Lime Down
Solar Park

Environmental Statement

Volume 3, Appendix 14-4: Noise Modelling

September 2025

Revision 1

Planning Inspectorate Reference: EN010168

Document Reference: APP/6.3

APFP Regulation 5(2)(a)

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Appendix 14-4: Noise Modelling

1.1 Introduction

1.1.1 This appendix contains the detailed results and assumptions for the construction and operational noise modelling conducted to support **ES Volume 3, Chapter 14: Noise and Vibration [EN010168/APP/6.1]**.

1.2 Construction and Decommissioning Noise Assessment from Plant on Site

1.2.1 Specific details of the construction works associated with the Scheme will be available once the detailed design and a construction methodology has been prepared. Therefore, at this stage, representative construction activities and reasonable worst-case assumptions, including the likely type and number of construction plant, have been assumed based on information available and previous noise assessments undertaken on similar types of developments.

1.2.2 Sound Power Level (Lw) values for equipment to be used during construction activities have been sourced from BS 5228:2009+A1:2014 Code of Practice for Noise and Vibration Control on Construction and Open Sites - Part 1 (Noise) (BS 5228-1:2014) (Ref 1) with the items of plant in **Table 1** being considered.

Table 1: Solar PV Sites and Cable Corridor Route Construction Plant Sound Power Levels

Activity	Item of Plant)	Number of Plant	BS 5228-1 Reference	Overall A-Weighted Sound Power Level, dB L_w
Construction of BESS, Inverters and Transformers	Tracked excavator	1	BS 5228: Tab C.4 #63	105
	Wheeled Loader	1	BS 5228: Tab C.2 #27	108
	Wheeled mobile telescopic crane	1	BS 5228: Tab C.4 #38	106
	Dump truck (tipping fill)	2	BS 5228: Tab C.2 #30	107
	Telescopic handler	1	BS 5228: Tab C.4 #55	98
	Cement mixer truck (discharging)	1	BS 5228: Tab C.4 #18	103
	Piling Rig	1	BS 5228: Tab C.3 #8	116
Construction of Solar PV Panels	Articulated dump truck	1	BS 5228: Tab C.5 #16	109
	Wheeled mobile telescopic crane	1	BS 5228: Tab C.4 #38	106

Activity	Item of Plant)	Number of Plant	BS 5228-1 Reference	Overall A-Weighted Sound Power Level, dB L_w
	Diesel generator	1	BS 5228: Tab C.4 #85	94
	Continuous flight auger piling	1	BS 5228: Tab C.3 #17	104
	Cement mixer truck (discharging)	1	BS 5228: Tab C.4 #18	103
	Dumper	1	BS 5228: Tab C.4 #9	105
Construction of main 400kV Substation	Tracked excavator	2	BS 5228: Tab C.4 #63	105
	Lorry	4	BS 5228: Tab C.2 #34	108
	Telescopic handler	2	BS 5228: Tab C.4 #55	98
	Continuous flight auger piling	1	BS 5228: Tab C.3 #17	104
	Wheeled mobile crane	4	BS 5228: Tab C.3 #30	98
	Hand-held welder (welding piles)	4	BS 5228: Tab C.3 #31	101
	Generator for welding	4	BS 5228: Tab C.3 #32	101
	Gas cutter (cutting top of pile)	4	BS 5228: Tab C.3 #34	96
	Mobile telescopic crane	2	BS 5228: Tab C.4 #41	99
	Lifting platform	4	BS 5228: Tab C.4 #57	95
	Site lift for workers	4	BS 5228: Tab C.4 #62	94
	Diesel generator	2	BS 5228: Tab C.4 #85	94
Construction of 132kV Substations	Tracked excavator	2	BS 5228: Tab C.4 #63	105
	Lorry	2	BS 5228: Tab C.2 #34	108
	Telescopic handler	2	BS 5228: Tab C.4 #55	98
	Continuous flight auger piling	1	BS 5228: Tab C.3 #17	104
	Wheeled mobile crane	2	BS 5228: Tab C.3 #30	98
	Hand-held welder (welding piles)	2	BS 5228: Tab C.3 #31	101

