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## Appendix 10A

### 10A.1 Descriptive Noise Units

Noise is defined as unwanted sound. The range of audible sound is from 0dB to 140dB. The frequency response of the human ear is usually taken to be about 18Hz (number of oscillations per second) to 18,000Hz. 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 sound level meter). The weighting which is most widely used and which correlates best with subjective response to noise is the A-weighting. This is an internationally accepted standard for noise measurements.

For variable noise sources such as traffic, an increase of 1dB (A), which equates for example to an approximate 25% increase in road traffic, is barely perceptible. In addition, a doubling of traffic flow will increase the overall noise by 3dB (A), providing that a number of factors, including speed, remain unchanged. The 'loudness' of a noise is a purely subjective parameter, but it is generally accepted that an increase/decrease of 10dB (A) corresponds to a doubling or halving in perceived loudness.

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

*The  $L_{Aeq}$  noise level*



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This is the 'equivalent continuous A-weighted sound pressure level, in decibels', and is defined in British Standard BS 7445 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 construction noise, and noise from industrial premises and is the most suitable unit for the description of many other forms of environmental noise.

*The  $L_{Amax}$  noise level*

This is the maximum noise level recorded over a particular measurement period.

*The  $L_{A10}$  noise level*

The  $L_{A10}$  is the noise level that is exceeded for 10% of the measurement period, and gives an indication of the noisier levels. It is a unit that has been used over many years for the measurement and assessment of road traffic noise.

*The  $L_{A90}$  noise level*

The  $L_{A90}$  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.

## **10A.2 Regulatory Context**

### ***Control of Pollution Act (CoPA) 1974***

The Act of Parliament which specifically relates to the control of noise and vibration from construction sites is the Control of Pollution Act 1974 (CoPA). This is achieved by the means of the imposition of appropriate conditions and by the development of agreed working procedures.



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Sections (S) 60 and 61 of the CoPA gives local authorities in Scotland, England and Wales special powers for controlling noise arising from construction and demolition works on any building or civil engineering sites. S60 refers to the control of noise on construction sites and provides legislation by which local authorities can control noise from construction sites to prevent noise disturbance occurring. In addition, it recommends that guidance provided by BS5228 be implemented to ensure compliance with S60. S61 refers to prior consent for work on construction sites and provides a method by which a contractor can apply for consent to undertake construction works in advance.

#### ***Environmental Protection Act (EPA)***

The Environmental Protection Act (EPA) (Section 79, Part III of Chapter 43, Statutory Nuisances and Inspections) contains a definition of what constitutes a “*statutory nuisance*” with regard to noise and places a duty on Local Authorities to detect any such nuisances within their area. This section further defines “*Best Practicable Means*” (BPM) as “*reasonably practical having regard, among other things, to local conditions and circumstances, to the current state of technical knowledge and to the financial implications*”.

Local Authorities have the power under Section 80, Part III of Chapter 43 of the EPA (summary proceedings for statutory nuisances) to serve an abatement notice requiring the abatement of a nuisance or requiring works to be executed to prevent their occurrence.

#### ***Land Compensation Act (LCA)***

Part 1 of the Land Compensation Act 1973 includes provision for compensation for loss in property value resulting from physical agents including noise. Part II includes provision for noise mitigation measures at dwellings adjacent to new highways if certain conditions are satisfied.



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### ***National Planning Policy Framework (NPPF, March 2012)***

The National Planning Policy Framework determines the government's planning policy for England. The NPPF states that, with respect to noise, planning policies and decisions should aim to:

- Avoid noise from giving rise to significant adverse impacts on health and quality of life as a result of new development;
- Mitigate and reduce to a minimum other adverse impacts on health and quality of life arising from noise from a new development, including through the use of conditions;
- Recognise that development will often create some noise and existing business wanting to develop in continuance of their business should not have unreasonable restrictions put upon them because of changes in nearby land uses since they were established; and
- Identify and protect areas of tranquillity which have remained relatively undisturbed by noise and are prized for their recreational and amenity value for this reason.

