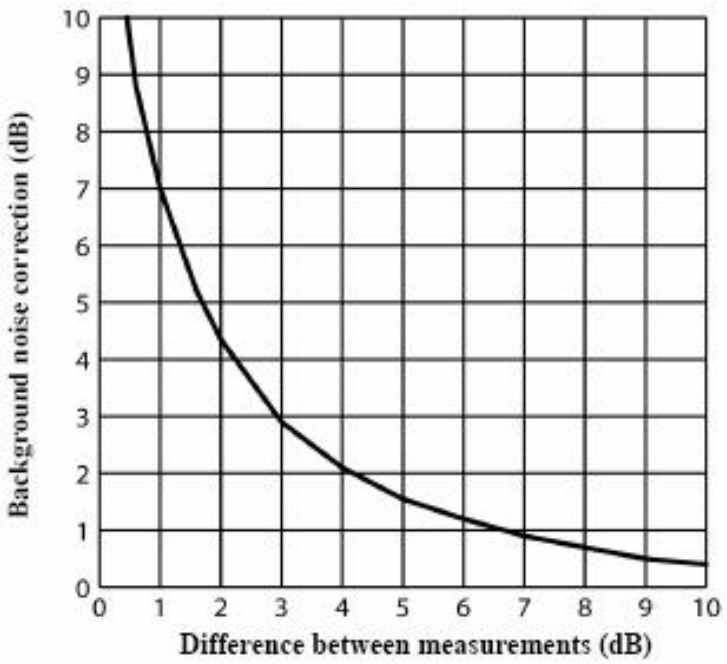
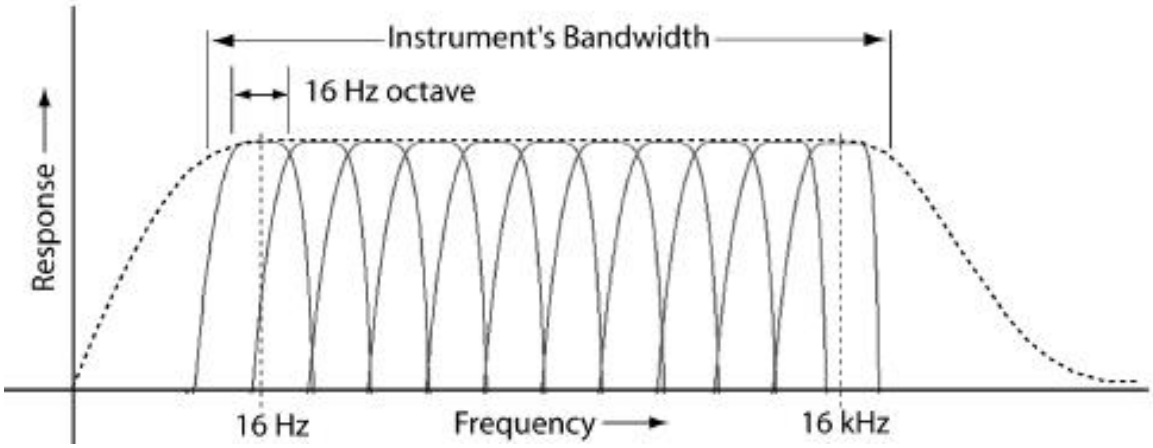
SOUND LEVEL METERS

1. AC/DC Output – Outputs the AC or DC signal to a data acquisition system or chart recorder.
2. Attenuation – Attenuation is a decrease in signal magnitude from one point to another, or the process causing this decrease. .
3. Background noise - Background noise can cause considerable error in measurement when its level is high relative to the level of a noise source of interest. If you can make measurements both with and without the contribution of a noise source of interest, you can mathematically subtract the background noise from the combined measurement, yielding the level of the noise source of interest alone. The accuracy of this determination improves as the difference between the two measurements increases.



