

INSPECTION AND TESTING OF EMERGENCY GENERATORS

Certification requirements

NFPA 101(00), Sec. 7.9.2.3 requires that emergency generators be installed, tested and maintained in accordance with NFPA 110, *Standard for Emergency and Standby Power Systems*. Chapter 2 of NFPA 101 references the 1999 edition of NFPA 110.

Buildings that fall under Chapter 18 of NFPA 101(00) and are equipped with or in which patients require the use of life-support systems (e.g. hospitals, nursing homes with residents on ventilators) must also meet the maintenance and testing provisions of the 1999 edition of NFPA 99, *Standard for Health Care Facilities* [see NFPA 101(00), Sections 18.2.9.2, 18.2.10.2, 18.5.1.2 and 18.5.1.3].

Provisions dealing with maintenance and testing of emergency generators can be found in NFPA 99(99), Sec. 3-4.4. This section starts out by referencing NFPA 110, but also deals with such issues as:

- Testing intervals
- Test conditions
- Personnel qualifications
- Maintenance and testing of circuitry
- Maintenance of batteries

Each facility should have a copy of these standards. They can be ordered from NFPA at 1-800-344-3555 or www.nfpaatalog.org.

Generator classifications

In order to follow the requirements in NFPA 99 and NFPA 110, you need to know the classification systems used by those standards:

1. Let's take a look at NFPA 99 first:
 - a. NFPA 99 treats emergency generators as part of an essential electrical system (EES), which is defined as, "A system comprised of alternate sources of power and all connected distribution systems and ancillary equipment, designed to ensure continuity of electrical power to designated areas and functions of a health care facility during disruption of normal power sources, and also to minimize disruption within the internal wiring system." [see NFPA 99(99), Chapter 2, *Definitions*].
 - b. NFPA 99 breaks essential electrical systems down into three categories – Type 1, Type 2 and Type 3. Basically, the services provided by a facility determine the type of EES required as follows:
 - NFPA 99(99), Sec. 12-3.3.2 requires essential electrical systems in hospitals to conform to Type 1 system requirements.
 - NFPA 99(99), Sec. 16-3.3.2 requires essential electrical systems in nursing homes to conform to Type 2 system requirements. By exception, however, Type 3 systems are allowed in nursing homes that do not provide life support (e.g. ventilators).
 - c. For a more detailed description of these three types of systems, see Chapter 3 of NFPA 99(99). If you're unsure about which type of system describes your generator, the vendor that installed and/or maintains your generator should be able to provide you with that information.

2. NFPA 110, on the other hand, treats emergency generators as part of an emergency power supply system (EPSS).
 - a. There are two important definitions to keep in mind [see NFPA 110(99), Chapter 2]:
 - *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.”

A further explanation can be found in the Appendix [see NFPA 110(99), Sec. A-2-1]:
“For rotary energy converters, components of an EPS include the following: 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 can 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 electrical power.”
 - b. NFPA 110 breaks emergency power supply systems down into two categories – Level 1 and Level 2. Once you know the NFPA 99 classification of your emergency generator (i.e. Type 1, Type 2 or Type 3), that standard tells you where your generator fits into NFPA 110. NFPA 99(99), Sec. 3-4.1.1.4 specifies that:
 - Type 1 and Type 2 essential electrical system power sources shall be classified as Level 1 generator sets per NFPA 110.
 - Type 3 essential electrical system power sources shall be classified as Level 2 generator sets per NFPA 110.

State licensure requirements

MSFC(07), Sec. 604.3 requires that emergency generators be maintained in accordance with the 2002 edition of NFPA 110. Fortunately, the provisions in this edition of the standard applicable to inspection and testing are very similar to those found in the 1999 edition of the standard.

