Hornsea Project Three
Offshore Wind Farm

Hornsea Project Three

Offshore Wind Farm

Environmental Statement:
Volume 6, Annex 8.3 – Operational Noise Model Input

PINS Document Reference: A6.6.8.3
APFP Regulation 5(2)(a)

Date: May 2018

Hornsea 3
Offshore Wind Farm

Ørsted

Environmental Impact Assessment

Environmental Statement

Volume 6

Annex 8.3 – Operational Noise Model Input

Liability

This report has been prepared by RPS, with all reasonable skill, care and diligence within the terms of their contracts with Orsted Power (UK) Ltd.

Report Number: A6.6.8.3

Version: Final

Date: May 2018

This report is also downloadable from the Hornsea Project Three offshore wind farm website at: www.hornseaproject3.co.uk

Ørsted

5 Howick Place

London, SW1P 1WG

Front cover picture: Kite surfer near a UK offshore wind farm © Orsted Hornsea Project Three (UK) Ltd., 2018.

Prepared by: RPS

Checked by: Sarah Drljaca

Accepted by: Stuart Livesey

Approved by: Stuart Livesey

Table of Contents

List of Tables

List of Figures

Glossary

Term	Definition
Decibel	Units of sound measurement and noise exposure measurement.
Equivalent continuous sound pressure level	Defined in BS 7445 (BSI, 2003) 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" (i.e. it is a measure of the noise dose or exposure over a period). 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 other forms of environmental noise. It is also the unit best suited to assessing community response.
Immission	The act of immitting, or of sending in – the correlative of emission, Emissions are emitted by the sound source and immissions are received by the noise sensitive receptor.
Noise and Sound	Response to sound can be subjective and is affected by many factors, both acoustic and non-acoustic. The significance of its impact, for example, can depend on such factors as the margin by which a sound exceeds the background sound level, its absolute level, time of day and change in the acoustic environment, as well as local attitudes to the source of the sound and the character of the neighbourhood. Sound can be measured by a sound level meter or other measuring system. Noise is related to a human response and is routinely described as unwanted sound, or sound that is considered undesirable or disruptive.
Octave	The range between two frequencies whose ratio is 2:1.
Octave bands	Groups of frequencies defined by standards where the upper frequency of each band is equal to twice the lower frequency of the next higher band. Octave bands are usually named by their geometric centre frequency. For example, the octave band extending between 44.7 Hz and 89.1 Hz is called the 63 Hz octave band. The octave band extending between 89.1 Hz and 178 Hz is called the 125 Hz octave band. The full complement of octave bands in the audible frequency range is as follows: 31.5, 63, 125, 250, 500, 1,000, 2,000, 4,000, 8,000 and 16,000 Hz.
Onshore elements of Hornsea Three	Hornsea Three landfall, onshore cable corridor, the onshore HVAC booster station, the onshore HVDC converter/HVAC substation and the interconnection with the Norwich Main National Grid substation.
Point/Line/Area Source	Noise sources can be modelled as point, line or area sources. Noise attenuation due to geometric spreading, which is the effect of acoustic energy being spread over an increasing surface with increasing distance from the source, can be different for the different types of source. When the distance from source to receptor is very much greater than the dimensions of the source, the attenuation due to geometric spreading from all source types is the same as for point sources.
Rating level, $L_{Ar,Tr}$	BS 4142 (BSI, 2014a) defines the rating level as 'The specific noise level plus any adjustment for the characteristic features of the noise.'
Receptor	A component of the natural or man-made environment that is affected by an impact, including people.
Slow/Fast Time Weighting	The response speed of the detector in a sound level meter. Slow response time is 1 second; fast response time is 1/8 second (0.125 seconds) and will detect changes in sound levels more rapidly than measurements made with Slow time-weighting.
Sound	See "Noise and Sound"
Sound Power Level (SWL, Lw)	A sound power level is a measure of the total power radiated as sound by a source in all directions. It is a property of the source and is essentially independent of the measuring environment. The sound power level of a source is expressed in decibels (dB) and is equal to 10 times the logarithm to the base 10 of the ratio of the sound power of the source to a reference sound power. The reference sound power in air is normally taken to be 10^{-12} watt.
SoundPLAN®	A computer software package that uses a ray-tracing numerical modelling approach to predict acoustic propagation from industrial and/or transport sound sources. The prediction methodologies follow national and international standards, such as ISO 9613 part 1.
Sound Pressure Level (SPL)	Sound pressure is the dynamic variation of the static pressure of air and is measured in force per unit area. Sound pressure is normally represented on a logarithmic amplitude scale, which gives a better relationship to the human perception of hearing. The sound pressure level is expressed in decibels (dB) and is equal to 20 times the logarithm to the base 10 of the ratio of the sound pressure at the measurement location to a reference sound pressure. The reference sound pressure in air is normally taken to be 20 µPa, which roughly corresponds to the threshold of human hearing.
Sound spectrum	A sound represented by its frequency components.
Source term	The acoustic properties of a source defined as a sound power level or as a sound pressure level under specific measurement conditions. Source terms are sometimes provided as a spectrum.
Specific sound level, $L_{Aeq,Tr}$	BS 4142 (BSI, 2014a) defines the specific sound level as the 'equivalent continuous A-weighted sound pressure level produced by the specific sound source over a given reference time interval.'
Third-octave bands	Frequency ranges where each octave is divided into one-third octaves.
Tonal	Sound sources sometimes contain audible or measurable components that can be identified as hums, whistles etc. The presence of these tonal components is sometimes considered to add an extra, annoying quality to the sound.

