This Technical Appendix document presents further detail on the national guidance and standards relevant to the noise assessment of the Solar Farm at Tye Lane.

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

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.

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.

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.

Relevant Guidance

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.

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

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 (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 Annexe 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 A1: BS5228 'ABC' Method Assessment Values

Assessment category and threshold value period (L_{Aeq})	Threshold Value, in decibels (dB)		
	Category A A)	Category B B)	Category C C)
Night-time (23:00 – 07:00)	45	50	55
Evening and Weekends D)	55	60	65
Daytime (07:00 – 19:00 and Saturdays 07:00 – 13:00)	65	70	75

NOTE 1 A significant effect has been deemed to occur if the total L_{Aeq} noise level, including construction, exceeds the threshold level for the Category appropriate to the ambient noise level.
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_{Aeq} noise level for the period increases by more than 3 dB due to construction activity.
NOTE 3 Applied to residential receptors only.

A) Category A: threshold values to use when ambient noise levels (when rounded to the nearest 5 dB) are less than these values
B) Category B: threshold values to use when ambient noise levels (when rounded to the nearest 5 dB) are the same as category A values
C) Category C: threshold values to use when ambient noise levels (when rounded to the nearest 5 dB) are higher than category A values
D) 19:00 – 23:00 weekdays, 13:00 – 23:00 Saturdays and 07:00 – 23:00 Sundays.

Method 2 of BS5228 refers to a '5dB(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 5dB or more, subject to lower cut off values of 65dB, 55dB and 45dB for the daytime, evening and night-time periods respectively.

The standard states 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.

BS4142: 2014+A1:2019 'Methods for rating and assessing industrial and commercial sound

The standard method for assessing noise of an industrial or commercial nature affecting housing, is British Standard BS 4142 "Method for rating and assessing industrial and commercial sound". A BS 4142 assessment is typically made by determining the difference between the industrial noise under consideration and the background sound level as represented by the L_{A90} parameter, determined in the absence of the industrial noise. The L_{A90} parameter is defined as the level exceeded for 90% of the measurement time, representing the underlying noise in the absence of short duration noise events such as dog barks or individual cars passing.

The industrial noise under consideration is assessed in terms of the ambient noise level, L_{Aeq}, but a character correction penalty can be applied where the noise exhibits certain characteristics such as distinguishable tones, impulsiveness or, if the noise is distinctively intermittent. The ambient noise level, L_{Aeq} is defined as the steady-state noise level with the same energy as the actual fluctuating sound over the same time period. It is effectively the average noise level during the period. The industrial noise level (L_{Aeq}) with the character correction (if necessary) is known as rating level, L_{Ar}, and the difference between the background noise and the rating level is determined to make the BS 4142 assessment. The standard then states:

a) "Typically, the greater the difference, the greater the magnitude of the impact.
b) A difference of around +10dB or more is likely to be an indication of a significant adverse impact, depending on the context.
c) A difference of around +5dB is likely to be an indication of an adverse impact, depending on the context.

d) The lower the rating level is relative to the measured background sound level, the less likely it is that the specific sound will have an adverse impact or a significant adverse impact. Where the rating level does not exceed the background sound level, this is an indication of the specific sound source having a low impact, depending on the context."

The standard outlines a number of methods for defining appropriate 'character corrections' to determine the rating levels to account for tonal qualities, impulsive qualities, other sound characteristics and/or intermittency.

The standard also highlights the importance of considering the context in which a sound occurs. The standard indicates that factors including the absolute sound level, the character of the sound, the sensitivity of the receptor and the existing acoustic character of the area should be considered when assessing the noise impact. The absolute sound level is of particular importance where the measured background sound levels are low, which is typically taken as LA90 30dB and below. In regard to low sound levels, the standard states:

"Where background sound levels and rating levels are low, absolute levels might be as, or more, relevant than the margin by which the rating level exceeds the background. This is especially true at night."

Guidelines for Environmental Noise Impact Assessment

The institute of Environmental Management and Assessment (IEMA) guidance (Oct 2014) addresses the key principles of noise impact assessment and how these fit within the Environmental Impact Assessment (EIA) process. The guidance document is not intended as a prescriptive methodology for noise impact assessment.

The document offers guidance on the processes involved in the assessment of noise for both the EIA process and smaller scale developments including: scoping; establishing baselines; prediction of noise levels; assessment; and mitigation.

The guidance details a matrix of degree of effect which is summarised below:

Table A2: Degree of Effect Matrix

		Importance/ Sensitivity of Receptor			
		High	Medium	Low	Negligible
Magnitude of Change	Large	Very Substantial	Substantial	Moderate	None
	Medium	Substantial	Substantial	Moderate	None
	Small	Moderate	Moderate	Slight	None
	Negligible	None	None	None	None

The effect matrix should be read in conjunction with the effect descriptors below.

