Acoustic Data

These definitions are intended simply as an aid to understanding and for this reason, some are not strictly scientifically accurate. For correct formal definitions, consult IEC standards 60651, 60804, 60942, 61252 and IEC 61672: 2003 part 1.

Sound: *Sound is simply Pressure. The units are Pascal (symbol Pa). Look at your Hi-Fi speakers at home, the cones vibrate and these vibrations are sending out waves of pressure (imagine them as being similar to the ripples on a pond, but in 3-D). These waves spread out in all directions from the original source; getting weaker the further they go. The ear picks up these vibrations and converts these pressure waves into electrical impulses that are carried to the brain to be "interpreted" as sounds.*

The Decibel: *(symbol dB). This is a logarithmic scale of pressure produced to allow a better correlation between what we hear and the scales we use. Being logarithmic, you can't add decibel values together, first you need to anti-log them to get actual pressure in Pascal, add these values together and then log the result. Needless to say this is time consuming when done by hand. To give some scale, '0' dB is a pressure of 20 micro Pascal, while 94dB is 1 Pascal and 140dB is 200 Pascal. Obviously, before computers, a scale from 20 mPa to 200 Pa (a ratio of 10,000,000:1) was difficult to read, but 0 to 140dB was simple to understand and display.*

Frequency Weighting: *Usually A or C & now Z. The ear responds to frequencies in a non-linear way; some tones being more easily perceived than others. Health, some drugs and pressure levels can also change the ear's frequency response. Because of this, filters are applied to sound levels and these modify the frequency response and the common 'A-frequency-weighting' is intended to approximate to the way your ears hear sounds. The symbol for the A weighted decibel is dB(A). It should be noted that A weighting does not show a 1 to 1 relationship to perceived loudness or even the full risk of damaging human hearing, but BY LAW, we must use it and in IEC 61672 it is mandated to be fitted to every sound level meter.*
***'C' weighting** is mainly used for lower frequency sounds usually in connection with True Peak (see below). It is 'level' from 31, 5Hz to 8kHz*
***'Z' or ZERO weighting** is introduced in IEC 61672 and is used instead of the old LIN or FLAT that varied from manufacturer to manufacturer. For a Class 1 instruments it is 'level' from 16Hz to 16kHz, in other words, f/2 and 2f times the 'C' limits..*
***'B' and 'D' weightings** have been 'retired'. 'B' was a 'half-way' house between 'A' and 'C' and 'D' was just for pure 'non-bypass' jet engines and these are only military today now Concorde has been axed.*

Time Weighting: *F, S and I. When sound level meters were first developed, 'dial and pointer' needles were used to display the level measured. These instruments had a response time depending somewhat on the inertia of the needle and were categorised initially as 'Fast' and 'Slow' responses. Subsequently 'Impulse' response was added, but in the 1960's, they were re-named 'F', 'S' and 'I' to be the same in every language. 'F' and 'S' are still used today, to get some idea of the speed of change of noise levels. 'I' time-weighting is not really used today and indeed the new standard IEC 61672 does not include it in the body of the standard, but many SLMs are still capable of reading data with this time-weighting, as it is still in German statute law.*

SPL: Sound Pressure Level. *This is the pressure after it has been "logged" into decibels. This is a rapidly changing figure that only tells us what the dB is now, and always has a time weighting applied. This does not give us much useful information. Formally, SPL is the 20 times the log of the root mean square of the pressure.*

Average Sound Level: *(common abbreviation Leq) When SPL is measured and recorded a graph may be produced, & Leq can be described as the area under the curves expressed as a average line. If noise levels are rapidly changing then Leq can be a useful tool and for this reason it is also called the "Equivalent Continuous Level". It is properly known as time-average sound level (symbol LAeq,T) but mainly only pedants use this terminology.*

Sound Exposure: *(symbol E). Formally, this is the time integral of the squared A-frequency-weighted sound pressure of a noise event and is expressed in pressure-squared-time, i.e. Pa^2s or Pa^2hr. Sound Exposure is in fact the most useful metric available, as being 'real' pressure based, two Exposure values can simply be added, unlike two decibel levels. It is not yet universally used as traditional acousticians, being brought up on decibels do not like change. To be fair, they also have some practical reasons as well as just 'tradition'. Sound Exposure being Pa^2 time is proportional to the energy of an event. Using decibels 2dB + 2dB = 5dB, using pressure in Pascal 2Pa + 2Pa = 4Pa.*