4. Bandwidth - A range of frequencies defined by an upper band-edge frequency, f2, and a lower band-edge frequency, f1. The bandwidth is the difference between the two frequencies (f2 – f1 Hz).
5. Broadband – Broadband measurements from a sound level meter refer to measurements made over the applicable frequency range of the instrument.
6. C-A – The C-A measurement is an SPL average that enhances the low-frequency components of the sound signal. The measurement is used to evaluate hearing protection and other noise reduction devices.
7. Center Frequency - The center frequency of each octave and third octave filter band. In the diagram below, 16 Hz is the center frequency of the 16 Hz octave.



8. CNEL – Community Noise Exposure Level – The CNEL is a 24-hour average sound level, which adds 5dB to noise measured between 7 p.m. and 10 p.m., and adds 10dB to noise measured between 10 p.m. and 7 a.m.
9. Criterion Level (CL) - Criterion level is the average SPL that will result in a 100% dose over the Criterion time, usually 8 hours.
10. Criterion Time (CT) - The time over which the Criterion Level is established, generally 8 hours.
11. Decibel (dB) - Sound Level Meters use the decibel as the unit of measure known as Sound Pressure Level (SPL). SPL uses the ratio between a reference level of 20 microPascals (.00002 Pascals) and the level being measured. SPL = 20 log (measured level/reference level). Example: the SPL for 1 Pascal is 20 log (1 Pascal/.00002 Pascal) = 94dB 20 microPascals (.00002 Pascals) is considered the average threshold of hearing. A whisper is about 20 dB. A normal conversation is typically from 60 to 70 dB, and a noisy factory from 90 to 100 dB. Loud thunder is approximately 110 dB, and 120 dB borders on the threshold of pain.
12. Difference between Noise Dosimeter and Sound Level Meter – Typically, a noise dosimeter is a small instrument, which is clipped to an employee to measure noise that the worker is exposed to while working on the job, and measurements like TWA and Dose are calculated. A Sound Level Meter is a hand-held instrument typically used for measurements such as community and environmental noise assessment, maintenance inspections and troubleshooting, and noise ordinance enforcement. Of course, some noise dosimeters can be used as a sound level meter and vice versa.
13. Dose - Related to the Criterion Level, a dose reading of 100% is the maximum allowable exposure to accumulated noise. For OSHA, 100% dose occurs for an average sound level of 90 dB over an 8-hour period (or any equivalent exposure). By using a TWA reading rather than the average sound level, the time period is no longer explicitly needed. A TWA of 90 dB is the equivalent of 100% dose. The dose will double (halve) every time the TWA increases (decreases) by the Exchange Rate. Example: OSHA uses an Exchange Rate of 5 dB. Suppose the TWA is 100 dB. The dose would double for each 5 dB increase over the Criterion Level of 90 dB. The resulting dose is therefore 400%. If the TWA was instead equal to 80 dB then the dose would halve for each 5 dB below the Criterion Level. The resulting dose would be 25%. When taking noise samples less that the full workday, dose is an easy number to work with because it is linear with respect to time. Example: If a 0.5-hour sample results in 9% dose and the workday is 7.5 hours long, then the dose for the full workday would be a 135% dose (7.5 / 0.5 x 9%). This is computed making the assumption that the sampled noise will continue at the same levels for the full 7.5-hour workday.
14. Dynamic Range - Sometimes called Linear Range. This is the range of input amplitudes on any given range setting over which the instrument can produce a

meaningful response. The bottom of the dynamic range is the instrument's Noise Floor for that range setting, and the top of the dynamic range is the maximum input signal that will not overload the instrument on that range setting.

15. Exceedance Level (Ln) - Exceedance levels represent the percent of the run time that was spent at or above the corresponding dB level. Example: An L40 equal to 73dB would mean that for 40% of the run time, the decibel level was equal to or higher than 73dB.
16. Exchange Rate (ER, also known as the Doubling Rate) – Exchange rate refers to how the sound energy is averaged over time. Using the decibel scale, every time the sound energy doubles, the measured level increases by 3dB. This is the 3dB exchange rate that most of the world uses. For every increase of 3dB in the time weighted average, the measured DOSE would double. Some organizations such as OSHA in the U.S. have argued that the human ear self compensates for changing noise levels and they felt that the 3dB exchange rate should be changed to more closely match the response of the human ear. OSHA currently uses a 5dB exchange rate, which would mean that the reported DOSE would double with every 5dB increase in the time weighted average. The exchange rate affects the integrated reading LAVG, DOSE, and TWA but does not affect the instantaneous sound level.
17. ExpHrs - Hours of sound exposure. Accumulated exposure to sound measured in hours using an Exchange Rate of 3 dB. The display will switch to ExpSec if RTIME is less than one hour.

