UNIVERSAL
1925 Hwy. 51/138 W● PO Box 411●Stoughton, WI 53589

INDUSTRIAL NOISE SERIES

Part I

FUNDAMENTALS

OF

ENVIRONMENTAL SOUND

Elden F. Ray

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I. SOUND METRICS

1. WHAT CAN YOU HEAR?

When we speak of acoustics most think of music, stereo systems and other elements of the science of producing sound in a pleasurable manner. Figure 1 illustrates the acoustical spectrum where sound can be heard or felt or both. Unwanted or nuisance sound is typically called noise. In general, our range of hearing is from about 18 Hz to 18,000 Hz and as we age the range is reduced. Note the *Threshold of Hearing* curve; below this line most people cannot hear sound and note that the most sensitive area is in the frequency range between 2k and 5k Hertz (Hz).

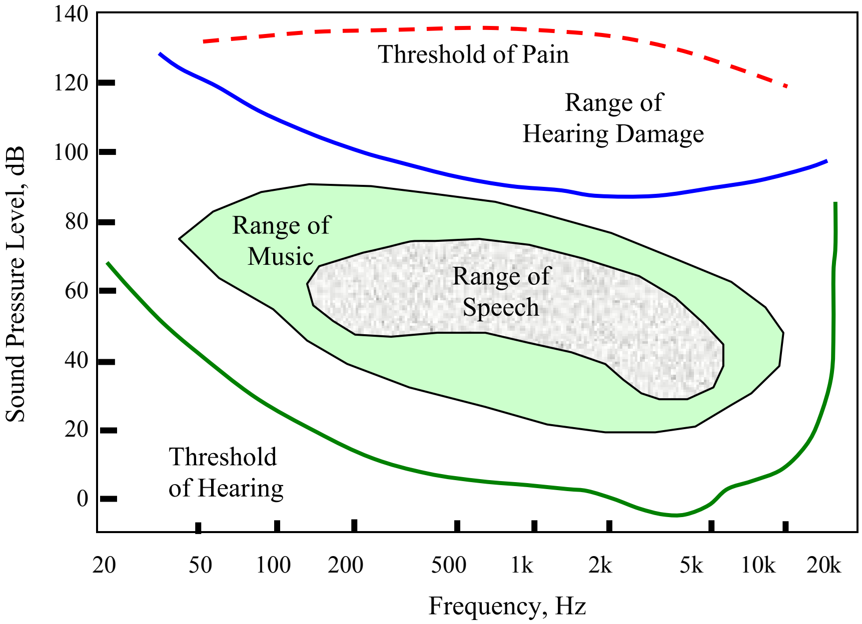

FIGURE 1 - AUDIBLE SPECTRUM (~18 HZ TO 18,000 HZ)

Generally, if you can feel the effects of sound then the levels are dangerously high and you are exposing yourself to harm. Studies have shown continuous long term exposure to just 75 decibels (dB) can lead to hearing loss. Whenever working around a loud source of noise wear hearing protection, even at home. The ear has a built in mechanism to help protect it somewhat from high amplitude sound but not impact noise, too quick for the ear to respond. When exposed to high sound levels the middle ear's connecting tissues stiffen to reduce the effect to the inner ear and is why when you leave a noisy environment your hearing threshold has shifted (everything sounds muffled) but will return to normal after a short period of time when the tissues relax. But constant exposure to high sound level will cause damage and the ear is one organ that does not heal. Once damaged, it remains damaged.

2. SOUND WAVES

Sound waves are very small pressure oscillations that travel through most all solids and fluids which includes air. Sound is typically generated by vibratory or oscillatory motion from a machine, loudspeaker or fluid flow past an object or other physical processes that involve some motion. Figure 2 illustrates a sound wave propagating through the atmosphere caused by ringing a tuning fork. The rapid oscillation of the tuning fork generates high pressures (red curves) and low pressures (not shown for clarity) that propagate through the air. Sound waves travel through air approximately 1,127 feet per second (344 m/s), or 768 mph (1237 km/h), at 68°F (20°C). To visualize a sound wave, throw a stone into a quiet body of water and watch the water ripples or waves travel out having crests and troughs similar that shown in the lower part of the following figure. Put an object in the water (that does not float) and watch the waves reflect or go around it. Sound waves do the same thing, reflect, bounce, and go-around and over objects as well as go through things including windows, doors, floors and walls. Just as a side note, water tables have been used for many years to visualize wave motions.

