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Vattenfall Wind Power Ltd

Thanet Extension Offshore Wind Farm

Annex 10.2: Noise and Vibration Supporting Information

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June, 2018

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ANNEX 10.2:
Noise and Vibration Supporting Information

1. Introduction

This document provides information on the assumptions used to predict the noise and vibration resulting from the proposed development. All calculations and results are presented in the main ES chapter (Document ref 6.3.10). The assumptions are presented as follows:

- Section 2 – Construction noise and vibration of the proposed development using the methodology defined in BS 5228-1:2009+A1:2014 (BSI 2009a) and BS 5228-2:2009+A1:2014 (BSI 2009b); and
- Section 3 - Operational sound of the proposed development using the methodology defined in BS 4142:2014 (BSI 2014a) and ISO 9613-2 (ISO 1996).

2. Construction Noise Assumptions

2.1 Construction Noise

Table 2.1 lists the main construction activities considered in the assessment.

Table 2.2 to Table 2.6 presents the assumed equipment and sound pressure levels that were used for the construction activities associated with Thanet Extension.

Table 2.7 and Table 2.8 presents the screening distances required to achieve the daytime and night-time BS 5228-1:2009+A1 (BSI 2009a) ABC category thresholds respectively, using the total activity levels as presented in Table 2.2 to Table 2.6. These calculations informed the study areas used in the ES (Document ref 6.3.10).

Table 2.1 Construction Activities considered in the Noise Predictions

Activities	Description
1	Cable Trenching, Soil Storage and Cable Installation
2	Transmission Joint Pits including cofferdams at landfall
3	Substation construction with Piling

Table 2.2 Assumed source sound power levels for cable trenching, soil storage and cable installation

BS 5228 Source Ref.	Equipment	Number of plant Operating on Site	% on-time	Measured L_{Aeq} at 10m (dB)	Corrected L_{Aeq} at 10m (dB)
Table C.2, Ref.42	Hydraulic vibratory compactor (tracked excavator) (225 kg / 193 bar / 17500 N)	1	50.00%	78	75.0
Table C.2, Ref.12	Dozer (142kW, 20T)	1	80.00%	81	80.0
Table D.6, Ref.16	Lorry mounted concrete pump (130kW)	2	50.00%	81	81.0
Table C.4, Ref.93	Angle Grinder (2.3kW, 4.7kg)	1	25.00%	80	74.0
Table C.2, Ref.14	Tracked Excavator (226kW, 40T)	1	80.00%	79	78.0
Table C.2, Ref.30	Dump Truck - tipping Fill (306kW, 29t)	4	25.00%	79	79.0
Table C.11, Ref.5	Lorry (for deliveries)	2	25.00%	80	77.0
Table C.4, Ref.88	Water Pump (Diesel)	1	100.00%	68	68.0
Total				88.3	86.8

Table 2.3 Assumed source sound power levels for construction of Transmission Joint Pits including cofferdams at landfall

BS 5228 Source Ref.	Equipment	Number of plant Operating on Site	% on-time	Measured L_{Aeq} at 10m (dB)	Corrected L_{Aeq} at 10m (dB)
Table C.2, Ref.42	Hydraulic vibratory compactor (tracked excavator) (225 kg / 193 bar / 17500 N)	1	50.00%	78	75.0
Table C.2, Ref.12	Dozer (142kW, 20T)	1	80.00%	81	80.0
Page 94 - Ref.16	Lorry mounted concrete pump (130kW)	2	50.00%	81	81.0
Table C.4, Ref.93	Angle Grinder (2.3kW, 4.7kg)	1	25.00%	80	74.0
Table C.2, Ref.14	Tracked Excavator (226kW, 40T)	1	80.00%	79	78.0
Table C.2 Ref.30	Dump Truck - tipping Fill (306kW, 29t)	4	25.00%	79	79.0
Table C.11, Ref.5	Lorry (for deliveries)	2	25.00%	80	77.0
Table D.4, Ref.4	Water Pump (Diesel)	1	100.00%	68	68.0
Table C.4, Ref.88	Sheet Steel Piling Diesel Hammer (3731 kg.m)	1	70.00%	100	96.5
Total				100.3	96.7