Acronyms

Acronyms	Description
BS	British Standard
GIS	Gas insulated switchgear
HVAC	High Voltage Alternating Current
HVDC	High Voltage Direct Current
$L_{Aeq,T}$	See "Equivalent continuous sound pressure level".
L_{Amax}	Maximum value of the A-weighted sound pressure level, measured using the fast (F) time weighting (in dBA).
L_{A90}	See "Background sound level".

Acronyms	Description
NSR	Noise sensitive receptor
SPL	Sound pressure level
SWL	Sound power level

Units

Unit	Description
GW	Gigawatt (power)
dB	Decibel (sound pressure level referenced to 20 μPa)

1. Operational Noise Input

1.1 Introduction

1.1.1.1 This annex presents the input parameters used in the operational noise assessment (as reported in volume 3, chapter 8: Noise and Vibration). These parameters have been used to create the operational noise model which is used to predict the immission of noise to the nearest noise sensitive receptors (NSRs) from the onshore HVAC booster station and HVDC converter/HVAC substation during the operation and maintenance phase of Hornsea Three.

1.1.1.2 A baseline noise survey has been undertaken to identify the existing noise environment and the results are presented in annex 8.1: Baseline Noise Survey.

1.2 Operational noise model input

1.2.1.1 The operational noise model has been developed using noise modelling software package SoundPLAN 7.4. The operational noise model follows the sound propagation modelling method defined in ISO 9613 'Attenuation of sound during propagation outdoors – Part 2: General method of calculation' (ISO, 1996) and is regarded as an industry standard model.

1.2.2 Operational noise model parameters

1.2.2.1 The calculation procedure of the operational noise model is controlled by parameters which determine what methodology and base assumptions are used in the model. These parameters include environmental factors such as air pressure, topography and ground conditions which influence how sound waves travel, and technical factors such as which calculation formulae are to be used.

1.2.2.2 For the purpose of Hornsea Three, these parameters comprise:

- Technical descriptions of building structure, topography and ground cover;
- The location and type of NSRs;
- Type of equipment at the onshore HVAC booster station and HVDC converter/HVAC substation, as well as their corresponding noise source levels;
- Assumptions of plant operating conditions.

Technical descriptions of building structure, topography and ground cover

1.2.2.3 The ground between Hornsea Three and the NSR locations has been modelled as being soft throughout (based on observations during site visits). Soft ground is defined in ISO 9613-2 1996 as "*Porous Ground, which includes ground covered by grass, trees, or other vegetation, and all other ground surfaces suitable for the growth of vegetation, such as farming land*", which is considered to be representative of the ground conditions in the vicinity of the onshore elements of Hornsea Three.

1.2.2.4 Terrain contour data, showing topography, has also been entered in the operational noise model based on Ordnance Survey (OS) land contours. The effect of screening due to existing buildings, barriers and vegetation, as well as proposed landscape planting, have not been included within the operational noise model to ensure a worst case assessment.

