfer pump operation	X				X	W	Q
	(e)	Solenoid valve operation	X				X	W	Q
	(f)	Strainer, filter and/or dirt leg				X		Q	Q
	(g)	Water in system		X		X		W	Q
	(h)	Flexible hose and connectors	X		R			W	M
	(i)	Tank vents and overflow piping unobstructed		X			X	A	A
	(j)	Piping	X					A	A
	(k)	Gasoline in main tank (when used)			R			A	A
2.	(a)	Lubrication System — Oil level	X	X				W	M
	(b)	Oil change			R			50 or A	50 or A
	(c)	Oil filter(s)			X			50 or A	50 or A
	(d)	Lube oil heater		X				W	M
	(e)	Crankcase breather	X		R	X		Q	S
3.	(a)	Cooling System — Level	X	X				W	M
	(b)	Antifreeze protection level					X	S	A
	(c)	Antifreeze			X			A	A
	(d)	Adequate cooling water to heat exchanger		X				W	M
	(e)	Rod out heat exchanger				X		A	A
	(f)	Adequate fresh air through radiator		X				W	M
	(g)	Clean exterior of radiator				X		A	A
	(h)	Fan and alternator belts	X	X				M	Q
	(i)	Water pump(s)	X					W	Q
	(j)	Condition of flexible hoses and connections	X	X				W	M
	(k)	Jacket water heater		X				W	M
	(l)	Inspect duct work, clean louvers	X	X	X			A	A
	(m)	Louver motors and controls	X			X	X	A	A
4.	(a)	Exhaust System — Leakage	X	X				W	M
	(b)	Drain condensate trap		X				W	M
	(c)	Insulation and fire hazards	X					Q	Q
	(d)	Excessive back pressure					X	A	A
	(e)	Exhaust system hangers and supports	X					A	A
	(f)	Flexible exhaust section	X					S	S
5.	(a)	Battery System — Electrolyte Level		X				W	M
	(b)	Terminals clean and tight	X	X				Q	Q
	(c)	Remove corrosion, case exterior clean and dry	X			X		M	M
	(d)	Specific gravity or state of charge					X	M	M
	(e)	Charger and charge rate	X					M	M
	(f)	Equalize charge		X				M	M
6.	(a)	Electrical System — General Inspection	X					W	M
	(b)	Tighten control and power wiring connections		X				A	A
	(c)	Wire chafing where subject to movement	X	X				Q	S
	(d)	Operation of safeties and alarms		X			X	S	S
	(e)	Boxes, panels and cabinets				X		S	S
	(f)	Circuit breakers, fuses .....every 2 years or NOTE: Do not break manufacturer's seals or perform internal inspection on these devices	X	X	R	X	X	M	A
	(g)	Transfer switch main contacts	X			X		A	A
	(h)	Calibration of voltage-sensing relays/devices .....every 5 years or		X			X	A	A
	(i)	Wire insulation breakdown .....every 3 years or					X	500	500

Table A-6-3.1(a) (Continued)

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 alternate suggested procedures.			Visual Inspection	Check	Change	Clean	Test	W—Weekly M—Monthly Q—Quarterly S—Semiannually A—Annually No. indicates hours	
Item No.		**X indicates action R indicates replacement, if needed**						**Level I**	**Level 2**
7.	(a)	Prime Mover — General Inspection	X					W	M
	(b)	Service air cleaner			X	X		S	S
	(c)	Governor oil level and linkage	X	X				M	M
	(d)	Governor oil			X			A	A
	(e)	Ignition system — plugs, points, coil, cap, rotor, secondary wire insulation	X	X	R	X	X	A	A
	(f)	Choke setting and carburetor adjustment		X				S	S
	(g)	Injector pump and injectors for flow rate, pressure and/or spray pattern					X	A	A
	(h)	Valve Clearance....every 3 years or					X	500	500
	(i)	Torque bolts....every 3 years or					X	500	500
8.	(a)	Generator — General Inspection	X					W	M
	(b)	Brush length, appearance, free to move in holder	X	X		X		S	S
	(c)	Commutator and slip rings	X			X		A	A
	(d)	Rotor and stator	X			X		A	A
	(e)	Bearing(s)	X		R			A	A
	(f)	Bearing grease		X	R			A	A
	(g)	Exciter	X	X		X		A	A
	(h)	Voltage regulator	X	X		X		A	A
	(i)	Measure and record resistance readings of windings with insulation tester (Megger)					X	A	A
9.	(a)	General condition of EPSS, any unusual condition of vibration, leakage, noise, temperature or deterioration	X			X		W	M
	(b)	Service room or housing housekeeping	X			X		W	M
10.		Restore system to automatic operation condition	X					W	M