Table 2.4 Assumed source sound power levels for substation construction with piling

BS 5228 Source Ref.	Equipment	Number of plant Operating on Site	% on-time	Measured L_{Aeq} at 10m (dB)	Corrected L_{Aeq} at 10m (dB)
Table C.11, Ref.1	Diesel Water Pump (136kW)	1	100.00%	81	81.0
Table C.2, Ref.42	Hydraulic vibratory compactor (tracked excavator) (225 kg / 193 bar / 17500 N)	1	50.00%	78	75.0
Table D.8, Ref.30	Road Roller (51kW)	1	50.00%	73	70.0
Table C.4, Ref.20	Cement Mixer Truck	4	25.00%	80	80.0
Table D.7, Ref.56	Diesel Driven Generator (75 kV.A)	1	100.00%	82	82.0
Table C.4, Ref.93	Angle Grinder (2.3kW)	1	25.00%	80	74.0
Table C.1, Ref.9	Pneumatic Breaker	1	50.00%	90	87.0
Table C.5, Ref.30	Ashphalt paver (+ tipper lorry) (112kW, 12 t hopper)	1	50.00%	75	72.0
Table C.2, Ref.12	Dozer (142kW, 20T)	1	80.00%	81	80.0
Table C.2, Ref.30	Dump Truck - tipping Fill (306kW, 29t)	4	25.00%	79	79.0
Table C.2, Ref.14	Tracked Excavator (226kW, 40T)	1	80.00%	79	78.0
Table C.11, Ref.5	Lorry (for deliveries)	2	25.00%	80	77.0
Table C.3, Ref.2	Hammer Hydraulic Rig (4 t hammer)	1	70.00%	87	85.5
Table C.5, Ref.5	Compressor	1	70.00%	65	63.5
Table C.4, Ref.46	Mobile Crane	1	50.00%	67	64.0
Table C.4, Ref.93	Hoists	1	50.00%	80	77.0
Table C.2, Ref.12	Tipper Lorries	2	25.00%	81	78.0
Table C.4, Ref.88	Fork Lift Truck	2	75.00%	68	69.8
Total				**101.7**	**100.1**

Table 2.5 Assumed source sound power levels for offshore cable laying near landfall

BS 5228 Source Ref.	Equipment	Number of plant Operating on Site	% on-time	Measured L_{Aeq} at 10m (dB)	Corrected L_{Aeq} at 10m (dB)
Table C7.2	Grab hopper dredging ship	1	100%	78.0	78.0
Total				**78.0**	**78.0**

Table 2.6 Assumed source sound power levels for offshore piling

Source Ref.	Equipment	Number of plant Operating on Site	% on-time	Measured L_{Aeq} at 10m (dB)	Corrected L_{Aeq} at 10m (dB)
Average of measured data (at varying distances) for an S-1200 piling hammer propagating over water*	S-1200 piling hammer propagating over water	1	100%	111.0	111.0
Total				111.0	111.0

*Data supplied to Amec Foster Wheeler by IHC Hydrohammer B.V for a previous noise assessment

Table 2.7 Calculated screening distance to daytime BS 5228-1:2009+A1:2014 Category Thresholds

Activity	Corrected L_{Aeq} at 10m (dB)	Distance rounded to lowest 5 meters (m)		
		Category A (LOAEL) 65 dB(A)	Category B 70 dB(A)	Category C (SOAEL) 75 dB(A)
Overground Cable Installation through the Country Park, cable trenching, soil storage and cable installation	86.8	120	70	40
Transmission Joint Pits including cofferdams at landfall	96.7	220	140	75
Substation construction	92.4	230	130	90

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Table 2.8 Calculated screening distance to night time BS 5228-1:2009+A1:2014 Category Thresholds