Location and type of NSRs

1.2.2.5 The receptors have been modelled at a height of 1.5 m and 4.0 m above ground to represent ground and first floor levels (i.e. standardised heights for residential properties) in order to investigate the noise impact from daytime and night time operational noise respectively. The assessment at first floor level will generally represent a worst case due to ground effects, topography and building geometry as the first floor level generally has less screening from obstacles and lower ground absorption of noise.

Equipment, noise source levels and plant operating assumptions

1.2.2.6 The operational noise model calculates the contribution from each noise source, input as a specified source type. Each noise source is specified according to its type (e.g. point, line, area) based on a given sound power level (e.g. octave (or third-octave) band sound power level) at selected locations. It predicts noise levels under light down-wind conditions based on geometrical divergence, atmospheric absorption, ground effects, screening and directivity based on the procedure detailed in ISO 9613.

1.2.2.7 Other than where specifically identified, the model is based on there being no enclosures for the HVDC converter/HVAC substation or component plant, as it represents the maximum design scenario.

1.2.2.8 An equipment list of operational plant was provided by the project team, dated 14 November 2017. The list identified the significantly noisy plant for a 3 x 540MVA onshore HVAC substation and a 2 x 900MVA onshore HVAC substation options for the onshore HVDC converter/HVAC substation, and for the onshore HVAC booster station. The equipment list is reproduced in Table 1.1. The term 'significantly noisy' is based on the equipment provider's judgement of what plant items might reasonably contribute to the overall noise emissions rather than the EIA definition of significance. Variation in the proposed equipment would not generally alter the outcome of the assessment, provided the overall noise emissions continue to be mitigated to the design level.

1.2.2.9 With regard to the HVDC converter/HVAC substation, the HVAC substation was considered to have greater noise emissions than the HVDC converter (based on the equipment that would be required) and therefore, the operational noise model considers the HVAC substation as the maximum design scenario for Hornsea Three. In addition, it has been assumed that no building enclosures will be provided around the noisy plant for the onshore HVAC substation as this represents the maximum design scenario.

Table 1.1: Equipment list – operational plant.

Component	Quantity of component in Operational Noise Model	Component Height (m)	Enclosed / External
Onshore HVDC converter/HVAC substation (HVAC substation – 3 x 540MVA) ***Ref Electrical layout ref J00299-L001 Rev A***			
400 / 220kV 540MVA SGT	6	11	External
220kV 300MVAr Variable SHR	12	9	External
220kV 250MVAr DRC (incl. cooler)	6	5	External
220kV 320MVA DRC Tx	6	9	External
220kV 200MVAr Harmonic Filter	6	10	External
400kV 150MVAr Harmonic Filter	4	10	External
400kV 150MVAr SHR	4	8	External
Onshore HVDC converter/HVAC substation (HVAC substation - 2 x 900MVA) ***Ref Electrical layout ref J00299-L002 Rev A***			
400 / 220kV 900MVA SGT	2 (sets of 3)	12	External
220kV 300MVAr Variable SHR	12	9	External
220kV 250MVAr DRC (incl. cooler)	6	5	External
220kV 320MVA DRC Tx	6	9	External
220kV 200MVAr Harmonic Filter	6	10	External
400kV 150MVAr Harmonic Filter	4	10	External
400kV 150MVAr SHR	4	8	External
Onshore HVAC booster station ***Ref Electrical layout ref J00299-L003 Rev A***			
220kV 300MVAr Variable SHR	6	9	Enclosed

1.2.2.10 It is noted that the plant list for the two onshore HVAC substation options in Table 1.1 are broadly similar, and would result in similar noise emissions. Thus, either would represent the maximum design scenario; for this assessment, the 3 x 540MVA plant list has been used, as per the layout in Figure 1.1.

Modelling the operational onshore HVDC converter/HVAC substation

1.2.2.11 For the purpose of the operational noise model the following assumptions have been made:

- The onshore HVDC converter/HVAC substation would be installed as per the project description (volume 1, chapter 3: Project Description); and
- The HVDC converter/HVAC substation would operate continuously and in accordance with the noise source levels and a list of typical equipment provided by the project team.

1.2.2.12 The noise model has been constructed to assess the noise immissions from the onshore HVAC substation in 3 x 540MVA configuration option for the operational onshore HVDC converter/HVAC substation. If other configuration options were implemented, they would be mitigated to achieve equal or reduced adverse impacts as reported here.

