INSPECTION AND TESTING OF EMERGENCY GENERATORS

Certification requirements

NFPA 101(12), Sec. 7.9.2.4 requires that emergency generators providing power to emergency lighting systems be installed, tested and maintained in accordance with NFPA 110, *Standard for Emergency and Standby Power Systems*. NFPA 101(12), Sec. 9.1.3.1 also requires that, where required for compliance with the Code, emergency generators and standby power systems be installed, tested and maintained in accordance with NFPA 110. NFPA 101(12), Sec. 2.2 references the 2010 edition of NFPA 110.

Buildings that fall under Chapter 18 of NFPA 101(12) 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 applicable provisions of the 2012 edition of NFPA 99, *Standard for Health Care Facilities* [see NFPA 101(12), Sections 18.2.9.2, 18.2.10.5, 18.5.1.2 and 18.5.1.3].

Provisions dealing with maintenance and testing of emergency generators can be found in NFPA 99(12), Sec. 6.4.4.1.1.4. 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 National Fire Prevention Association (http://catalog.nfpa.org/)

State licensure requirements

Title 10 713-3.25 h requires that emergency generators be inspected, tested and maintained in accordance with the 2010 edition of NFPA 110.

Maintenance and testing – Applicable standards

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

- Chapter 8 of the 2010 edition of NFPA 110
- Sections 6.4.4.1.1, 6.5.4.1.1 and 6.6.4.1.1 of the 2012 edition of NFPA 99

Maintenance and testing – General

1) Maintenance and testing are 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(10), Section 8.1.1].

2) Your facility should have at least one (with two recommended) set 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(10), Section 8.2.2]. These manuals must, at a minimum, contain the following:

   a) A detailed explanation of the operation of the emergency power supply system
   b) Instructions for routine maintenance
   c) Detailed repair instructions
   d) An illustrated parts list and part numbers
   e) 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(10), 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 NFPA 99(12), Sec. 6.4.4.1.1.4(C); NFPA 110(10), Sec. 8.4.8]. 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) NFPA 110 does 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. [see NFPA 110(10), Sections 8.4.2.1 and 8.4.2.4.1]. NFPA 99(12), Sec. 6.4.4.1.1.4(A), however, requires that generator sets be tested <u>12 times a year, with testing intervals of not less than 20 days nor more than 40 days.</u>

<u>Weekly inspections</u>

To meet federal certification and state licensure requirements, health care facilities must inspect their emergency generators weekly [see NFPA 110(10), 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. Lubrication system (check for proper oil level and oil operating pressure; lube oil heater)
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 and battery charger – maintenance-free batteries require routine visual inspection and maintenance in accordance with manufacturer's instructions]
6. Electrical system (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 <u>not</u> 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.*

<u>Monthly testing</u>

1) To meet federal certification and state licensure requirements, health care facilities must exercise their emergency generators under load at least monthly [see NFPA 110(10), Sec. 8.4.1].

   a) Diesel generator sets are required to be exercised at least once monthly, for a minimum of 30* minutes, using one of the following methods [see NFPA 110(10), Sec. 8.4.2]:
      i) 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).

ii) 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.

(1) 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.

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

iii) 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 50 percent of nameplate kW rating for 30 continuous minutes, followed by 50 percent of nameplate rating for 30 minutes and at not less than 75 percent of the nameplate kW rating for 60 minutes, for a total test duration of 1.5 continuous hours [see NFPA 110(10), Sec. 8.4.2.3].

b) Spark-ignited generator sets (e.g. gasoline-powered, natural gas-powered or propane-powered) must be exercised at least once a month with the available load for 30 minutes or until the water temperature and oil pressure have stabilized.

c) Where equivalent loads are used for testing, it is 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(10), Sections 8.4.2.2 and 8.4.2.4.2].

d) Where a generator set is used for standby power, 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.

2) The monthly test is required to be initiated by simulating a power outage using the test switch(es) on the automatic transfer switch(es) or by opening a normal breaker [see NFPA 110(10), Sec. 8.4.3]. Opening a normal breaker shall not be required.

3) Load tests must include complete cold starts [see NFPA 99(12), Sec. 6.4.4.1.1.4(B); NFPA 110(10), Sec. 8.4.4].

4) Time delays must be set as follows [see NFPA 110(10), Sections 6.2 and 8.4.5]:

a) Time delay on start: 1 second minimum (0.5 second minimum for gas turbine units). This is to prevent nuisance starts and possible subsequent load transfer in the event of harmless momentary power dips.

***Note:** NFPA 101(12), Sec. 7.9.1.3 requires that emergency loads be picked up within 10 seconds.

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

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) [see NFPA 110(10), Sec. A.6.2.8].

d) Time delay on shutdown: A minimum time delay of 5 minutes must be provided for unloaded running of the generator prior to shutdown to allow for engine cooldown – small (15 kW or less) air-cooled prime movers are exempt from this requirement [see NFPA 110(10), Sec. 6.2.10].

***Note:** Some generator manufacturers recommend a longer cooldown period. If so, NFPA 110(10), Sec. 8.1.1 requires that the manufacturer's recommendations be followed.