Table A-6-3.1(b) Maintenance Log—Routine Maintenance, Operation and Testing (RMOT)

Service Frequency			Performed By																				
Item No.	Level 1	Level 2	Date																				
1 a	W	M																					
b	W	M																					
c	W	Q																					
d	W	Q																					
e	W	Q																					
f	Q	Q																					
g	W	Q																					
h	A	A																					
i	A	A																					
j	A	A																					
k	A	A																					
2 a	W	M																					
b	*50/A	50/A																					
c	50/A	50/A																					
d	W	M																					
e	Q	S																					

Table A-6-3.1(b) (Continued)

Item No.	Service Frequency Level 1	Service Frequency Level 2	Performed By / Date																				
3 a	W	M																					
b	S	A																					
c	A	A																					
d	W	M																					
e	A	A																					
f	W	M																					
g	A	A																					
h	M	Q																					
i	W	Q																					
j	W	M																					
k	W	M																					
l	A	A																					
m	A	A																					
4 a	W	M																					
b	W	M																					
c	Q	Q																					
d	A	A																					
e	A	A																					
f	S	S																					
5 a		M																					
b	Q	Q																					
c	M	M																					
d	M	M																					
e	M	M																					
f	M	M																					
6 a	W	M																					
b	A	A																					
c	Q	S																					
d	S	S																					
e	S	S																					
f	A	A																					
g	A	A																					
h	A	A																					
7 a	W	M																					
b	S	S																					
c	M	M																					
d	A	A																					
e	A	A																					
f	S	S																					
g	A	A																					
h	†3/500	3/500																					
i	3/500	3/500																					
8 a	W	M																					
b	S	S																					
c	A	A																					
d	A	A																					
e	A	A																					
f	A	A																					
g	A	A																					
h	A	A																					
9 a	W	M																					
b	W	M																					
10	W	M																					

* Abbreviation for 50 or A † Every three years or 500 hours

Table A-6-4.1(a) Rotating Equipment Operation and Testing Log

Items	Performed By																								
Fill In Appropriate Readings	Date																								
1. Table 6-3.1																									
2. RTM																									
3. Power fail																									
4. T/D start																									
5. Crank time																									
6. Transfer																									
7. (a) ac volt																									
(b) Hz																									
(c) ac amp																									
8. (a) Oil press.																									
(b) dc amps																									
9. (a) Oil press.																									
(b) dc amps																									
(c) W/A temp.																									
10. Restore normal																									
11. (a) Oil press.																									
(b) dc amps																									
(c) W/A temp.																									
(d) ac volts																									
(d) Hz																									
(f) ac amps																									
12. T/D retransfer																									
13. T/D stop																									
14. Auto Mode																									
Comments																									

Table A-6-4.1(b) Stored Energy System Operation and Testing Log

Items	Performed By																							
Fill In Appropriate Readings	Date																							
1. Table 6-3.1																								
2. Power fail																								
3. (a) ac volt																								
(b) Hz																								
(c) ac amp																								
4. dc voltage																								
(a) cent. batt.																								
(b) unit equip.																								
(c) UPS																								
5. Restore power																								
6. Batt. chg. rate																								
7. Batt. gravity																								
Comments																								