1.2.2.13 The onshore HVAC substation contains a mixture of transformers, reactive plant, coolers, Gas Insulated Switchgear (GIS) and filters, all of which are significant noise sources. Most of the plant will be installed externally, with only the GIS proposed to be installed within a building hall. As it is enclosed, the GIS is unlikely to significantly contribute to the overall noise emissions from the onshore HVAC substation; therefore, the assessment has only considered the noise impact from the external plant items within the operational noise model. What constitutes as '*significantly contributes to*', is based on the equipment provider's judgement of what plant items might reasonable contribute to the overall noise emissions rather than the EIA definition of significance.

1.2.2.14 In additional to the general environmental noise across the local area (of road traffic, wind in vegetation etc.) the existing baseline environment (see volume 6 annex 8.1 Baseline Noise Survey) currently includes noise from electrical infrastructure, with a large substation towards the east of the site, and overhead electrical high voltage cables bounding the site to the south-west. Given the mixture of sources within the onshore HVDC converter/HVAC substation area and the baseline noise levels and character, it is not necessary to apply a noise rating correction to the overall sound emissions from the onshore HVAC substation in the operational noise model in accordance with BS 4142:2014 (British Standards Institution, 2014).

1.2.2.15 In the specification of plant associated with the HVAC substation, the operational noise model assumes that the overall sound resulting from the operation of the facility be non-tonal and non-impulsive (to the specification of BS 4142:2014). Where this cannot be achieved, additional mitigation or reduction in plant noise source level would be made such as to achieve a similar rating level as would be produced by non-tonal plant, again allowing for a rating correction as defined in BS 4142:2014.

1.2.2.16 The sound power level presented in Table 1.2 has been used in the operational noise model. The noise spectra used for the plant in Table 1.2 is provided in Table 1.3.

Table 1.2: Onshore HVAC substation plant – operational noise model inputs.

Component	Number	Noise emission. SWL Sound Power Level (per item)	AC/DC	Point/Line/ Area/Volume source	Height	Enclosed/external	Spectrum				
							(A) Tonal	(B) Harmonic	(C) LF 100-250Hz	(D) Broadband	Model Spectrum Number
540 MVA SGT	6	93 dB(A)	AC	Area	11 m	External				✓	D2
150-300 Mvar VSR	12	97 dB(A)	AC	Line	9 m	External				✓	D1
300Mvar DRC (incl. cooler)	6	93 dB(A)	AC	Area	5 m	External			✓		C1
320MVA step up transformer	6	91 dB(A)	AC	Area	9 m	External	✓				A2
200 Mvar 220kV filter	6	91 dB(A)	AC	Area	10 m	External		✓			B1
150 Mvar 400 kV filter	3	91 dB(A)	AC	Area	10 m	External		✓			B1
150 Mvar 400kV Shunt reactor	3	93 dB(A)	AC	Area	8 m	External				✓	D2

Table 1.3: Onshore HVAC substation plant – operational noise model input frequency weightings.

D - Averaged Industry Spec								
	Sum	**63Hz**	**125Hz**	**250Hz**	**1kHz**	**2kHz**	**4kHz**	**8kHz**
dB	11.1	9.2	4.1	0.7	-6.2	-9.1	-11.3	-13.2
dB(A)	-0.1	-17.0	-12.0	-7.9	-6.2	-7.9	-10.3	-14.3
300 MV SR AND 150-300 Mvar VSR								
	Sum	**63Hz**	**125Hz**	**250Hz**	**1kHz**	**2kHz**	**4kHz**	**8kHz**
dB (A)	97.0	80.1	85.1	89.2	90.9	89.2	86.8	82.8
dB	108.2	106.3	101.2	97.8	90.9	88.0	85.8	83.9
150 Mvar 400kV Shunt Reactor AND 540 MVA SGT								
	Sum	**63Hz**	**125Hz**	**250Hz**	**1kHz**	**2kHz**	**4kHz**	**8kHz**
dB (A)	93.0	76.1	81.1	85.2	86.9	85.2	82.8	78.8
dB	104.2	102.3	97.2	93.8	86.9	84.0	81.8	79.9

