NOISE AND VIBRATION FUNDAMENTALS

NOISE GLOSSARY

Sound: Sound is a vibratory disturbance created by a moving or vibrating source in the pressure and density of a gaseous or liquid medium or in the elastic strain of a solid that is capable of being detected by the hearing organs.

Noise: Noise is defined as sound that is loud, unpleasant, unexpected, or undesired and that causes a disturbance to humans.

Decibel (dB): The decibel is a unit used to measure the intensity of a sound or the power level of an electrical signal by comparing it with a given level on a logarithmic scale.

A-weighting (dBA): A-weighted sound levels represent the overall noise at a receiver that is adjusted in frequency to approximate typical human hearing sensitivity.

Equivalent continuous sound level (L_{eq}): L_{eq} is the equivalent continuous sound level and represents the total sound energy average over a period of interest.

Maximum sound level (L_{max}): The maximum level describes the maximum noise level reached during a single noise event.

Minimum sound level (L_{min}): The minimum sound level measured with 'A' frequency weighting and fast time weighting during the measurement period.

Statistical noise descriptors (Ln): Statistical analysis of noise levels. The 'n' denotes the percentage exceedance, for example the value of L90 shows the noise level that was exceeded for 90% of the measurement duration.

Root mean square (rms): The square root of the arithmetic average of the squared amplitude of a vibration signal.

Sound pressure level (SPL): A logarithmic measurement of the rms sound pressure of a sound relative to a reference value. It is measured in decibels (dB).

Day-night level (L_{dn}): L_{dn} is the energy average of A-weighted sound levels occurring over a 24-hour period, with a 10 dB penalty applied to A-weighted sound levels occurring during nighttime hours between 10:00 p.m. and 7:00 a.m.

Community noise equivalent level (CNEL): Similar to L_{dn}, CNEL is the energy average of the A-weighted sound levels occurring over a 24-hour period, with a 10 dB penalty applied to A-weighted sound levels occurring during nighttime hours between 10:00 p.m. and 7:00 a.m., and a 5 dB penalty applied to the A-weighted sound levels occurring during evening hours between 7:00 p.m. and 10:00 p.m.

Peak particle velocity (PPV): The peak signal value of an oscillating vibration velocity waveform. Usually expressed in inches/second in the United States.

Vibration decibel (VdB): The root mean square vibration velocity in a decibel scale used to convey the magnitude of the vibration signal felt by the human body, in inches per second.

Sensitive receptor: Noise- and vibration-sensitive receptors include land uses where quiet environments are necessary for enjoyment and public health and safety. Residences, schools, motels and hotels, libraries, religious institutions, hospitals, and nursing homes are examples.

HUMAN PERCEPTION OF SOUND

In acoustics, sound perceived by humans is a vibration that propagates longitudinally through an elastic medium such as air, which is also known as an acoustic wave or pressure wave. This longitudinal wave is comprised of an amplitude, frequency, and wavelength. The amplitude of a sound wave can be defined as the loudness or the amount of maximum displacement of vibrating particles of the medium from their mean position when the sound is produced. Sound pressure level is the most common descriptor used to describe the perceived "loudness" of an ambient sound level. The standard measurement unit of sound pressure is called a decibel (dB). The frequency of sound is the number of oscillations per second and is measured in hertz (Hz). Frequency and pitch are often used synonymously – the higher the frequency, the higher the pitch. Lastly, the wavelength is simply the size of a wave measured from one peak to the next. The wavelength of a sound is inversely proportional to its frequency, and therefore, the higher the frequency, the shorter the wavelength.

A healthy and typical audible range for adult humans is between 20 Hz and 20,000 Hz. However, the human response to frequencies within the audible range are not all the same and tends to drop below 20,000 Hz with aging. To address this, the A- weighted scale is applied (dBA). The scale assigns a weight to the decibel value of sound based on the sensitivity of the ear at a particular frequency. Generally, the human ear naturally deemphasizes frequencies below 1,000 Hz and emphasizes frequencies between 1,000 Hz and 5,000 Hz. The human ear therefore has a natural "pick-up" in the frequencies that make consonant sounds in human speech.

Because the decibel is based on a logarithmic scale, a doubling of a sound source is perceived as a 3 dBA increase which is often referred to as the just noticeable difference threshold in an outdoor or uncontrolled environment. A change in 1 to 3 dBA is detectable under quiet, controlled, laboratory conditions. A change of 5 dBA is readily perceptible to most people and a change in 10 dBA is perceived as a doubling (or halving) of the sound. Another example is to consider that a 10 dBA increase is 10 times more intense than 1 dBA, a 20 dBA increase is 100 times more intense, a 30 dBA increase is 1,000 times more intense, and so on. Table 1, Common Noise Levels, show a range of urban noise sources, their noise levels, and subjective human impression.