$$EXP_{Hrs} = [2^{(L_{eq}-94)/3.01}] \frac{\text{RTIME}}{3600} \text{ Pa}^2\text{H}$$

18. ExpSec - Seconds of sound exposure. Accumulated exposure to sound measured in seconds using an Exchange Rate of 3 dB. The display will switch to ExpHrs if RTIME is greater than 3600 seconds.

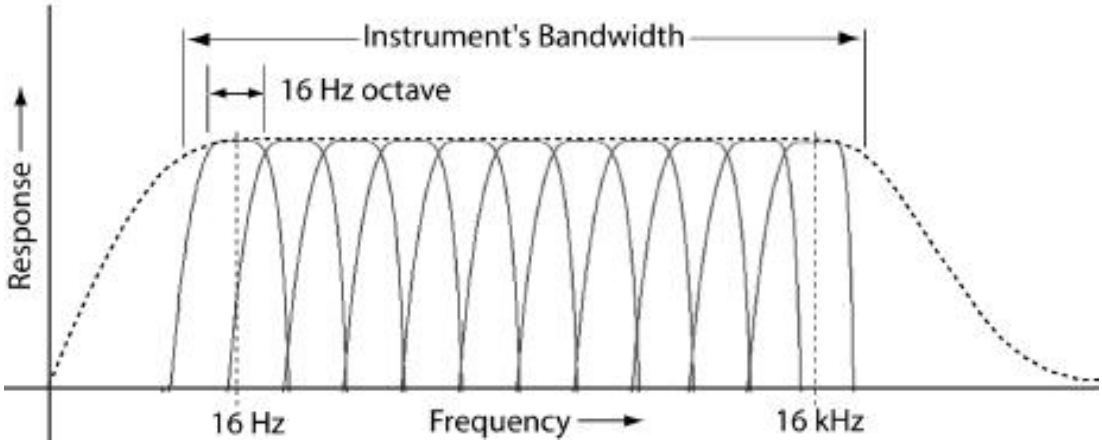
$$EXP_{Sec} = [2^{(L_{eq}-94)/3.01}] \text{ RTIME Pa}^2\text{S}$$

19. Filter – A sound level meter equipped with a filter allows measurements of sound at specific octaves or third octaves (depending on the type of filter). Without a filter, the sound level meter makes broadband measurements.
20. Integrating Threshold (sometimes called "cutoff") – The threshold affects the Lavg, TWA, and Dose measurements. All sound below the threshold is considered nonexistent noise for the averaging and integrating functions. The threshold does not affect measurements in the sound level mode. OSHA uses two different thresholds. The original Occupational Noise Exposure Standard (1971) used a 90dB threshold and called for engineering controls to reduce the noise levels if the eight-hour TWA was greater than 90dB. The Hearing Conservation Amendment (1983) uses an 80dB threshold and calls for a hearing conservation program to be put in place if the eight-hour TWA exceeds 85dB (50% dose). The Hearing Conservation Amendment is the more stringent of the two rulings and is what most US industrial users are concerned with. Example: With an 80dB threshold, suppose you placed a 79dB calibrator on the unit for a period of time. Because all of the noise is below the threshold, there would be no average (you can think of it as an average of 0dB). If the calibrator were 80dB instead, then the average would be 80dB. On histogram printouts, typically 1 minute (or other specified increment) averages are printed. Because real noise fluctuates, it is quite possible to have an average level below the threshold. This also applies for the overall Lavg.
21. Lavg, L_{AV} - Lavg is the average sound level measured over the run time. This becomes a bit confusing when thresholds are used. Any sound below the threshold is not included in this average. Remember that sound is measured in the logarithmic scale of decibels therefore the average cannot be computed by simply adding the levels and dividing by the number of samples. When averaging decibels, short durations of high levels can significantly contribute to the average level. Example: Assume the threshold is

