GENTEX TECHNICAL BULLETIN

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PRODUCT UPDATE: Understanding Audible Signal Appliances

The purpose of this article is to allow end users of audible signal appliances to become aware of how these devices are rated and some considerations when choosing appliances and deciding where they are to be mounted.

Before you can determine what devices to use and where they are to be placed, you must understand how they are rated. Sound is defined as a fluctuation in atmospheric pressure in the range of human hearing (i.e. 20-20,000Hz). The threshold of human hearing is a fluctuating pressure of 10^{-12} W/m^2. W/m^2 stands for watts per meter squared and is a method of measuring the pressure being exerted. The threshold of pain occurs at 1 W/m^2. Our ears respond equally to equal ratio changes of intensity of sound power. Sound **power** is proportional to the square of sound **pressure**. Since the human ear mimics a logarithmic scale, the term decibel was chosen to describe the logarithmic ratio between sound pressure measured and a reference sound pressure. The reference chosen is the threshold of hearing which is 10^{-12} W/m^2. The equation is as follows:

$$SP\ (dB) = (10 \log_{10}) \left[\frac{\text{sound power}}{10^{-12}\ \text{W/m}^2} \right]$$

If the threshold of pain is inserted into the equation, a value of 120dB is calculated.

A second important consideration of sound is frequency. Although the ear is sensitive to 20-20,000Hz, the range 100-3,150Hz is the most important due to the increase in sensitivity of the human ear over this range. For example, a sound pressure of 60dB at 1,000Hz would appear as loud as 67dB at 9,000Hz. Therefore, a sound pressure level in dB without any consideration of frequency is meaningless. To use a single dB rating over the entire range, various frequencies are weighted according to an international weighing curve to achieve sound pressure ratings in **dBA.**

Both NFPA 72 and the ADA recommend that the sound level of audible public mode signals be at least 15dBA above the prevailing equivalent sound level. NFPA 72 recommends the following mounting location:

> 6-3.5.1 Where ceiling heights permit, wall-mounted appliances should have their tops at heights above the finished floors of not less than 90 in. (2.3m) and below the finished ceilings of not less than 6 in. (0.15m). This does not preclude ceiling-mounted or recessed appliances.

You should be aware, however, that the ADA recommends a slightly different approach to mounting locations for appliances. It is stated in section 4.28.3 (6) that "The appliance shall be placed 80 in. (2030mm) above the highest floor level within the space or 6 in. (152mm) below the ceiling whichever is lower." You should consult your local codes or AHJ for specific requirements for your installation.

According to a study by Dr. E. Harris Nober at the University of Massachusetts, a sound level of 75dBA at the pillow is required to wake a sleeping person. However, according to independent studies, when signal appliances are placed only in the hallway, there is an average of only 56dBA at the pillow location. This is obviously inadequate to alert a sleeping individual according to the above study. While it may be possible to load up the spaces external to the sleeping quarters with signaling appliances, this is not typically a good solution since it will only lead to exceeding the maximum dBA in the hall while still not providing adequate notification in the room. The same study also revealed that when an auxiliary sounder was placed in each room, the average sound level pressure at the pillow was 87dBA. This more than adequately satisfies the above criteria for alerting a sleeping individual. While this approach may not be currently mandated by any standards or codes, the significance of this information should not be ignored. There is literature available which allows designers to accurately estimate dBA levels at various locations within a structure taking into account distances, interior surfaces and building partitions. If all these calculations are not performed in the design of a fire alarm system, it will probably lead to inadequate sound pressure levels within rooms that do not have a signal appliance.

TIPS TO KEEP IN MIND

- Sound pressure drops by 6dB for each doubling of distance in open field conditions.
- Indoors noise drops 3-5dB for each doubling of distance near the source. Further from the source there is a reduction of only 1-2dB due to reflections of sound off walls and ceiling.
- A significant amount of sound may be absorbed by furnishings such as acoustical ceilings and thick carpets.
- Drapery and carpets absorb high frequency sounds much more effectively than low.
- High frequency sounds tend to be more directional.
- Low frequencies tend to spread out more uniformly.
- Building materials (partitions) tend to attenuate sounds an addtional 5dB for each doubling of frequencies. For example, if the attenuation of a 1000Hz signal is 47dB the attenuation will increase to 52dB at 2000Hz.