Maintenance and Testing of Generators– 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)

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(10), Section 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(10), Section 8-2.3.]

4. Routine maintenance and operational testing of the emergency generator and associated components must be overseen by a properly trained person NFPA 110(10), Sec. 8.4.8

5. The standards do not establish a specific date and time of day for required testing. Those are to be determined by the owner and are typically scheduled so as to provide minimum disruption of facility operations.

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

- Chapter 8 of the 2010 edition of NFPA 110(10)
- Sections 6.4 (Type-1) 6.5 (Type-2) and 6.6 (Type-3) of NFPA 99(12)

Weekly inspections

To meet federal certification and state licensure requirements, healthcare 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 Level
2. Oil Level and Viscosity
3. Cooling system
4. Exhaust system
5. Battery system
6. Electrical Connections
7. Physical Condition

**NOTE: This is not an all-inclusive list. The equipment manufacturer may have additional maintenance requirement*

Monthly Testing

1. To meet federal certification requirements, healthcare facilities must exercise their emergency generators under load at least monthly [see NFPA 110(10), Sec. 8.4.]

a. The base requirement is that generators be exercised for a minimum of 30 minutes [see NFPA 110(10), Sec. 8.4.2]:

2. 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.

a. 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).

b. Spark-ignited 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(10), Sec. 8.4.2.4].

c. 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(12), Sec. 6.4.4.1.1.4(A) requires a minimum 20-day and maximum 40-day interval between tests.

3. Load tests must include complete cold starts [NFPA 110(10), Sec. 8.4.4].

4. Time delays must be set as follows [see NFPA 110(10), Sec. 8.4.5]:

a. Time delay on start: 1 second minimum.*
Exception: Gas turbine cycle: 0.5 second minimum.
*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: 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.

*Generators must be inspected and tested in accordance with NFPA 110-8.4

Document Testing Results

NFPA 110(10), Sec. 8.3.3 requires the establishment of a written schedule for routine generator maintenance and testing.

** Because there is a lot riding on the successful operation of a facility's emergency generator, it is strongly recommended to 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 surveyor 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 NFPA 110(10), Sections 8.3.4 and 8.3.4.1].

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.

Calculate Generator Load

To calculate a 3 phase kWh from measuring amps of each phase
kW=Volts (Average) X Amps (average) X Power-Factor (.8) x 1.732 /1000
*Use the average of the three voltage readings (V1+V2+V3) /3
*Take the amperage reading from each phase and average them (A1+A2+A3 /3)

** The power factor (pf) is the ratio between kilowatts (kW) and kilovolt amps (kVa) that is drawn from an electrical load. It is determined by the generators connected load. The pf on the nameplate of a generator relates the kVa to the kW rating.

***The standard power factor for a three phase generator is .8.

Once kWh is determined divide that number by what shows on the generator kW gauge to ensure greater than 30% is reached during monthly load test. If the 30% is not reached an annual load test shall be required.

Transfer switches

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(02), 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 monthly to ensure that they are maintained free from accumulated dust and dirt and to check for deterioration of the transfer switch contacts [see NFPA 110(10), 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…

Shutting off power, especially shutting off the main electrical 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).

[References: NFPA 99; NFPA 110]