Great North Road Solar and Biodiversity Park

Environmental Statement

Volume 4 – Technical Appendices

Technical Appendix A12.2 – Noise and Vibration Modelling

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Contents

A12.2.1 CONSTRUCTION NOISE

1 The following construction activities have been considered as part of this assessment:

- Construction of hardstanding;
- Installation of PV modules and fencing;
- Installation of substations and BESS; and
- Installation of cable route.

2 Construction noise predictions have been made using the formulae specified in BS 5228:2009+A1:2014 – *Code of practice for noise and vibration control on construction and open sites*. Noise levels for plant / equipment items have been sourced from Annex C of BS 5228-1.

3 As a worst case, predictions of construction noise level are based on the following assumptions:

- All plant operational simultaneously;
- No reduction in noise due to barrier effects, either through existing buildings or created by the progressive installation of PV panels;
- All plant operating 100 % of the time; and
- No reduction in noise as a result of topographical screening.

4 The number of HGV movements has been calculated by taking the worst-case daily total 2-way movements down a single public road (68 2-way movements, including a 50% uplift) and dividing by the number of working hours (10.5).

5 Tables A12.2.1 – A12.2.4 below present the modelling inputs for each construction activity.

Table A12.2.1: Construction of Hardstanding

BS 5228 Ref.	Plant / Equipment	Quantity	On-time (%)	Sound Pressure Level at 10 m dB, L_{Aeq}	Sound Power Level (LWA), dB
Construction Equipment					
C3.20	Compact excavator	1	100	68	96
C4.41	Mobile crane	1	100	71	99
C2.13	Crawled dozer	1	100	78	106
C2.15	Excavator	1	100	76	104
C4.55	Telehandler	1	100	70	98
C4.78	Generator	1	100	66	94
C2.39	Vibrating roller	1	100	74	102
Haulage					
C2.34	Road Lorry	6 per hour	-	80	108

Table A12.2.2: Installation of PV Modules and Fencing

BS 5228 Ref.	Plant / Equipment	Quantity	On-time (%)	Sound Pressure Level at 10m dB, L_{Aeq}	Sound Power Level (LWA), dB
Construction Equipment					
C3.17	Piling Rig	3	100	76	109
C4.41	Mobile Tele Crane	1	100	71	99
C2.15	Tracked Excavator	1	100	76	104
C4.55	Telehandler	3	100	70	103
C4.78	Generator	1	100	66	94
C3.20	Compressor for Piling	3	100	75	108
Haulage					
C2.34	Road Lorry	6 per hour	-	80	108

Table A12.2.3: Substation and BESS Construction

BS 5228 Ref.	Plant / Equipment	Quantity	On-time (%)	Sound Pressure Level at 10m dB, L_{Aeq}	Sound Power Level (LWA), dB
Construction Equipment					
C3.20	Compact Excavator	1	100	68	96
C4.41	Mobile Tele Crane	1	100	71	99
C4.93	Angle Grinder	1	100	80	108
C2.13	Crawled Dozer	1	100	78	106
C4.55	Telehandler	1	100	70	98
C4.78	Generator	1	100	66	94
C3.17	Piling Rig	1	100	76	104
C3.20	Compressor for Piling	1	100	75	103
C3.34	Gas Cutter	1	100	68	96
C4.57	Lifting Platform	1	100	67	95
Haulage					
C2.34	Road Lorry	6 per hour	-	80	108

Table A12.2.4: Cable Installation

BS 5228 Ref.	Plant / Equipment	Quantity	On-time (%)	Sound Pressure Level at 10m dB, L_{Aeq}	Sound Power Level (LWA), dB
Construction Equipment					
C4.66	Backhoe Loader	1	100	69	97
C2.17	Excavator	1	100	70	98
C4.55	Telehandler	1	100	70	98
C4.78	Generator	1	100	66	94
C2.39	Vibrating Roller	1	100	74	102
C2.44	Direction Drill Generator (for HDD)	1	100	77	105
C2.45	Water Pump (for HDD)	1	100	65	93
C3.17	Auger Piling (for HDD)	1	100	76	104
Haulage					
C2.34	Road Lorry	6 per hour	-	80	108

6 The overall noise levels for each activity have been calculated by combining the noise from the construction equipment and HGV movements within the construction area itself.

7 In order to identify receptors which may experience medium levels of effect, the distances at which noise from each activity would fall below 65 dB $L_{Aeq,t}$ (i.e. the level at which a medium magnitude of effect would be experienced) have been calculated.