The guidance contained within the NPPF further determines that consideration should be given to the Noise Policy Statement for England (DEFRA, March 2010).

### ***Noise Policy Statement for England (NPSE, March 2010)***

The Noise Policy Statement for England attends to three types of noise;

- “Environmental noise” which includes noise from transportation sources;

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- “Neighbour noise” which includes noise from inside and outside people’s homes; and,
  - “Neighbourhood noise”, which includes noise arising from within the community such as industrial and entertainment premises, trade and business premises, construction sites and noise in the street.

In line with the aims determined within the NPPF, the NPSE presents the following three aims;

- 1) Avoid significant adverse impacts on health and quality of life from environmental, neighbour and neighbourhood noise within the context of Government policy on sustainable development;
- 2) Mitigate and minimise adverse impacts on health and quality of life from environmental, neighbour and neighbourhood noise within the context of Government policy on sustainable development; and,
- 3) Where possible, contribute to the improvement of health and quality of life through the effective management and control of environmental, neighbour and neighbourhood noise within the context of Government policy on sustainable development.

### **10A.3 Relevant Guidance Applicable to the Assessment of Noise**

In addition to the regulatory guidance detailed above, assessment methodologies appropriate for this type of development will also be referred to within the completion of this study.

The relevant guidance and methodology documents are discussed in the following sections.



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***BS4142: 2019 – Methods for rating and assessing industrial and commercial sound***

This revision to the British Standard was issued at the start of November 2014 and provides a methodology for the rating and assessing of sound associated with both industrial and commercial premises. The purpose of the Standard is clearly outlined in the opening section where it states the method to be appropriate for the consideration of:

- Sound from industrial and manufacturing processes;
- Sound from fixed installations which comprise mechanical and electrical plant and equipment;
- Sound from the loading and unloading of goods and materials at industrial and/or commercial premises; and,
- Sound from mobile plant and vehicles that is an intrinsic part of the overall sound emanating from premises or processes, such as that from forklift trucks, or that from train or ship movements on or around an industrial and/or commercial site.

The Standard is based around the premise that the significance of the impact of an industrial/ commercial facility can be derived from the numerical subtraction of the background noise climate level (not necessarily the lowest background level measured, but the typical background of the receptor) from the measured/calculated rating level of the specific sound under consideration. This comparison will enable the impact of said sound to be concluded based upon the premise that typically “the greater this difference, the greater the magnitude of the impact”. This difference is then considered as follows:

- A difference of around +10dB or more is likely to be an indication of a significant adverse impact, depending on the context;
- A difference of around +5dB is likely to be an indication of an adverse impact, depending upon context; and,

- The lower the rating level is relative to the measured background sound level, the less likely it is that the specific sound source will have an adverse impact or a significant adverse impact.

BS4142 further states that “where the rating level does not exceed the background sound level, this is an indication of the specific sound source having a low impact” again depending upon the specific context of the site. The Standard further qualifies the assessment protocol by outlining conditions to the comparative assessment and stating that “not all adverse impacts will lead to complaints and not every complaint is proof of an adverse impact”, thus implying that all sites should be assessed on their own merits and specifics.

The Standard quantifies the typical reference periods (for the purposes of the standard) to be used in the assessment of noise:

Typical Daytime 07:00 – 23:00 1hr assessment period

Typical Night-time 23:00 – 07:00 15min assessment period

The Standard outlines a number of methods for defining appropriate “character corrections” within the Rating Levels to account for tonal qualities, Impulsive qualities, other sound characteristics and/or intermittency. These are a) the Subjective Method, b) the Objective Methods for tonality, and c) the Reference Method. It is noted by the Standard that where multiple features are present the corrections should be added in a linear fashion to the Specific level.