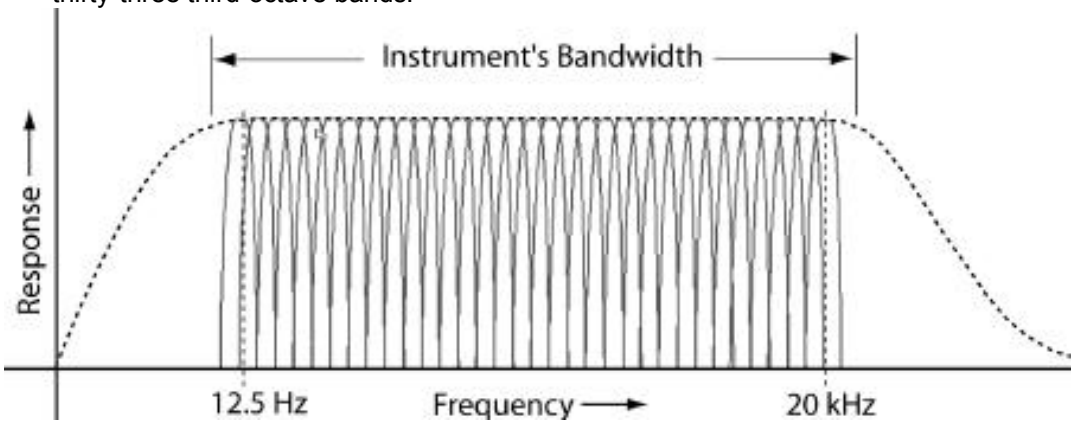
set to 80 dB and the Exchange Rate is 5 dB (the settings of OSHA's Hearing Conservation Amendment). Consider taking a one-hour noise measurement in an office where the A-weighted sound level was typically between 50 dB and 70 dB. If the sound level never exceeded the 80 dB threshold during the one hour period, then the Lavg would not indicate any reading at all. If 80 dB was exceeded for only a few seconds due to a telephone ringing near the instrument, then only those seconds will contribute to the Lavg resulting in a level perhaps around 40 dB (notably lower than the actual levels in the environment).

22. LDN (Level Day Night) – Representing the Day/Night sound level, this measurement is a 24-hour average sound level where 10 dB is added to all of the readings that occur between 10pm and 7am. This is primarily used in community noise regulations where there is a 10 dB "penalty" for nighttime noise. Typically LDN's are measured using A weighting, a 3 dB Exchange Rate, and no Threshold.
23. LEP,d - Daily personal noise exposure level.
24. Leq, L_{EQ} (Equivalent Level) – The true equivalent sound level measured over the run time. The term LEQ is functionally the same as LAVG except that it is only used when the Exchange Rate is set to 3 dB and the threshold is set to none.
25. Level (L_{FT})* - Notation used to represent sound pressure level measurements in IEC/ISO notation, where the measurements are made with particular frequency (F) and time (T) response parameters. For an actual measurement, the F and T parameters are replaced by standardized notation for those parameters.
26. Lex - **dBA** Lex means the level of an employee's total exposure to noise over the entire workday and adjusted to an equivalent eight-hour exposure. For example, an employee who works in an average of 85 dBA of noise for 16 hours has an Lex of 88 dBA; and for 4 hours, an Lex of 82 dBA. This is primarily used in Canada.
27. Lex in Pa2h and % Dose - L_{EX} is the noise exposure dose and it can be expressed in percent dose or in Pa2h. It is equal to the mean square sound pressure, in Pa2h corresponding to the L_{EX} value multiplied by 8 hours, which yields $L_{EX,8H}$. Time is measured in hours and the sound pressure amplitude is measured in Pascals (same unit used for barometric air pressure). With noise dose as a single descriptor it is can be noted that a noise dose of 1.6 Pa2h is equal to 87 dBA for 8 hours since 1 Pa2h is equal to 85 dBA for 8 hours. There might be some slight rounding of fractions of a decibel in this but essentially this is the relationship. So a person with a pure average of 87 dBA for 8 hours would have a noise dose of 100% and an $L_{EX,8H}$ of 1.6 Pa2h. Without the time factor, such as in the case of specific peak measurements, you can note that 200 Pascals = 140 dB, 140 Pascals = 137 dB, and 112 Pascals = 135 dB and these are the three levels specified in the new noise regulations for the EC.
28. Linear Range – see Dynamic Range.
29. L_{Mn}, Lmin (Minimum Level) * - The lowest sampled sound level during the instrument's run time allowing for the unit's Response Time setting (Fast or Slow).
30. L_{Mx}, Lmax (Maximum Level) * - The highest sampled sound level during the instrument's run time allowing for the unit's Response Time setting (Fast or Slow).
31. Ln, LnX (Exceedance Level) * - Exceedance levels represent the percent of the run time that was spent at or above the corresponding dB level. Example: An L40 equal to 73dB would mean that for 40% of the run time, the decibel level was equal to or higher than 73dB.
32. Logging (also called Data Logging) - Certain measurements, such as average level (Lavg) and maximum level (Lmax), can be recorded by the meter at regular intervals. For example: A sound level meter is set to log Lavg and Lmax at one minute logging intervals. If the SLM runs for one hour, then it would log 60 Lavg results and 60 max levels. You would be able to see the average and maximum levels for each minute of the one hour run time.