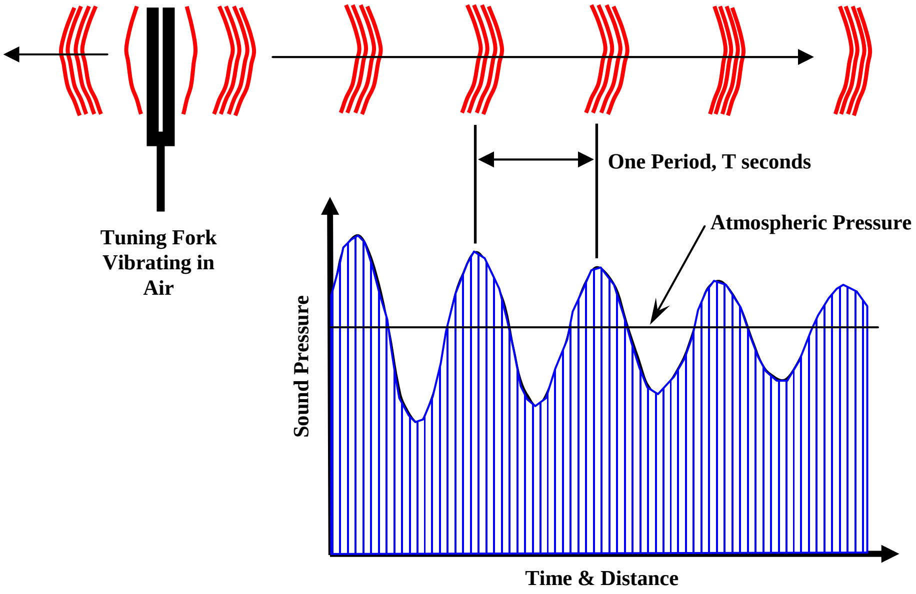

FIGURE 2 - A PERIODIC SOUND WAVE OF FREQUENCY, 1/T

One period (T) is the time of one full cycle of a sound wave. The physical motion of a structure or device (fan, pump, etc.) produces sound waves like that of the tuning fork above and if the motion is periodic or occurs at a repetitive rate, the sound is then occurring at a particular frequency. Something occurring at a rate of 100 times per second has a frequency of 100 Hz; the notation for frequency is Hertz (Hz) with physical units of 1/second (the term, *cycles per second* is not used in acoustics or noise control). A machine or motor that rotates 60 times a second (3600 rpm) has a frequency of 60 Hz. A tone is generally caused by acoustic energy emitted at a discrete frequency (such as a whistle) and when sound is produced by a group of (closely spaced) frequencies that sound is generally called broadband (such as sound from a waterfall).

Middle C on a piano has a frequency of 256 Hz, an octave up is 512 Hz and an octave down is 128 Hz. There is a direct relation between wavelength (λ), frequency (f) and the speed of sound (c).

$$\lambda = c/f \text{ feet or meters, depending on units of c} \tag{1}$$

The speed of sound (c) increases with temperature too and at low frequencies (f), it becomes evident that wavelengths can become quite large. Low frequency sound is very difficult to mitigate or reduce because of the large wavelengths.

Sound waves are generally modeled as a sinusoidal function as illustrated in the following figure (a sine wave). Shown is a single frequency at constant amplitude, the same type of wave as shown in Figure 2. The zero line represents atmospheric pressure and the sound pressure is positive above the line and negative below the line. This is what causes the ear drum to cycle in and out so the inner ear can process the motion into what we hear; so imagine your ear drum moving in and out like the wave shown and if the sound energy is too high it can damage the ear. The very top and bottom of the wave is the peak amplitude but the energy of the sound wave is better represented by its amplitude.

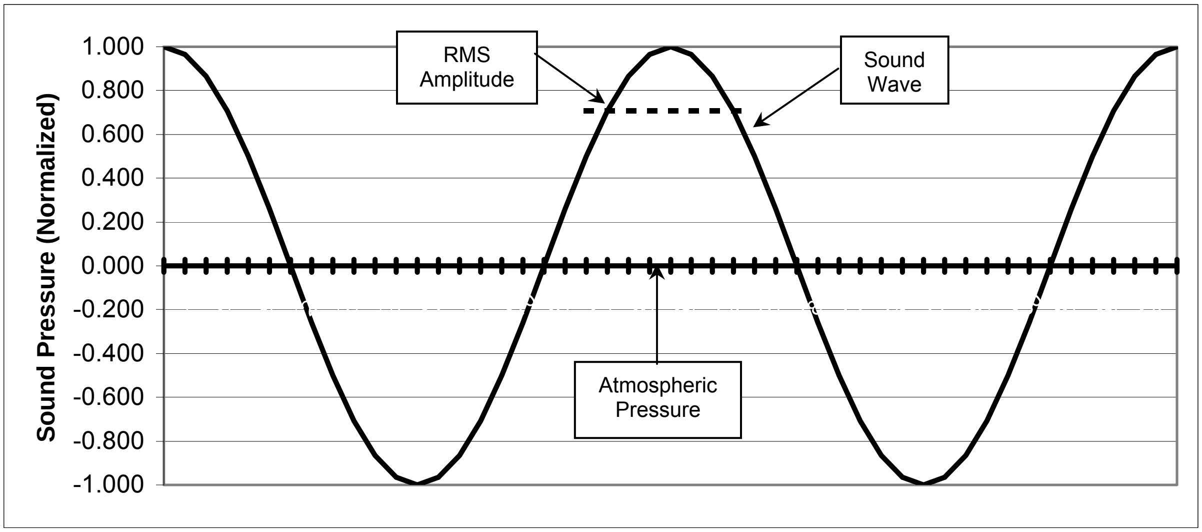

FIGURE 3 - BASIC ELEMENTS OF A SOUND WAVE

Now, in actuality sound waves do not really propagate as a nice sinusoidal wave as shown but travel as a series of progressive wave fronts or “walls of sound” having alternating high and low pressures that cause the ear to oscillate enabling you to hear the sound and its pitch or frequency. The sound wave flows around everything as it travels and reflects off surfaces as well. At very low frequencies this “wall of energy” is very pronounced, difficult to attenuate, and frequently hard to identify where it is coming from because it seems to be everywhere. At high frequencies the sound energy is very directional because the sound waves are very short so are usually associated with a small or discrete source of sound. One may be able to find the source of middle and higher frequency sound by cupping your ears and use your hearing sensitivity as a directional receiver.

The sound level displayed on a sound meter is the rms amplitude of the acoustic signal or frequency. RMS means the *root mean square* of the pressure wave and is the energy level of the sound wave; it is 0.707 x peak pressure level. The difference between the peak and rms sound level amplitudes is 3 decibels (dB). Machines or events can be very noisy but it is the sound that is measured, so sound levels are reported not noise levels.