Table 1
Common Noise Levels

Common Outdoor Activities	Noise Level (dBA)	Common Indoor Activities
	110	Rock band
Jet flyover at 1,000 feet		
	100	
Gas lawnmower at 3 feet		
	90	
Diesel truck at 50 feet at 50 mph		Food blender at 3 feet
	80	Garbage disposal at 3 feet
Noisy urban area, daytime		

Common Outdoor Activities	Noise Level (dBA)	Common Indoor Activities
Gas lawnmower, 100 feet	70	Vacuum cleaner at 10 feet
Commercial area		Normal speech at 3 feet
Heavy traffic at 300 feet	60	
		Large business office
Quiet urban daytime	50	Dishwasher in next room
Quiet urban daytime	40	Theater, large conference room (background)
Quiet suburban nighttime		
	30	Library
Quiet rural nighttime		Bedroom at night, concert hall (background)
	20	
		Broadcast/recording studio
	10	
Threshold of hearing	0	Threshold of hearing
Source: California Department of Transportation (Caltrans). 2013, September. Technical Noise Supplement ("TeNS").		

HEALTH EFFECTS OF NOISE TO HUMANS

Loud noise can create physical and psychological stress, reduce productivity, and interfere with communication and concentration. Short term exposure to loud noise can also cause a temporary change in hearing (your ears may feel stuffed up) or a ringing in your ears (tinnitus). These short-term problems may go away within a few minutes or hours after leaving the noise. However, repeated exposures to loud noise can lead to permanent tinnitus and/or hearing loss. The effects of noise induced hearing loss can be profound, limiting your ability to hear high frequency sounds, understand speech, and seriously impairing your ability to communicate (OSHA).

SOUND PROPAGATION

In an exterior environment when a noise event occurs, the noise level diminishes with distance to the inverse square law which states that for every doubling of distance from the noise source to receiver, sound attenuates 6 dBA for point sources (most stationary noise sources such as mechanical equipment, loudspeakers, and people talking) and 3 dBA for line sources (e.g., roadways and rail lines). This is the minimum attenuation achieved and does not account for additional ground absorption and acoustical shielding from other buildings, walls, trees, or other physical barriers.

VIBRATION FUNDAMENTALS

Vibration is an oscillatory motion that can be described in terms of displacement, velocity, or acceleration. Because the motion is oscillatory, there is no net movement of the vibration element and the average of any of the motion metrics is zero. Displacement is the most intuitive metric. For a vibrating floor, the displacement is simply the distance that a point on the floor moves away from its static position. The velocity represents the instantaneous speed of the floor movement and acceleration is the rate of change of the speed. Although displacement is easier to understand than velocity or acceleration, it is rarely used for describing ground-borne vibration. Most transducers used for measuring ground-borne vibration use either

velocity or acceleration. Furthermore, the response of humans, buildings, and equipment to vibration is more accurately described using velocity or acceleration.

The typical frequency range of most ground-borne vibrations that can be felt by humans is less than 1 Hz to a high of 200 Hz. Common vibration metrics used to assess vibration are the root mean square (vibration decibel, VdB) and peak particle velocity (PPV). PPV is often used in monitoring of construction vibration (such as blasting) and to assess potential architectural damage since it is related to the stresses that are experienced by buildings. The units for PPV in the United States are normally inches per second (in/sec). VdB is commonly used when assessing the human response (also referred to human annoyance) to vibration as it uses the arithmetic average of the squared amplitude of the signal. Like noise, groundborne vibration attenuates with distance. Vibration attenuation varies depending on the soil type, compaction, and vibration frequency.

Traffic, including heavy trucks traveling on a highway, rarely generates vibration amplitudes high enough to cause structural or cosmetic damage. However, there have been cases in which heavy trucks traveling over potholes or other discontinuities in the pavement have caused vibration high enough to result in complaints from nearby residents. These types of issues typically can be resolved by smoothing the roadway surface. In describing vibration in the ground and in structures, the motion of a particle (i.e., a point in or on the ground or structure) is used.