Activity	Item of Plant)	Number of Plant	BS 5228-1 Reference	Overall A-Weighted Sound Power Level, dB L_w
	Generator for welding	2	BS 5228: Tab C.3 #32	101
	Gas cutter (cutting top of pile)	2	BS 5228: Tab C.3 #34	96
	Mobile telescopic crane	2	BS 5228: Tab C.4 #41	99
	Lifting platform	2	BS 5228: Tab C.4 #57	95
	Site lift for workers	2	BS 5228: Tab C.4 #62	94
	Diesel generator	2	BS 5228: Tab C.4 #85	94
Cable Installation	Tracked excavator	1	BS 5228: Tab C.4 #63	105
	Wheeled Backhoe Loader	1	BS 5228: Tab C.4 #66	97
	Dumper	2	BS 5228: Tab C.4 #9	105
	Telescopic Handler	1	BS 5228: Tab C.4 #55	98
	Vibratory Roller	1	BS 5228: Tab C.5 #27	95

1.3 Construction and Decommissioning Noise Assessment from Horizontal Directional Drilling

1.3.1 Due to the potential requirements for continuous night-time working for Horizontal Directional Drilling (HDD) activities, HDD has been assessed separately to construction noise of plant on site during core working hours on a case-by-case basis.

1.3.2 Sound Power Level (Lw) values for equipment to be used during HDD construction activities have been sourced from BS 5228-1:2014 (Ref 1) with the items of plant in **Table 2** being considered.

Table 2: HDD Construction Plant Sound Power Levels

Activity	Item of Plant)	Number of Plant	BS 5228-1 Reference	Overall A-Weighted Sound Power Level, dB L_w
Horizontal Directional Drilling	Directional Drill (Generator)	1	BS 5228: Tab C.2 #44	105
	Water Pump	1	BS 5228: Tab C.2 #45	93

Activity	Item of Plant)	Number of Plant	BS 5228-1 Reference	Overall A-Weighted Sound Power Level, dB L_w
	Tracked Excavator	1	BS 5228: Tab C.2 #14	107
	Drilling Rig	1	BS 5228: Tab C.3 #15	110

1.4 Construction and Decommissioning Vibration Assessment from Plant on Site

Continuous Flight Auger Piling

1.4.1 It has been assumed that, based on construction requirements for similar developments, that Continuous Flight Auger (CFA) piling may be required for construction of the main 400kV Substation, 132kV Substations and Solar PV Mounting Structures.

1.4.2 Piling source data from BS 5228:2009+A1:2014 Code of Practice for Noise and Vibration Control on Construction and Open Sites - 2 (Vibration) (BS 5228-2:2014) (Ref 1) has been used to estimate the likely distances at which PPV levels would exceed the LOAEL and SOAEL thresholds, defined in Section 14.6 of **ES Volume 2**, **Chapter 14 Noise and Vibration [EN010168/APP/6.1]**, at nearby sensitive receptors. These are presented in **Table 3**.

Table 3: CFA Piling Vibration Prediction Input Data

Global Variable	Value
Activity	Bored CFA Piling
Distance (m)	40
Distance (m)	15
Building Type	Residential
Working Hours, day (07:00-23:00)	1
Working Hours, night (23:00-07:00)	0
Prediction location	Ground floor
Receptor building floor type	Slab construction
Peak Particle Velocity (vres), mm/s at 40m	0.3
Peak Particle Velocity (vres), mm/s at 15m	0.9

1.4.3 CFA piling may generate adverse levels of vibration (i.e. exceeding 0.3mm/s) at receptors within 40m and significant levels of vibration (i.e. exceeding 1.0mm/s) at receptors within 15m.

Vibratory Roller

1.4.4 The highest levels of vibration generated by cable laying activities would be the use of vibratory rollers during reinstatement.

1.4.5 Vibratory roller source data from BS 5228-2:2014 (Ref 2) has been used to estimate the likely distances at which PPV levels would exceed the LOAEL and SOAEL thresholds at nearby sensitive receptors, as defined in Section 14.6 of **ES Volume 2, Chapter 14 Noise and Vibration [EN010168/APP/6.1]**. These are presented in **Table 4**.

Table 4: Compaction Vibration Prediction Input Data

Global Variable	Value
Activity	Compaction
Distance (m)	50
Distance (m)	25
Building Type	Residential
Working Hours, day (07:00-23:00)	1
Working Hours, night (23:00-07:00)	0
Prediction location	Ground floor
Receptor building floor type	Slab construction
Amplitude of Drum Vibration (A), mm	0.56
Vibrating Roller Drum Width (Ld), m	0.75
Number of Vibrating Drums (nd)	1
Frequency of vibration	0
Peak Particle Velocity (vres), mm/s at 50m	0.4
Peak Particle Velocity (vres), mm/s at 25m	1.1

1.4.6 Vibratory rollers may generate adverse levels of vibration (i.e. exceeding 0.3mm/s) at receptors within 50m and significant levels of vibration (i.e. exceeding 1.0mm/s) at receptors within 25m.