3. THE WEIGHTED SOUND LEVEL

The human ear simultaneously receives sound at many frequencies all at different amplitudes. The ear is a dynamic filter and shifts its sensitivity based on the amplitude and frequency of the sound. It performs poorly at low frequencies, very well at middle frequencies and begins to fade at high frequencies and then rapidly drops sensitivity above 12,000 Hz as shown in Figure 1.

In order to analyze the human response to sound or noise, researchers developed electronic weighting curves or filters for sound equipment to electronically process the sound as it would be processed by the ear. Now what is being done is electronic processing is being performed to process the sound to simulate a biological function (hearing). These weighting curves are commonly known as A, B, C, D, and E and are applied depending upon what is being measured. Why so many weightings? because the ear responds differently when exposed to different types of sound.

For common environmental sound assessments, the A, B, and C weightings were initially used depending on the amplitude of the overall sound level. This was cumbersome and eventually the A-weighted sound level was adopted for most all environmental conditions. It seemed to be a fairly good universal indicator for assessing human response to sound and avoided a lot of confusion about what weighting was used and made sound equipment less expensive. The C-weighted sound level was generally used for assessing “unweighted” sound levels usually aimed at assessing low frequency noise. As a consequence, A and C weightings (or filtering) are now the most widely used in environmental acoustics.

The following figure illustrates the A and C weighting curves from 12.5 Hz through 10,000 Hz. A microphone-sound meter system measures the true sound pressure level, as represented by the zero level in the figure, and to simulate how the ear receives the sound the weighting is applied to the measured sound level. Note that if you were to flip the A weighting curve over it would be very similar to the Threshold of Hearing curve shown in Figure 1. So, one can see that the ear is not real sensitive in the low frequencies. Of course everyone is different, and some people are actually hypersensitive to certain sounds.

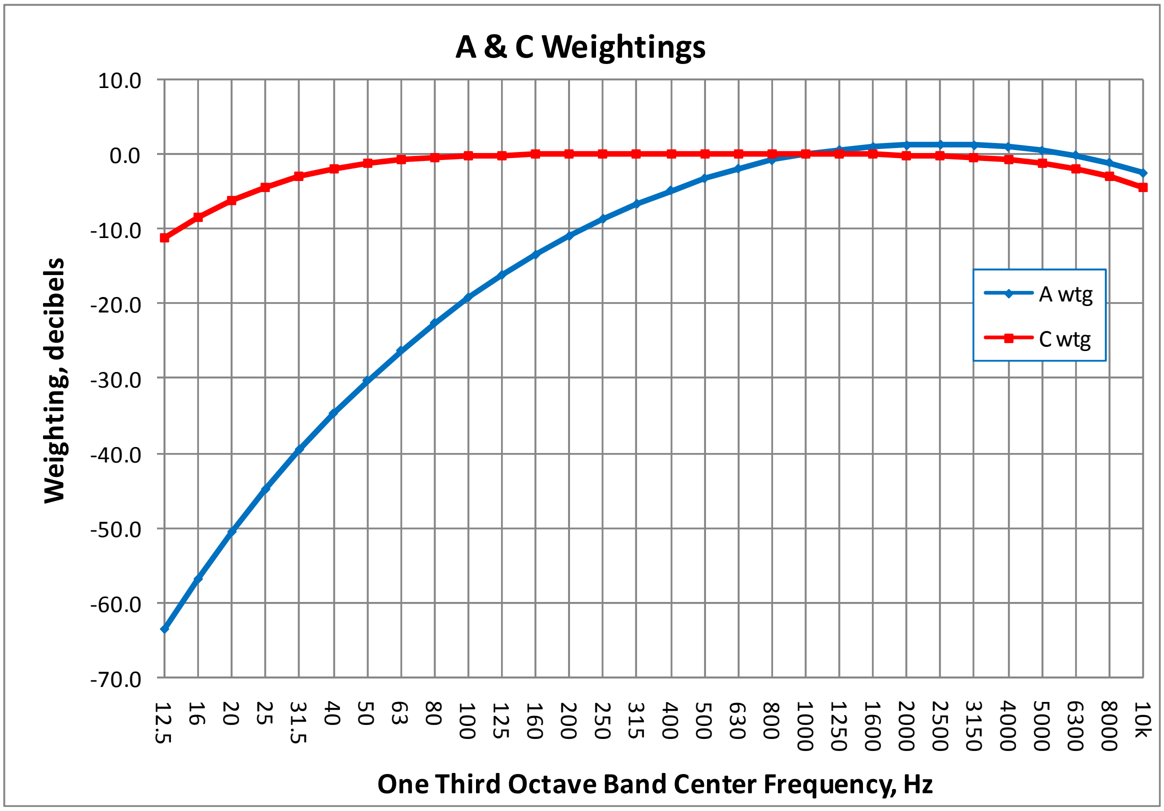

FIGURE 4 - A AND C WEIGHTINGS APPLIED TO SOUND LEVEL MEASUREMENTS

The overall A-weighted sound level is simply called the *sound level* given as a decibel level without the annotation of dB(A). A *sound level* is understood to be A-weighted; for example, if someone reported a sound level of 55 dB it is understood to be the overall A-weighted sound level. This simplification is acceptable for generally making noise measurements and is widely used in enforcement of noise ordinances because of its simplicity of measuring noise and coming up with a single value to evaluate. Also, it is important to understand that the *sound level* is a summation of all the acoustical energy (sound) from 10 Hz to 20k Hz as processed and presented as single decibel value by the sound level meter. A *sound level meter* only measures the overall A-weighted sound level and perhaps the overall C-weighted sound level if equipped.

