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Preliminary Environmental Information Report

Volume III

Appendix 10-1: Noise and Vibration Glossary

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EN010156

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10.1 Noise

10.1.1 Noise is defined as unwanted sound. Human hearing is able to respond to sound in the frequency range 20Hz (deep bass) to 20,000Hz (high treble) and over the audible range of 0 dB (the threshold of perception) to 140 dB (the threshold of pain). The ear does not respond equally to different frequencies of the same magnitude but is more responsive to mid-frequencies than to lower or higher frequencies. To quantify noise in a manner that approximates the response of the human ear, a weighting mechanism is used, which reduces the importance of lower and higher frequencies in a similar manner to human hearing.

10.1.2 The weighting mechanism that best corresponds to the response of the human ear is the 'A'-weighting scale. This is widely used for environmental noise measurement, and the levels are denoted as dB(A) or L_{Aeq}, L_{A90} etc. according to the parameter being measured. The Glossary explains the acoustic terminology that is used in the chapter.

10.1.3 The decibel scale is logarithmic rather than linear, and hence a 3 dB increase in sound level represents a doubling of the sound energy present. Judgement of sound is subjective, but as a general guide a 10 dB(A) increase can be taken to represent a doubling of loudness, whilst an increase in the order of 3 dB(A) is generally regarded as the minimum difference needed to perceive a change under normal listening conditions.

10.1.4 An indication of the range of sound levels found commonly in the environment is given in the table below.

Table 10.1.1 Typical sound levels found in the environment

Sound pressure level, dB(A)	Location
0	Threshold of hearing
20 to 30	Quiet bedroom at night
30 to 40	Living room during the day
40 to 50	Typical office
50 to 60	Inside a car
60 to 70	Typical high street
70 to 90	Inside factory
100 to 110	Burglar alarm at 1m away
110 to 130	Jet aircraft on take off
140	Threshold of pain

10.1.5 The subjective response to a noise is dependent not only upon the sound pressure level and its frequency, but also its intermittency. Various indices have been developed to try and correlate annoyances with the noise level and its fluctuations.

- **Sound Pressure**: Sound, or sound pressure, is a fluctuation in air pressure over the static ambient pressure.
- **Sound Pressure Level (Sound Level):** The sound level is the sound pressure relative to a standard reference pressure of 20 Pa (20x10-6 Pascals) on a decibel scale.
- **Sound Power:** The sound energy radiated per unit time by a sound source. Measured in Watts (W).
- **Sound Power Level, L_W**: Sound power measured on a decibel scale, relative to a reference value of 10 12 W.
- **Decibel (dB):** A scale for comparing the ratios of two quantities, including sound pressure and sound power. The difference in level between two sounds s1 and s2 is given by 20 $\log_{10}$ (s1/s2). The decibel can also be used to measure absolute quantities by specifying a reference value that fixes one point on the scale. For sound pressure, the reference value is 20 Pa.

- **A-weighting, dB(A):** The unit of sound level, weighted according to the A-scale, which takes into account the increased sensitivity of the human ear at some frequencies.
- **Noise Level Indices:** Noise levels usually fluctuate over time, so it is often necessary to consider an average or statistical noise level. This can be done in several ways, so a number of different noise indices have been defined, according to how the averaging or statistics are carried out.
- **$L_{eq,T}$:** A noise level index called the equivalent continuous noise level over the time period T. This is the level of a notional steady sound that would contain the same amount of sound energy as the actual, possibly fluctuating, sound that was recorded.
- **$L_{max,T}$:** A noise level index defined as the maximum noise level during the period T. L_{max} is sometimes used for the assessment of occasional loud noises, which may have little effect on the overall L_{eq} noise level but will still affect the noise environment. Unless described otherwise, it is measured using the 'fast' sound level meter response.
- **$L_{90,T}$:** A noise level index. The noise level exceeded for 90% of the time over the period T. L_{90} can be considered to be the "average minimum" noise level and is often used to describe the background noise.
- **$L_{10,T}$:** A noise level index. The noise level exceeded for 10% of the time over the period T. L_{10} can be considered to be the "average maximum" noise level. Generally used to describe road traffic noise.
- **L_{AE} (or SEL):** A noise level index. Equivalent to the $L_{Aeq,T}$ condensed into a one second period. Typically used when dealing with noise events where the activity duration is not necessary the same as under the conditions the source data was obtained.
- **Free-Field**: Far from the presence of sound reflecting objects (except the ground), usually taken to mean at least 3.5m away.
- **Façade**: At a distance of 1m in front of a large sound reflecting object such as a building façade.
- **Slow and Fast Time Weightings**: Averaging times used in sound level meters. Defined in BS 5969.