8 It is notable that the calculation of these distances assumes all construction equipment identified in Tables A12.2.1 – A12.2.4 is operational simultaneously, for 100% of the time, at the same location. In practice, it is highly unlikely that this would occur.

9 Table A12.2.5 below presents the distances at which noise from each construction activity would be equal to the daytime construction noise threshold of 65 dB $L_{Aeq,t}$, as discussed in Section 12.4.3 of Chapter 12 [EN010162/APP/6.2.12].

Table A12.2.5: Distances at which noise from construction activities would equal 65 dB $L_{Aeq,t}$

Construction of tracks and hardstanding	PV module construction	Installation of substations and BESS	Installation of cable route
65 m	75 m	80 m	55 m

10 In order to assess noise from HGV movements along public roads, the $L_{Aeq,t}$ level has been calculated assuming the following:

- 80 dB L_{Aeq} at 10 m from a single lorry movement (as per C2.34 in BS 5228);
- 6 HGV movements per hour;
- Average speed of 50 km/h;
- 4 m to nearest receptors, in line with CRTN; and
- No account made for screening.

11 Based on the above, the predicted noise level for HGV movements is 60 dB $L_{Aeq,t}$.

12 The above prediction is conservative for the following reasons;

- HGV movements include a 20 % uplift to allow for uncertainty in the number of HGVs required, and account for fluctuations where HGV movements are not spread evenly across the month / day;
- HGV movements have been based on the maximum anticipated number of daily HGV movements; and
- In practice, dwelling located adjacent to public roads will likely be located greater than 4 m from the road.

A12.2.2 CONSTRUCTION VIBRATION

13 Construction activities with the potential to result in vibration impacts are as follows:

- Vibratory piling of PV mounting structures framework, fencing and HDD; and
- Vibratory compaction of tracks / hardstanding areas.

14 The formulae BS 5228-2 have been used to predict vibration from each of the above activities, based on the following inputs:

- 85 kJ hammer energy for PV mounting piling rig;
- 0.86 mm maximum drum vibration amplitude, based on CAT CB10 Vibratory Roller for vibratory compaction of tracks; and
- 2x vibrating drums.

15 In order to identify receptors which may experience construction vibration effects, the distances at which vibration from each activity would fall below 1 mm/s PPV (i.e. the level at which a medium magnitude of effect would be experienced) have been calculated, as detailed in Table A12.2.6.

Table A12.2.6: Distances at which vibration from construction activities would equal 1 mm/s

Vibratory piling of PV mounting, fencing and HDD	Vibratory compaction of tracks / hardstanding areas
25 m	20 m

A12.2.3 OPERATIONAL NOISE

A12.2.3.1 MODELLING PARAMETERS

16 The specific sound level at each assessed NSR has been calculated in SoundPlan software, using the environmental noise propagation model ISO 9613-2:2024 - Acoustics, '*Attenuation of sound during propagation outdoors – Part 2: General method of calculation*'.

17 The ISO 9613-2 method predicts the level of sound at a receptor by taking the octave band sound power level spectrum of the source and applying a number of attenuation factors that determine the resulting level at the receptor location. The following parameters were used in the prediction model and are considered to provide a conservative prediction of the noise levels likely to be experienced in practice:

- Atmospheric conditions of 10°C and 70% relative humidity;
- A ground factor of G= 0 (hard ground) for BESS / substation hardstanding areas and areas of water, and G=1 (soft ground) for all other areas;
- Includes local topography;
- Buildings in the surrounding area are included and modelled with a standard height of 6 m;
- No boundary fences or walls have been included in the noise model;
- A 4 m high acoustic fence has been included around the BESS and 400 kV Substation area;
- A receiver height of 1.5 m at the closest external amenity space at the identified NSR locations (approximating head height).

18 Modelling has been undertaken based on the illustrative layout. The illustrative layout includes the following noise sources:

- 539x Inverter stations (162x array inverters, 377x BESS inverters);
- 754x Battery storage containers;
- 17x Substation transformers (3x 33 kV transformers per intermediate substation, 4x 33 kV and 1x 400 kV transformers 400 kV substation); and
- 6x Harmonic filters (i.e. 1x harmonic filter per intermediate substation, 2x harmonic filter in 400 kV substation).

19 Additional infrastructure includes storage containers and switchgear / metering equipment. These elements emit negligible levels of noise and therefore have not been considered further as part of this assessment.