4. SOUND AND DECIBELS

Research showed that hearing response was fairly proportional to the base 10 logarithm and the bel, a logarithmic power ratio was developed by the telecommunications industry in the 1920s and 1930s for analyzing telephones and communications equipment and the development of sound measuring equipment. The bel is named for Alexander Graham Bell, and ten decibels equal one bel. Logarithms, bels and decibels are non-dimensional units so a reference must be cited in order to know what physical units the decibel is representing; that is why you always see, “dB re: xxx units.” The acoustical community adopted this usage which has become global in its applications; a sound level in the U.S. is the same anywhere else in the world. Mathematically, the sound pressure level is,

$$\text{SPL or } L_p = 20 \text{ Log } (P/Pr) \quad \text{dB, re: 20 micro-Pascals} \qquad (2)$$

where P is the sound pressure and Pr is the reference value to make the ratio dimensionless. The sound meter microphone and electronics process the sound pressure to present the decibel sound level (the rms amplitude).

Figure 5 shows the logarithmic relationship between sound pressure and sound pressure level and illustrates why decibels are a bit more convenient to use. The dynamic range of hearing extends from about 0 dB to well in excess of 140 dB after which hearing damage will most certainly occur. The maximum sound level that can occur in the atmosphere (based on 14.7 psia) is about 194 dB!

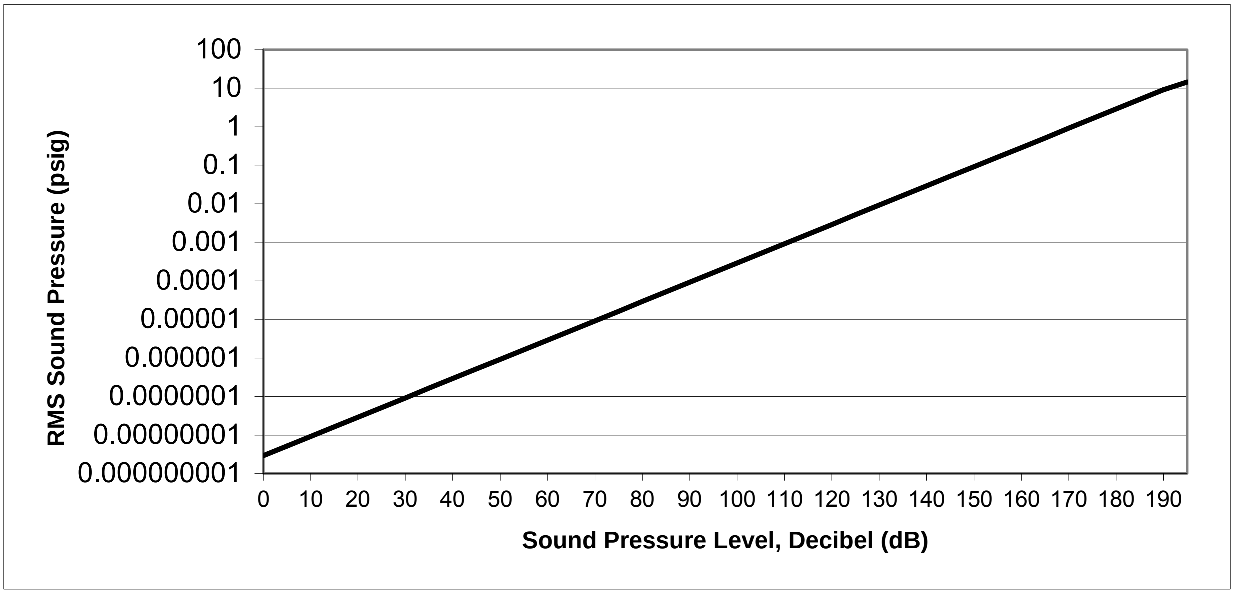

FIGURE 5 - SOUND PRESSURE VS SOUND PRESSURE LEVEL

The vertical scale is a logarithmic scale (factors of 10 equally spaced) and the horizontal scale shows the corresponding level in decibels, also a logarithmic scale. Notice how cumbersome and error prone it would be to notate sound level in actual units of pressure.

So, how sensitive is our hearing and how does a decibel sound level correlate with what we hear. The following figure gives an idea of typical sound levels. These give a general idea of the quantitative sound level you may associate with a familiar environment. Sound levels in excess of 70 dB are generally associated with commercial, manufacturing and industrial facilities.