Activity	Corrected L_{Aeq} at 10m (dB)	Distance rounded to lowest 5 meters (m)		
		Category A (LOAEL) 45 dB(A)	Category B 50 dB(A)	Category C (SOAEL) 55 dB(A)
Transmission Joint Pits including cofferdams within Intertidal Zone	96.7	1400	890	560

Table 2.9 Minimum distance to noise sensitive receptors

Receptor	Cable trenching, soil storage, cable installation and resurfacing (m)	Transmission Joint Pits including cofferdams at landfall (m)	Substation construction (m)	Screening assumptions between works and receptor
LT1 - 33 Beech Grove, Cliffsend	770	850	2450	None
LT2 - 9 Oakland Court, Ramsgate	750	730	2350	None
LT3 - 125 Sandwich Road	580	590	2150	None
LT4 - Stonelees Cottage, Ebbsfleet Lane	60	550	500	None
LT5 Stonar Cottage	110	1920	440	None
ST1 - Pegwell Bay Country Park	0	0	1600	None
ST2 - Great Oaks Small School	670	780	1150	None
ST3 - Baypoint Club	100	790	400	None
ST4 - Land at Stonelees Golf Centre	350	480	780	None

2.2 Construction Vibration

Vibration levels from piling have been calculated using the following formula prescribed in BS 5228-2:2009:A1:2014 (BSI 2009b):

$$Vres \leq K_p \left[\frac{\sqrt{W}}{r^{1.3}}\right]$$

Where:			
	$Vres$	=	*Resultant PPV, in millimetres per second (mm/s)*
	K_p	=	*Ground conditions (a scaling factor of 3 has been used to represent piles driven into stiff cohesive soil*
	W	=	*Hammer energy in joules (J)*
	r	=	*Slope distance from the pile toe or tunnel crown, in meters (m)*

Table 2.10 and Table 2.11 detail the vibration predictions at which there is a risk of cosmetic damage to buildings and exceeding the SOAEL for human exposure respectively. For predicting vibration inside a property on the first floor it has been assumed that the vibration inside the building is 4 times the vibration on the ground outside the building.

Table 2.10 Distance at which there is a risk of impact piling resulting in cosmetic damage to buildings (predicted vibration at building foundations)

Hammer drop weight (kg)	Drop height (m)	Hammer Energy (kJ)	Ground Conditions	Resultant PPV (mm/s)	Distance from piling activity (m)
4000	1	40	3 (stiff cohesive soil)	6[1]	35
4000	0.5	20	3 (stiff cohesive soil)	6[1]	26
4000	0.25	10	3 (stiff cohesive soil)	6[1]	20

[1] Conservative threshold for the onset of cosmetic damage to buildings from transient vibration

Table 2.11 Distance at which there is a risk of impact piling exceeding the SOAEL for human exposure to construction vibration in residential environments (predicted vibration inside sensitive building)

Hammer drop weight (kg)	Drop height (m)	Hammer Energy (kJ)	Ground Conditions	Resultant PPV (mm/s)[2]	Distance from piling activity (m)
4000	1	40	3 (stiff cohesive soil)	1[2]	400
4000	0.5	20	3 (stiff cohesive soil)	1[2]	300
4000	0.25	10	3 (stiff cohesive soil)	1[2]	230

[1] Determined at the worst location on a normally loaded floor inside a sensitive building (usually the centre of the floor)
[2] SOAEL for the human perception of construction vibration

3. Operational Sound

3.1 Substation Modelling

In order to determine the impact of operational sound emitted by the substation, a comprehensive sound model was developed using the Stapelfeldt LimA computational sound modelling suite (v. 11.2_7).

Sound levels provided by Xero Energy have been used to assist in modelling the proposed transformers and reactor cores.

LimA is used widely in sound modelling and mapping projects throughout the UK and Europe. Developed by Stapelfeldt Ingenieuresellschaft mbH, it can implement a number of methodologies for the calculation of sound levels, including the calculation of industrial sound in accordance with ISO 9613-2, road traffic noise in accordance with the Calculation of Road Traffic Noise (CRTN, 1988) methodology, and rail traffic noise in accordance with Calculation of Rail Noise (CRN, 1995) methodology.

