LARSON DAVIS
A PCB DIVISION

ENVIRONMENTAL NOISE MONITORING

TOP 10 THINGS YOU NEED TO KNOW FOR YOUR MEASUREMENTS

1. FAST VS SLOW TIME WEIGHTINGS

The time weighting selected determines the response speed of the sound level meter when reacting to changes in noise level. This dates back to the days of analog sound level meters, which had a needle moving back and forth to give a reading. The needle would be in constant motion as sound pressure levels quickly changed. Early sound level meters damped the movement of the needle to make the meter easier to read. Different meters could display different results depending on the properties of the needle. Eventually, the standards of slow, fast, and impulse time weightings were developed to help standardize readings.

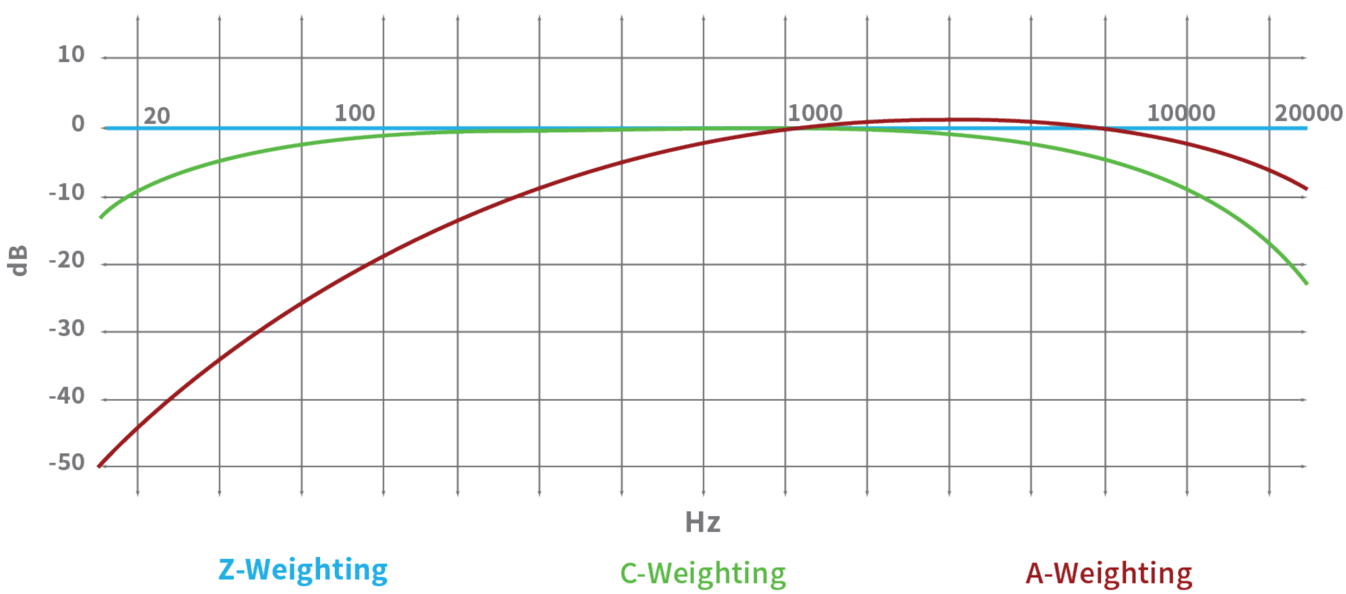
Although the current IEC 61672-1 standard includes Fast and Slow time weightings, modern digital meters include the three described here so modern measurements can be compared with tests done in the days of analog meters

- **Fast:** Perhaps the most commonly used weighting for noise measurements, Fast reacts quickly to level changes, using a 125 ms time constant.
- **Slow:** Often still used for environmental noise studies, the 1 s time constant provides data that is a more "smoothed out" indication of average noise levels.
- **Impulse:** A remnant from the superseded IEC 651 standard, designed for measurement of sounds with fast rise and decay including pile driving, explosions, or gunshots. Impulsive Weightings are still included in meters, and have an extremely fast 35 ms rise slope, but decay very slowly (1.5 s) to better analyze the high level moments of short duration events.

2. FREQUENCY WEIGHTINGS

Frequency weightings are common, special frequency filters that adjusts the amplitude of all parts of the frequency spectrum of the sound or vibration

- **A-Weighting:** A weighting filter that most closely matches how humans perceive sound, especially low to moderate levels. This weighting is most often used for evaluation of environmental sounds. Notated by the "A" in measurement parameters including dBA, L_{Aeq}, L_{AF}, L_{AS}, etc.
- **C-Weighting:** Commonly used filter that adjusts the levels of a frequency spectrum in the same way the human ear does when exposed to high or impulsive levels of sound. This weighting is most often used for evaluation of equipment sounds.
- **Flat or Linear Weighting:** No longer used in current standards. Flat weighting indicated that no filter was applied, across a stated frequency range. Since 2003, IEC 61672 standard notes use of Z-weighting.
- **Z-Weighting:** "Zero" or no frequency weighting applied: in actuality, a passband filter from 10 Hz to 20 kHz. Often shown as dBZ, L_{Zeq}, L_{ZS}, etc.



