A15.1: Noise & Vibration - Technical Definitions

1 Introduction

1.1.1 This appendix provides definitions of some of the terms used in the noise and vibration chapter to aid understanding.

1.1.2 The sound wave travelling through the air is a regular disturbance in ambient atmospheric pressure. These pressure fluctuations, when of frequencies within the audible range, are detected by the human ear which passes nerve responses to the brain, producing the sensation of hearing. Noise has been defined in a variety of ways and is very much dependant on factors such as the listener's attitude to the source of the sound and their environment, but is essentially any sound that is unwanted by the recipient.

1.1.3 It is not possible to measure the degree of nuisance caused by noise directly, as this is essentially a subjective response of the listener, but it is possible to measure the "loudness" of that noise. Loudness is related to both the sound pressure (the magnitude of the maximum excursion of the pressure wave around the ambient atmospheric pressure) and the frequency, both of which can be measured.

1.1.4 The human ear is sensitive to a wide range of sound levels; the sound pressure level of the threshold of pain is over a million times that of the quietest audible sound. In order to reduce the relative magnitude of the numbers involved, a logarithmic scale of decibels (dB) based on a reference level of the lowest audible sound is used.

1.1.5 The response of the human ear is also not constant over all frequencies. It is therefore usual to weight the measured frequency to approximate human response. This is achieved by using filters to vary the contribution of different frequencies to the measured level. The "A" weighting network is the most commonly used and has been shown to correlate closely to the non-linear and subjective response of humans to sound. The use of this weighting is denoted by a capital A in the unit abbreviation (i.e. L_{Amax}, L_{Aeq}, L_{A90} etc.) or a capital A in brackets after a dB level (i.e. 3 dB(A)).

2 Technical Definitions

2.1.1 Technical definiitions for terms used in the assessment are provided below.

Sound Pressure Level (SPL)

The sound pressure level (LP or SPL) is the instantaneous acoustic pressure and is measured in decibels (dB). Since the ear is sensitive to variations in pressure, rather than source power or intensity, the measurement of this parameter gives an indication of the impact on people. The SPL is defined as:

$$SPL = 10\log_{10}\left(\frac{p^2}{p_{ref}^2}\right) \quad \text{or} \quad SPL = 20\log_{10}\left(\frac{p}{p_{ref}}\right)$$

where:
p is the rms pressure of the sound in question (in pascals)
pref is the reference sound pressure, defined as the limit of human audibility (2 x 10-5 Pa)

Sound Power Level (PWL)

The sound power level (LW or PWL) is a measure of the acoustic energy output of a source and is a property of the source itself. The PWL is also measured in dB and is given by:

$$PWL = 10\log_{10}\left(\frac{W}{W_0}\right)$$

where:
W is the sound power of the source (in watts)
W_0 is the reference sound power (10-12 watts)

Leq

The Leq is defined as the equivalent continuous sound level and is the most widely used parameter for assessing environmental noise. Since this descriptor is a type of average level, it must by definition have an associated time period over which the measurement is referring to. This is often included in the abbreviation in the form Leq, T, where T is the time period (i.e. LAeq, 5 min). The formula for calculating the Leq is:

$$L_{eq} = 10\log_{10}\left(\frac{1}{t_2 - t_1}\int_{t_1}^{t_2}\frac{p^2}{p_{ref}^2}.dt\right)$$

In practice, since most modern sound level meters are digital and hence take periodic samples of the sound pressure level, the Leq will be the logarithmic average of all the SPL samples taken in the measurement period.

Lmax

The Lmax is defined as the maximum rms level recorded during a measurement period.

Ln

The Ln is a statistical descriptor and refers to the level that is exceeded for n% of the time during a particular measurement period. Again, the measurement period that the descriptor refers to is often included in the abbreviation in the format Ln, T. Two of the most commonly used statistical descriptors used for environmental noise assessments are the L90 and the L10. These are described in more detail below.

L10

The L10 refers to the level exceeded for 10% of the measurement period and is commonly used in assessing road traffic noise as it has been found to give a good indication of the subjective human response to this type of noise.

L90

The L90 refers to the level exceeded for 90% of the measurement period and is widely considered to represent background noise, or the underlying noise in an area between noisy events (such as cars passing etc.).

Free-Field

The term “free-field” refers to noise levels that have been measured or predicted in the absence of any influence of reflections from nearby surfaces. In practice, a measurement is considered to be free-field if it was taken at a distance of over 3.5 m from any reflecting surfaces.

Façade Level

Façade levels refer to levels taken at a distance of between 1 and 3.5 m of the façade of a building. The difference between the façade and free-field level will depend on the distance from the reflecting surface, but is generally accepted to be approximately 2.5 dB(A).

L_{night}

The L_{night} is a façade noise index derived from the $L_{A10,18h}$ index using TRL conversion method.

$L_{night,outside}$

The $L_{night,outside}$ is defined as the free-field A-weighted long-term average sound level of the 8-hour night-time period determined over all nights of a year outside a property.