# Great Event Audio Addendum 1: What is Sound?

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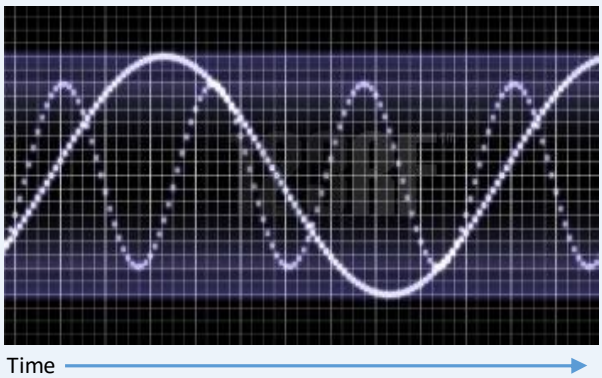
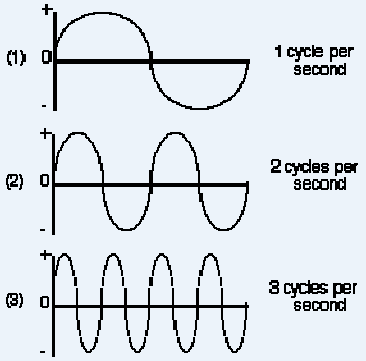
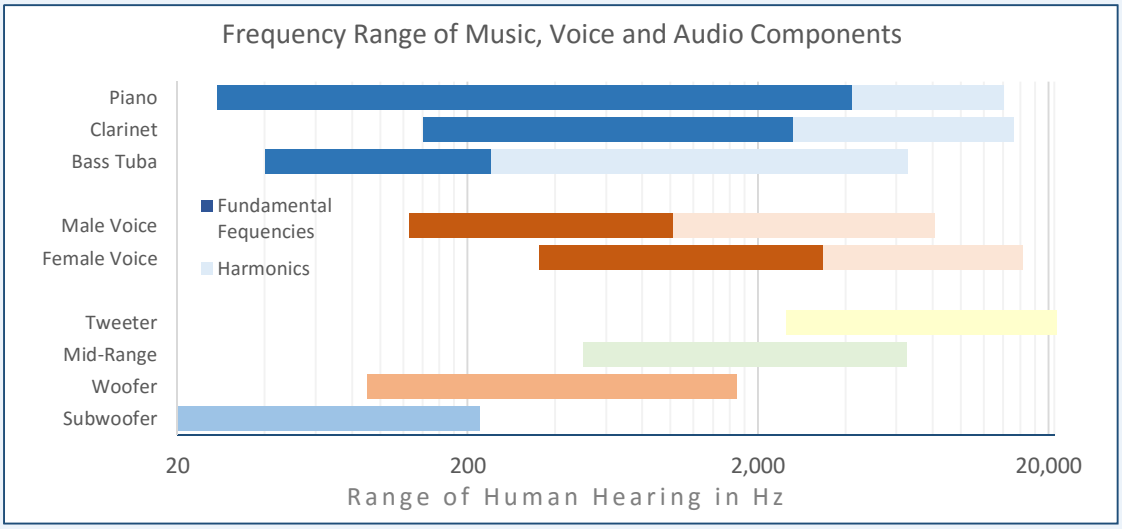
**WHAT IS SOUND?**

Sound is produced by air pressure that travel in waves, thus called ***sound waves***, which vary in length. Each wave has a specific in ***frequency*** (called ***Hertz***, or Hz) which is the number of cycles that wave will complete in a second. High frequencies have shorter waves and the highest C on a piano, for example, will complete as many as 4,100 cycles (Hz) per second. The lowest C is longer and will complete only 32 Hz (cycles per second).




Humans normally hear frequencies in the 20 Hz to 20,000 (20k) Hz range. This spectrum, plotted on an algorithmic scale, is known as a ***frequency range***. Most sounds we hear and recognize are actually a combination of many frequencies. Different instruments and the human voice produce different ranges of frequencies.




**CAN YOU HEAR ME?**

The intensity of sound levels are known as ***sound pressure level*** (SPL), which measures the loudness or amplitude of sound. (In audio parlance, loudness is referred to as "gain." The word volume is not used

since it can imply spatial and other measurements that are not relevant.) Sound pressure levels, or loudness, are measured in ***decibels*** (***dB***s), which is 1/10 of a bel, named after inventor Alexander Graham Bell.

The decibel has no absolute value; rather, it is a *relative* value – in this case, ***threshold of hearing*** (TOH) which is designated as 0 dB. Higher values along the decibel scale represent increases in SPLs relative to this threshold of 0 dB. A sound that is ten times more intense than the threshold of hearing has a value of 10 dB. However, dB is not a linear, but rather, a *logarithmic* scale. Therefore, 20 dB is actually 100 times more intense (10x10), 30 dB is 1,000 times more intense (10x10x10), and so on.

However (and this where it gets complicated), we do not *perceive* sound the same way. While a 10 dB increase in sound pressure levels is a tenfold increase in sound energy, that same 10 dB increase translates into hearing that is roughly only twice as loud; 20 dB would be 4 times as loud, and so on.

This is information becomes important is several areas of event audio, such as deciding what equipment is best for your program material, creating the best spatial setup for your venue, and ensuring even coverage and a comfortable listening level, and more.

Here are the sound pressure levels for some common sounds and their relationship to TOH.

| **Source of sound (distance)** | **SPL (dB)** | **>TOH** |
|---|---|---|
| Immediate soft tissue damage | 185 | $10^{18.5}$ |
| Instant perforation of the ear drum | 160 | $10^{16}$ |
| .45 Colt pistol (25 feet) | 140 | $10^{14}$ |
| Threshold of pain<br>Jet engine (100 m) | 130 | $10^{13}$ |
| Short term hearing damage | 120 | $10^{12}$ |
| Front row at a rock concert | 110 | $10^{11}$ |
| Niagara Falls<br>Hearing damage during long-term effect<br>Vacuum cleaner | 90<br><br>80 | $10^{9}$<br><br>$10^{8}$ |
| Passenger car (10 m) | 70 | $10^{7}$ |
| TV set at home level (1 m) | 60 | $10^{6}$ |
| Normal conversation (1 m) | 50 | $10^{5}$ |
| Quiet auditorium | 40 | $10^{4}$ |
| Very calm room | 30 | $10^{3}$ |
| Rustling leaves, calm breathing | 10 | $10^{1}$ |
| Threshold of hearing (TOH) at 2 kHz | 0 | $10^{0}$ |

*Measurements are approximate; TOH = Threshold of hearing