20 Noise sources are modelled as follows:

- Inverter stations modelled as point sources at a height of 3.5 m;
- Battery containers modelled as industrial buildings with area sources on each facade;
- Transformers modelled as point sources at height of 5.5 m; and
- Harmonic filters modelled as point sources at height of 5.5 m.

A12.2.3.2 SOUND LEVEL DATA

21 The plant modelled as part of this assessment has been provided by the Client and is based on that used for similar developments.

22 Noise emission data for all plant is summarised in Table A12.2.7 below.

Table A12.2.7: Equipment Sound Power Levels

Equipment	Sound Power Level dB, L_{WA}	Octave Band Centre Frequency, Hz, dBA							
		63	125	250	500	1000	2000	4000	8000
Inverter Stations	86	60	65	72	69	68	76	84	75
Battery Containers	76	57	75	61	62	65	62	55	50
Transformers	88	62	78	84	83	80	63	61	53
Harmonic Filters	77	51	67	73	72	69	52	50	42

A12.2.3.3 RATING LEVEL CORRECTIONS

23 BS 4142 states that corrections should be applied to account for certain acoustic features which have the potential to increase the level of impact at nearby dwellings.

24 The three acoustic features to be considered in the application of rating corrections are as follows:

- Impulsivity: No impulsive characteristics are anticipated from the Development;
- Tonal Elements: The main noise emitting plant in the Development are the cooling systems associated with the inverter stations and transformers. Based upon substantial prior experience of operational solar and BESS developments, the overall noise from such developments is typically broadband in nature and therefore non-tonal. However, in order to account for any potential tonal character emitted by the transformers, a 2 dB correction has been applied as a conservative approach;
- Intermittency: While certain plant may operate on thermostats, there will be no synchronisation between the various units. The overall noise level change due to a single inverter or battery unit switching on / off would be negligible, and not distinguishable at the receptors. Therefore, when taken as a whole, the Development will not have '*identifiable on / off conditions'* in terms of BS 4142, and no correction for intermittency is therefore required.

25 Based on the above, the Rating levels at the assessed NSRs are therefore 2 dB higher than the Specific levels.

A12.2.3.4 OPERATIONAL NOISE MODELLING RESULTS

26 Table A12.2.8 presents the predicted noise level at each assessed NSR, as well as the daytime background noise level, margin between background level and Rating level, and the subsequent magnitude of effect, subject to the 35 dB threshold, as per the criteria in Table 12.6 of chapter 12.

Table A12.2.8: Daytime Operational Noise Assessment

NSR	Specific Level, dB(A)	Rating Level, dB(A)	Daytime Background Noise Level, dB L_{A90}	Margin, dB	Magnitude of Effect
H1	23	25	54	-29	Negligible
H2	17	19	41	-22	Negligible
H3	14	16	54	-38	Negligible
H4	16	18	41	-23	Negligible
H5	18	20	41	-21	Negligible
H6	17	19	41	-22	Negligible
H7	16	18	41	-23	Negligible
H8	18	20	54	-34	Negligible
H9	20	22	41	-19	Negligible
H10	20	22	48	-26	Negligible
H11	18	20	36	-16	Negligible
H12	18	20	42	-22	Negligible
H13	25	27	42	-15	Negligible
H14	16	18	36	-18	Negligible
H15	19	21	46	-25	Negligible
H16	25	27	46	-20	Negligible
H17	23	25	46	-21	Negligible
H18	18	20	39	-19	Negligible
H19	26	28	39	-11	Negligible
H20	21	23	39	-16	Negligible
H21	31	33	41	-8	Negligible
H23	18	20	39	-19	Negligible
H51	30	32	37	-5	Negligible
H52	27	29	42	-13	Negligible
H53	32	34	42	-8	Negligible
H54	25	27	42	-15	Negligible

