TECHNICAL APPENDIX D

D.1 Description of Noise and Vibration Units

D.1.1 Noise

Noise is defined as unwanted sound. The range of audible sound is from 0 dB to 140 dB. The frequency response of the ear is usually taken to be about 18 Hz (number of oscillations per second) to 18,000 Hz. The ear does not respond equally to different frequencies at the same level. It is more sensitive in the mid-frequency range than the lower and higher frequencies and because of this, the low and high frequency components of a sound are reduced in importance by applying a weighting (filtering) circuit to the noise measuring instrument. The weighting which is most widely used and which correlates best with subjective response to noise is the dB(A) weighting. This is an internationally accepted standard for noise measurements.

For variable noise sources such as traffic, a difference of 3 dB(A) is just distinguishable. In addition, a doubling of a noise source would increase the overall noise by 3 dB(A). For example, if one item of machinery results in noise levels of 30 dB(A) at 10 m, then two identical items of machinery adjacent to one another would result in noise levels of 33 dB(A) at 10 m. The 'loudness' of a noise is a purely subjective parameter but it is generally accepted that an increase/decrease of 10 dB(A) corresponds to a doubling/halving in perceived loudness.

External noise levels are rarely steady but rise and fall according to activities within an area. In an attempt to produce a figure that relates this variable noise level to subjective response, a number of noise indices have been developed. These include:

- **L_{Aeq} noise level:** This is the 'equivalent continuous A-weighted sound pressure level, in decibels' and is defined in British Standard 7445 (BS 7445)[1] as the 'value of the A-weighted sound pressure level of a continuous, steady sound that, within a specified time interval, T, has the same mean square sound pressure as a sound under consideration whose level varies with time'.

  It is a unit commonly used to describe community response plus, construction noise and noise from industrial premises and is the most suitable unit for the description of other forms of environmental noise. In more straightforward terms, it is a measure of energy within the varying noise.

- **L_{A90} noise level:** This is the noise level that is exceeded for 90% of the measurement period and gives an indication of the noise level during quieter periods. It is often referred to as the background noise level and is used in the assessment of disturbance from industrial noise.

- **SEL noise level:** This described by CRN[2] as the level at the reception point which if maintained constant for a period of 1 second, would cause the same A-weighted sound energy to be received.

- **Hz (Hertz):** The tonal quality of a sound is described and measured in terms of the frequency content and is commonly expressed as octave or third octave bands, the latter being the division of the octave bands into three for finer analysis, across the frequency spectrum. The smaller the octave band or third octave band centre frequency number, defined in terms of Hz, the lower the sound. For example 63 Hz is lower than 500 Hz and is perceived as a deeper sound. The attenuation due to air absorption and natural barriers increases with frequency i.e. low frequencies are always the most difficult to control.

D.1.2 Vibration

Groundborne vibration from construction sources, such as piling, can be a source of concern for occupants of buildings in the vicinity. The concern can be that the building may suffer some form of cosmetic or structural damage or that ground settlement may arise that could subsequently lead to damage. Research associated with British Standard 7385 (BS 7385)[3], concerned with vibration-induced building damage found that although a large number of case histories were assembled, very few cases of vibration-induced damage were found. However, structural vibration in buildings can be detected by the occupants and can affect them in many ways: their quality of life can be reduced, as also can their working efficiency, although, there is little evidence that whole-body vibration directly affects cognitive processes. It should be noted that there is a major difference between the sensitivity of people feeling vibration and the onset of levels of vibration that damage a structure.

- **Vibration Dose Value (VDV):** The effect of building vibration on people inside buildings is assessed by determining their vibration dose. Present knowledge indicates that this is best evaluated with the VDV, as promoted through British Standard 6472 Part 1 (BS 6472)[4]. VDV defines a relationship that yields a consistent assessment of intermittent, occasional and impulsive vibration, as well as continuous input, and correlates well with subjective response. The way in which people perceive building vibration depends upon various factors, including the vibration frequency and direction. The VDV is given by the fourth root of the integral of the fourth power of the acceleration after it has been frequency weighted, which has the unit '$ms^{-1.75}$'.

- **Peak Particle Velocity (PPV):** Peak particle velocity is defined as 'the maximum instantaneous velocity of a particle at a point during a given time interval', and has been found to be the best single descriptor for correlating with case history data on the occurrence of vibration-induced damage.

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[1] British Standards Institution. (BSI) (2003). British Standard (BS) 7445: Description and measurement of environmental noise. Part 1: Guide to environmental quantities and procedures. BSI. London

[2] Department of Transport (DoT) (1995). Calculation of Railway Noise. HMSO. London.

[3] British Standards Institution. BS 7385 Part 2. Evaluation and measurement for vibration in buildings. Part 2: Guide to damage levels from groundborne vibration. 1993.

[4] BSI. (2008). BS 6472: Guide to evaluation of human exposure to vibration in buildings. BSI. London.