The Subjective Method is based on the following corrections:

**Table 10A-1: BS4142 Subjective Method Rating Corrections**

Level of Perceptibility	Tonal Correction	Impulsivity Correction	Correction for "Other sound characteristics"	Intermittency Correction
No Perceptibility	+0 dB	+0 dB	Where neither tonal nor impulsive but clearly identifiable +3 dB	If intermittency is readily identifiable +3 dB
Just Perceptible	+2 dB	+3 dB		
Clearly Perceptible	+4 dB	+6 dB		
Highly Perceptible	+6 dB	+9 dB		

However, the Standard states that the assessment methodology provided not intended for the derivation of internal noise levels arising from sound levels outside or “where background sound levels and rating levels are low”, however, with regard to the latter no definition of “low” is provided . Where these situations prevail it is considered appropriate to reference the absolute guidance levels provided in British Standard BS 8233: 2014 – Guidance on Sound Insulation and Noise Reduction for Buildings and the World Health Organisation ‘Guidelines for Community Noise’ and ‘Night Noise Guidance for Europe’.

***BS5228 +A1:2014 - ‘Code of practice for noise and vibration control on construction and open sites’ Part 1: Noise***

Part 1 of BS5228, Code of practice for basic information and procedures for noise control, gives recommendations for basic methods of noise control relating to construction and open sites where work activities/operations generate significant noise. The document includes sections on: legislative background; community relations; training; occupational noise effects; neighbourhood nuisance; project supervision; and control of noise.

Annexes include information on: EC and UK legislation; noise sources, remedies and their effectiveness (mitigation options); sound level data for onsite equipment and site activities (source terms that are used for modelling); a methodology for estimating noise from sites



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(calculation procedures which form the basis of the modelling packages); and guidance relating to noise monitoring.

It is noted, that the guidance of BS5228 Part 1 provides example noise effect significance criteria within Annex E, and states the key factors that must be considered. These include:

- a) site location;
- b) existing ambient noise levels;
- c) duration of site operations;
- d) hours of work;
- e) attitude of the site operator; and
- f) noise characteristics.

BS5228 contains two example methods of determining the significance of construction noise. Method 1 'The ABC Method' examines absolute levels based on various threshold categories and is detailed in the table below:

**Table 10A-2: BS5228 Construction Significance Criteria – ABC Method**

Assessment category and threshold value period (L <sub>Aeq</sub> )	Threshold value, in decibels (dB)		
	Category A <sup>A)</sup>	Category B <sup>B)</sup>	Category C <sup>C)</sup>
Night-time (23:00 – 07:00)	45	50	55
Evening and Weekends <sup>D)</sup>	55	60	65
Daytime (07:00 -19:00) and Saturdays (07:00 – 13:00)	65	70	75
<p>NOTE 1 A significant effect has been deemed to occur if the total L<sub>Aeq</sub> noise level, including construction, exceeds the threshold level for the Category appropriate to the ambient noise level.</p> <p>NOTE 2 If the ambient noise level exceeds the threshold values given in the table (i.e. the ambient noise level is higher than the above values), then a significant effect is deemed to occur if the total L<sub>Aeq</sub> noise level for the period increases by more than 3 dB due to construction activity.</p> <p>NOTE 3 Applied to residential receptors only.</p>			
<p><sup>A)</sup> Category A: threshold values to use when ambient noise levels (when rounded to the nearest 5 dB) are less than these values</p> <p><sup>B)</sup> Category B: threshold values to use when ambient noise levels (when rounded to the nearest 5 dB) are the same as category A values</p> <p><sup>C)</sup> Category C: threshold values to use when ambient noise levels (when rounded to the nearest 5 dB) are higher than category A values</p> <p><sup>D)</sup> 19:00 – 23:00 weekdays, 13:00 – 23:00 Saturdays and 07:00 – 23:00 Sundays.</p>			

Method 2 of BS5228 refers to a '5 dB(A) Change' and states that construction noise is deemed to be significant if the total noise level exceeds the pre-construction ambient noise level by 5 dB or more, subject to lower cut off values of 65 dB, 55 dB and 45 dB for the daytime, evening and night-time periods respectively.