1.5 Operational Noise Assessment

1.5.1 The plant comprising the Scheme has been derived from **ES Volume 2, Figure 3-1: Indicative Site Layout Plan [EN010168/APP/6.2]** and **ES Volume 2,**

Figure 3-3: 400kV Substation and BESS Layout [EN010168/APP/6.2]. **ES Volume 1, Chapter 3: The Scheme [EN010168/APP/6.1]** clarifies that the Scheme is made up of up to 270 BESS Containers, 90 BESS Inverters, a 400kV Substation comprised of five transformers, four 132kV Substations comprised of two transformers each, and 166 Conversion Units. These upper limits have been assumed in the operational noise modelling.

1.5.2 Operational sound power levels, summarised in **Table 5**, have been derived from manufacturer specification data sheets and the embedded mitigation specified in Section 14.9 of **ES Volume 1, Chapter 14: Noise and Vibration [EN010168/APP/6.1]**.

Table 5: Operational Plant Sound Power Levels

Source	Source Type (Sound Power Descriptor)	Number of Plant	Source Height (m)	Total Unmitigated A-Weighted Sound Power Level, dB L_w	Total A-Weighted Sound Power Level with Embedded Mitigation, dB L_w
BESS Containers (Sungrow ST5015UX-4H-LN&ST5015UX-4H-US-LN)	Point Source	72	2.82.65	82.6	-
BESS Containers (Sungrow ST5015UX-4H-LN&ST5015UX-4H-US-LN) with Air-Cooled Heat Exchanger	Point Source	198	3.5	-	74.6
BESS Inverters (Power Electronics PCSK GEN3)	Point Source	90	2.5	94.8	87.9
400kV Substation Transformer (Hyundai Electric)	Horizontal Area Source	5	5.8	88.0	73.0
132kV Substation Transformer (60MVA, 132/33 kV Mobile Substation)	Horizontal Area Source	2 (per substation compound)	5.8	78.0	63.0
Conversion Units (SMA Sunny Central UP BU-LS-001)	Point Source	159	2.5	90.6	-
Conversion Units (SMA Sunny Central UP BU-LS-001) with Silencer	Point Source	7	2.5	-	83.3

1.5.3 The modelling has assumed that 75% of BESS units (198) are fitted with air-cooled heat exchangers, all substation transformers are within enclosures and seven conversion units are installed with silencers.

1.5.4 Full octave or 1/3 octave band spectral data is presented for each item of plant below in **Table 6.**

Table 6: Operational Plant Spectral Data

Source	1/3 Octave (Hz)																													
	25	31.5	40	50	63	80	100	125	160	200	250	315	400	500	630	800	1k	1.2k	1.6k	2k	2.5k	3.15k	4k	5k	6.3k	8k	10k	12.5k	16k	20k
BESS Container	45	48	51	53	60	59	60	67	67	69	68	69	70	72	73	73	73	73	71	70	69	68	65	63	61	59	54	49	48	34
BESS Container with Heat Exchanger	37	40	43	45	52	51	52	59	59	61	60	61	62	63	65	65	65	65	63	62	61	60	57	55	53	51	46	41	40	26
BESS Inverter with Silencer	-	-	-	52	56	59	64	70	69	74	81	76	74	71	70	71	72	73	74	74	75	74	74	78	77	74	73	-	-	-
400kV Substation Transformer with Enclosure	-	-	-	-	47	-	-	63	-	-	69	-	-	68	-	-	65	-	-	48	-	-	46	-	-	38	-	-	-	-
132kV Substation Transformer with Enclosure	-	-	-	-	37	-	-	53	-	-	59	-	-	58	-	-	55	-	-	38	-	-	36	-	-	28	-	-	-	-
Conversion Unit	31	39	43	52	55	57	65	59	59	63	65	70	64	64	65	64	64	61	59	58	72	81	61	64	74	66	66	-	-	-
Conversion Unit with Silencer	-	-	-	62	64	68	71	75	78	85	84	82	83	84	83	84	85	84	83	82	80	78	76	75	73	68	64	-	-	-

1.5.5 **Table 7** summarises the predicted noise levels at the nearest sensitive receptors relative to the Solar PV Sites. Daytime predicted levels are at a height of 1.5m, whereas night-time predictions are at a height of 4.0m above local ground level (representative of first-floor bedroom windows during the night) and 6.5m above ground level for certain receptors (representative of second-floor bedroom windows during the night).