Table A-6-4.1(c) Suggested Operation and Testing

I. Rotating Equipment—Levels 1 and 2

Item Number	Function
1.	Perform maintenance per Table A-6-3.1(a).
2.	Record running time meter reading at start and end of test.
3.	Simulate normal power failure from a "cold start" by use of the test switch in automatic transfer switch or by opening normal power supply to EPSS.
4.	Observe and record time delay on start.
5.	Record cranking time (terminates when engine starts).
6.	Transfer load to EPS. (*See 6-4.1 and 6-4.2.*)
7.	Record AC voltage, frequency, amperage.
8.	Record initial oil pressure and battery-charging rate.
9.	Record oil pressure, battery-charging rate, and water or air temperature after 15 minutes running time.
10.	Return test switch to normal or reestablish normal power supply at such time as will cause a minimum running time of 30 minutes under load.
11.	Record prime mover and AC instruments just prior to transfer.
12.	Record time delay on retransfer.
13.	Record time delay on shutdown for units so equipped.
14.	Place unit in automatic operation mode.

II. Stored Energy System—Weekly for Level 1, Monthly for Level 2

Item Number	Function
1.	Perform applicable maintenance per Table A-6-3.1(a).
2.	Simulate normal power failure.
3.	Record AC voltage, amperage, and frequency on UPS.
4.	Record DC voltage on central battery, unit equipment, and UPS.
5.	Restore normal power supply after appropriate load period of: (a) UPS: 2 minutes on 5-minute battery, 5 minutes on 15-minute battery. (b) Central battery or unit equipment: 15 minutes on weekly or monthly test and 1½ hours or 4 hours, per occupancy requirement or code requirements, on an annual test.
6.	Record battery charge rate on restoration to normal.
7.	Test and record battery specific gravity or state of charge after recharge time allowed by code.

Appendix B Diagrams of Typical Systems

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

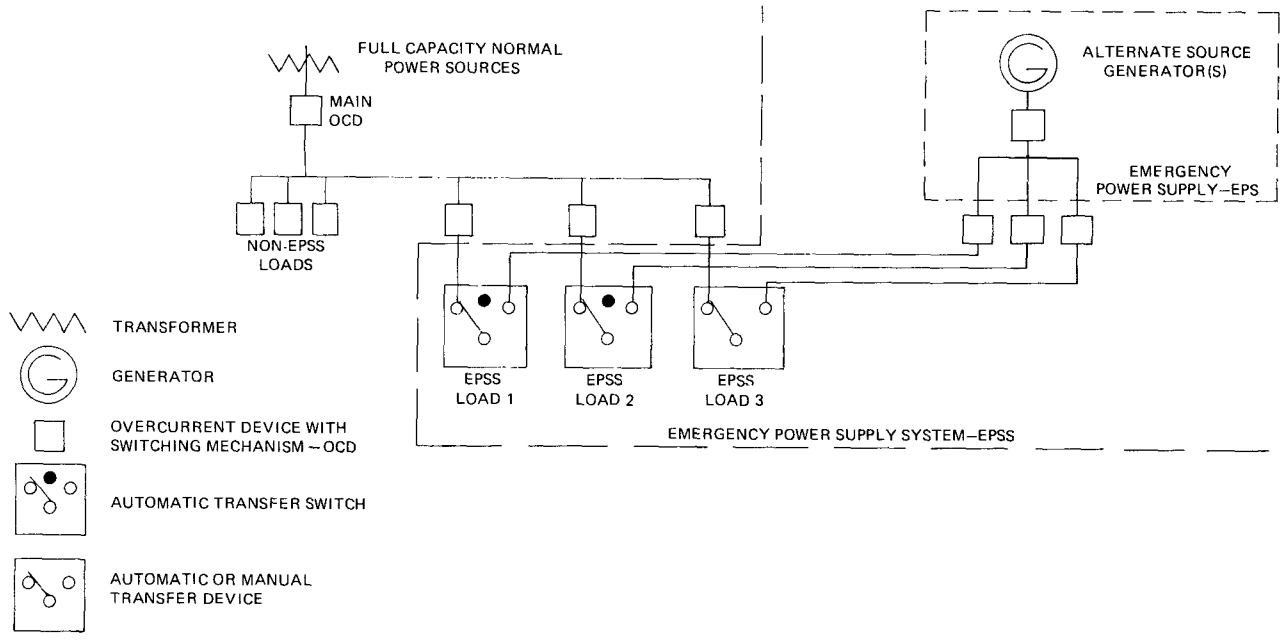

Figure B-1 Typical rotating emergency power supply system.

