NOISE & NOISE MEASUREMENT

1. Sound (Noise) Level

Sound and unwanted sound, called noise, is the result of fluctuations or oscillations in atmospheric pressure. These excite the ear mechanism and evoke the sensation of hearing.

The human ear responds to changes in sound pressure over a very wide range - the loudest sound pressure to which the human ear responds is ten million times greater than the softest. This large ratio is reduced to a more manageable size by the use of logarithms. The logarithms scale provides a more convenient way of comparing the sound pressure of one sound with another. To avoid a scale which is too compressed, a factor of 10 is introduced, giving rise to the decibel unit.

The level of sound pressure *p* is said to be Lp decibels greater than a reference sound pressure *Pref* according to the following definition:

Sound Pressure Level (Lp or SPL) = $10 \log_{10}(P^2/Pref^2)$ dB

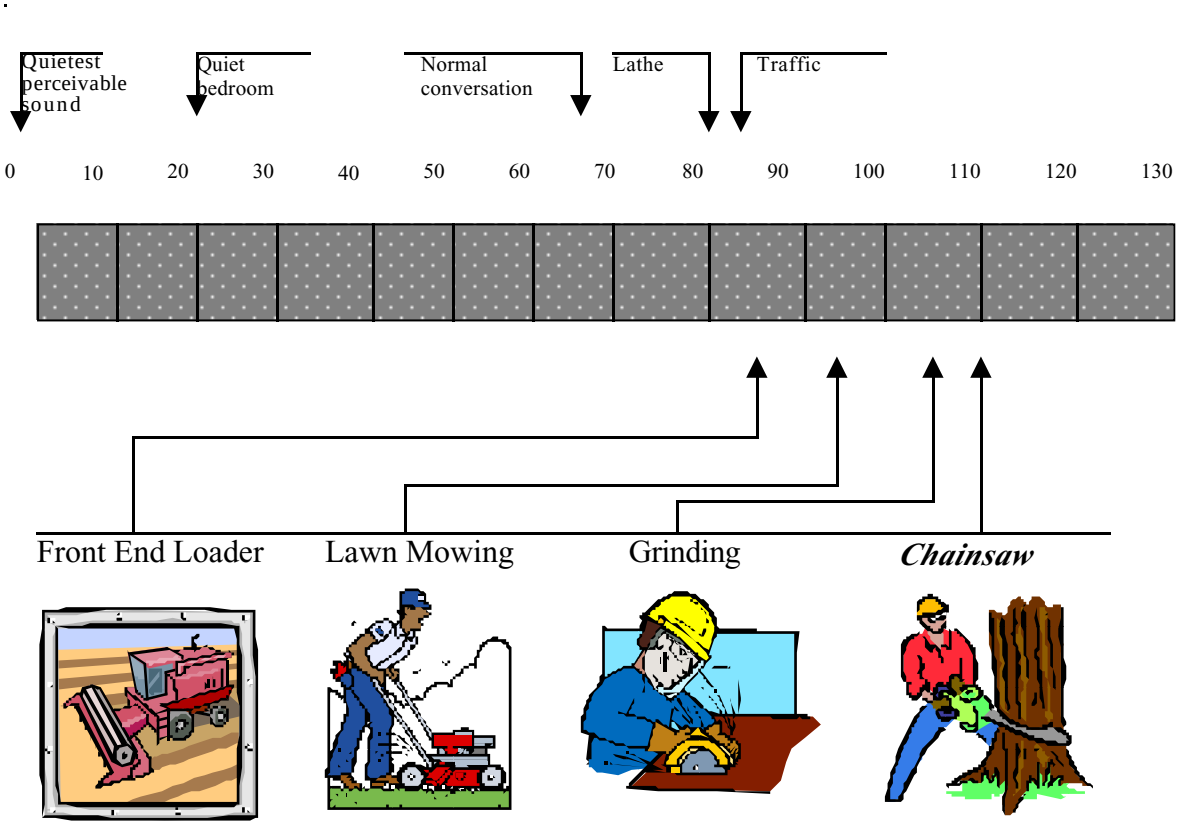
$= 20 \log_{10}P - 20\log_{10}Pref$ dB

where *p* is the sound pressure fluctuation (above or below atmospheric pressure) and *Pref* is 20 micropascals (2×10^{-5}Pa), which is approximately the threshold of hearing.

The decibel scale is shown in **Figure 1**.

Figure 1: The Decibel Scale

The Decibel Scale - some typical sound levels



2 A-Weighted Decibels, dBA

The threshold of human hearing varies with frequency, being most sensitive to sound mid frequencies (500 Hz to 4000 Hz), and less sensitive at lower and higher frequencies. The pressure amplitude of a sound therefore does not directly relate to its perceived loudness and both frequency and amplitude need to be taken into account. For low level sounds, a filter having a frequency response corresponding to that of human hearing (in level range about 40 dBA), is incorporated in sound level meters. Sound level measurements made using this filter (A-weighting) are described as A-weighted decibels, dBA.

The level of a sound expressed in dBA is a reasonable measure of the loudness of that sound. Different sounds having the same dBA level generally sound about equally as loud, although the character of the noise also plays a part in its perceived loudness.

A change of 1dBA or less in the level of a sound is difficult for most people to detect, whilst a 3 dBA to 5dBA change corresponds to small but noticeable change in loudness. A 10 dBA change is generally accepted to correspond to an approximate doubling or halving in loudness. **Table 1** following, gives examples of dBA levels are shown in Table 1.

Table 1: Example Noise Levels

Sound Pressure Level (dBA)	Typical Source	Subjective Evaluation
140	Long range gun, gunner s ear	Extremely noisy to intolerable
130	Threshold of pain	
120	Jet take-off at 100m	
110	Night club dance floor	
100	Loud car hom at 3 metres	Very noisy
90	Heavy truck at 10m	
80	Curbside of busy street	Loud
70	Car interior	
60	Normal conversation at 1m	Moderate to quiet
50	Office noise	
40	Living room in quiet area	Quiet to very quiet
30	Inside bedroom at night	
20	Unoccupied recording studio	Almost silent

3. Statistical Analysis of Sound (Noise)

Ambient sound varies in level over time and so is commonly described statistically in terms of exceedence levels. These levels summarise the percentage of time a noise level was exceeded during the measurement period at the measurement point.

For example, if a noise level of 80 dBA was exceeded 10% of the time during a sampling period, this result would be described as an LA10 of 80 dBA. Statistical sound level meters usually generate a range of percentile results between 0 and 100.

An A-weighted noise level exceeded for N% of a given measurement period is denoted as an LAN of that level. LA1 is the noise level exceeded for 1% of the time, LA10 the noise exceeded for 10% of the time, and so on. LA90 is a commonly used measure of the average minimum or background A-weighted noise level.

Another index of sound level that is also in common usage is the A-weighted equivalent continuous noise level, denoted as LAeq . LAeq is essentially the constant sound pressure level, which is equivalent to (contains the same amount of acoustical energy as) the varying sounds level over the measurement period.

Figure 2 depicts a sixty second measurement sample of a varying sound and some of the descriptors discussed.

Figure 2: Sound Variation with Time and its Descriptors