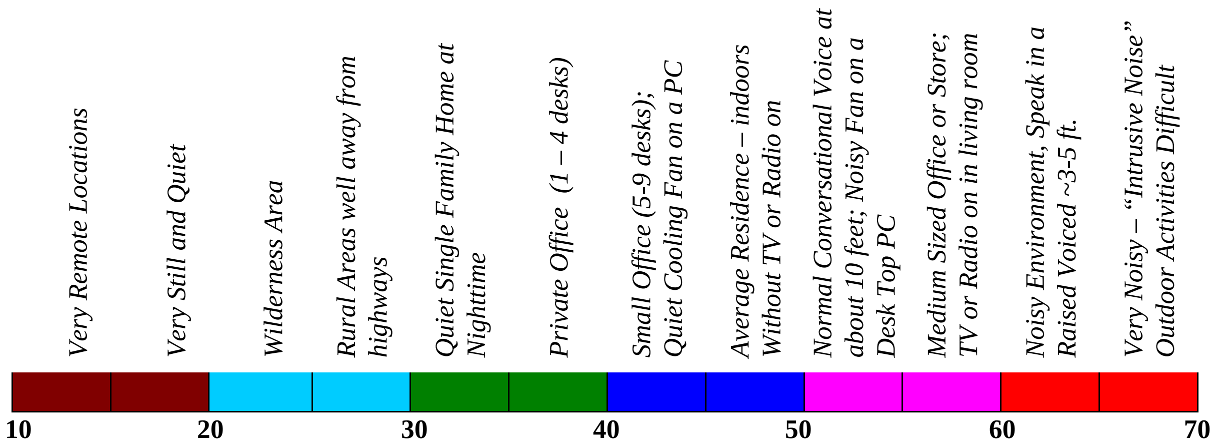

FIGURE 6 - TYPICAL RANGE OF SOUND LEVELS, DECIBELS

5. FREQUENCY AND BANDWIDTHS

Sound data is typically presented as a function of frequency. The frequency band identifies where the sound energy is so a noise control device can be effectively designed. The sound level in each band can be significantly different from the adjacent band. The following table presents standard octave and one-third octave bands and their corresponding bandwidths.

TABLE I - ACOUSTICAL BANDWIDTHS

Frequency Bandwidths, Hz	⅓ Octave Band Center Freq. Hz	Octave Band Center Freq. Hz
11.2 - 14.1	12.5	16
14.1 - 17.8	16	
17.8 - 22.4	20	
22.4 - 28.2	25	31.5
28.2 - 35.5	31.5	
35.5 - 44.7	40	
44.7 - 56.2	50	63
56.2 - 70.8	63	
70.8 - 89.1	80	
89.1 - 112	100	125
112 - 141	125	
141 - 178	160	
178 - 224	200	250
224 - 282	250	
282 – 355	315	
Frequency Bandwidths, Hz (cont.)	⅓ Octave Band Center Freq. Hz	Octave Band Center Freq. Hz
355 - 447	400	500
447 - 562	500	
562 - 708	630	
708 - 891	800	1,000
891 - 1,122	1,000	
1,122 - 1,413	1,250	
1,413 - 1,778	1,600	2,000
1,778 - 2,239	2,000	
2,239 - 2,818	2,500	
2,818 - 3,548	3,150	4,000
3,548 - 4,467	4,000	
4,467 - 5,623	5,000	
5,623 - 7,079	6,300	8,000
7,079 - 8,913	8,000	
8,913 - 11,220	10,000	

A review of the table shows that the band widths are not constant and become wider in the higher bands, a geometric progression. Industry standards groups established 1,000 Hz as the datum for establishing the bandwidths. An octave higher is the 2,000 Hz band and an octave lower is the 500 Hz band (an octave is a doubling or halving). The demarcation between bandwidths is roughly the geometric mean; for example, the demarcation between the 500 and 1,000 Hz bands is $(500\cdot1000)^{½} = 707$ but the actual is 708 Hz. Note that, $(f_1\cdot f_2)^{½} = \sqrt{(f_1 \times f_2)}$.

The most common bandwidths used are the nine octave bands from 31.5 Hz to 8k Hz. Generally, machinery noise is not a concern above the 8k Hz band but sometimes it is in the 16 Hz band for very low frequency sound. In general, designing noise control devices using octave or one-third octave bands is acceptable and only on rare occasions does a discrete frequency or tone become a problem.

6. ACOUSTICAL SPECTRA

When a noise problem occurs it is important to identify the cause and measure the source of noise. When designing noise control equipment you need to identify the frequencies and generally the type of problem will dictate the type of measurements. In Figure 7 you can see the fundamental tone (2,100 Hz blade passing frequency) and its harmonics from a combustion turbine inlet. This was a case where the owner decided to save money on silencing.