Maintenance and testing – Applicable standards

Requirements for routine maintenance and operational testing of emergency generators can be found in:

- Chapter 6 of the 1999 edition of NFPA 110
- Chapter 8 of the 2002 edition of NFPA 110
- Sections 3-4.4, 3-5.4 and 3-6.4 of NFPA 99(99)

Maintenance and testing – General

1. Maintenance and testing is critical to the continued reliability of your emergency generator and must be performed in accordance with manufacturer’s recommendations, instruction manuals, and the minimum requirements of NFPA 110 and the authority having jurisdiction (AHJ) [see: NFPA 110(99), Section 6-1.1; NFPA 110(02), Sec. 8.1.1].

2. Your facility should have at least two sets of instruction manuals for all major generator components. One set should be kept in a secure, convenient location near the equipment. The other set should be kept in a different secure location [see: NFPA 110(99), Section 6-2.1; NFPA 110(02), Sec. 8.2.1]. These manuals must, at a minimum, contain the following:
 - A detailed explanation of the operation of the emergency power supply system
 - Instructions for routine maintenance
 - Detailed repair instructions
 - An illustrated parts list and part numbers
 - Illustrated and schematic drawings of electrical wiring systems, including operating and safety devices, control panels, instrumentation and annunciators
3. Special tools and testing devices necessary for routine maintenance must be available for use when needed [see: NFPA 110(99), Section 6-2.3; NFPA 110(02), Sec. 8.2.3].
4. Routine maintenance, inspection and operational testing of the emergency generator and associated components must be overseen by a properly trained person [see MSFC(07), Sec. 604.5; NFPA 99(99), Sec. 3-4.4.1.1(b)3; NFPA 110(99), Sec. 6-4.7; NFPA 110(02), Sec. 8.4.7]. Evidence of such training should be kept in the designated employees' personnel file. In the absence of a properly trained person on-site, an outside vendor may need to be contracted to oversee the performance of all or part of these services.
5. The standards do not establish a specific date and time of day for required testing. Those are to be determined by management and are typically scheduled so as to provide minimum disruption of facility operations.

Weekly inspections

To meet federal certification and state licensure requirements, healthcare facilities must inspect their emergency generators weekly [see NFPA 110(99), Sec. 6-4.1; NFPA 110(02), Sec. 8.4.1]. At a minimum, this weekly inspection should include a check of the following:

1. Fuel (check main and day tank fuel supply levels; day tank float switch; piping, hoses and connectors; operating fuel pressure; and for any obstructions to tank vents and overflow piping)
2. Oil (check for proper oil level and oil operating pressure; lube oil heater)
 - Engine oil level can be checked with the unit stopped or running on many engines; otherwise, it should be checked with the unit stopped
 - Oil operating pressure should normally be above 40 psi
3. Cooling system (check coolant level, water pump(s), jacket water heater, belts, hoses, fan)
4. Exhaust system (check drain condensate trap and for possible leakage)
5. Battery system [look for possible corrosion; check specific gravity, electrolyte level (a level between 1250 and 1275 is acceptable) and battery charger]
6. Electrical (conduct a general inspection of wiring and connections; check circuit breakers/fuses)
7. Prime Mover/Generator (Check for debris, foreign objects, loose or broken fittings; check guards and components; look for any unusual condition of vibration, leakage, noise, temperature or deterioration)

NOTE: This is not an all-inclusive list. The equipment manufacturer may have additional maintenance requirements that will likely include monthly, quarterly, semi-annual and annual inspections and checks.

Monthly testing

1. To meet federal certification and state licensure requirements, healthcare facilities must exercise their emergency generators under load at least monthly [see NFPA 110(99), Sec. 6-4.1; NFPA 110(02), Sec. 8.4.1]. There are a number of ways to comply with this requirement:
 - a. The base requirement is that generators be exercised for a minimum of 30 minutes* using one of the following methods [see NFPA 110(99), Sec. 6-4.2; NFPA 110(02), Sec. 8.4.2]:
 - i. Under operating temperature conditions and at not less than 30 percent of the generator's nameplate kW rating. A 100 kW generator, for example, would need to be exercised under a load of at least 30 kW to meet this requirement.
 - Normal operating temperatures are set by the manufacturer. Something to consider when scheduling your monthly tests is that your particular generator may not reach operating temperature in 30 minutes* and that running the generator for short periods of time may be harmful to the engine. You also want to make sure that the generator runs long enough to ensure that all engine parts are properly lubricated.
 - ii. Loading that maintains the minimum exhaust gas temperatures recommended by the manufacturer (it is unlikely that minimum exhaust gas temperatures will be reached if the generator isn't carrying a load equivalent to at least 30 percent of the generator's nameplate kW rating).