CONSTRUCTION NOISE DATA & MODELING

9143 De Soto CalEEMod Construction Equipment Defaults

5.2. Off-Road Equipment

5.2.1 Unmitigated

Phase Name	Equipment Type
Site Preparation	Graders
Site Preparation	Rubber Tired Dozers
Site Preparation	Tractors/Loaders/Backhoes
Grading	Graders
Grading	Tractors/Loaders/Backhoes
Grading	Rubber Tired Dozers
Building Construction	Cranes
Building Construction	Forklifts
Building Construction	Generator Sets
Building Construction	Tractors/Loaders/Backhoes
Building Construction	Welders
Paving	Tractors/Loaders/Backhoes
Paving	Pavers
Paving	Paving Equipment
Paving	Rollers
Paving	Cement and Mortar Mixers
Architectural Coating	Air Compressors

Roadway Construction Noise Model (RCNM),Version 1.1

Report date: 01/05/2024
Case Description: 9143 De Soto

**** Receptor #1 ****

Baselines (dBA)

Description	Land Use	Daytime	Evening	Night
Construction Mix	Commercial	75.0	70.0	70.0

Equipment

Description	Impact Device	Spec Usage (%)	Actual Lmax (dBA)	Receptor Lmax (dBA)	Estimated Distance (feet)	Shielding (dBA)
Grader	No	40	85.0		50.0	0.0
Dozer	No	40		81.7	50.0	0.0
Tractor	No	40	84.0		50.0	0.0
Crane	No	16		80.6	50.0	0.0
Man Lift	No	20		74.7	50.0	0.0
Generator	No	50		80.6	50.0	0.0
Front End Loader	No	40		79.1	50.0	0.0
Backhoe	No	40		77.6	50.0	0.0
Welder / Torch	No	40		74.0	50.0	0.0
Paver	No	50		77.2	50.0	0.0
Roller	No	20		80.0	50.0	0.0
Drum Mixer	No	50		80.0	50.0	0.0
Compressor (air)	No	40		77.7	50.0	0.0

Results

Equipment	Calculated (dBA) Lmax	Leq	Noise Limits (dBA) Day Lmax	Day Leq	Evening Lmax	Evening Leq	Night Lmax	Night Leq	Noise Limit Exceedance (dBA) Day Lmax	Day Leq	Evening Lmax	Evening Leq	Night Lmax	Night Leq
Grader	85.0	81.0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Dozer	81.7	77.7	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Tractor	84.0	80.0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Crane	80.6	72.6	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Man Lift	74.7	67.7	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Generator	80.6	77.6	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Front End Loader	79.1	75.1	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Backhoe	77.6	73.6	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Welder / Torch	74.0	70.0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Paver	77.2	74.2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Roller	80.0	73.0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Drum Mixer	80.0	77.0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Compressor (air)	77.7	73.7	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Total	85.0	87.4	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

9143 De Soto - Vibration Damage Attenuation Calculations

Levels, PPV (in/sec)

Distance in feet	**Vibration Reference Level at *25 feet***	**Receptor Distance 1** *95*	**Receptor Distance 2** *70*	**Receptor Distance 3** *18*	**Receptor Distance 4** *10*
Vibratory Roller	0.21	0.028	0.045	0.344	0.830
Large Bulldozer	0.089	0.012	0.019	0.146	0.352
Loaded Trucks	0.076	0.010	0.016	0.124	0.300
Jackhammer	0.035	0.005	0.007	0.057	0.138
Small Bulldozer	0.003	0.000	0.001	0.005	0.012

9143 De Soto CalEEMod Construction Vehicles Defaults

5.3. Construction Vehicles

5.3.1 Unmitigated

			Total Trips Per Phase	
Phase Name	**Trip Type**	**One-Way Trips per Day**	**Non Haul**	**Haul Tucks**
Site Preparation				
	Worker	8	8	
	Vendor			
	Hauling	0		0
	Onsite truck			
Grading				
	Worker	10	10	
	Vendor			
	Hauling	41		**41**
	Onsite truck			
Building Construction				
	Worker	46	**64**	
	Vendor	18		
	Hauling	0		**0**
	Onsite truck			
Paving				
	Worker	13	13	
	Vendor			
	Hauling	0		0
	Onsite truck			
Architectural Coating				
	Worker	9	9	
	Vendor			
	Hauling	0		0
	Onsite truck			
		Max	**64**	**41**

NOISE MONITORING DATA

Long-term Measumrent Location 1 (LT-1)
De Soto Avenue, Between Dearborn Street and Nordhoff Street in Los Angeles, CA
January 3rd - 4th, 2024