NSR	Specific Level, dB(A)	Rating Level, dB(A)	Daytime Background Noise Level, dB L_{A90}	Margin, dB	Magnitude of Effect
H55	35	37	45	-8	Negligible
H56	34	36	45	-9	Negligible
H57	32	34	37	-3	Negligible
H58	25	27	39	-13	Negligible
H59	25	27	40	-13	Negligible
H60	25	27	40	-13	Negligible
H61	28	30	40	-10	Negligible
H62	26	28	40	-12	Negligible
H63	28	30	40	-10	Negligible
H64	22	24	38	-14	Negligible
H65	32	34	42	-9	Negligible
H66	20	22	34	-13	Negligible
H67	19	21	34	-13	Negligible
H68	22	24	32	-8	Negligible
H69	17	19	32	-13	Negligible
H70	21	23	33	-10	Negligible
H71	19	21	33	-12	Negligible
H72	29	31	33	-2	Negligible
H73	16	18	33	-15	Negligible
H74	20	22	33	-11	Negligible
H75	15	17	37	-20	Negligible
H76	13	15	37	-23	Negligible
H77	20	22	38	-16	Negligible
H78	23	25	38	-13	Negligible
H79	19	21	34	-13	Negligible
H80	22	24	36	-12	Negligible
H81	24	26	36	-10	Negligible
H82	25	27	36	-9	Negligible
H83	26	28	36	-8	Negligible
H84	19	21	36	-15	Negligible
H85	15	17	33	-16	Negligible

NSR	Specific Level, dB(A)	Rating Level, dB(A)	Daytime Background Noise Level, dB L_{A90}	Margin, dB	Magnitude of Effect
H86	17	19	33	-14	Negligible
H87	20	22	33	-11	Negligible
H88	20	22	33	-11	Negligible
H89	28	30	33	-3	Negligible

27 Table A12.2.9 presents the predicted noise level at each assessment receptor, as well as the night-time background noise level, margin between background level and Rating level, and the subsequent magnitude of effect subject to the 35 dB threshold, as per the criteria in Table 12.6 of Chapter 12.

Table A12.2.9: Night-time Operational Noise Assessment

NSR	Specific Level, dB(A)	Rating Level, dB(A)	Night-time Background Noise Level, dB LA90	Margin, dB	Magnitude of Effect
H1	23	25	40	-15	Negligible
H2	17	19	33	-14	Negligible
H3	14	16	40	-24	Negligible
H4	16	18	33	-15	Negligible
H5	18	20	33	-13	Negligible
H6	17	19	33	-14	Negligible
H7	16	18	33	-15	Negligible
H8	18	20	40	-20	Negligible
H9	20	22	33	-11	Negligible
H10	20	22	39	-17	Negligible
H11	18	20	33	-13	Negligible
H12	18	20	34	-14	Negligible
H13	25	27	34	-7	Negligible
H14	16	18	33	-15	Negligible
H15	19	21	37	-16	Negligible
H16	25	27	37	-11	Negligible
H17	23	25	37	-12	Negligible
H18	18	20	34	-14	Negligible
H19	26	28	34	-6	Negligible

NSR	Specific Level, dB(A)	Rating Level, dB(A)	Night-time Background Noise Level, dB LA90	Margin, dB	Magnitude of Effect
H20	21	23	34	-11	Negligible
H21	31	33	31	2	Low
H23	18	20	34	-14	Negligible
H51	30	32	33	-1	Negligible
H52	27	29	33	-4	Negligible
H53	32	34	33	1	Low
H54	25	27	30	-3	Negligible
H55	35	37	36	1	Low
H56	34	36	36	0	Low
H57	32	34	33	1	Low
H58	25	27	31	-5	Negligible
H59	25	27	33	-6	Negligible
H60	25	27	33	-6	Negligible
H61	28	30	33	-3	Negligible
H62	26	28	33	-5	Negligible
H63	28	30	33	-3	Negligible
H64	22	24	33	-9	Negligible
H65	32	34	33	1	Low
H66	20	22	27	-6	Negligible
H67	19	21	27	-6	Negligible
H68	22	24	28	-4	Negligible
H69	17	19	28	-9	Negligible
H70	21	23	27	-4	Negligible
H71	19	21	27	-6	Negligible
H72	29	31	27	4	Low
H73	16	18	28	-10	Negligible
H74	20	22	28	-6	Negligible
H75	15	17	31	-14	Negligible
H76	13	15	31	-17	Negligible
H77	20	22	23	-1	Negligible
H78	23	25	23	2	Low

NSR	Specific Level, dB(A)	Rating Level, dB(A)	Night-time Background Noise Level, dB LA90	Margin, dB	Magnitude of Effect
H79	19	21	28	-7	Negligible
H80	22	24	21	3	Low
H81	24	26	21	5	Low
H82	25	27	21	6	Low
H83	26	28	21	7	Low
H84	19	21	21	0	Low
H85	15	17	22	-5	Negligible
H86	17	19	22	-3	Negligible
H87	20	22	21	1	Low
H88	20	22	21	1	Low
H89	28	30	21	9	Low