10.2 Vibration

10.1.1 Vibration is defined as a repetitive oscillatory motion. Groundborne vibration can be transmitted to the human body through the supporting surfaces; the feet of a standing person, the buttocks, back and feet of a seated person or the supporting area of a recumbent person. In most situations, entry into the human body will be through the supporting ground or through the supporting floors of a building. Vibration from road traffic can also be airborne. Such airborne vibration is transmitted as a low-frequency sound wave and is often perceived when the sound wave causes windows or other objects to rattle.

10.1.2 Vibration is often complex, containing many frequencies, occurring in many directions and changing over time. There are many factors that influence human response to vibration. Physical factors include vibration magnitude, vibration frequency, vibration axis, duration, point of entry into the human body and posture of the human body. Other factors include the exposed persons experience, expectation, arousal and activity.

10.1.3 Experience shows that disturbance or annoyance from vibration in residential situations is likely to arise when the magnitude of vibration is only slightly in excess of the threshold of perception.

10.1.4 The threshold of perception depends on the frequency of vibration. The human body is most sensitive to vibration in the frequency range 1 to 80 Hz and especially sensitive to vibration in the range 4 to 8 Hz. As with noise, a frequency weighting mechanism is used to quantify vibration in a way that best corresponds to the frequency response of the human body. For occupants within buildings, the frequency weighting curve is defined in BS 6472: 1992 'Evaluation of Human Exposure to Vibration in Buildings'. In general, vibration is only perceptible in residential situations when the building is close to a railway, construction site or very close to a road that carries large and heavy vehicles.

- **Displacement, Acceleration and Velocity; Root Mean Square (r.m.s.) and Peak Values; and Peak Particle Velocity (PPV):** Vibration is an oscillatory motion. The magnitude of vibration can be defined in terms of displacement (how far from the equilibrium position that something moves), velocity (how fast something moves), or acceleration (the rate of change of velocity). When describing vibration, one must specify whether peak values are used (i.e. the maximum displacement or maximum velocity) or r.m.s. / r.m.q. values (effectively an average value) are used. Standards for the assessment of building damage are usually given in terms of peak velocity (usually referred to as Peak Particle Velocity, or PPV), whilst human response to vibration is often described in terms of r.m.s. or r.m.q. acceleration.

- **Root Mean Square (r.m.s.)**: The r.m.s. value of a set of numbers is the square root of the average of the squares of the numbers. For a sound or vibration waveform, the r.m.s. value over a given time period is the square root of the average value of the square of the waveform over that time period.
- **Root Mean Quad (r.m.q.):** The r.m.q. value of a set of numbers is the fourth root of the average of the fourth powers of the numbers. For a vibration waveform, the r.m.q. value over a given time period is the fourth root of the average value of the fourth power of the waveform over that time period.
- **Attenuation:** A general term used to indicate the reduction of noise or vibration, or the amount (in decibels) by which it is reduced.
- **Vibration Dose Value (VDV):** This is a measure of the amount of vibration that is experienced over a specified period, and has been defined so as to quantify the human response to vibration in terms of comfort and annoyance. The Vibration Dose Value is used to assess the likely levels of adverse comment about vibration, and is defined mathematically as the fourth root of the time integral of the fourth power of the acceleration, after it has been frequency weighted to take into account the frequency response of the human body to a vibration stimulus. Measured in units of m $s^{-1.75}$.