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Power Quality and Generators – Part 3: Complying with the Codes and Controlling Noise

Editor's Note: This is the third installment in an ongoing series that will cover basic engineering and code issues for standby generators.

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References to standby, prime and continuous ratings were identified in my first column in this series on generators. This subject is critical but is sometimes overlooked. Therefore, it deserves some additional clarification.

Once an engineer has identified the anticipated environment and load profile in which the generator is going to be located, additional sizing constraints must be considered. There are typically three ratings that can be applied to generators: standby rating, prime rating and continuous rating.

Standby-rated generators for life-safety and legally required standby loads, as well as for some optional loads, are intended to be used in the event of an unusual utility power outage. The standby rating typically means rated to be run 100 hours per year, have a load factor of 60% or less and have a typical peak demand of 80% of standby-rated kW with 100% available for the duration of an emergency outage.

Prime-rated generators are typically standby-rated generator de-rated to 90% of their standby rating. The prime-rated generator is typically rated to have no limit to the number of run hours per year. In addition, the load factor is rated at 60% to 70%. Normally, the peak demand is rated at 100% of prime-rated kW for occasional use, but for less than 10% of operating hours. Typical applications are for industrial, peak shaving or cogeneration operations.

Continuous-rated generators are usually standby-rated generators de-rated to 80% of their standby rating. The continuous-rated generator is typically rated to have no limit to the number of run hours per year. In addition, the load factor is rated at 70% to 100%, and typically, peak demand is rated at 100% of continuous-rated kW for 100% of operated hours. Like prime-rated, these, too, are generally for industrial facilities, peak shaving or cogen.

Load factor is described as the sum of the loads a generator set experiences, while it is running under load, divided by the number of hours it operates under those loads.

Maintenance and warranty issues may become a problem if these generator ratings are exceeded. The engineer must reference specific generator ratings and warranty issues. The types and specifications noted above are for reference only.

Generator system design and sizing can be complex. To effectively design and size generator systems, an engineer needs to understand the effects of different components in the electrical system and be able to navigate through the various electrical, building and *NFPA* codes.

The *International Building Code* represents additional challenges to the design engineer. Because many jurisdictions have adopted the IBC code, with provisions that will affect the sizing, location and fuel supplies of standby generators, its worth taking a look at some of the issues here.

For example, *IBC 403.10.1* specifically indicates that a generator set inside a building shall be enclosed with two-hour fire resistant rated fire barrier assemblies. This code section must be discussed with the design team architect to ensure proper code compliance.

IBC Table 414.2.2 indicates the percentage of maximum allowable quantity per control area for diesel fuel storage. Any level above or below grade has allowed maximums lower than 100% of those quantities stated in *IBC Table 307.7 (1).* The IBC indicates that, in a non-sprinkled building, a maximum of 120 gallons of diesel fuel is allowed. In a sprinkled building, the total is doubled to 240 gallons of diesel fuel. Based on IBC tables noted above, for a storage area two floors below grade, a non-sprinkled building would have a maximum allowable fuel storage of only 60 gallons. This represents a 50% reduction just based on the location of the storage tank. In addition, fuel storage is not allowed in areas lower than two stories below grade.

IBC 3003.1.4, Venting, indicates that where standby power is connected to the elevators, the machine room ventilation or air conditioning shall be connected to the standby power source.

IBC 1007.2.1 addresses buildings with four or more stories and indicates that, in buildings where a required accessible floor is four or more stories above or below the level of exit discharge, at least one required accessible means should be an elevator. The IBC then goes on to dictate that that standby power must be provided as per chapter 27 and 30. Chapter 27 dictates the use of stationary generators. This provision could certainly increase the number of generators required on future projects.

I recommend coordinating with your authority having jurisdiction for their final interpretation of these codes prior to completing design documents.