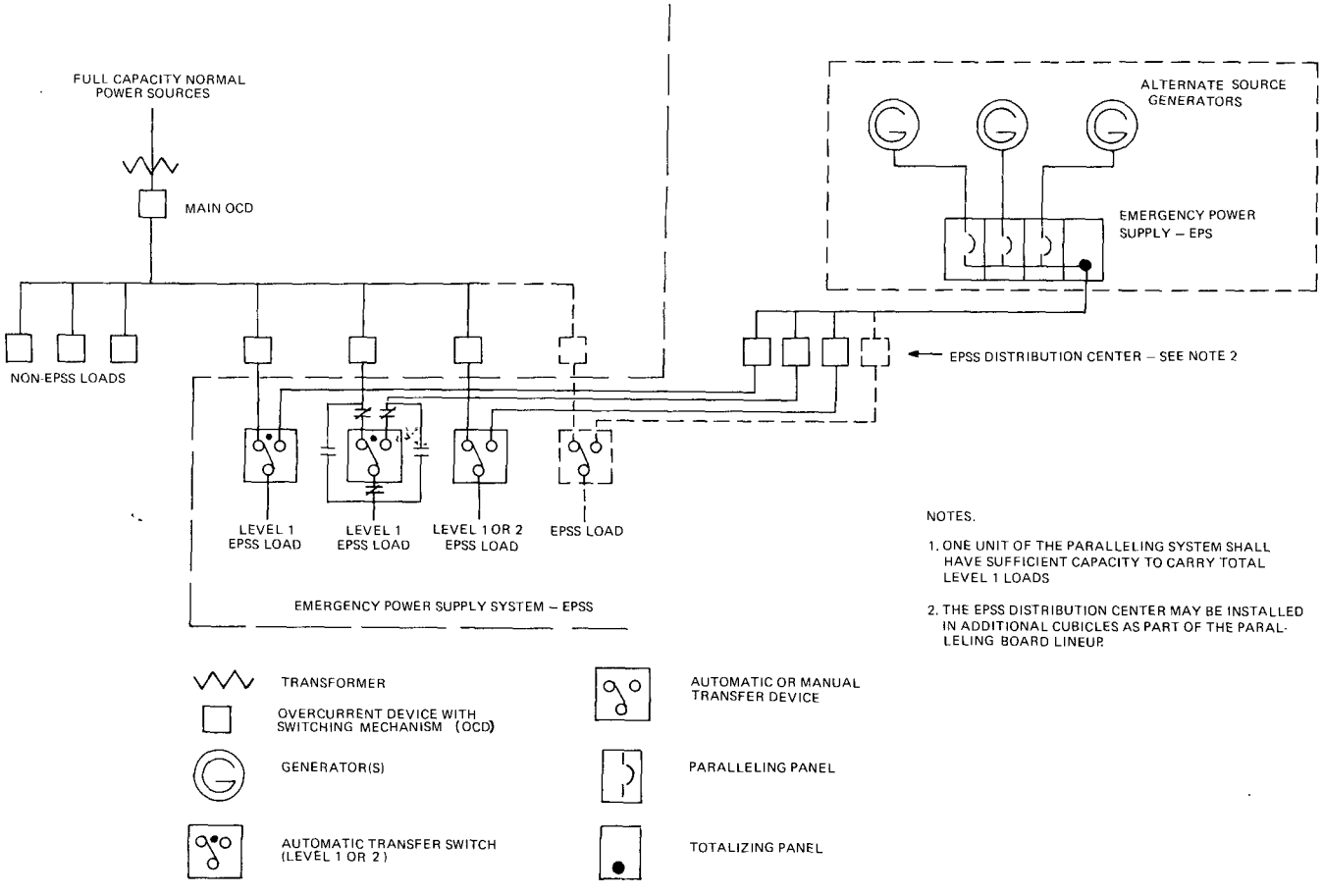

Figure B-2 Typical multiple unit emergency power supply system.