A - tonal spec													
	Sum	**50Hz**	**63Hz**	**80Hz**	**125Hz**	**160Hz**	**200Hz**	**250Hz**	**315Hz**	**400Hz**	**500Hz**	**630Hz**	**800Hz**
dB	20.1	-	19.9	-	-	-	5.6	-	3.3	-	-	-	-
dB(A)	0.0	-	-6.3	-	-	-	-5.3	-	-3.3	-	-	-	-
Transformer Coolers [per item] AND Air Handling Unit (3 external AHU per 1.2GW system) [per set of 3]													
	Sum	**50Hz**	**63Hz**	**80Hz**	**125Hz**	**160Hz**	**200Hz**	**250Hz**	**315Hz**	**400Hz**	**500Hz**	**630Hz**	**800Hz**
dB (A)	93.0	-	86.7	-	-	-	87.7	-	89.7	-	-	-	-
dB	113.2	-	112.9	-	-	-	98.6	-	96.3	-	-	-	-
320MVA step up transformer													
	Sum	**50Hz**	**63Hz**	**80Hz**	**125Hz**	**160Hz**	**200Hz**	**250Hz**	**315Hz**	**400Hz**	**500Hz**	**630Hz**	**800Hz**
dB (A)	91.0	-	84.7	-	-	-	85.7	-	87.7	-	-	-	-
dB	111.2	-	110.9	-	-	-	96.6	-	94.3	-	-	-	-
Cooling Towers/valve cooling (24 fans per set per 1.2 GW)													
	Sum	**50Hz**	**63Hz**	**80Hz**	**125Hz**	**160Hz**	**200Hz**	**250Hz**	**315Hz**	**400Hz**	**500Hz**	**630Hz**	**800Hz**
dB (A)	108.0	-	101.7	-	-	-	102.7	-	104.7	-	-	-	-
dB	128.2	-	127.9	-	-	-	113.6	-	111.3	-	-	-	-

B - harmonic spec													
	Sum	**50Hz**	**63Hz**	**80Hz**	**125Hz**	**160Hz**	**200Hz**	**250Hz**	**315Hz**	**400Hz**	**500Hz**	**630Hz**	**800Hz**
dB	18.3	-	-	-	-	-	2.9	-	-7.6	-11.4	18.3	-	-
dB(A)	0.1	-	-	-	-	-	-8.0	-	-14.2	-16.2	0.1	-	-
	Sum	**50Hz**	**63Hz**	**80Hz**	**125Hz**	**160Hz**	**200Hz**	**250Hz**	**315Hz**	**400Hz**	**500Hz**	**630Hz**	**800Hz**
dB (A)	91.0	-	-	-	-	-	82.9	-	76.7	74.7	91.0	-	-
dB	111.2	-	-	-	-	-	93.7	-	83.3	79.5	111.2	-	-
C - LF spec													
	Sum	**50Hz**	**63Hz**	**80Hz**	**125Hz**	**160Hz**	**200Hz**	**250Hz**	**315Hz**	**400Hz**	**500Hz**	**630Hz**	**800Hz**
dB	15.1	-	-	-	9.1	6.4	3.9	1.6	-	-	-	-	-
dB(A)	0.0	-	-	-	-7.0	-7.0	-7.0	-7.0	-	-	-	-	-
300Mvar DRC (incl. cooler)													
	Sum	**50Hz**	**63Hz**	**80Hz**	**125Hz**	**160Hz**	**200Hz**	**250Hz**	**315Hz**	**400Hz**	**500Hz**	**630Hz**	**800Hz**
dB (A)	93.0	-	-	-	86.0	86.0	86.0	86.0	-	-	-	-	-
dB	113.2	-	-	-	102.1	99.4	96.9	94.6	-	-	-	-	-
Converter Reactors (set of 6 reactors per 1.2GW) [per set of 6]													
	Sum	**50Hz**	**63Hz**	**80Hz**	**125Hz**	**160Hz**	**200Hz**	**250Hz**	**315Hz**	**400Hz**	**500Hz**	**630Hz**	**800Hz**
dB (A)	100.0	-	-	-	93.0	93.0	93.0	93.0	-	-	-	-	-
dB	120.2	-	-	-	109.1	106.4	103.9	101.6	-	-	-	-	-
Main Power Transformer (3 single phase transformers per 1.2GW) [per set of 3]													
	Sum	**50Hz**	**63Hz**	**80Hz**	**125Hz**	**160Hz**	**200Hz**	**250Hz**	**315Hz**	**400Hz**	**500Hz**	**630Hz**	**800Hz**
dB (A)	102.0	-	-	-	95.0	95.0	95.0	95.0	-	-	-	-	-
dB	122.2	-	-	-	111.1	108.4	105.9	103.6	-	-	-	-	-