** Note: Warm-up and cool-down times do not count toward the required 30 minutes.*

- b. An alternate method is provided for diesel-powered generators that do not meet the testing requirements outlined in 1.a above. This could occur when, for example, a large generator in relation to the load is installed (e.g. either to account for the largest motor connected to the generator or to accommodate future expansion of the facility). Such generators can be exercised monthly with the available load and exercised annually with supplemental loads at 25 percent of nameplate rating for 30 minutes, followed by 50 percent of nameplate rating for 30 minutes, followed by 75 percent of nameplate rating for 60 minutes, for a total of 2 continuous hours [see NFPA 110(99), Sec. 6-4.2.2; NFPA 110(02), Sec. 8.4.2.3].
- c. For gasoline-powered, natural gas-powered or propane-powered generators that do not meet the testing requirements outlined in 1.a above, it will likely be necessary to add more load to the generator or conduct a load bank test to comply with testing requirements (a load bank is, typically, a mobile piece of equipment that simulates the actual electrical load the generator is intended to power). Where equivalent loads are used for testing, it's important to note that such loads are required to be automatically replaced with the emergency loads in case of failure of the normal power [see NFPA 110(99), Sec. 6-4.2.1; NFPA 110(02), Sec. 8.4.2.2].
- d. Where a generator set is used for peak load shaving or operated during a power outage, such use is allowed to be substituted for a routine monthly test, **provided** the generator is operated in accordance with the standards and the appropriate data are recorded. Another thing to keep in mind, however, is that NFPA 99(99), Sec. 3-4.4.1.1(b)1 requires a minimum 20-day and maximum 40-day interval between tests [see also NFPA 99(99), Sections 3-5.4.1.1(b) and 3-6.4.1.1(b)].

2. Load tests must include complete cold starts [see NFPA 99(99), Sec. 3-4.4.1.1(b)2; NFPA 110(99), Sec. 6-4.3; NFPA 110(02), Sec. 8.4.3].
3. Time delays must be set as follows [see NFPA 110(99), Sec. 6-4.4; NFPA 110(02), Sec. 8.4.4]:
 - a. Time delay on start: 1 second minimum.*
Exception: Gas turbine cycle: 0.5 second minimum.
*Note: NFPA 101(00), Sec. 7.9.1.2 requires that emergency loads be picked up within 10 seconds.
 - b. Time delay on transfer to emergency: none.
 - c. Time delay on restoration to normal power: 5 minutes minimum (to give the primary source sufficient time to stabilize before retransfer of the load, a delay of between 15 and 30 minutes is recommended).
 - d. Time delay on shutdown: 5 minutes minimum.

It's important to be prepared in case something goes wrong during testing. It is strongly recommended that your facility have a policy in place that makes provisions for a portable generator or other alternate power source for situations in which the emergency generator malfunctions or, worse yet, is out of service.

Transfer switches

1. Transfer switches are required to be operated monthly [see MSFC(07), Sec. 604.3.3; NFPA 110(99), Sec. 6-4.5; NFPA 110(02), Sec. 8.4.5].
2. This monthly test must consist of electrically operating the transfer switch from the normal/standard position to the alternate position and then a return to the normal/standard position [see MSFC(07), Sec. 604.4.1; NFPA 110(99), Sec. 6-4.5; NFPA 110(02), Sec. 8.4.5.1].
 - In many cases, a "Transfer Test" switch or button is provided and can be used to perform this test. Where this feature does not exist, it may be necessary to manually disconnect normal power in some fashion to the transfer switch (see "some words of caution on testing" below).
3. Transfer switches must also be inspected monthly to ensure that they are maintained free from accumulated dust and dirt and to check for deterioration of the transfer switch contacts [see MSFC(07), Sec. 604.3.3; NFPA 110(99), Sec. 6-3.5; NFPA 110(02), Sec. 8.3.5].
4. Because they are such a key component in the successful operation of your emergency generator, it is recommended that you consider having infrared testing of your transfer switch(es) conducted annually to check for loose connections.