The LimA sound modelling suite allows a 3D environmental model to be constructed, using digital mapping and topographic data. The following has been taken into account:

- Sound source location - assumed to be point sources set out in the centre of the proposed substation equipment location;
- Sound emission data – Adopted from publicly available data of a similar scheme (Triton Knoll Offshore Wind Farm Limited, 'Onshore Substation Noise Modelling Report', April 2015, Document Ref. 6.2.5.11.3);
- Sound source on-time – this reflects the operational hours and duration of operation sound sources of which is assumed to be on continuously;
- Distance between sound source and receptor – based on the scheme locations and OS digital mapping data;
- Receptor locations – based on OS digital mapping data;
- Ground contours – from OS digital data;
- Locations and dimensions of barriers (man-made or topographic) between sound source and receptor; and
- Ground attenuation – related to the type of ground cover between the source and the receptor.

LimA allows the calculation of sound levels at specific, single points, or over a calculation-grid of specified size. Single point receptors were calculated for the closest existing façades representative of the measurement areas with calculation heights of 1.5m and 4.0m used to represent the daytime and night-time levels respectively in the model.

Table 3.1 details the assumptions made for the substation sound sources.

Table 3.2 details the spectral shapes adopted for the substation sound sources.

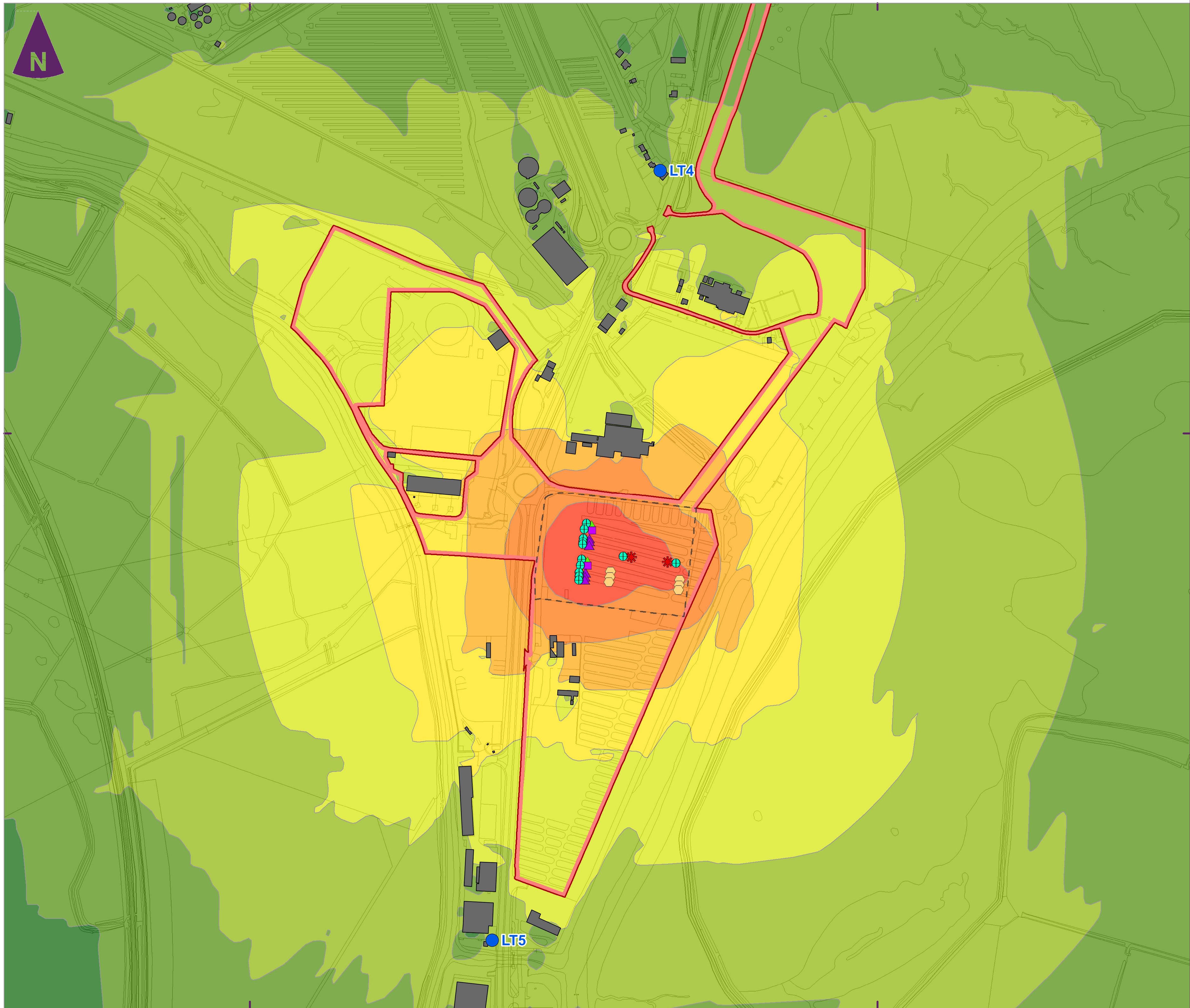
Figure 3.1 details the noise contours for the onshore substation.