Table A3: Effect Descriptor

Very Substantial	Greater than 10dB L_{Aeq} change in sound level perceived at a receptor of great sensitivity to noise.
Substantial	Greater than 5dB L_{Aeq} change in sound level at a noise-sensitive receptor, or a 5 to 9.9dB L_{Aeq} change in sound level at a receptor of great sensitivity to noise.
Moderate	A 3 to 4.9dB L_{Aeq} change in sound level at a sensitive or highly sensitive noise receptor, or a greater than 5dB L_{Aeq} change in sound level at a receptor of some sensitivity.
Slight	A 3 to 4.9dB L_{Aeq} change in sound level at a receptor of some sensitivity.
None/ Not Significant	Less than 2.9dB L_{Aeq} change in sound level and/or all receptors are of negligible sensitivity to noise or marginal to the zone of influence of the proposals.

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 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.

This Technical Appendix document outlines the protocols and methodologies employed within the scope of the 3D acoustic modelling of the Solar Farm.

Prediction Protocols

The facility is neither in situ or operational at the current time therefore, noise associated with the plant/ equipment has been assessed by means of a 3D noise model, constructed using the IMMI software.

Within the modelling exercise informing this study, acoustic propagation has been calculated in accordance with ISO9613-2: Acoustics – Attenuation of sound during propagation outdoors: Part 2: General method of calculation. The Immi software implements this methodology in full.

The prediction methodology of the ISO Standard takes account of wind and meteorological conditions in the following ways:

- Wind Direction – The software assumes a positive wind vector in all directions from the source to receptor.
- Humidity – 70%
- Temperature – 10°C

In addition, ground conditions are considered to be soft between the site and receiver locations.

Foundation of the Noise Model

The noise model was constructed utilising the following information:

- OS Open data mapping (TIFF format);
- Digital Terrain Mapping obtained from OS Open Data (DWG format);
- Site layout plan supplied by Engena Ltd; and,
- Noise levels for the proposed plant and equipment provided by Engena Ltd.

Modelling Assumptions

Within the construction of the noise model the following assumptions have been made:

- All predictions are made to a free field receptor location at a height of 1.5m above local;
- Screening effect of hedgerows and perimeter fences etc is assumed to be negligible;
- All off site buildings are assumed to be 8m high from local ground height.

To confirm, the following noise sources were used within the noise modelling assessment:

MV Power Station

The site will accommodate 17no power transformer / inverter units. The information provided indicates that the units will be from the SMA MV Power Station Range fitted with appropriate dampeners to reduce overall noise emissions. The power stations will operate during both the charging and discharging phases.

Information available for the units used in this assessment is summarised in the Table below. This presents the sound power level used in the noise modelling assessment.

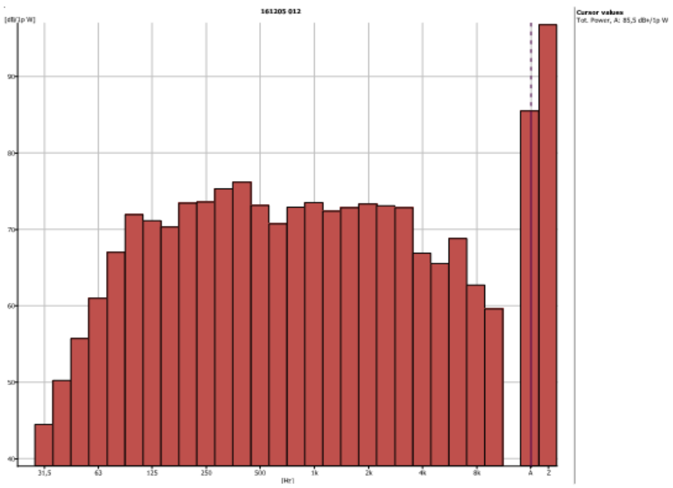
Table B1: Power Transformer / Inverter Linear Sound Power Level Spectrum

Noise Source	Sound Power Levels in Octave Bands, Hz dB							L_{WA}, dB
	63Hz	125Hz	250Hz	500Hz	1kHz	2kHz	4kHz	
Assumed Mitigated SMA	96.7	92.1	87.6	81.9	77.7	76.6	73.4	85.5

The information available includes 1/3rd octave band noise levels and is copied below for reference.

2 PRELIMINARY RESULTS - VIBRATION DAMPER

- Tonality is nearly eliminated
- The overall noise level is the same, i.e. -8dB(A) reduction but with reduced tonality at the switching frequencies.



Frequency	Tot.Pwr,A
25 Hz	39,02
31,5 Hz	44,5
40 Hz	50,24
50 Hz	55,71
63 Hz	60,98
80 Hz	67,02
100 Hz	71,93
125 Hz	71,13
160 Hz	70,33
200 Hz	73,42
250 Hz	73,56
315 Hz	75,3
400 Hz	76,17
500 Hz	73,12
630 Hz	70,74
800 Hz	72,9
1 kHz	73,49
1,25 kHz	72,38
1,6 kHz	72,83
2 kHz	73,29
2,5 kHz	73,09
3,15 kHz	72,84
4 kHz	66,89
5 kHz	65,54
6,3 kHz	68,8
8 kHz	62,71
10 kHz	59,59
A	85,48
Z	96,77

Analysis of the 1/3rd octave band information indicates no tonal content in the noise emissions.