The Standard references that it is good practice to attempt to minimise construction noise impacts through environmental controls defined in either a Construction Environmental Management Plan (CEMP) or a Code of Construction Practice.

***BS5228 'Code of practice for noise and vibration control on construction and open sites'  
Part 2: Vibration***

Part 2 of BS5228 gives recommendations for basic methods of vibration control relating to construction and open sites. The Standard also describes the legislative background to vibration control and offers advice regarding the establishment of effective liaison between developers, site operators and local authorities. The Standard also contains guidance on measuring and assessing the effects of vibration.

With regard to the assessment of significance of vibration BS5228 refers to BS6472 (discussed in more detail later in this section). However, BS5228 also presents the following guidance on vibration levels and effects referenced to PPV criteria as reproduced below:

**Table 10A-3: BS5228 Vibration Significance Criteria**

BS5228 Guidance on effects of vibration levels	
Vibration Level	Effect
0.14 mm/s	Vibration might be just perceptible in the most sensitive situations for most vibration frequencies associated with construction. A lower frequencies, people are less sensitive to vibration
0.3mm/s	Vibration might be just perceptible in residential environments
1.0 mm/s	It is likely that vibration of this level in residential environments will cause complaint, but can be tolerated if prior warning and explanation has been given to residents
10 mm/s	Vibration is likely to be intolerable for any more than a very brief exposure to this level

With regard to structural response to vibration BS5228 refers to the damage threshold criteria presented in BS7385 discussed later in this section.



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***BS6472 - Guide to evaluation of human exposure to vibration in buildings; Parts 1 and 2: 2008***

This British Standard presents guidelines for the evaluation of vibration issues relating to human perception. Part 1 of the document examines vibration from sources other than blasting and Part 2 deals with blast-induced vibration. Due to the nature of the vibration generating activities proposed within the construction operations associated with the TRRC development it is considered that only part 1 of the Standard is appropriate.

Part 1, vibration from sources other than blasting, categorises vibration as either being continuous, intermittent, occasional or impulsive in nature. The distinct classifications are as defined by the Standard as below:

- I. *Continuous Vibration* – Vibration is continuous when it is uninterrupted for the assessment period. This can be either a daytime period of 16 h, e.g. 7:00 to 23:00, or a night-time period of 8 h, e.g. 23:00 to 7:00;
- II. *Intermittent Vibration* – Intermittent vibration is vibration which is perceived in separately identifiable repeated bursts. Its onset can be sudden, or there might be a gradual onset and termination bounding a more sustained event. Bursts may happen several to many times in a day or night period;
- III. *Occasional Vibration* – Occasional vibration occurs less often than intermittent vibration, and might be less predictable;
- IV. *Impulsive Vibration* – whether continuous, intermittent or occasional is characterised by rapid build up to a peak, which may or may not be sustained for a period, followed by a damped decay, which may or may not involve several cycles of vibration (dependent upon frequency and damping). It can also consist of a sudden

application of several cycles at approximately the same amplitude, providing that the duration is short.

Table 10A-3 below summarises the guidance of Part 1 with respect to human perception thresholds. The table presents values at which vibration from construction activities are likely to result in adverse comment from occupiers in terms of 16hr daytime (07:00 – 23:00) and 8hr night-time (23:00 – 07:00) Vibration Dose Values (VDV).

Vibration Dose Value (VDV) can be defined as the relationship between the duration of the exposure and the magnitude of a vibration event for the assessment of impulsive and intermittent vibration. VDV is a time dependant based parameter whereby *“a two fold decrease in vibration magnitude is equivalent to a 16 fold decrease in the duration of the vibration”*. This is due to the relationship between the exposure and magnitude, which is defined by the fourth root of the integral of the fourth power of the frequency weighted acceleration.