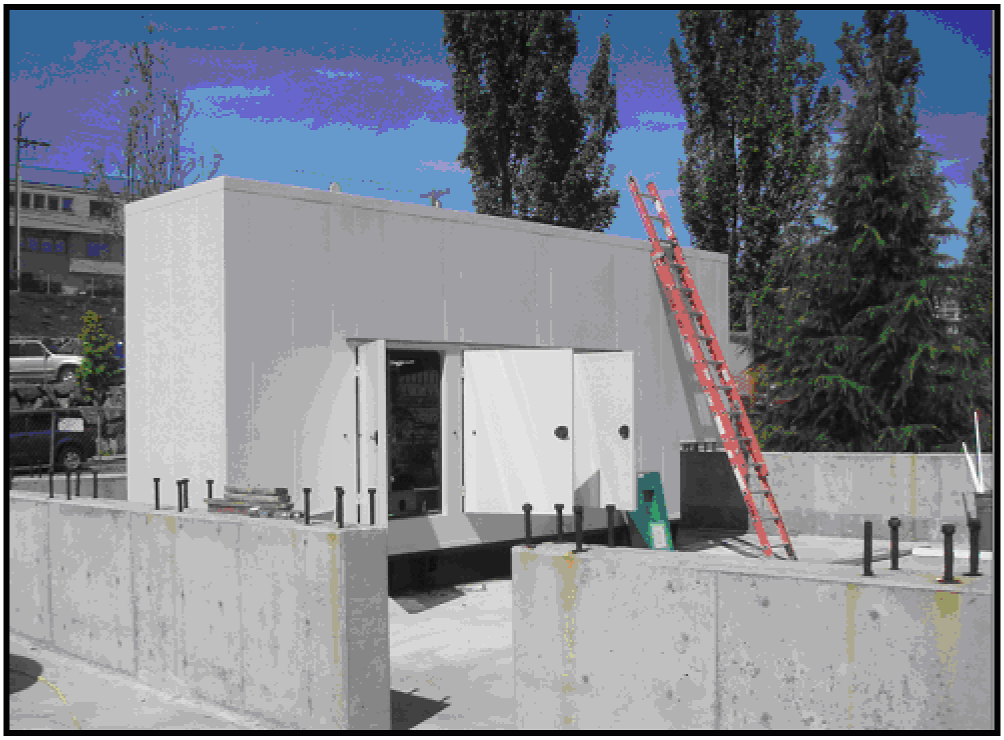
Also, many state and local AHJs enforce noise ordinances. For instance, the Washington State Administrative Code identifies three classification: Class A for residential, Class B for commercial and Class C for industrial areas.

When the noise source is in a Class B commercial zone and the receiving property line is in a Class B zone, the maximum noise level shall not exceed 60 db. Other local jurisdictions enforce even stricter noise ordinances that allow lower dB levels at the opposing property line. Critical grade mufflers, silencers and sound suppression enclosures may be required to meet these ordinances. Additionally, locating the generator as far away from the adjacent property line can reduce the noise levels.

Sound levels and noise levels, as specified in jurisdictional noise ordinances and in acoustical measurements, are expressed in decibels (dB). These sound levels are weighted to be consistent with the normal sensitivity of the human ear. This is referred to as an A-weighted sound level, abbreviated (dBA). To give you some reference as to what these dBA levels represent as far as real life noise, 0 dBA is the threshold of hearing, a whisper is about 30 dBA, normal conversation is about 50 dBA, a rock concert is about 120 dBA and a nearby jet is about 150 dBA.

As sound travels away from its source and spreads over a large area, it decreases in loudness. Sound decreases by about 6 dB for every doubling of distance from the noise source**.** A doubling of noise power would represent a 3 decibel (dB) increase. A 6 dB increase would occur if the power goes up by a factor of four times. The decibel change would be 10 dB for an increase of 10 times the noise power. Noise is measured using a logarithmic scale. It is apparent that the logarithmic scale compacts the dBA measurement values and makes them appear to have less of an effect than they actually do on the noise level.

If an acoustical analysis indicates that there is only a 3 dB increase in noise, it means that the noise power has been doubled. In a loud environment, during the day in an industrial area, you may not be able to distinguish a 3 dB increase. If the surrounding area is quit, say for instance at night in a residential area when the ambient noise is at a much lower level, one will probably notice this change in noise power.



An exterior mounted generator with a critical grade muffler and a sound attenuated enclosure. Radiator and combustion air is intake is taken from the lower right section of the enclosure. Radiator output is expelled on the upper left section. Total noise output is relegated to a virtual hum.

Occupational Safety and Health Administration (OSHA) has proposed permissible noise exposure times. Some of these are listed below:

- 85 dB and higher - prolonged exposure will result in hearing loss
- 90 dBA - no more than 8 hours per day
- 95 dBA - no more than 4 hours per day
- 100 dBA - no more than 2 hours per day
- 105 dBA - no more than 1 hour per day

Noise control can be achieved by eliminating mechanical noise and exhaust noise. Isolating the engine from the structure with vibration isolators can control mechanical noise emanating from the structure housing the generator. Mechanical noise emanating in the air can be controlled with the use of sound enclosures, baffles, absorption materials or a combination of all the methods. Below is a list of the methods and the approximate sound level dB(A) reduction.

- Vibration isolators 2 dB(A)
- Baffles 5 dB(A)
- Absorption materials 5 dB(A)
- Rigid sealed enclosure 15-20 dB(A)
- Enclosure and isolators 25-30 dB(A)
- Enclosure, absorption and isolators 35-40 dB(A)
- Double walled enclosure, absorption and isolators 60-80 dB(A)

The most common way to reduce exhaust noise is with a silencer. This measure can reduce exhaust noise by 15 dB(A) when measured at 3 meters or 10 ft from the source.

Generator db(A) levels are typically given for distances of 7 meters or 23 ft from the generator. For instance, an exterior mounted 900 kW generator in a rigid sealed enclosure can have noise levels above 80 dB(A) at 23 ft. The same generator in a noise rated enclosure can lower those levels to 65 dBA at 7 meters or 23 feet. Depending on the size of the generator, the proximity to the adjoining property line and the extent of the noise regulations, it may be appropriate to hire a qualified acoustical consultant to calculate and simulate post construction noise levels to ensure compliance with regulations.