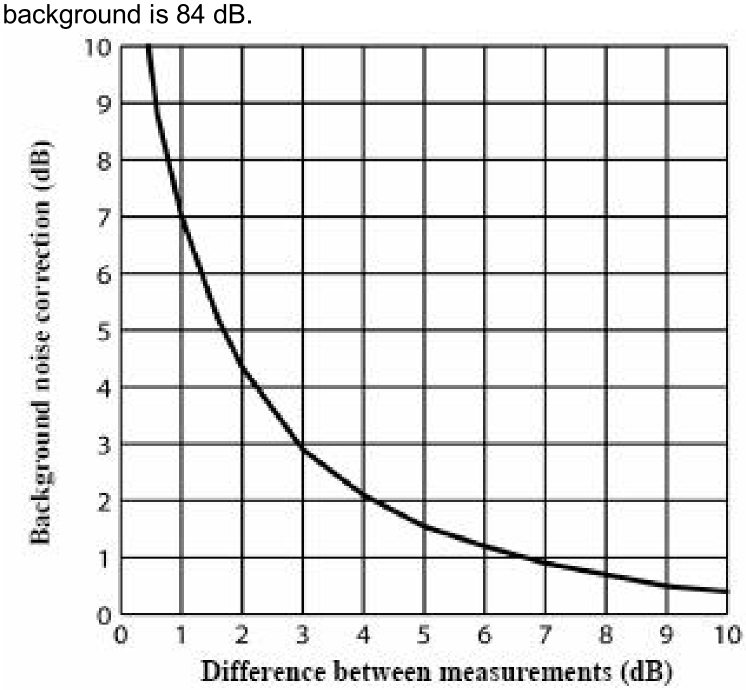
DOSIMETER TERMS

1. Background Noise, effects of – 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.

To remove background noise

1. Obtain a measurement that includes the contribution of the noise source of interest (the combined measurement).
2. Make a second measurement under exactly the same conditions as in Step 1 but without the presence of the noise source of interest (the background noise measurement).
3. Determine the decibel difference between these two measurements.
4. Find that difference on the x-axis of the figure below.
5. Find the point on the curve directly above this difference.
6. Read the corresponding value on the y-axis for that point (the correction value).
7. Subtract the correction value from the combined measurement.

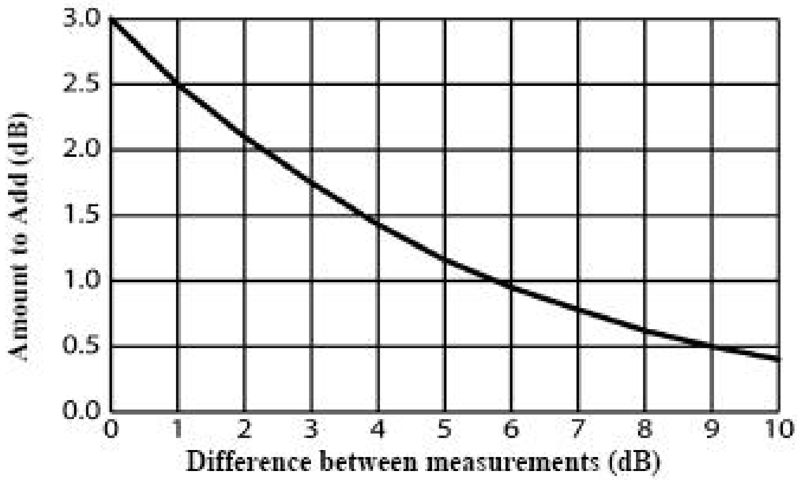
Example: Measurements with and without the noise source of interest are 91 dB and 90 dB, respectively. For a difference of 1 dB, the background noise correction value is 7 dB. Therefore the level for the noise source of interest without the noisy background is 84 dB.