3. L_{MAX} VS L_{PEAK}

- L_{max} is the root mean squared (RMS) maximum level of a noise, or the highest value measured by the meter over a given period of time. This value is based on the time weighted sound level in dB. The time constant used can be fast or slow. Often, this parameter will be described along with information about the weightings used (for example, L_{AFmax} indicates the maximum level measured with fast detector and A-weighting). This is NOT the same as L_{peak} (see below).
- L_{min} is the root mean squared (RMS) minimum level of a noise, or the lowest value measured by the meter over a given period of time. Just like for L_{max}, the value is based on the time weighted sound level in dB. The time constant used can be fast or slow.
- L_{peak} is not the same as L_{max}! L_{peak} is the maximum instantaneous sound pressure level during the measurement period – or the maximum sound pressure level with no time constant applied. It is the true peak, or crest, of the sound pressure wave within the measurement period.) L_{peak} can not be calculated from L_{max} levels of typical transient signals. Peak is often used in ballistics testing, but should not be used for environmental noise studies – even gusts of wind can yield high peak measurements. Finally, older peak measurements were often done with Z-weighting, but modern standards typically indicate that C-weighted peak (L_{Cpeak}) should be used.

4. OCTAVE BAND FILTERS 1/1 AND 1/3

For a wide range of applications from environmental testing to noise control, it is important to analyze both overall broadband levels as well as spectral content of measurements. With spectral information, the source and content of the measured level can be better understood. Constant percentage bandwidth filters (1/1 and 1/3 octave) are commonly used to discern tonal content as well as differences between deep bass and high treble tones.

An octave is a doubling of frequency (e.g., 500 Hz to 1 kHz); depending on the application, an even closer look at frequency composition may be necessary (3 and 12 bands per octave). International standards define a range covering the entire range of human hearing, from 6.3 Hz to 20 kHz for 1/3 octave bands.

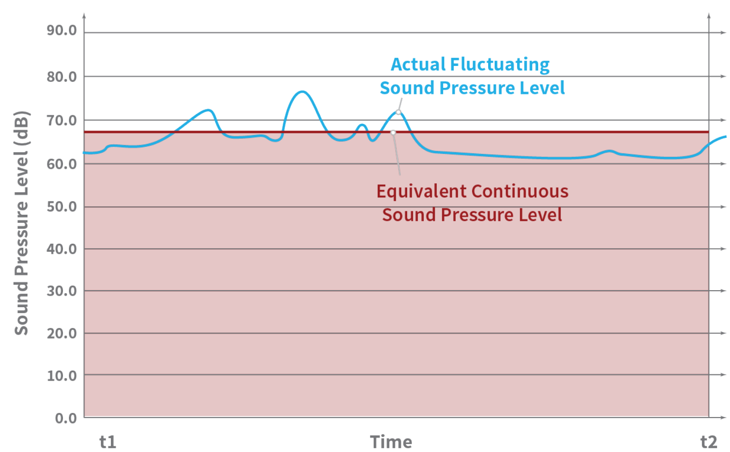
5. WHAT IS AN L_{EQ}?

L_{eq} is the level of a constant sound over a specific time period that has the same sound energy as the actual (unsteady) sound over the same period.

$$L_{eq} = 10Log_{10}\left[\frac{\int_{T_1}^{T_2} p^2(t)dt}{p_o^2 T}\right]$$

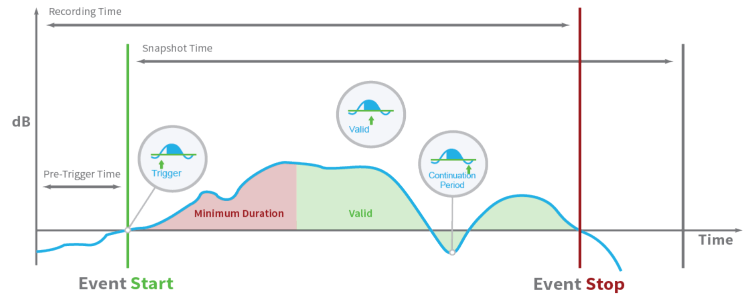
where p is the sound pressure and the Measurement Duration (specific time period) is T=T2-T1.

In other words, the actual sound pressure levels will vary all throughout a measurement period. Imagine creating a continuous sound throughout that same period with the same total sound energy as the actual varying sound levels. That continuous sound pressure level is L_{eq}.