**Table 10A-4: BS6472 VDV Significance Criteria**

Building/Location	Period	Threshold Criterion mm/s		
		Low probability of Adverse Comment (ms <sup>-1.75</sup> )	Adverse Comment Possible (ms <sup>-1.75</sup> )	Adverse Comment Probable (ms <sup>-1.75</sup> )
Residential Building	Day-time	0.2 to 0.4	0.4 – 0.8	0.8 to 1.6
Residential Building	Night-time	0.1 to 0.2	0.2 to 0.4	0.4 to 0.8

NOTE – For offices and workshops, multiplying factors of 2 and 4 respectively should be applied to the above vibration dose value ranges for a 16 hour day.



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***BS7385 – Evaluation and measurement for vibration in buildings Part 1: 1990 and Part 2:1992***

With respect to damage criteria associated with ground borne vibration the appropriate guidance is contained within BS 7385.

It is stated within of BS7385 that “*Peak Particle Velocity (PPV) has been found to be the best single descriptor” of vibration induced damage*”. The standard recommends the simultaneous measurement of the three orthogonal components of particle velocity (Longitudinal, Vertical and Transverse) in order to attain the maximum value in any plane. The figures stated below relate to this maximum value.

With regard to damage to buildings resulting from vibration, the following three categories have been defined in order to aid with description:

**Cosmetic** - the formation of hairline cracks or the growth of existing cracks in plaster, drywall surfaces or mortar joints.

**Minor** - the formation of large cracks or loosening and falling of plaster on drywall surfaces, or cracks through bricks / concrete blocks.

**Major or Structural** - damage to structural elements of a building.

The guidance limits proposed for the prevention of cosmetic damage within this BS are contained within Table 10A-5 below. The table presents thresholds at which vibration from construction activities may result in damage as measured in Peak Particle Velocity (PPV).

**Table 10A-5: BS6472 VDV Significance Criteria**

Line	Type of Building	Peak Component particle velocity in frequency range of predominant pulse	
		4Hz to 15Hz	15Hz and above
1	Reinforced or framed structures. Industrial and heavy commercial buildings	50mms <sup>-1</sup> at 4Hz and above	
2	Un-reinforced or light framed structures. Residential or light commercial type buildings	15mms <sup>-1</sup> at 4Hz increasing to 20mms <sup>-1</sup> at 15Hz	20mms <sup>-1</sup> at 15Hz increasing to 50mms <sup>-1</sup> at 40Hz and above

It is further stated within BS7385 that the onset of Minor damage is possible at magnitudes greater than twice those presented within Table 10A-5 above, with Major damage to the structural elements of a building occurring at values in excess of four times the values quoted above. With regard to cosmetic damage the “probability of damage tends towards zero at 12.5mms<sup>-1</sup> peak component particle velocity”.

Relating to cosmetic damage resulting from continuous vibration events (as defined within BS6472: 1992), the values as presented within Table 10A-4 above may require to be reduced by a factor of up to 50%.

***BS8233: 2014 ‘Guidance on sound insulation and noise reduction for buildings’***

This is the current UK guidance methodology with regard to acceptable noise levels within buildings utilised by humans. The standard defines design criteria for certain habitable rooms for new or altered dwellings. These design criteria can also be applied to existing dwellings.

Table 10A-6 below shows a summary of the levels recommended in BS8233 for rooms used for resting and sleeping within residential settings.

**Table 10A-6: BS8233 Internal Design Criteria Values**

BS8233 Internal Noise Criteria			
Activity	Location	07:00 to 23:00	23:00 to 07:00
Resting	Living Rooms	35dB LAeq, 16hr	-
Dining	Dining room/ Area	40dB LAeq, 16hr	-
Sleeping (daytime resting)	Bedroom	35dB LAeq, 16hr	30dB LAeq, 8hr

***The World Health Organisation Guidelines for Community Noise***

The World Health Organisation’s (WHO) ‘Guidelines for Community Noise’ report for external environmental noise levels states that;

*“4.2.7 Annoyance responses*

*During the daytime, few people are seriously annoyed by activities with LAeq levels below 55dB; or moderately annoyed with LAeq levels below 50dB. Sound pressure levels during the evening and night should be 5-10dB lower than during the day....”*

For night-time noise sources the WHO guidelines recommend a night-time (23:00 – 07:00) 8hour noise level of 30dB LAeq inside bedrooms (for reasonably steady noise source) to avoid sleep disturbance.

