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Sound Measurements and Specifications - Industrial Focus

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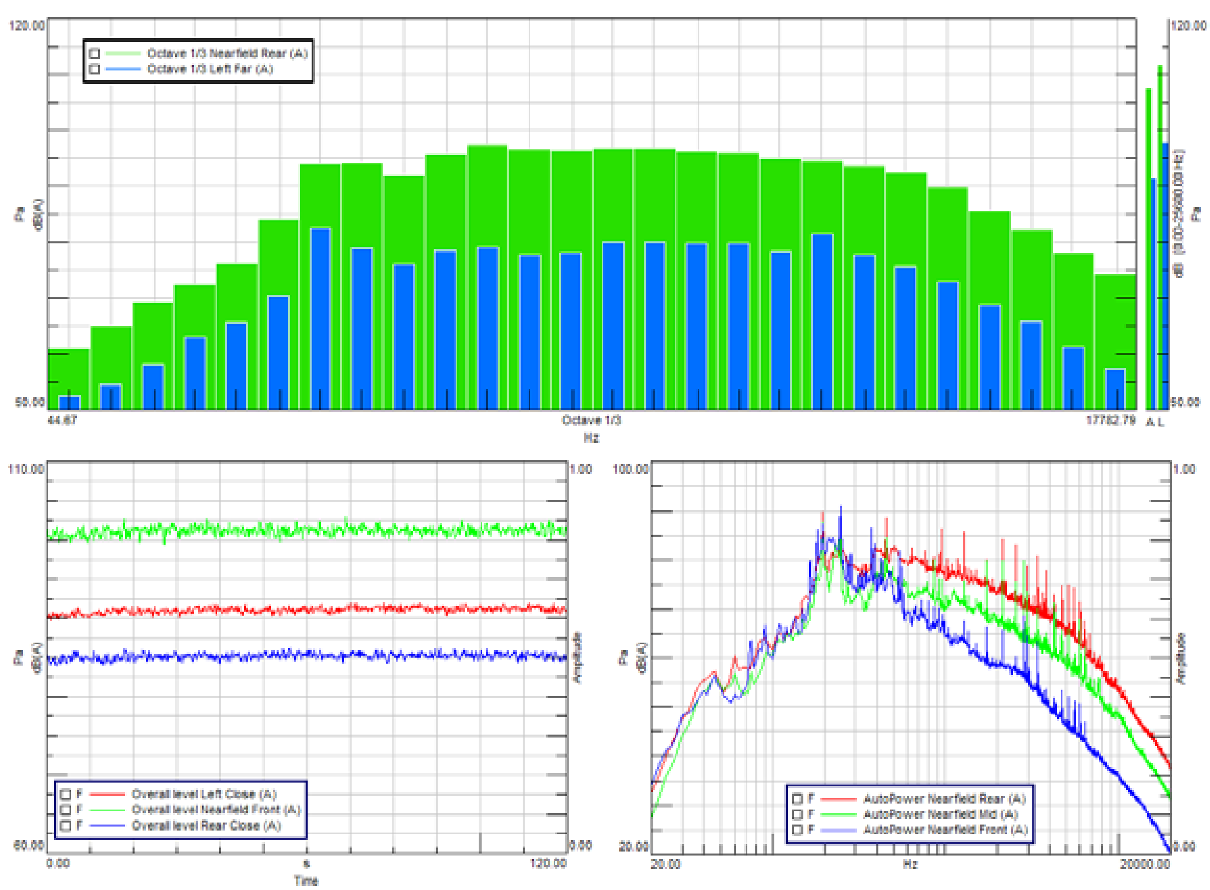
INTRODUCTION

Ambient noise conditions are a growing concern among manufacturers, business owners, and residents. Understanding the fundamental concepts of acoustic testing and terminology is a key part in reading specifications, municipal codes, and generator performance. This brief will explain some of the fundamentals of sound and how these numbers pertain to generator specifications.



MEASURING SOUND

Sound is the result of pressure fluctuations in a physical medium. For the purposes of acoustics and noise, the medium is usually air. The goal of an acoustic measurement is to quantify those pressure fluctuations in a manner that indicates how loud a sound is perceived by the listener.

The fundamental transducer used for measuring sound is a microphone, which acts in a manner similar to the eardrum. There are many different types and styles of microphones, but ultimately they all function as pressure transducers. The Sound Level Meter (SLM) is an essential tool for measuring sound levels and consists of a microphone paired with basic electronics in order to measure Sound Pressure Levels (SPL).

The range of pressures that humans perceive is large enough that a linear scale would be inconvenient for both notation and calculation. Sound pressure measurements are therefore converted to a logarithmic scale using decibels (dB). Equation 1 below shows the formula for converting acoustic pressure to decibels. The decibel itself is not a unit, but rather a ratio of a measured quantity to a reference quantity. When dealing with acoustic quantities it is good practice to use a suffix such as "dB-SPL". This removes any ambiguity as to the quantity being reported and the reference value use for the conversion. The reference value for sound pressure is 20 μPa, which represents the threshold of hearing. Table 1 shows a series of everyday events and their respective sound pressure levels.