2. Boom-mounted vs. Cable-mounted microphone – when used for dosimetry the microphone is typically clipped to a shirt at the shoulder or collar. When used as an SLM the microphone is still attached to the cable, but it is also typically mounted to a metal rod, or boom.

3. Class 1/Class 2 microphones – See "Type 1/Type 2 microphones" below

4. Combining Noise sources* – Because sound levels are measured in decibels they cannot be simply added together. A sound level of 90dB plus 90dB does not yield 180dB but rather 93dB. The procedure for mathematically determining a combined level of sound from independent measurements made for two noise sources is given below.
1. Make independent measurements for both noise sources, where each exists without the presence of the other.
2. Determine the decibel difference between these two measurements.
3. Find that difference on the x-axis of the figure below.
4. Find the point on the curve directly above this difference.
5. Read the corresponding value on the y-axis for that point (the Amount to Add).
6. Add this value to the larger of the two measurements.
Example: Independent measurements for the two noise sources yielded levels of 90 dB and 91 dB. For a difference of 1 dB, the correction factor taken from the curve below is 2.5 dB. Therefore the combined level when these two sound sources are present in the measurement area at the same time 93.5 dB.



5. Crest Factor - Crest Factor is the ratio of the instantaneous peak value of a wave to its RMS value. This is a performance specification of a meter's ability to process signals that have peaks that are substantially higher than their RMS averages.
6. Criterion Level (CL) – Criterion level is the average SPL that will result in a 100% dose over the Criterion time, usually 8 hours. The Criterion Level is typically set by a regulating agency, such as OSHA, and is not usually applicable for community noise monitoring. **Examples**: OSHA mandates the Criterion Level (maximum allowable accumulated noise exposure) to be 90 dB for 8 hours. For an 8-hour sample, an average level (LAVG) of 90 dB will result in 100% dose. For the OSHA HEARING CONSERVATION AMENDMENT, the "action level" is 85 dB for 8 hours. This would result in a 50% dose reading. Note that the Criterion Level has not changed. (If the Criterion Level were changed to 85 dB then an 8-hour average of 85 dB would result in 100% dose.)
7. Criterion Time – The time over which the Criterion Level is established, generally 8 hours.
8. 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.

9. **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.
10. **Exceedence Levels** – 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.
11. **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.
12. **Field Calibration (vs. Factory Calibration), pre-calibration, post-calibration** – To be sure the dosimeter is functioning within specified tolerance limits, it should be returned to the factory annually for a factory recalibration. To verify that the dosimeter is measuring properly during normal use, field calibrations should be performed. Pre-calibration is performed prior to any data being recorded by the dosimeter. During a pre-calibration, the dosimeter level may be adjusted to match the calibrator output level. Post-calibration is a simple verification that the instrument has remained in calibration throughout the measurement period.
13. **Free field setting (microphone)** – Measurements made in an area without sound reflections, diffractions and absorptions caused by nearby objects (including the operator). Sound waves are free to spread out continuously, like ripples on a pond, without reflection. When making free field measurements with a dosimeter set up for use as a sound level meter, the microphone is typically pointed directly at the sound source.
14. **Hearing Conservation (HC)*** – The Occupational Safety and Health Administration (OSHA) and Mine Safety and Health Administration (MSHA) provide regulatory standards for hearing conservation programs. In addition, the American Conference of Governmental Industrial Hygienists (ACGIH) provides industrial standards for hearing conservation programs. **http://www.osha.gov/** , **http://www.msha.gov/** , **http://www.acgih.org/home.htm**
15. **Hertz (Hz)** – Unit of vibration frequency in cycles per second.