1.5.6 No operational noise is associated with the Cable Route Corridor and as such, it has been scoped out of the operational assessment.

Table 7: Predicted Sound Levels at Sensitive Receptors

Receptor	Daytime Predicted Sound Level (Free-field), dB $L_{Aeq,T}$	Night-time Predicted Sound Level (Free-field), dB $L_{Aeq,T}$
R01	31	12
R02	31	9
R03	31	5
R04	31	12
R05	25	13
R06	26	13
R07	27	12
R08	26	13
R09	26	13
R10	32	32
R11	30	16
R12	27	20
R13	25	17
R14	27	19
R15	28	24
R16	33	31
R17	28	18
R18	26	21
R19	28	26
R20	34	32
R21	30	26

Receptor	Daytime Predicted Sound Level (Free-field), dB $L_{Aeq,T}$	Night-time Predicted Sound Level (Free-field), dB $L_{Aeq,T}$
R22	30	15
R23	28	27
R24	35	20
R25	29	17
R26	26	15
R27	23	13
R28	29	24
R29	27	23
R30	30	22
R31	26	16
R32	33	17
R33	30	16
R34	25	15
R35	30	27
R36	28	25
R37	27	20
R38	25	19
R39	25	19
R40	24	19
R41	29	23
R42	33	20
R43	31	25
R44	29	24
R45	31	29

1.5.7 In the determination of rating levels (as per guidance from British Standards (BS) 4142:2014+A1:2019 Methods for Rating and Assessing Industrial and Commercial Sound (BS 4142:2014) (Ref 2) section 9.2 ‘Subjective method’), a +3dB acoustic feature correction for ‘’distinctiveness’ has been applied to the predicted levels set out in Table 7. No other penalties have been applied as it is expected for operational

noise to remain continuous and constant and no tonality correction has been applied due to the distance between the Scheme and nearby noise sensitive receptors.

1.5.8 Assessments of operational noise are presented in **Table 8** (daytime) and **Table 9** (night-time).

Table 8: BS4142:2014 Assessment – Daytime (07:00-23:00)

Receptor	Predicted Rating LeveL, dB $L_{Ar,Tr}$	Background Level, dB $L_{A90,T}$	Difference between Rating and Background Level, dB	Effect Level
R01	34	39	-5	LOAEL
R02	34	39	-5	LOAEL
R03	34	39	-5	LOAEL
R04	34	36	-2	Between LOAEL and SOAEL
R05	28	40	-12	Below LOAEL
R06	29	40	-11	Below LOAEL
R07	30	40	-10	Below LOAEL
R08	29	40	-11	Below LOAEL
R09	29	44	-15	Below LOAEL
R10	35	30	+5	SOAEL
R11	33	30	+3	Between LOAEL and SOAEL
R12	30	34	-4	Between LOAEL and SOAEL
R13	28	35	-7	Below LOAEL
R14	30	35	-5	LOAEL
R15	31	32	-1	Between LOAEL and SOAEL
R16	36	34	+2	Between LOAEL and SOAEL
R17	31	30	+1	Between LOAEL and SOAEL

Receptor	Predicted Rating LeveL, dB $L_{Ar,Tr}$	Background Level, dB $L_{A90,T}$	Difference between Rating and Background Level, dB	Effect Level
R18	29	30	-1	Between LOAEL and SOAEL
R19	31	30	+1	Between LOAEL and SOAEL
R20	37	36	+1	Between LOAEL and SOAEL
R21	33	36	-3	Between LOAEL and SOAEL
R22	33	36	-3	Between LOAEL and SOAEL
R23	31	36	-5	LOAEL
R24	38	36	+2	Between LOAEL and SOAEL
R25	32	36	-4	Between LOAEL and SOAEL
R26	29	32	-3	Between LOAEL and SOAEL
R27	26	32	-6	Below LOAEL
R28	32	36	-4	Between LOAEL and SOAEL
R29	30	36	-6	Below LOAEL
R30	33	36	-3	Between LOAEL and SOAEL
R31	29	32	-3	Between LOAEL and SOAEL
R32	36	32	+4	Between LOAEL and SOAEL
R33	33	32	+1	Between LOAEL and SOAEL