33. Lpk, L_{Pk} (Peak Level) - Peak is the highest instantaneous sound level that the microphone detects. Unlike the Max Level, the peak is detected independently of the unit's Response Time setting (Fast or Slow). Example: The peak circuitry is very sensitive. Test this by simply blowing across the microphone. You will notice that the peak reading may be 120 dB or greater. When taking a long-term noise sample (such as a typical 8-hour workday sample for OSHA compliance), the peak level is often very high. Because brushing the microphone over a shirt collar or accidentally bumping it can cause such a high reading, the user must be careful of placing too much emphasis on the reading.
34. Maximum Level (Max, Lmax) – See **L_{Mx}** above.
35. Measurement Range - The decibel range within which the unit's measurements are valid. On many Sound Level Meters the measurement range is user selectable.
36. Microphone polarization - Microphones require an electrical charge (polarization) to operate. Some microphones carry their own charge (have an internal polarization), while others require a charge (polarization) provided by the sound level meter.
    a. Condenser microphones – These require 200V polarization to be provided by the meter.
    b. Prepolarized (electret) microphones – These microphones do not require the 200V polarization provided by the meter.
37. Microphone Sensitivity (differences between mics) – Different types of microphones may respond slightly different from one another. Check your instrument's user's manual before using a microphone that was not supplied with the meter. If a microphone with different sensitivity is used on a meter, internal meter settings may need to be changed and the meter should be calibrated with the new microphone.
38. Microphone Types - SLM's may be used with different types of microphones: free field or pressure. The type of microphone determines the angle at which the SLM should be held. This angle only really matters at higher frequency noises. Refer to the user's instruction manual for information on the type of microphone used on the meter.
    a. Free Field – When using this type of microphone, point the sound level meter directly at the sound source (0 degrees).
    b. Pressure – When using this type of microphone, point the sound level meter approximately 90 degrees to the direction of the sound.
    c. Random Incidence – When using this type of microphone, point the sound level meter approximately 70 degrees to the direction of the sound.
39. Minimum Level (Min, Lmin) – See **L_{Mn}** above.
40. Noise - Noise is any unwanted sound.
41. Noise Floor - The signal magnitude at the bottom of the instrument's linear range. Input signals below the noise floor cannot be differentiated from the internal noise of the instrument.
42. Octave Band(s) * - An Octave band is defined as a frequency band whose upper band-edge frequency is twice the lower band frequency.
    a. 1/1 octave (whole octave) - In sound pressure measurement, the audio spectrum is divided into adjacent frequency bands called octaves, where the center frequency of each octave band is twice the center frequency of the octave band directly below it. There are eleven octave bands in the audio spectrum, as pictured in the following diagram.



b. 1/3 octave (third octave) - Each octave band can be divided into three adjacent bands called third-octave bands. The following diagram shows the thirty-three third-octave bands.