6. WHAT IS AN EVENT?

An event is simply a period in the sound measurement to which the user would like to pay extra attention. Data can be collected or sound recordings made when an event is triggered.



- **Minimum Duration:** In situations where only noise events lasting longer than a certain time interval are needed, the user can select a minimum duration requirement for the storage of noise events data. The longest allowable minimum duration is 60 seconds.
- **Continuation Period:** Each noise event is initiated when the sound level exceeds the SPL1 or Peak 1 level. There may be situations where sound level drops below the threshold for a short period of time before rising above it again, in which case you may prefer to consider this a continuation of the event rather than the conclusion of the event and the beginning of another. Continuation Period is the time the sound level can fall below the threshold level and still be considered in the same event. Beginning when the levels both drop below their thresholds, if either level rises above its respective threshold over a time interval equal to the continuation period, the noise event is considered complete. If, however, there is an exceedance of a threshold during the continuation period, the event is considered to be continued as if there had been no level drop below a threshold.
- **Pre-Trigger Time:** The number of seconds of sound or data recorded before the event begins
- **Snapshot Time:** The maximum number of seconds the recording will continue after the event begins
- **Recording Time:** Recordings are stored for the shorter duration of these two: From the time the pre-trigger occurs until:
  - Event Stop occurs or
  - Snapshot Time setting is reached
- **Triggering:** Events can be triggered when the measured sound reaches a static sound pressure level or by dynamic triggering. In dynamic triggering, an event is triggered when the noise level is a user-specified number of decibels over the background noise.

7. MEASUREMENT HISTORY, TIME HISTORY, & EVENT HISTORY

Some sound level meters can measure and record multiple groups of data simultaneously. For example, the Larson Davis SoundAdvisor Model 831C offers the opportunity to store three groups of measurement data:

- **Measurement History:** Typically allows the user to view data in larger chunks, with measurement periods from 1 minute to 24 hours.
- **Time History:** Time history can be a much more granular look at the data. The period can be 2.5 miliseconds or up to 24 hours. $L_{eq\ max}$, $_{min}$, and $_{peak}$ with slow, fast, or impulse weightings, plus several other measurement parameters fitting with various international standards, can be captured.
- **Event History:** The meter can be set up to measure and record events, which can be triggered in a number of different ways. Level triggering allows the meter to begin an event when a measurement parameter (including running L_{eq}, L_{eq} with A, C, or Z frequency weighting and slow, fast or impulsive time weighting, and L_{peak} with A,C, or Z weightings) exceeds one or more fixed, predefined levels. Dynamic triggering causes an event to occur when the sound level exceeds the varying background noise by a user-defined number of decibels. In addition to saving data for each event, sound recordings can also be captured.

8. IDENTIFYING NOISE SOURCE

- **Record audio clips of noise events only:** When monitoring for noise exceedance, it can be tempting to record audio continuously, 24/7. This produces unnecessary data, which can be difficult to manage. With too much data, it is costly and cumbersome to store, communicate, and analyze the information that is most important. Instead, the features of a noise monitoring system can record noise only when there is an "event," or when the noise exceeds a certain fixed or dynamic threshold for a minimum period of time.
- **Rely on alerts from the noise monitoring system:** The Model 831C SoundAdvisor with ELA and SR options will send an email or text alert that includes an audio clip of the event whenever the noise gets too loud for too long. This allows the user to determine the source of the noise and take action to mitigate the situation in real time.
- **Examine data and noise events:** In post-processing with free G4 Utility Software from Larson Davis.

9. CLASS 1 METERS VS CLASS 2 METERS

Often, the choice of Class 1 or Class 2 meter comes down to which type of meter the regulation you need to comply with specifies.

- **Class 1 meters**
  - Meet tighter tolerances
  - Measure over a wider frequency range
  - Are typically required when data is used in legal proceedings
  - Are often more appropriate for environmental noise monitoring of low level noises
  - Can be used for Class 2 measurements as well, as all specs are exceeded
- **Class 2 meters**
  - Have looser tolerances
  - Are sometimes appropriate for occupational noise applications

10. FIELD CALIBRATION OF SOUND LEVEL METERS

Field calibration is a simple check of the meter's response against a known sound pressure level. This check is done at just a single known frequency (often 1 kHz) and level (94 dB or 114 dB). The microphone is insterted into an acoustic calibrator. The sound level meter will alert the user of any discrepancy between the measured and actual sound pressure level and prompt the user to save the result of any measured difference.

A pre-measurement calibration check for Sound Level Meters is always important. It becomes even more important in the case of outdoor measurements, because environmental conditions (temperature and pressure) can affect the sensitivity of the microphone.

It is important to let both the meter and the calibrator adjust to the weather conditions for the time stated in the manual before performing the calibration check. For temperature changes of 5 degrees C or a humidity change of 25%, the stabilization time is approximately 30 minutes.

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