5) Documentation of the monthly testing of your emergency generator(s) should, at aminimum, include the following information:
   a) Identification of generator tested (e.g. Generator #1)
   b) Date generator was installed/placed in service
   c) Generator standby nameplate rating in kW
   d) 30% of generator standby nameplate rating in kW
   e) Fuel type (e.g. diesel, gasoline, etc.)
   f) Normal operating temperature
   g) Date of test
   h) Signature or initials of person performing the test
   i) Identification of ATS(s) used to initiate the test
   j) ATS transfer time (0 to 10 seconds)***
   k) Time delay for cooldown (minimum 5 minutes required)
   l) Elapsed run time (support with hour meter "start" and "stop" times
   m) Oil pressure during test
   n) Operating temperature during test
   o) Engine exhaust temperature during test, if applicable
   p) kw (load under test)
   q) Identification of unsatisfactory conditions and corrective action taken (including parts replaced)

   ****Note:** NFPA 99(12), Sec. 6.4.4.1.1.2 specifies that the 10-second criterion does not apply during the monthly testing of the generator. This provision, new to the 2012 edition of the standard, recognizes that additional time may be needed during normal monthly testing to allow for paralleling with normal power. It is important to note that, if the 10-second criterion is not met during the monthly test, a process must be provided to annually confirm the capability of the life safety and critical branches to comply with the requirement in NFPA 99(12), Sec. 6.4.3.1 that power be restored within 10 seconds after interruption of normal power. Most health care facilities experience a power outage at least once a year. As a suggestion, a facility could record the transfer time during an actual outage and use that documentation to confirm compliance with Sec. 6.4.3.1.*

It is 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.

3-year Testing

Level 1 emergency power supply systems (EPSS) – those installed where failure of the equipment to perform could result in loss of human life or serious injuries – are required to be tested at least once within every 36 months in accordance with the following [see NFPA 110 (10), Sec. 8.4.9]:

- Testing must be continuous for the duration of the generator's assigned class, but is not required to exceed 4 hours:
- The test must be initiated by operating at least one transfer switch test function and then by operating the test function of all remaining ATSs or initiated by opening all switches or breakers supplying normal power to all ATSs that are part of the EPSS being tested.
- The minimum load for a diesel-powered emergency power supply (EPS) must be not less than 30 percent of the standby nameplate kW rating of the generator. A supplemental load is allowed to be used to meet or exceed the 30 percent requirement.
- The minimum load for a diesel-powered EPS must be that which maintains the minimum exhaust gas temperatures as recommended by the manufacturer.
- The minimum load for spark-ignited EPSs must be the available EPSS load.
- The test required in 8.4.9 is allowed to be combined with one of the monthly tests required by Sec. 8.4.2 and one of the annual tests required by Sec. 8.4.2.3 as a single test.
- Where the test required by Sec. 8.4.9 is combined with the annual load bank test, the first 3 hours must be not less than the minimum loading required by Sec. 8.4.9.5 and the remaining hour must be not less than 75 percent of the standby nameplate kW rating of the generator.

Automatic Transfer Switches (ATS)

1. Transfer switches are required to be operated monthly [see NFPA 110(10), Sec. 8.4.6.

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 NFPA 110(10), Sec. 8.4.6.1].
    - 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 on a routine basis (monthly is recommended) to check connections, check for evidence of overheating or excessive contact erosion (terminals and connectors are normal color), listen for unusual sounds, to ensure that the switches are maintained free from accumulated dust and dirt, and ensure that all covers are tight and doors securely closed NFPA 110(10), Sec. 8.3.5].

4. EPSS circuit breakers for Level 1 system usage, including main and feed breakers between the EPS and the transfer switch load terminals, are required to be exercised annually with the EPS in the "off" position [see NFPA 110(10), Sec. 8.4.7].
    - Circuit breakers rated in excess of 600 volts for Level 1 system usage are required to be exercised every 6 months and tested under simulated overload conditions every 2 years [see NFPA 110(10), Sec. 8.4.7.1].

5. 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 2012 *Health Care Facilities Handbook* to Sec. 6.4.4.1.1.4(B), which addresses test conditions (including cold starts and appropriate automatic and manual transfer of essential electrical system loads), provides more food for thought:

> "Testing criteria required by 6.4.4.1.1.4(B) 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 occurs during testing."
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> "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 must 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(10), Sec. 8.3.3 requires the establishment of a written schedule for routine generator maintenance and testing. A sample schedule can be found in Annex A of the standard [see Figure A.8.3.1(a)]** or may even be available from the equipment manufacturer [see also: 2012 *Health Care Facilities Handbook* Annex B, Figure B.6.2].

> **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 EPSS 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 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 NFPA 99(12), Sec. 6.4.4.2; NFPA 110(10), Sections 8.3.4 and 8.3.4.1].

- A sample maintenance log can be found in Annex A of NFPA 110 [see NFPA 110(10), Figure A.8.3.1(b)] or may even be available from the equipment manufacturer [see also:].
- A sample testing log can also be found in Annex A of NFPA 110 [see NFPA 110(10), Figure A.8.4.1(a) or may even be available from the equipment manufacturer.
- As an alternate, you can use these samples to create your own logs.

It is 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.