Table 3.1 Assumptions made for substation sound sources

Source	Sound Power Level (dB L_{WA})	Modelled Height (m)	Quantity in Model	Spectral shape
SVC PLUS Cooler	90	1.8	2 (3 per set)	C
SVC PLUS Reactor	82.9	1.5	2	B
220MVA SGT	95	2.5	2	A
220MVA SGT Cooler	87	2.5	2	C
400kV Harmonic Filter	86.5	1.5	2 (3 per set)	B
50MVAr Shunt Reactor	92	2.5	2	A
50MVAr Shunt Reactor Cooler	84	2.5	2	C
SVC Transformer	92	2.5	2	A
SVC Transformer Cooler	84	2.5	2	C

Table 3.2 Spectral Shapes

ID	Plant	A-Weighted Relative Level (dBA) per Third Octave Band (Hz)							
		100	125	160	200	250	315	400	500
A	Transformers	-6.3			-5.3		-3.3		
B	Reactors/ Filters	-1.2			-8.2		-14.2	-16.2	-18.2
C	Coolers	-7	-7	-7	-7	-7			



Key

- Onshore Red Line Boundary
- Substation footprint
- Noise sensitive receptor

Substation Sources

- Super Grid Transformer
- Harmonic Filter
- Shunt Reactor
- SVC Transformer
- SVC Reactor
- Cooler

Specific Sound Level (dB)

- < 25
- 25 - 30
- 30 - 35
- 35 - 40
- 40 - 45
- 45 - 50
- 50 - 55
- > 55

0 100 200 300 m

Scale at A3: 1:6,000

Thanet Offshore Windfarm Extension

amec foster wheeler

Figure 3.1
Onshore substation noise contours

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4. References

- BSI 2009a - British Standards Institution (2009), 'BS 5228-1-2009 (+A1: 2014), Code of practice for noise and vibration control on construction and open sites = Part 1 Noise'.
- BSI 2009b - British Standards Institution (2009), 'BS 5228-2 (2009) +A1: 2014, Code of practice for noise and vibration control on construction and open sites – Part 2 Vibration'.
- BSI 2014a - British Standards Institute (2014), 'BS 4142, Method for rating industrial noise affecting mixed residential and industrial areas'.
- ISO 1996 - International Standards Organisation (1996), 'Acoustics – Attenuation of sound during propagation outdoors – Part 2: general Method of Calculation, International Standard ISO 9613-2: 1996 (E)'.
- TKOWFL 2015 - Triton Knoll Offshore Wind Farm Limited, 'Onshore Substation Noise Modelling Report', April 2015, Document Ref. 6.2.5.11.3