Some words of caution on testing...

1. Shutting off power, especially shutting off the main breaker, can expose a person to possible shock, electrocution and/or arc flash hazards. It is important, therefore, that anyone performing a test in this fashion be adequately trained and take proper safety precautions, including the wearing of proper personal protective equipment (PPE). *To reduce the safety risks, it is strongly recommended that facilities not already so equipped consider adding a switch for testing of their transfer switches.*

2. The explanatory information in NFPA's 1999 *Health Care Facilities Handbook* to Sec. 3-4.4.1.1(b)2, which addresses test conditions (including cold starts and appropriate automatic and manual transfer of essential electrical system loads), provides more food for thought:

“Testing procedures might range from manually disconnecting power to the power sensors on transfer switches to manually opening the main incoming feeder breakers. It is very important that each test method be fully understood by all staff through appropriate notification and that the consequences of each method (if something fails to function) be weighed carefully. A procedure for returning to the normal power source should also be established in the event a failure occurred during testing.”

“There is a false assumption that disconnecting a facility's mains is the best method of testing the standby generator(s) and essential electrical system. One has to always consider the possibility that failure of the disconnecting means or some other unexpected contingency might make it difficult or impossible to restore normal power. It is probably better to initiate engine start by interrupting power just ahead of the transfer switch(es) on an alternating or rotating basis in order to make sure each transfer switch has an intact engine start circuit.”

DOCUMENT your inspections and tests

NFPA 110(99), Sec. 6-3.3 requires the establishment of a written schedule for routine generator maintenance and testing [see also: MSFC(07), Sec. 604.3.1]. A sample schedule can be found in Appendix A of the standard [see Figure A-6-3.1(a)]** or may even be available from the equipment manufacturer [see also: NFPA 110(02), Sec. 8.3.3 and Figure A.8.3.1(a); 1999 *Health Care Facilities Handbook* Appendix C-3.2].

** Because there is a lot riding on the successful operation of a facility's emergency generator, it is strongly recommended that the schedule for Level 1 emergency power supply systems be followed when establishing your maintenance schedule.

A written record of generator inspections, tests, exercising, operation and repairs must be maintained on the premises and be available for review by the fire inspector on request. This record must, at a minimum, include: the date of the report, name(s) of the person(s) providing the service, identification of unsatisfactory conditions and corrective action taken (including parts replaced), and any testing of repairs recommended by the manufacturer [see MSFC(07), Sec. 604.3.2; NFPA 99(99), Sec. 3-4.4.2; NFPA 110(99), Sec. 6-3.4; NFPA 110(02), Sections 8.3.4 and 8.3.4.1].

- A sample inspection log can be found in Appendix A of NFPA 110(99) [see Figure A-6-3.1(b)] or may even be available from the equipment manufacturer [see also: NFPA 110(02), Figure A.8.3.1(b)].
- A sample testing log can be found in NFPA 110(02), Figure A.8.4.1(a) or may even be available from the equipment manufacturer.
- As an alternate, sample inspection and testing logs have been developed to serve as a guide that you can use in creating your own logs. Completed logs are provided to serve as examples of how the logs are expected to be filled out.

It's important that at least two people in your facility know where your logs are kept to increase the likelihood that they can be readily provided if requested during an inspection. It is recommended that these logs be maintained for at least three years.

[Click Here for the Emergency Generator Weekly Inspection Checklist](#)

[Click Here for the Emergency Generator Monthly Test Log](#)