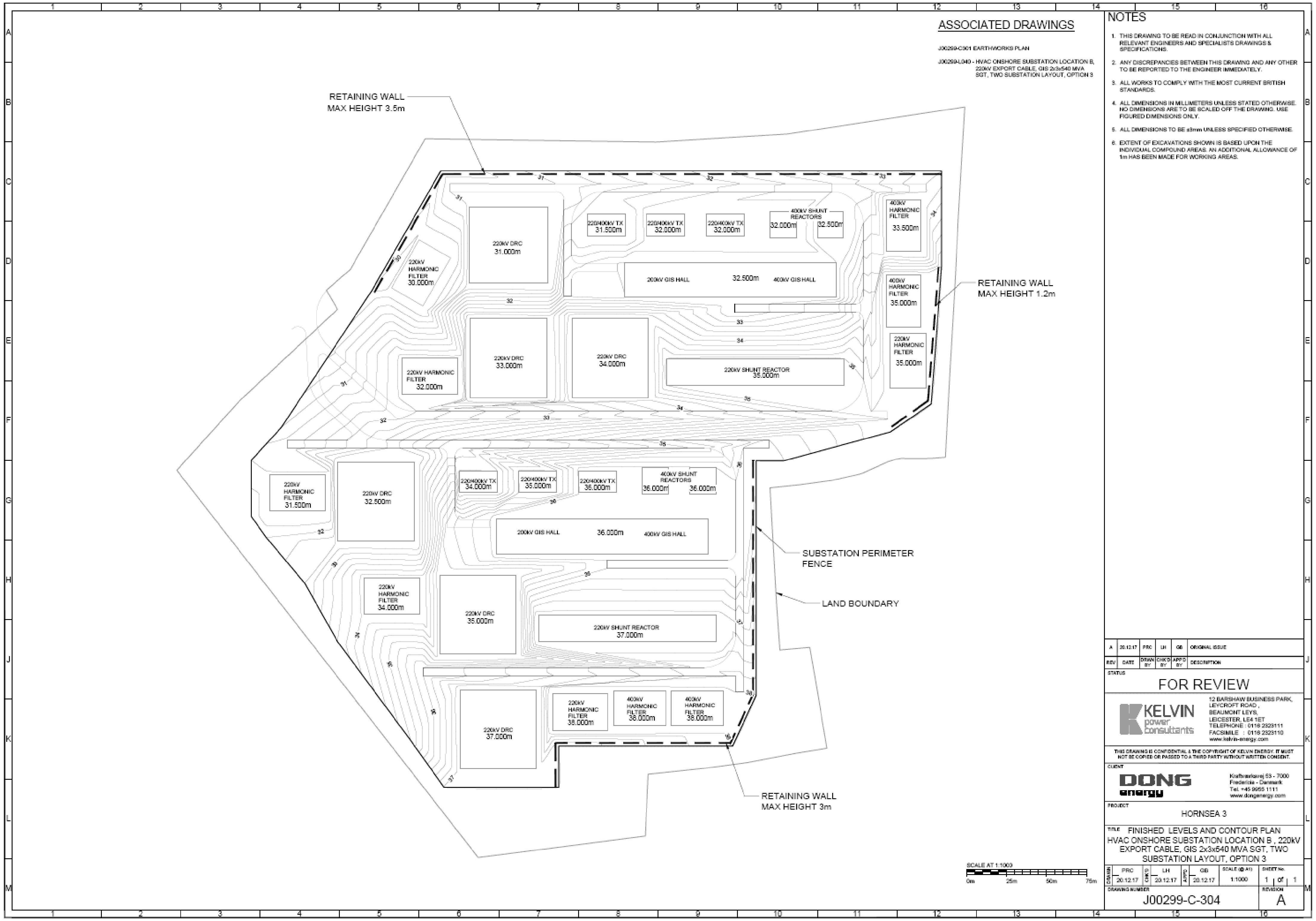

Figure 1.1: Onshore HVAC substation indicative plant layout.

