ENGINEERING WHITE PAPER

Internal use only

November 16, 2020

Sound & what to know in the HVAC industry

Most HVAC equipment generates sound. Even equipment with no moving parts can generate sound- think louvers with too much airflow through them whistling. Sound can be perceived as annoying or distracting. And in some cases, the sound our equipment will generate can even be harmful to our ears. Because of this there are sound compliance codes and Sound Engineers that design & analyze sound in systems. For these reasons and more it is important that we all know the basics of sound and how it is utilized so we effectively navigate this important aspect of equipment selection & compliance.

Definition of sound

Mechanical energy that repetitively causes collisions of molecules in a medium, resulting in periodic changes in the form of waves, which can propagate through gaseous, liquid, and solid materials.

Harmonics & Frequency

The lowest resonant frequency of a vibration object is called its Fundamental Frequency. A harmonic is an integer (whole number) multiple of the fundamental frequency.

Octave Bands

Octave Frequency Bands divide the human hearing spectrum into 10 parts. The center frequencies of these bands are defined by ISO as 31.5hz, 63hz, 125hz, 250hz, 500hz, 1k hz, 2k hz, 4k hz, 8k hz, and 16k hz

Sound Power L_w verses Sound Pressure L_p

Sound power is a property of a sound source, equal to the total power emitted by that source in all directions. Sound pressure is a property of the field at a point in space. Think of sound pressure as what you hear (your ear).

Be sure you understand whether a schedule or competitor's sound information is sound power or sound pressure at some distance from the equipment. This will ensure you are bidding to equivalent performance.

dB, dBA & NC

Noise level is measured in decibels (dB). The louder the noise, the higher the decibels. The dB scale is used to express the ratio of one value of a power or field quantity to another, on a logarithmic scale. A reference level for dB is dBA which is a weighted scale for judging loudness that corresponds to the hearing threshold of the human ear. You will often see noise levels given in dBA instead of dB per octave band.

The human ears response to sound level is roughly logarithmic and the dB scale reflects that. Two identical pieces of equipment doing the same duty will double the sound intensity which is an increase of 3dB to the sound of the single unit sound power. While an increase of 3dB doubles the sound intensity a 10dB increase is required before a sound is perceived to be twice as load. The sound intensity multiplies by 10 with every 10dB increase.

Noise Criterion (NC) curves are used to specify the maximum acceptable level in each octave band of a frequency spectrum. This spectrum curve only meets NC45. NC curves are based on sound pressure so the condition of the space is important in the calculation. Since we cannot control the construction of a space this method of rating product can be problematic. Therefore, we always encourage sharing sound power rather than NC numbers with sound consultants (engineers) who typically welcome our sound power data.

Attenuating Sound

We can do a lot to attenuate sound when necessary but the best solution on a sound sensitive job is to ensure you select quiet equipment in the first place. Beware of municipal sound codes and whether or not nighttime level requirements are below that of the daytime level requirement. Many municipalities have zones which dictate what levels are acceptable. The city of Seattle has commercial, industrial, & residential zone designations and depending on where the source of sound is coming from and where the sound is being heard you will have different thresholds. For example, if your equipment is on the roof of a building in a commercial zone and it is adjacent to a residential

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zone you'll have one value that may be lower than the same building next to another building in the same commercial zone.

When dealing with outdoor sound attenuation we must know what sound pressure level we must be at or below and where that is located. Distance from the sound source is the best method of attenuation but we can also employ compressor acoustic packages and/or quiet condenser fan options. It is also effective to have modulating condenser fans that control to head pressure so they turndown to slower speeds at night when the loads are typically smaller. Barrier walls can also be placed between the unit and the measuring point which essentially makes the sound travel farther (up and over vs straight line) causing more attenuation due to distance traveled, but these barriers can be very expensive.

When dealing with indoor noise we employ silencers, acoustic packages, or even redirect sound. We also must be mindful of sound coming from our vibrating equipment on a roof. In these cases, we often employ vibration or heavy mass roofcurbs to mitigate the lower frequency sound.

Tools at our disposal for calculating and analyzing sound

There are tools & resources at our disposal to calculate dBA and the summing of multiple sound sources. Daikin has a calculator available for our use within their Acoustic Analyzer program (see below).

We can also perform sound analysis based on indoor or outdoor scenarios with Daikin's Acoustic Analyzer program. Below is a screen shot of an outdoor scenario with a Daikin RTU.

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