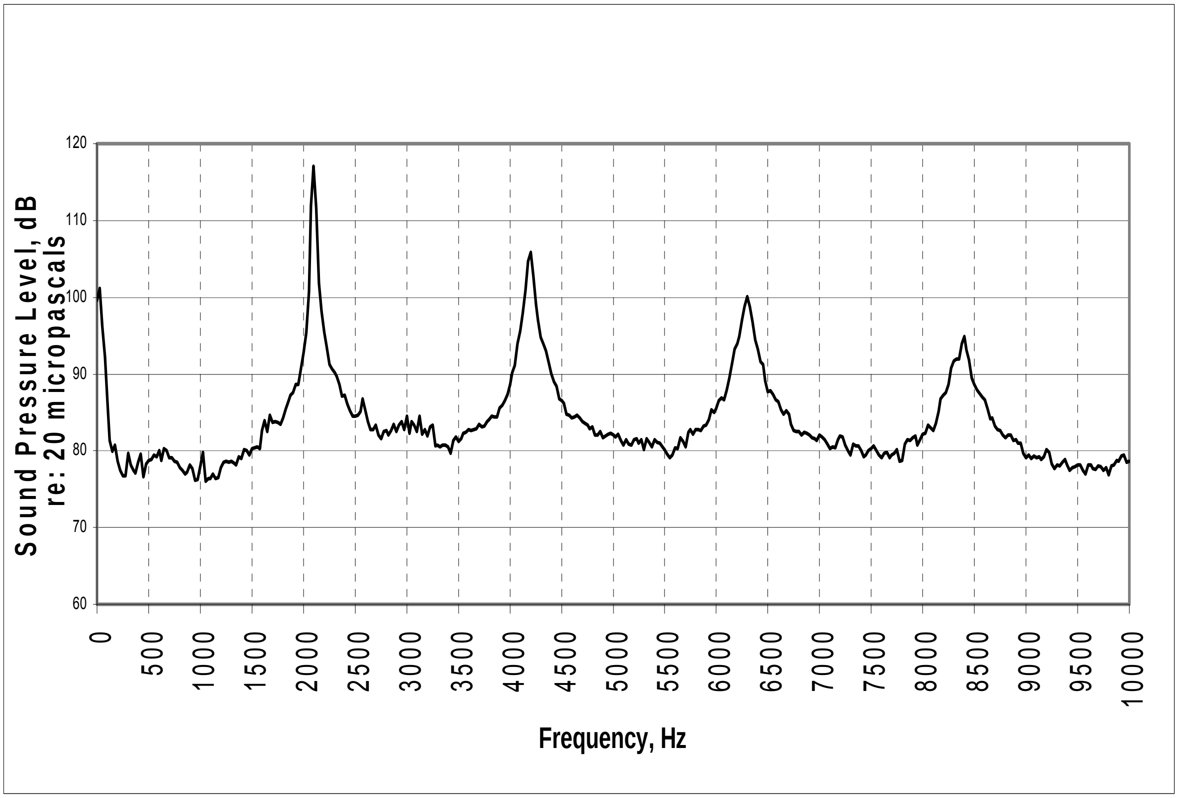

FIGURE 7 – COMBUSTION TURBINE INLET TONES, FUNDAMENTAL BPF = 2,100 HZ

Figure 8 presents two sound pressure level (SPL) measurements (solid lines) and the corresponding A-weighted measurements (dash lines) of a fairly broadband noise source. In reviewing the data one would assume that the major acoustical energy is in the 63 Hz to 100 Hz bands. But what is dominating the sound level, as heard, is the acoustical energy in the 1,000 Hz and 1,250 Hz bands. So here it is shown the relative importance of using A-weighted analysis to assess the measurement and identify where noise control measures need to be implemented.

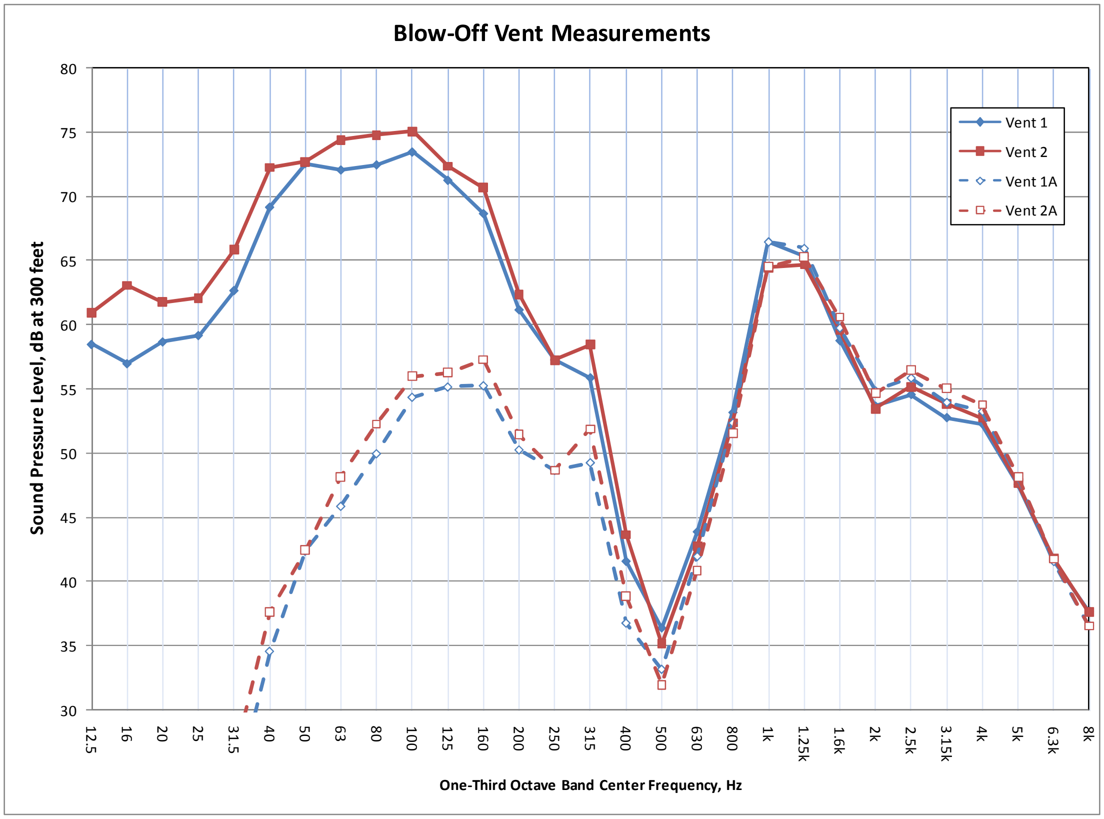

FIGURE 8 – UNWEIGHTED VS A-WEIGHTED MEASUREMENT

Figures 7 and 8 showed the importance in obtaining accurate and adequate field measurements when solving noise problems. Figure 7 shows the importance of making narrowband frequency measurements to identify the exact frequencies. The term, *narrowband* refers to any type of frequency analysis that uses a relatively small frequency bandwidth, from fractions of a Hertz to several Hertz. As shown in Figure 8, any noise control treatment would need to be focused in the 1,000 Hz and 1,250 Hz bands.

It is important to know that a silencer or noise control device cannot be designed to simply reduce an overall sound level; that is, if a person reports he has a sound level of 80 dB and needs to reduce it by 20 dB there is no way to guarantee that the device will work because there is no information as to the frequency content of the sound energy.