1.2.2.17 The location of the plant items for the operation noise model has been determined from the drawing provided in Figure 1.1, which shows an indicative plant layout for the 3 x 540MVA onshore HVAC substation. The two GIS halls are the only on-site items identified as providing notable screening, modelled with 12 m height.

1.2.2.18 The ground surrounding the onshore HVDC converter/HVAC substation area is predominantly farmland, and has been modelled as acoustically soft. Ground height contours for the surrounding area have been extracted from Ordnance Survey Terrain 50 OpenData.

1.2.2.19 Landscaping is provided around some of the site perimeter (see Outline Landscape Management Plan (document reference A8.7) accompanying the DCO application). No allowance for acoustic screening is made for this proposed landscaping in the operational noise model to ensure the maximum design scenario has been assessed.

Modelling onshore HVAC booster station

1.2.2.20 As with the onshore HVDC converter/HVAC substation, for the purpose of the operational noise model the following assumptions have been made:

- The onshore HVAC booster station would be installed as per the project description (volume 1, chapter 3: Project Description); and
- The HVAC booster station would operate continuously and in accordance with the noise source levels and equipment list provided by the project team.

1.2.2.21 The onshore HVAC booster station would comprise an array of six "300 Mvar SR" units. By design, the six units would be enclosed. There are no additional items of reactive plant or other significant noise sources proposed to be installed within the onshore HVAC booster station. The assessment has therefore only considered the noise impact from these additional plant items within the operational noise model. The existing baseline environment does not currently include significant noise from electrical infrastructure.

1.2.2.22 From the information provided by the equipment providers, in accordance with BS 4142:2014 (British Standards Institution, 2014) no noise rating correction has been applied to the overall sound emissions from the HVAC booster station. In the specification of plant associated with the onshore HVAC booster station, the operational noise model assumes that the overall sound resulting from the operation of the facility be non-tonal and non-impulsive (to the specification of BS 4142:2014). Where this cannot be achieved, additional mitigation or reduction in plant noise source level would be made such as to achieve a similar rating level as would be produced by non-tonal plant, again allowing for a rating correction as defined in BS 4142:2014.

1.2.2.23 The sound power level presented in Table 1.4 has been used in the operational noise model. The noise spectrum used for the 300 Mvar SR plant is provided in Table 1.5.

1.2.2.24 The ground surrounding the onshore HVAC booster station is predominantly farmland, and has been modelled as acoustically soft. Ground height contours for the surrounding area have been extracted from OS Terrain 50 OpenData.

1.2.2.25 Landscaping is provided around some of the site perimeter (see Outline Landscape Management Plan accompanying the DCO application). No allowance for acoustic screening is made for this in the operational noise model. Therefore, the maximum design scenario has been assessed.

1.3 Operational noise output

1.3.1.1 Results of the operational noise model and assessment are provided in annex 8.4: Operational Noise Model Output.

Table 1.4: Onshore HVAC booster substation plant – operational noise model inputs.

Component	Number	Noise emission. SWL Sound Power Level (per item)	AC/DC	Point/Line/ Area/Volume source	Height	Enclosed/external	Spectrum				
							(A) Tonal	(B) Harmonic	(C) LF 100-250Hz	(D) broadband	Model Spectrum Number
220kV 300MVAr Variable SHR	6	97 dB(A)	AC	Area	9 m	Enclosed				✓	**D1**

Table 1.5: Onshore HVAC booster station plant – operational noise model input frequency weightings.

Frequency Weighting	Sum	63Hz	125Hz	250Hz	1kHz	2kHz	4kHz	8kHz
dB (A)	97.0	80.1	85.1	89.2	90.9	89.2	86.8	82.8
dB	108.2	106.3	101.2	97.8	90.9	88.0	85.8	83.9

1.4 References

British Standards Institution (BSI) (2014) British Standard 4142: Methods for rating and assessing industrial and commercial sound. Milton Keynes, BSI.

British Standards Institution (BSI) (2003) BS 7445-1: Description and measurement of environmental noise. Guide to quantities and procedures. Milton Keynes, BSI.

International Organization for Standardization (ISO) (1996) ISO 9613 Attenuation of sound during propagation outdoors – Part 2: General method of calculation. Geneva, International Organization for Standardization.