Equation 1 - Pressure to Decibel

$$L_p = 20 \log\left(\frac{p_{rms}}{p_0}\right)$$

Source	dB(A) - SPL
Jet Takeoff at 30 m	120
Rock Concert	110
Heavy Machinery	100
City Traffic	80
Office Conversation	60
Quiet Library	40
Anechoic Chamber	20
Threshold of Hearing	0

Table 1 - Common Sound Pressure Levels

Figure 1 - Sound Level Meter

FREQUENCY CONTENT

The frequency at which a sound wave oscillates is important. It requires more energy at very low or very high frequencies to be perceived as loud as tones in the middle range of hearing. To compensate for this, weightings can be applied to acoustic measurements in order to better represent the performance of human hearing. There are several standardized weighting networks (A, B, C, etc.), each of which was designed around a specific loudness level. A-weighting has become the standard weighting network applied to most acoustic measurements seen by consumers. Measurements that have been weighted will include as suffix, as in "dBA" or "dB(A)".

When more detail than a single overall level is needed, frequency content can be presented as octave bands (coarse) or third octave bands (fine). Whole (or 1/1) octave bands are usually sufficient for most machinery specifications. Many sound level meters incorporate filters that calculate octave band data in addition to the overall level. Frequency is specified in Hertz (Hz), or cycles per second.

Table 2 below shows an example of octave band data. A logarithmic sum of each octave band yields the overall level in the column on the right.

Octave Band	63 Hz	125 Hz	250 Hz	500 Hz	1 kHz	2 k Hz	4 kHz	8 kHz	dB(A)-SPL
Level, dB(A)	56	66	61	67	69	66	62	57	74

Table 2 - Example Octave Band Data

PREDICTING SOUND PRESSURE

A common request is to predict the change in sound pressure level over a given distance. The behavior of a noise source in a free field is relatively predictable using the simple math shown below (Equation 2). The caveat is that generators are rarely installed in the same idealized conditions under which they are tested. The presence of a building or wall near the unit will make prediction much more difficult, but the formula below is useful for rough estimates.

Equation 2 - Free Field Sound Divergence

$$L_2 = L_1 - 20\log\left(\frac{d_2}{d_1}\right)$$

Where L1 is the measured level (in dB), d2 is the desired distance, and d1 is the distance at which L1 was measured.

Example: A unit was measured to have a sound pressure level of 70 dB(A) at 7 m. A customer needs to know how loud the unit will be at a shorter distance of 3 m. The above formula shows an increase of 7 dB(A) for a predicted value of 77 dB(A). The formula works for greater distances, as well. Doubling the desired distance to 14 m yields a reduction of 6 dB(A) for a predicted value of 64 dB(A).

GENERATOR SETS

Generac Power Systems provides solutions from portable 2 kW inverters to trailer-mounted 2 Megawatt generators. The information most valuable to the end user depends on the application, and the presented sound data can range from a single point to eight points. All measurements are taken by Generac engineering staff using calibrated Class 1 sound level meters.

Residential: The sound pressure level as measured from the consumer's point of view (front panel) at 7m at various loads as listed in the manual.

Commercial and Industrial: Octave band and overall levels at both no load and full load as measured at 7 m from each side of the unit.

Large Industrial: Trailer-mounted and very large industrial units are measured at eight microphone positions around the generator set per Figure 1. Future product will be measured in the same manner.

Product sound pressure levels are measured in idealized, repeatable conditions. The unit is tested in an open area at fixed distance. For most generator products, the de facto standard is 7 meters, or about 23 feet.

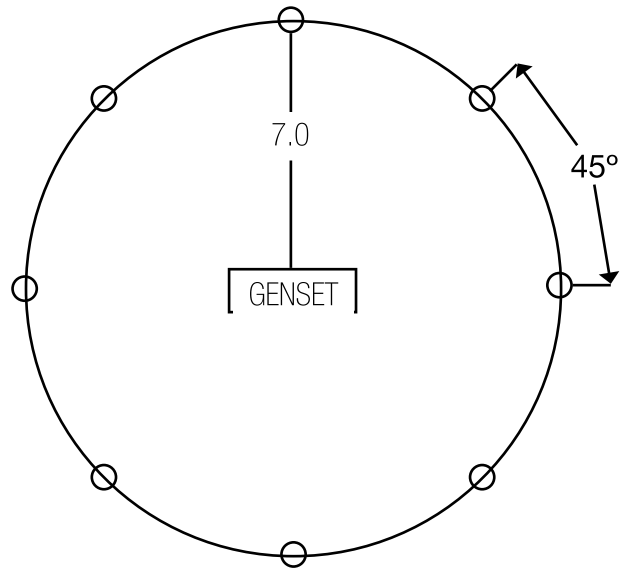


Figure 2 - 7 Meter Measure Points

No manufacturer can predict or publish a guaranteed on-site sound pressure level. The sound pressure levels measured by installers, specifying engineers, or municipal inspectors are the cumulative result of the generator, ambient noise, and reflective surfaces or buildings around the generator.