SOUND LEVEL DESCRIPTORS

in Alphabetical Order

FHWA-HEP-17-053

The **$L_{10}(t)$** is a statistical descriptor of the sound level exceeded for 10% of the time of the measurement period (t). It can be obtained using short-term measurements; however, it cannot be accurately added to or subtracted from other L_{10} measures or other descriptors. Typically, the L_{10} is about 3 dB(A) above the $L_{EQ}(t)$. This measurement is permitted for use by the Federal Highway Administration.

The **$L_{50}(t)$** is a statistical descriptor of the sound level exceeded for 50% of the time of the measurement period (t).

The **$L_{90}(t)$** is a statistical descriptor of the sound level exceeded 90% of the time of the measurement period (t). This is considered to represent the background noise without the source in question. Where the noise emissions from a source of interest are constant (such as noise from a fan, air conditioner or pool pump) and the ambient noise level has a degree of variability (for example, due to traffic noise), the L_{90} descriptor may adequately describe the noise source.

The **L_{DEN} or CNEL** (Community Noise Exposure Level) descriptor describes a receiver's cumulative noise exposure from all events over a full 24 hours [$L_{EQ}(24)$], with a 5-dB penalty applied to evening hours (between 7 PM and 10 PM), and a 10-dB penalty applied to nighttime hours (between 10 PM and 7 AM). The L_{DEN} is computed as follows:

$$L_{DEN} = L_{AE} + 10*\log_{10}(N_{DAY} + 3*N_{EVE} + 10*N_{NIGHT}) - 49.4\ (dB)$$

N_{DAY} = Number of vehicle pass-bys between 7 AM and 7 PM
N_{EVE} = Number of vehicle pass-bys between 7 PM and 10 PM
N_{NIGHT} = Number of vehicle pass-bys between 10 PM and 7 AM
49.4 = A normalization constant which spreads the acoustic energy associated with highway vehicle pass-bys over a 24-hour period, i.e., $10*\log_{10}$ (86,400 seconds per day) = 49.4 dB.

[1]The **L_{DN} or DNL** (Day-Night Average Sound Level) descriptor describes a receiver's cumulative noise exposure from all events over a full 24 hours [$L_{EQ}(24)$], with a 10 decibel (dB) penalty applied to nighttime hours (between 10pm and 7am). This metric corresponds well to human annoyance levels; however, it does not lend itself to intuitive interpretation. An L_{DN} at or below 65 dB is commonly used for noise planning purposes to denote areas suitable for residential use. An accurate L_{DN} requires 24-hour measurements although there are methods available to obtain it by extrapolating short term measurements. These methods have varying degrees of accuracy. The L_{DN} computed with C-weighting is denoted CDNL or L_{CDN}, and is used by the Air Force in the evaluation of sonic booms from aircraft. The A-weighted L_{DN}, used by the Federal Transit Administration, is computed as follows:

$$L_{DN} = L_{AE} + 10*\log_{10}(N_{DAY} + 10*N_{NIGHT}) - 49.4\ (dB)$$

N_{DAY} = Number of vehicle pass-bys between 7 AM and 10 PM
N_{NIGHT} = Number of vehicle pass-bys between 10 PM and 7 AM
49.4 = A normalization constant which spreads the acoustic energy associated with highway vehicle pass-bys over a 24-hour period, i.e., $10*\log_{10}$ (86,400 seconds per day) = 49.4 dB.

The **L_{DNMR}, or Onset-Adjusted Monthly DNL**, accounts for the increased annoyance of rapid onset sounds. This descriptor accounts for events that are sporadic and occur at random times and is used by the Air Force. The conventional L_{DN} metric is adjusted by adding penalties to the SEL. For events with a rate of increase in sound level below 15 dB per second no adjustment is made; from 15 - 150 dB per second, a penalty ranging from 0 to 11 dB is added; for rates above 150 dB per second an 11 dB penalty is added. The L_{DN} is then determined as usual and designated as Onset-Rate Adjusted DNL. The number of average daily events is determined by using the calendar month with the highest number of these events. The monthly average is denoted L_{DNMR} and it is always equal to or greater than the L_{DN}.

The **L_E, or SEL** (Sound Exposure Level [A or C-weighted: L_{AE} or L_{CE},]), is used to measure a single acoustic event. It is the foundation metric for many of the other descriptors. L_E is a composite descriptor that represents both the intensity of a sound and its duration, and provides a measure of the net impact of an entire acoustic event. Mathematically, the mean square sound pressure is computed over the duration of the event, then multiplied by the duration in seconds, and the resultant product is turned into a sound level. As the summation of all the sound energy in a single event, the SEL is generally 5 to 10 dB higher than the maximum.