43. Overload (OL) – An overload will occur whenever the input signal exceeds the dynamic range of the instrument.

44. OLtime, %OL, OL% - These are SLM measurements. OLtime is the period of time during which the input signal is above the linear measurement range of the instrument. OL% is the fraction of run time during which an overload condition exists.

45. Pascal (Pa) - Unit of pressure equal to 1 Newton per square meter.

46. Pa^2Hr – Pascal squared hours - A measure of the noise exposure of a person. It is an alternative means of stating how much noise to which a person has been exposed. A noise exposure level of 85 dBA is the same as 1 Pa2hr.

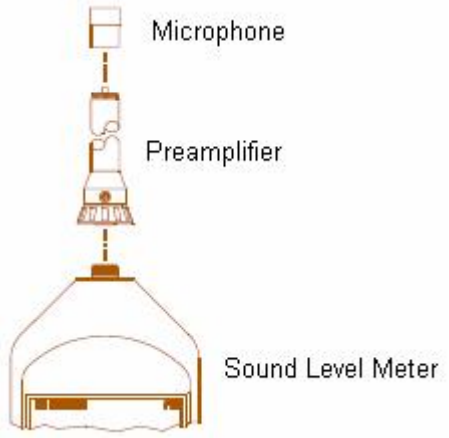
47. Pdose - Projected dose is a SLM measurement. It is the calculated dose for a projected amount of time, based on actual dose measurement from the actual run time. Example: If a 0.5 hour sample results in 9% dose and the workday is 7.5 hours long, then the dose for the full workday would be computed as (7.5 hours / 0.5 hours) * 9% = 135% dose. This is computed making the assumption that the sampled noise will continue at the same levels for the full 7.5-hour workday.

48. Peak (Lpk, L_{Pk}) - Peak is the highest instantaneous sound level that the microphone detects. Unlike the Max Level, the peak is detected independently of the unit's Response Time setting (Fast or Slow). Example: The peak circuitry is very sensitive. Test this by simply blowing across the microphone. You will notice that the peak reading may be 120 dB or greater. When taking a long-term noise sample (such as a typical 8-hour workday sample for OSHA compliance), the peak level is often very high. Because brushing the

microphone over a shirt collar or accidentally bumping it can cause such a high reading, the user must be careful of placing too much emphasis on the reading.

49. Polarization, prepolarized - Microphones require an electrical charge (polarization) to operate. Some microphones carry their own charge (prepolarized), while others require a charge (polarization) provided by the sound level meter.

50. Preamplifier (Preamp) - On some sound level meters a preamplifier is used to connect the microphone to the unit.

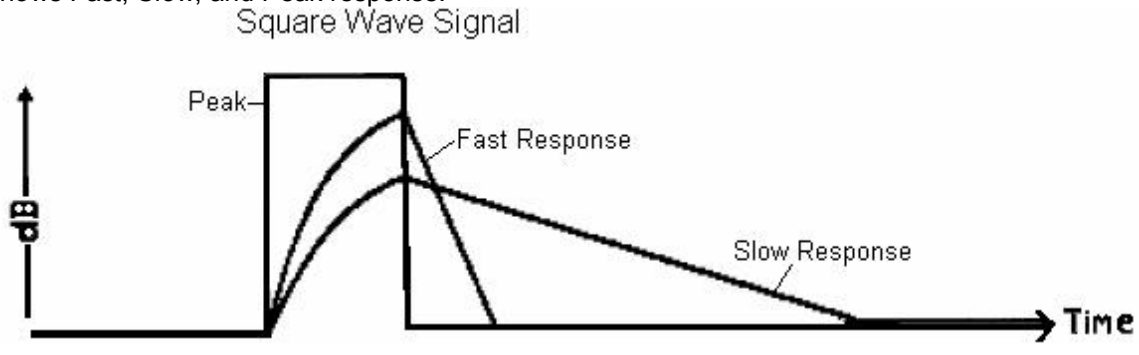


51. Prt - Projected Time – This is a variable amount of time used to calculate projected measurements (PTWA, Pdose) from actual measurements.