Sound Exposure Level: *(symbol LAE, abbreviation SEL). This is simply the sound exposure expressed as a logarithm. Effectively Leq is SEL divided by time. Again like SE, SEL is an amount of noise. Thus while Leq, the average level can go up and down, SEL can only go up, you cannot get 'less sound' once it has happened. The habit has grown up of calling SEL the 1 second equivalent Leq. This is a misunderstanding of reality, although these have the same numerical value. SEL is invaluable for measuring the noise of a single event and indeed some people even think SEL stands for 'Single Event Level'. SE, SEL, Leq and noise dose are all simply mathematically related and if time is known, they can all be calculated very simply. Indeed, most modern sound level meters only measure SE; they calculate everything else internally.*

Maximum Sound Level: *(symbol Lmax). This is quite simply the maximum time and frequency weighted sound level ie LASmax, the maximum level using A frequency-weighting and S time-weighting.*

Peak Sound Level: *(symbol Lpeak) This is not the same as Maximum Sound Level. Peak Sound Level records the peak of the original pressure wave, not the 'rectified' result. This is commonly associated with C or Z frequency weighting, but has no time weighting. If the noise being measured is impulsive such as a hammer being used, then the Peak level may easily be 20dB higher than the maximum sound level, this is due to the time weighting being applied to the max sound level. To give some scale. The time constant for 'I' (Impulse) response is 35millisec. The maximum permitted acquisition time of Peak is 100* microseconds. Clearly a very short pulse will read very differently on Peak and 'MAX I'.

Dose: *This is the permitted amount of noise that a person is exposed to and can be expressed in many ways. Maximum dose limits are set by governments to limit the exposure of workers to noise and there are many ways of describing this exposure. The reality is that all 'dose' systems – except in the USA - allow a maximum Sound Exposure each day or week, but few use simple Sound Exposure as their metric; lawyers and politicians are involved in regulations so it can't be simple. In Europe, the current normal maximum suggested exposure, is 85dB for 8 hours. 'Per cent' dose is a number laid down by politicians in a particular political region and is simply the ratio of the actual dose divided by the maximum permitted, multiplied by 100. This means 100% dose is NOT the same in all countries. "% dose" is easy to understand, but makes life difficult if the maximum exposure limit is changed, as all existing instruments have to be re-scaled or scrapped. To get round this problem, 'dosimeters' were re-named as 'Personal Sound Exposure Meters' (PSEM) and are described in IEC 61252.*

3 and 5 dB doubling *(Q = 3 or Q = 5) In almost every country, 'dose' is measured by the 'Equal Energy' rule and ALL the units referred to above assume this. In this rule, a doubling of the exposure is equivalent to halving the exposure TIME. The Equal Energy rule is automatically a '3dB doubling' rule. In the USA – and almost nowhere else - the dose relationship is that every time the level goes up by 5dB the time is halved. There has never been a mathematical reason for this and the original 1960's logic no longer applies. Today like 'I-time–weighting' in Germany "It's just the rules". There is no way whatever to convert between 3 and 5dB systems, so the PSEM you use MUST be specified for 3 or 5 dB. Pulsar 60 series can do 3, 4 and 5 dB doubling. The model 22 doseBadge is normally 3dB, but is available in 5dB models. The 5dB rules means that USA workers are far less protected than the rest of the world against Occupational Noise Exposure.*

EU Noise levels. *The European Directive exposure levels in force from 1989 are still current in 2004, but the EU Directive requires a change in February 2006 to a more stringent set of requirements as the table below.*

European Directive exposure levels

In use Years	1989 - 2005	2006 onward
Unit to use	LEP,d	LEX
Action level 1	85 dBA	80 dBA
Action level 2	90 dBA	85 dBA
Limit value	N/a	87 dBA
1st Peak action level	N/a	135 dBC
2nd Peak action level	N/a	137 dBC
Peak limit value	140 dBC	140 dBC

The change from LEP,d to LEX, is simply a change of name of the unit. The basis of the unit is still Leq normalised to an 8hr period. 'Normalised' means simply that the noise exposure is calculated based on a shorter period than the 8 hours in the regulations and scaled accordingly.

Real Time Analyser. *If the frequency has to be measured to select ear defenders, there are two common ways, REAL TIME and sequential time. A Real Time Analyser or RTA, measures each frequency band AT THE SAME TIME, whereas a sequential unit measures them one after another. If the noise is changing, clearly the RTA is likely to give more accurate data, especially if the band readings are in Leq. The Pulsar models 30 and 33 are both RTA and while more expensive than their sequential time equivalents such as models 73 and 74, may give worthwhile accuracy improvements. However, some user think that the lower cost, manually operated 73 and 74 are simpler to use than the computerised 30 and 33.*