For internal noise levels during the daytime and evening period it is suggested that a noise level of 35dB LAeq, 16hr (07:00 – 23:00hrs) be achieved to avoid speech intelligibility and moderate annoyance.

A summary of the guideline internal noise levels, taken from Table 1 of the WHO guidelines, is presented below within Table 10A-6.

**Table 10A-7: WHO Guideline Values**

Specific Environment	Critical Health Effect(s)	L <sub>Aeq</sub> (dB)	Time Base (Hours)	L <sub>Amax, fast</sub> (dB)
Dwelling, Indoors	Speech Intelligibility & Moderate annoyance daytime & evening	35	16	-
Inside bedrooms	Sleep disturbance, night-time	30	8	45

**World Health Organisation: Night Noise Guidelines for Europe (2009)**

The ‘Night Noise Guidelines for Europe’ was published by the WHO in 2009 and works in association with the 2000 Guidelines for Community Noise. The guidance identifies that for night-time noise levels of 30dB outside, there would be no observed biological effects. The threshold where complaints may be expected to be received is given as being at L<sub>night outside</sub> levels of 35dB, although the Guidelines state there is limited evidence available to demonstrate this.

The guidance also states that;

*“Considering the scientific evidence on the thresholds of night noise exposure indicated by L<sub>night, outside</sub> as defined in the Environmental Noise Directive (2002/49/EC), an L<sub>night, outside</sub> of 40dB should be the target of the night noise guidelines (NNG) to protect the public, including the most vulnerable groups such as children, the chronically ill and the elderly.”*

The document accords well with the ‘Good’ internal design criteria as defined within BS8233 when windows are open for ventilation.

### ***The Design Manual for Roads and Bridges***

The Design Manual for Roads and Bridges (DMRB) Volume11, Section 3, Part 7, HD213/11 Noise and Vibration provides advice on the assessment of noise and vibration impacts due to road traffic.

It does not provide procedures for calculating noise from road traffic; instead it provides guidance on assessing the potential impact of changes in noise levels on sensitive receptors. The assessment methodology for impact significance is based upon the premise that subjective response to noise from a new source is proportional to the change in overall noise level. The DMRB rates impact through consideration of the change in 18 hour  $L_{A10}$  measurement by noise change bands in both the long and short terms.

The DMRB short term and long term scale to assess noise impacts is shown in Table 10A-8 below.

**Table 10A-8: DMRB Noise Change Impact Significance Criteria**

Short Term Change (Opening year)	Impact Descriptor	Magnitude	Long Term Change (Future Assessment year)
0.0 dB	No Change		0.0 dB
0.1 – 0.9 dB	Negligible		0.1 – 2.9 dB
1.0 – 2.9 dB	Minor		3.0 – 4.9 dB
3 – 4.9dB	Moderate		5.0 – 9.9 dB
5.0 dB +	Major		10.0 dB +

### ***Calculation of Road Traffic Noise Memorandum***

The Technical Memorandum, Calculation of Road Traffic Noise (CRTN) (Department of Transport and Welsh Office, 1988) document details an empirical prediction methodology for the calculation of road traffic noise. The procedures described within the document set



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out the calculation methodology as well as the information requirements which includes traffic flow components, the type of ground cover, relevant heights and distances, and the presence of any barriers/obstructions.

These are used in order to calculate the source noise level of the given road link and the reduction in noise at a given receiver location due to propagation and screening effects.

The document further outlines where and how the monitoring of existing traffic noise conditions should be undertaken