52. PTWA - Projected TWA - Projected TWA is a SLM measurement. It is the calculated TWA for a projected amount of time, based on actual noise measurement from the actual run time.

53. Reference pressure (also Reference Sound Pressure) - The sound pressure at the threshold of human hearing, as measured under standard conditions. The generally accepted magnitude of this pressure is 2×10^{-5} Pascals (Pa).

54. Response Times/Tone Burst Response - The response time setting determines how quickly the unit responds to fluctuating noise. Typically, noise is not constant. If you were to try to read the sound level without a response time, the readings would fluctuate so much that determining the actual level would be extremely difficult. Using a response of slow or fast simply smoothes the noise fluctuation and makes the sound level easier to work with. While the terms slow and fast have very specific meanings (time constraints), they work very much as you would expect. The fast response would result in a more fluctuating sound level reading than would the slow response. The following diagram shows Fast, Slow, and Peak response.



55. SEL – Sound Exposure Level * - The sound exposure level averages the sampled sound over a one second period. Assuming the sampled run time to be greater than one

second, SEL is the equivalent one-second noise that would be equal in energy to the noise that was sampled. SEL is typically measured using a 3dB exchange rate without a threshold. SEL is not used by OSHA. Example: Suppose you wanted to measure in a location next to railroad tracks, which also happened to be in the takeoff path of an airport. A train passes by taking 10 minutes with an average sound level of 82dB. A jet passes overhead taking 45 seconds with an average level of 96dB. Which of these events results in more sound energy? You can answer the question by comparing their SEL readings, which compress each event into an equivalent one-second occurrence. SEL for the train = 109.7dB, SEL for the jet = 112.5dB.

56. SLM – Sound Level Meter

57. SPL - Sound Pressure Level

58. Taktm, Taktmx, TAKMx – Taktmaximal - An exposure measurement that is used commonly when monitoring with respect to regulations in Germany, this is a time average over a sampling interval that uses the highest level occurring during the preceding Taktmaximal Interval, either three or five seconds, and assumes that it was present for the whole Taktmaximal Interval.

59. Threshold (sometimes called "cutoff")* – The threshold affects the Lavg, TWA, and Dose measurements. All sound below the threshold is considered nonexistent noise for the averaging and integrating functions. The threshold does not affect measurements in the sound level mode. OSHA uses two different thresholds. The original Occupational Noise Exposure Standard (1971) used a 90dB threshold and called for engineering controls to reduce the noise levels if the eight-hour TWA was greater than 90dB. The Hearing Conservation Amendment (1983) uses an 80dB threshold and calls for a hearing conservation program to be put in place if the eight-hour TWA exceeds 85dB (50% dose). The Hearing Conservation Amendment is the more stringent of the two rulings and is what most US industrial users are concerned with. Example: With an 80dB threshold, suppose you placed a 79dB calibrator on the unit for a period of time. Because all of the noise is below the threshold, there would be no average (you can think of it as an average of 0dB). If the calibrator were 80dB instead, then the average would be 80dB. On histogram printouts, typically 1 minute (or other specified increment) averages are printed. Because real noise fluctuates, it is quite possible to have an average level below the threshold. This also applies for the overall Lavg.

60. TWA – Time Weighted Average – The time weighted average always averages the sampled sound over an 8-hour period. TWA starts at zero and grows. The TWA is less than the Lavg for a duration of less than eight hours, exactly equal to the Lavg at eight hours, and grows higher than Lavg after eight hours. TWA represents a constant sound level lasting eight hours that would result in the equivalent sound energy as the noise that was sampled. Example: Think of TWA as having a large 8-hour container that stores sound energy. If you run a dosimeter for 2 hours, your Lavg is the average level for those 2 hours - consider this a smaller 2-hour container filled with sound energy. For TWA, take the smaller 2-hour container and pour that energy into the larger 8 hour TWA container. The TWA level will be lower. Again, TWA is ALWAYS based on the 8-hour container. When measuring using OSHA's guidelines, TWA is the proper number to report provided that the full work shift was measured. Example: If the work shift is 6.5 hours long, then measure for the entire 6.5 hours. TWA is the correct level to report to OSHA. It does not have to be modified.