16. **Lavg (Average Level) –** 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).
17. **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.
18. **Lep,d–** Daily personal noise exposure level.
19. **Leq (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.
20. **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.
21. **Logging –** Also called Data Logging. Certain measurements, such as average level (Lavg) and maximum level (max), can be recorded by the dosimeter at regular intervals. For example: A dosimeter is set to log Lavg and max at one minute logging intervals. If the dosimeter 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.
22. **Maximum Level (Lmax)–** The highest sampled sound level during the instrument's run time allowing for the unit's Response Time setting (Fast or Slow).
23. **Measurement Range -** The decibel range within which the unit's measurements are valid.
24. **Minimum Level (Lmin) –** The lowest sampled sound level during the instrument's run time allowing for the unit's Response Time setting (Fast or Slow).
25. **Noise Floor–** In a "Perfectly Quiet" room, the electrical noise produced by the microphone is approximately 35 dB on A-weighting and 45 dB on C-weighting. These levels are known as the Noise Floor of the instrument. The Noise Floor can cause inaccurate measurements at low measurement levels. Measurements must always be at least 5 dB above the Noise Floor to be valid. Therefore, the lowest valid measurements of the dosimeter are approximately 40 dB on A-Weighting and 50 dB on C-Weighting.
26. **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.

27. PEL (Permissible Exposure Level) – The A-weighted sound level at which exposure for a Criterion Time, typically eight hours, accumulates a 100% noise dose.

28. Projected Time*– The variable amount of time used to make a projected dose calculation from an actual dose measurement.

29. Random incidence (microphone) – This only applies to Class/Type 1 microphones. Measurements made in an area where sound waves are coming from all directions, including reflections and diffractions. When the dosimeter is being used as a sound level meter in an area where reflections and diffractions from nearby objects are present, use the Random Incidence Corrector with the microphone, and angle the microphone at approximately 70 degrees. Most personal noise dosimetry applications do not require the random incidence corrector, since they are not measured with a Class/Type 1 microphone.

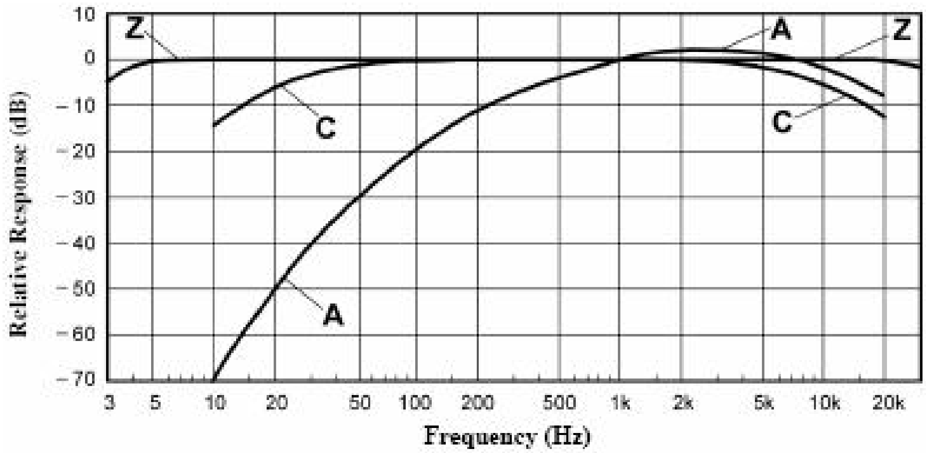
30. Response Time – The response determines how quickly the unit responds to fluctuating noise. Fast has a time constant of 125 milliseconds. Slow has a time constant of 1 second. Example: Typically, noise is not constant. If you were to try to read the sound level without a response time, the readings 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 OSHA regulations require the slow response.

31. RMS (Root Mean Square) - The RMS voltage of a signal is computed by squaring the instantaneous voltage, integrating over the desired time, and taking the square root. Simply put, the RMS values are the results from the dosimeter with the response time and weighting settings taken into account.

32. 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.

33. 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.

34. 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.
35. 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.
36. 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.



37. Windscreen – A windscreen is 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 (hair, clothing, etc.) brushing against the microphone. The windscreen will also help protect the microphone from dust and debris.