7. SOUND MEASUREMENT

Modern digital sound level meters and analyzers (conforming to ANSI S1.43 or IEC 804), with integral signal processors can now record and process the sound measurement over a defined time span that can range from a few milli-seconds to hours to days. The variations of the sound level over a time period are processed to arrive at a single *equivalent* sound level. This is referred to as the *equivalent sound level*, denoted as LEQ or L_{eq}. The term "LEQ" was used extensively back in the 1980s and 90s to distinguish the sound measurement from the old method of reporting the sound level from an old analog type sound level meter where the sound level was read off a dial ("eyeball averaging"). So, when you hear someone speak of the "LEQ," it is not something special or different, it is the sound level or sound pressure level as measured over a time period.

Sound analyzers are used to measure sound and process the sound measurement to identify the frequencies and their respective amplitudes. This type of measurement is critically important in noise control as it is necessary to know what frequency or frequencies need mitigation. Now, machines and equipment produce sound at many frequencies, dozens of frequencies. This makes it very challenging to design noise control treatments. To help simplify this process, sound is measured across a set range or series of frequencies that are grouped together in bands. By a study of these bands of acoustic energy, noise control solutions can be developed and if a band of sound seems problematic then a more detailed study can be made. This approach is commonly used and results in satisfying most all noise control needs the vast majority of the time.

II. BASICS OF NOISE CONTROL

1. SOUND PRESSURE AND SOUND POWER

There are two parameters of sound that are used: sound pressure level and sound power level. Sound pressure is what is heard and measured with a sound meter at some location relative to the device being measured. Sound power is the acoustical power (watts) emitted by the device. An analogy for understanding these parameters is the light bulb. An incandescent light bulb or lamp is rated in watts but emits light (lumens). If you are very close to the light it is very bright and far away it is very dim. So, distance from the lamp affects its brightness but regardless its wattage is the same. Sound behaves the same way, the farther away from a device the lower the sound pressure level but the sound power level is the same.

When we have sound power data we have the absolute acoustical energy and is a distinct advantage over just having sound pressure levels or sound level data which requires detailed measurement information; that is, as noted above, the distance from the device and the area over which the measurement was made is needed. It is imperative that this data be well defined. When only receiving sound pressure levels, with only a vague description, makes any design and analysis difficult.

The physical relationship between sound power and sound pressure has the following basic form,

$$L_W = L_p + 10 \text{ Log } (A) \quad \text{dB re: 1 pico-watt} \tag{3}$$

Where the “A” term describes the area over which sound pressure levels (L_p) were measured which is influenced by the size of the source of noise (machine). By examining equation (3) it shows the importance of defining the measurement area which includes the precise location of microphones, defining the surface surrounding the source of noise, and correctly processing the measurements to arrive at an accurate measurement and calculation of sound power level. Sound power is critical to know as it is used in modeling and calculating sound propagation as given by the form.

$$L_p = L_W - 10 \text{ Log } (A) \quad \text{dB re: 20 micro-pascals} \tag{4}$$

This is very simplified but is used to show that the sound level at the receiver (L_p) is dependent upon “A” (distance or area over which the sound travels) and the sound power level (L_W). By knowing the sound power level the sound level at any location can be calculated.

Equations (3) and (4) are performed for each frequency band in predicting the sound levels and ISO 9613-2, *Acoustics – Attenuation of sound during propagation outdoors*, is the standard used for modeling outdoor sound propagation and predicting far field sound levels. Many computerized prediction and modeling programs are based on this standard.

2. NOISE CONTROL

In order not to exceed a sound level at some location, noise control measures are implemented that are focused on mitigating the noise from machinery, equipment, industrial plants and other facilities to comply with the regulatory requirements. The noise control measures are generally custom designed to the specific needs because regulations vary widely from one area to another.

Other than state, county, or local ordinances that may impose some type of environmental sound limit, there are no federal regulations limiting noise from industrial plants or any fixed base facilities except for FERC (Federal Energy Regulatory Commission), which regulates interstate transportation of fuels and energy (pumping/compressor stations). Highway noise and airport noise are regulated by the U.S. DOT (FHWA, FAA) and HUD specifies noise limits in federally funded urban renewal projects and OSHA regulates worker exposure to the cumulative effects of noise, not the level of the noise.

The design of the noise control products is based on the noise produced by the machine and the resulting sound level it produces at some location. The mathematics is pretty simple and follows the technique expressed by Equation (4). Let’s assume a machine has a sound power level of 100 dB, the distance term is 20 dB and at the distance location the sound level is not to exceed 65 dB.

$$L_p = 100 - 20 = 80 \quad \text{dB re: 20 micro-pascals} \tag{5a}$$

The required noise reduction (NR) of the machine is then,

$$NR = 80 - 65 = 15 \quad \text{dB} \tag{5b}$$

For safety purposes, most noise control designs include a 3 dB margin so the total NR is 18 dB. For very sensitive areas or high risk applications, the margin may be higher.

This is a very simplified example but outlines the general approach. Now this calculation is done for all nine octave bands and for every source of noise and then combined to arrive at the sound level at the property line or where the criterion is applied. In some cases, this calculation is done for the 27 or 30 one-third octave bands. The resulting sound pressure level in each band is then mathematically adjusted and summed to arrive at the overall sound level.

3. ACOUSTICAL METRICS AND TERMINOLOGY

One major benefit regarding the metrics and terminology of acoustics is it is one of the few engineering realms that is truly international; decibels, sound pressure levels, sound power levels, frequency, bandwidths and many other parameters are all identical around the world. A sound level of 55 dB in Europe is identical to that in the U.S. or anywhere else. Sound absorption coefficients, flow resistivity, transmission loss, and noise reduction all mean the same thing but the notations may be different.