Receptor	Predicted Rating LeveL, dB $L_{Ar,Tr}$	Background Level, dB $L_{A90,T}$	Difference between Rating and Background Level, dB	Effect Level
R34	28	32	-4	Between LOAEL and SOAEL
R35	33	36	-3	Between LOAEL and SOAEL
R36	31	36	-5	LOAEL
R37	30	32	-2	Between LOAEL and SOAEL
R38	28	32	-4	Between LOAEL and SOAEL
R39	28	32	-4	Between LOAEL and SOAEL
R40	27	32	-5	LOAEL
R41	32	32	0	Between LOAEL and SOAEL
R42	36	34	2	Between LOAEL and SOAEL
R43	34	34	0	Between LOAEL and SOAEL
R44	32	34	-2	Between LOAEL and SOAEL
R45	34	30	+4	Between LOAEL and SOAEL

Table 9: BS4142:2014 Assessment – Night-time (23:00-07:00)

Receptor	Predicted Rating LeveL, dB $L_{Ar,Tr}$	Background Level, dB $L_{A90,T}$	Difference between Rating and Background Level, dB	Effect Level
R01	15	36	-21	Below LOAEL

Receptor	Predicted Rating LeveL, dB $L_{Ar,Tr}$	Background Level, dB $L_{A90,T}$	Difference between Rating and Background Level, dB	Effect Level
R02	12	36	-24	Below LOAEL
R03	8	36	-28	Below LOAEL
R04	15	34	-19	Below LOAEL
R05	16	31	-15	Below LOAEL
R06	16	31	-16	Below LOAEL
R07	15	31	-16	Below LOAEL
R08	16	31	-15	Below LOAEL
R09	16	36	-21	Below LOAEL
R10	35	30	+5	SOAEL
R11	19	30	-11	Below LOAEL
R12	23	30	-7	Below LOAEL
R13	20	34	-14	Below LOAEL
R14	22	34	-12	Below LOAEL
R15	27	30	-3	Between LOAEL and SOAEL
R16	34	30	+4	Between LOAEL and SOAEL
R17	21	30	-9	Below LOAEL
R18	24	30	-6	Below LOAEL
R19	29	30	-1	Between LOAEL and SOAEL

Receptor	Predicted Rating LeveL, dB $L_{Ar,Tr}$	Background Level, dB $L_{A90,T}$	Difference between Rating and Background Level, dB	Effect Level
R20	35	30	+5	SOAEL
R21	29	30	-1	Between LOAEL and SOAEL
R22	18	30	-12	Below LOAEL
R23	30	30	0	Between LOAEL and SOAEL
R24	23	30	-7	Below LOAEL
R25	20	30	-10	Below LOAEL
R26	18	30	-12	Below LOAEL
R27	16	30	-14	Below LOAEL
R28	27	30	-3	Between LOAEL and SOAEL
R29	26	30	-4	Between LOAEL and SOAEL
R30	25	30	-5	LOAEL
R31	19	30	-11	Below LOAEL
R32	20	30	-10	Below LOAEL
R33	19	30	-12	Below LOAEL
R34	18	30	-12	Below LOAEL
R35	30	30	0	Between LOAEL and SOAEL
R36	28	30	-2	Between LOAEL

Receptor	Predicted Rating LeveL, dB $L_{Ar,Tr}$	Background Level, dB $L_{A90,T}$	Difference between Rating and Background Level, dB	Effect Level
				and SOAEL
R37	23	30	-7	Below LOAEL
R38	22	30	-8	Below LOAEL
R39	22	30	-8	Below LOAEL
R40	22	30	-8	Below LOAEL
R41	26	30	-4	Between LOAEL and SOAEL
R42	23	30	-7	Below LOAEL
R43	28	30	-2	Between LOAEL and SOAEL
R44	27	30	-4	Between LOAEL and SOAEL
R45	32	30	+2	Between LOAEL and SOAEL

1.6 References

Ref 1 British Standards Institute (2014) BS 5228-1:2009+A1:2014. Code of Practice for Noise and Vibration Control on Construction and Open Sites – Part 1: Noise & Part 2: Vibration 2009

Ref 2 British Standards Institute (BSI) (2019) BS 4142:2014+A1:2019. 'Method for Rating Industrial and Commercial Sound' 2014.