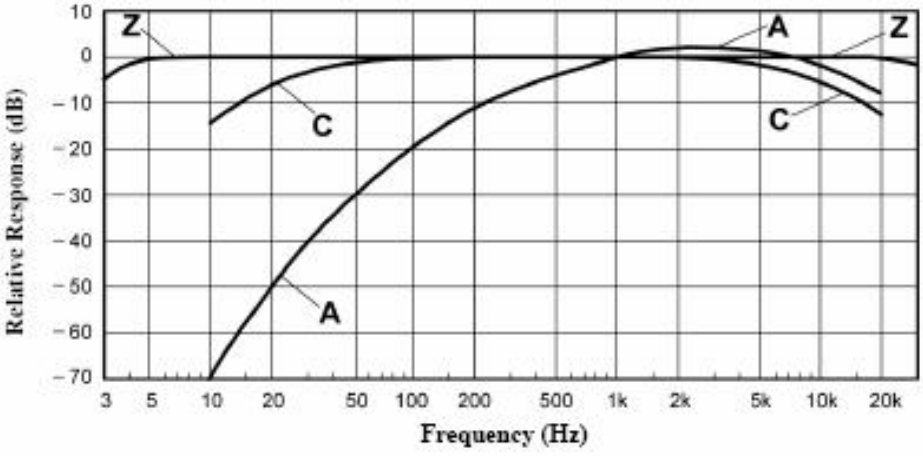
61. Type 1, Type 2 – Also called Class 1 and Class 2. This is an accuracy specification. There is an entire ANSI standard written around the difference between Type 1 and 2. The accuracy of the measurements varies depending on the frequency of the sound being measured. Basically Type 1 means approximately ± 1dB accuracy and Type 2 means approximately ± 2dB accuracy. But again, this varies depending upon the frequency of the sound.

62. Under Range – URTime or UR% - Under Range is when the input signal falls below the measurement range of the instrument. URTime is the period of time during

which the input signal falls below the measurement range of the instrument. UR% is the fraction of the run time during which an under range condition exists.

63. UL - Upper Limit – This is a feature available on many of the Quest meters. The user can select a certain decibel level. The dosimeter will then record the amount of time that the sound level was at or greater than the preset level. This time is then recorded as "UL TIME". The Upper Limit is a measurement parameter. Setting it does not affect the operating range of the instrument.

64. Weighting (A, C, Z, etc.) – "A", "B", "C", "Z" and LINEAR are the standard weighting networks available. These are frequency filters that cover the frequency range of human hearing (20Hz to 20 kHz). "A" weighting is the most commonly used filter in both industrial noise applications (OSHA) and community noise regulations. "A" weighted measurements are often reported as dBA. The "A" weighted filter attempts to make the dosimeter respond closer to the way the human ear hears. It attenuates the frequencies below several hundred hertz as well as the high frequencies above six thousand hertz. "B" weighting is similar to "A" weighting but with less attenuation. The "B" weighting is very seldom, if ever, used. The "C" weighting provides a fairly flat frequency response with only slight attenuation of the very high and very low frequencies. "C" weighting is intended to represent how the ear perceives sound at high decibel levels and is often used as a "flat" response when LINEAR is not available. "C" weighted measurements are often reported as dBC. "Z" is zero weighting, with no weighting across the frequency range of human hearing. LINEAR is thought of as having a flat frequency response curve over the entire measurement frequency range. LINEAR is most commonly found on upper model sound level meters and is typically used when performing octave band filter analysis.



65. Windscreen – A covering for the microphone that reduces disturbances caused by wind and direct contact with other surfaces. The windscreen is placed over the microphone when taking measurements to help prevent false high readings due to wind blowing across the microphone or objects brushing against the microphone. The windscreen will also help protect the microphone from dust and debris.