ACOUSTICAL TERMINOLOGY

a. All acoustical sound levels and sound pressure levels are referenced to 20 micro-pascals (20×10^{-6} pascals, or 20µ pascals, or 0.00002 N/m^2). This reference level was chosen with respect to the sound pressure level at 1,000 Hz that was used to define the lowest acoustic pressure that the ear can detect.

b. All acoustical sound power levels are referenced to one pico-watt (1×10^{-12} watt). Very old documentation may still cite 1×10^{-13} watt, which has not been used for 40 years, and can result in a ten decibel design error.

c. The *Sound level* is the overall sound level in decibels (dB) and includes all the sound energy in the range from 10 Hz to 20,000 Hz and is the overall A-weighted sound level unless noted otherwise. If denoted as *Lin* or Z wtd (linear or flat) it means no filtering or weighting has been applied to the data.

d. The *A-Weighted sound level* may be annotated by the following symbols: L_A, L_{AT}, and L_{eqA}; an example of usage is, L_A 85 dB. The use of dBA or dB(A) (or any type of suffix to dB) is no longer promulgated in usage and technically not used.

e. The *C-Weighted sound level* is the overall C-weighted sound level in decibels (dB) and has the following symbols: L_C, L_{CT}, L_{eqC}; and again, using dBC or dB(C) is no longer promulgated in usage.

f. The *Z-Weighted sound level* is the overall un-weighted sound level in decibels (dB).

g. *Sound Pressure Level* (*SPL*) is the sound level at a frequency or in a frequency band and has the following notations: L_p , L_{pT} , or L_{eq}. Note that the subscript is a lower case "p" and not a capital. The capital usage denotes sound power level. (The use of "p" or "P" as subscripts is confusing and is virtually recognized as "pressure" by the technical community so it is always important to supply the reference quantity. A formal expression would be L_p 85 dB re: 20 micro-pascals.

h. *Sound Power Level* (*PWL*) is the amount of acoustical energy being emitted from equipment per second and has the following notations: L_P, L_W, or L_{WA} for an A-weighted sound power level. The subscript "P" is a capital letter and as mentioned above can be confused for sound pressure. A formal expression would be, L_W 95 dB re: one pico-watt.

i. *Frequency* is the rate at which sound is produced per second and has units of hertz (Hz). It is the reciprocal of the period, 1/T where T is time period in seconds of a sound wave (Figure 2).

j. *Bandwidth* is a grouping of frequencies that convey the total sound pressure or sound power level in those frequencies. The sound energy is summed together and the amplitude given for that bandwidth. Table I lists the standard octave and one-third octave bands.

NOISE CONTROL TERMINOLOGY

Absorption Coefficient – all materials can absorb acoustical energy, which is a frequency dependent property. Absorption values range from 0 to 1.0 indicating 0% to 100% percent absorption of acoustic energy. Values over 1.0 are obtained under reverberant conditions and may be used in room acoustics.

Damping – usually a visco-elastic material applied to a structure to reduce a resonant condition. Otherwise, just applying damping only adds weight and cost with minimal acoustical benefit. Damping materials are not to be applied to high temperature surfaces. Please note, it is NOT spelled, *dampening* which means, *making something wet.*

Dynamic Insertion Loss (DIL) – is the sound reduction in decibels provided by a silencer or other similar device when inserted into a duct or other noise path with fluid flow present. Fluid flow (usually air) generates flow noise, which can degrade performance in low noise applications.

Dynamic Transmission Loss (DTL) – is the *Universal* term for transmission loss in decibels provided by a silencer or other similar device when inserted into a duct or other noise path with fluid flow present. Fluid flow generates flow noise which can degrade performance in low noise applications.

Insertion Loss (IL) – is the noise reduction in decibels provided by a silencer or other similar device when inserted into a duct or other noise path under static (no flow) conditions; when flow is present it is referred to as dynamic insertion loss (DIL).

Lagging – usually an insulated wrapping around ductwork or piping to reduce break-out noise. Lagging must be de-coupled from the duct/pipe usually by the insulation and the outer layer a limp impervious covering; the heavier the better.

LEQ – equivalent continuous sound level is the total acoustical energy measured over a time period and presented as an *equivalent* continuous sound level. Over a time period, sound levels can vary and the LEQ represents the equivalent sound (energy) level over that period.

Mass Law – increasing the mass of the structure usually results in lower noise emissions but a doubling of the mass results in only a 6 dB reduction. Mass Law = 20 Log (M2/M1) dB where M1 is the original weight and M2 is the new weight and has frequency dependent limitations.

Noise Reduction (NR) – a general expression or term for some noise mitigating feature that reduces noise. It is the relative difference in sound pressure level or sound power level in decibels.

Noise Reduction Coefficient (NRC) – arithmetic mean of sound absorption coefficients in the 250, 500, 1,000 and 2,000 Hz bands; the higher the number the better.

Speed of Sound (sonic velocity) at atmospheric pressure may be estimated by

$$c = 49.03\sqrt{\left(T\ {}^{\circ}F + 460\right)}\ \text{ft/s}, \quad \text{or} \qquad c = 20.05\sqrt{\left(T\ {}^{\circ}C + 273\right)}\ \text{m/s}$$

where, T is the temperature in either Fahrenheit or Celsius as appropriate.

Sound Transmission Class (STC) – single number rating of airborne noise reduction of a building partition. The number is an indicator of the acoustic transmission loss (TL) performance from 125 Hz to 4,000 Hz; the higher the number the better.

Sound Trap – trade term for a silencer.

Transmission Loss (TL) – a measure of the NR in decibels and is typically associated with the noise reduction provided by a wall or a silencer. For silencers, TL is the difference in sound power levels across the silencer (or other device) in decibels. For walls, the TL is the difference in sound pressure levels across a wall or barrier.