[1]The **$L_{EQ}(t)$**, or Time-Equivalent Sound Level, descriptor accounts for noise fluctuations from moment to moment by averaging the louder and quieter moments, and giving more weight to the louder moments. It represents the equivalent continuous sound pressure level over a given period of time. L_{EQ} is SEL over some time period normalized by that time. It can be obtained using short -term measurements. L_{EQ} should not be confused with L_{50}; L_{EQ} is a measure of sound energy, not a statistical measure or statistical average.

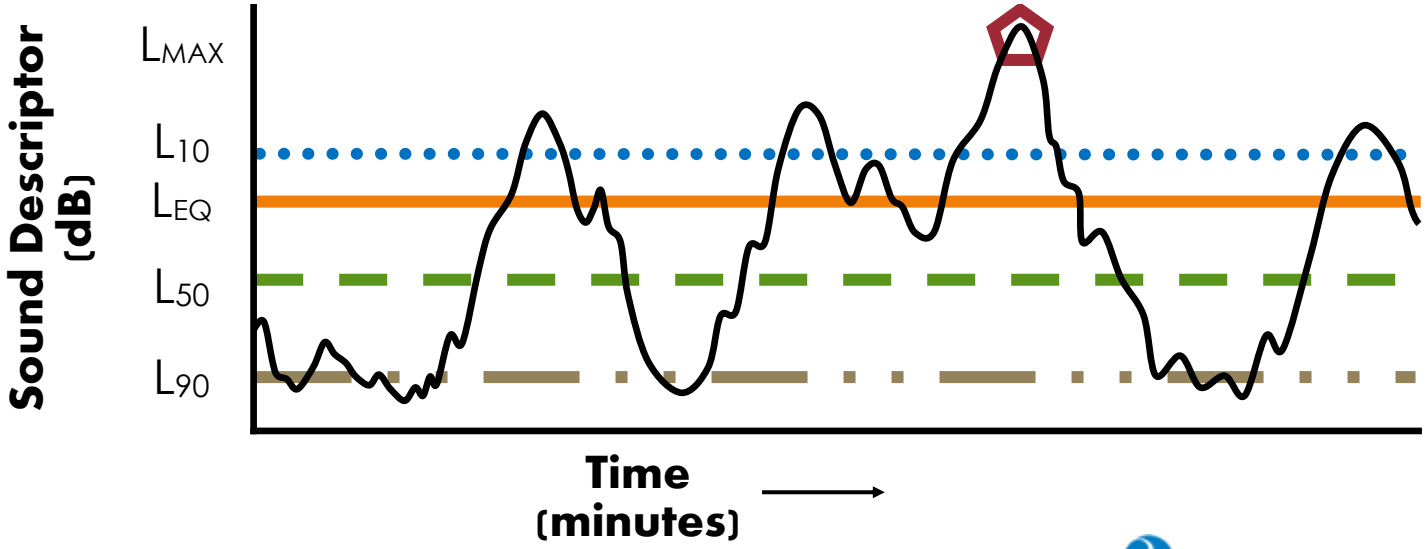
$$L_{EQ(time)} = L_{AE} - 10*\log_{10}(time_2 - time_1)\ (dB)$$

The **L_{MAX}, or Maximum Sound Level**, descriptor is the highest sound level measured during a single noise event (such as a vehicle pass by), in which the sound level changes value as time goes on. The maximum sound level is important in judging the interference caused by a noise event with common activities. L_{MAX} ignores the number and duration of these events, and cannot be totaled into a one-hour or a 24-hour cumulative measure of impact.

The **L_{PK}, or Peak Sound Level**, is a descriptor representing the true peak of the sound pressure wave. It is not the same as the L_{MAX}. The L_{PK} is the maximum value reached by the sound pressure. It is useful for capturing impulsive sounds, where the true instantaneous sound pressure is of interest. This pressure is usually presented in physical units of pounds per square foot (psf) and does not use either A or C weighting, nor is a time-constant applied. This parameter is typically used for regulating mining and blasting operations, and is also used by the Air Force.

[1]Neither the L_{EQ} nor the L_{DN} is an "average" in the normal sense of the word, where introduction of a quiet event would pull down the average. All sounds are included in the noise exposure that underlies L_{EQ} and L_{DN}. None of the noise is being ignored, even though the L_{EQ} and L_{DN} are often numerically lower than many maximum A-weighted Sound Levels. Noise exposure includes all events and all noise levels that occur during their time periods -- without exception. Every added event, even the quiet ones, will increase the noise exposure, and therefore increase L_{EQ} and L_{DN}. (Transit Noise and Vibration Impact Assessment - FTA-VA-90-1003-06, May 2006).

Visual Comparison of the Sound Levels Represented by Select Descriptors



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