Appendix 9.4

Noise Propagation Modelling Inputs and Results

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OPERATIONAL NOISE MODELLING INPUTS AND ASSUMPTIONS

Prediction of operational noise was carried out using CadnaA noise propagation software. Assumptions and model inputs are detailed below. Further details of noise propagation modelling methodology can be found in EIAR Chapter 9: Noise and Vibration.

CadnaA Noise Model Set Up

CadnaA (Computer Aided Noise Abatement) is a leading proprietary software for environmental noise propagation calculation, presentation and assessment. The CadnaA noise modelling software package was set up to use ISO9613 "Attenuation of Sound during Propagation Outdoors Part 2 General Method of Calculation" prediction methodology along with a range of topographical and ordnance data collected on the surrounding area to build up a picture of the noise environment in the vicinity of noise sources. The ISO 9613-2 propagation model is a light downwind model, which assumes that weather conditions are favourable for sound propagation. Where conditions are less favourable to sound propagation occur, such as when the assessment locations are crosswind or upwind of the Proposed Development, the sound levels would be expected to be lower and the downwind predictions presented would be regarded as conservative i.e. greater than those experienced in practice.

The software was used to build a 3-dimensional model of all features which may affect the generation and propagation of noise in the vicinity of the Proposed Development and to predict the specific sound levels due to the Proposed Development at nearby residential properties (receptors).

The propagation model takes account of sound attenuation due to geometric spreading and atmospheric absorption. The assumed temperature and relative humidity are 10 ˚C and 70 % respectively. Ground effects are also taken into account by the propagation model, with ground effects surrounding noise sources and receptors being of particular significance. CadnaA allows definition of ground absorption across a whole site or with a map of ground absorption. Hard ground is represented by Ground Absorption G=0, G=1 for soft ground and G=0.5 is typically adopted to reflect a mix of hard and porous ground. For this project G=0.5 has been applied within the Proposed Development site boundary to represent the mix of hard and soft ground within the site. For the area surrounding the site, hard ground (G=0) has been applied to larger areas of hard standing, for example the M7 industrial estate and surrounding agricultural lands have been assumed to comprise primarily soft ground and have been assigned G=1.

Where buildings have been included in the model, reflections have been included, with a reflection loss of 0 dB unless otherwise stated.

Noise-sensitive receptors have been included in the model at a height of 1.5m above ground level for daytime predictions and 4m above ground level for night-time predictions.

Unless otherwise stated, noise sources have been assumed to have a 100% 'on-time'.

Sound pressure levels were predicted at all 42 representative noise-sensitive receptors for both daytime (07:00 – 23:00) and night-time (23:00 – 07:00) periods. Receptor height for daytime predictions was 1.5m above ground level, with 4m above ground level assumed for night-time predictions.

Plant and Equipment Noise Source Data

A review of the Proposed Development has identified the following key items of plant and equipment which have the potential for significant noise emissions are:

- Data centre cooling system for each of the 6 buildings;
- Data external plant compound;
- Substation.

Plant and equipment source sound levels have been provided in manufacturer datasheets and acoustic testing reports. Where sound pressure levels have been provided, these have been converted to sound power levels, with dimensions of equipment obtained from manufacturer datasheets and project general arrangement and section drawings. It should be noted that manufacturer datasheets are typical for the type of plant and equipment to be installed, and are subject to final equipment selection. Installed plant and equipment will achieve the same noise levels (or lower) than those indicated within this assessment. A summary of the model inputs is shown in the sections that follow. The number of sources etc are per building, with all six data centre buildings having identical layouts and noise sources.

Data Centre Cooling System

The data centre cooling system for each building comprises 56no. duplex Air Handling Units (AHUs). Each duplex unit has 12no. supply fans and 8no. return fans, with a total of 672 supply fans and 448 return fans per data centre building.

Supply fans will draw fresh air through louvres along the sides of the data centre building. The AHU air intakes are located behind the long facades of each Data Centre, with large louvered sections sitting within the façade to provide ventilation to the AHUs internally. The location of the supply air louvred sections are illustrated in the elevation drawings within Volume II: Figures and Drawings. Each long façade has been modelled with four vertical area sources for the louvred areas, each with an overall sound power level representative of 1/8 of the AHU air intake fans within the Data Centre building.

AHU exhaust noise is generated by the extract fans, which are located within the AHU itself and ducted to the penthouse louvres at roof level. Each duplex AHU comprises 8 extract fans.

Return fans from either 2no. or 4no. duplex AHU units will direct exhaust air to one of 16no. common penthouse louvre above roof level. Each data hall will have 12 exhaust shafts serving 4no. duplex units and 4 exhaust shafts serving 2no. duplex units. The general arrangement and section drawings for the data halls can be found in Volume II Figures and Drawings.

Typical arrangement of a group of 4no. duplex AHU units and the associated exhaust ‘penthouse louvres’ is shown in Figure 9D.2 and Figure 9D.3.

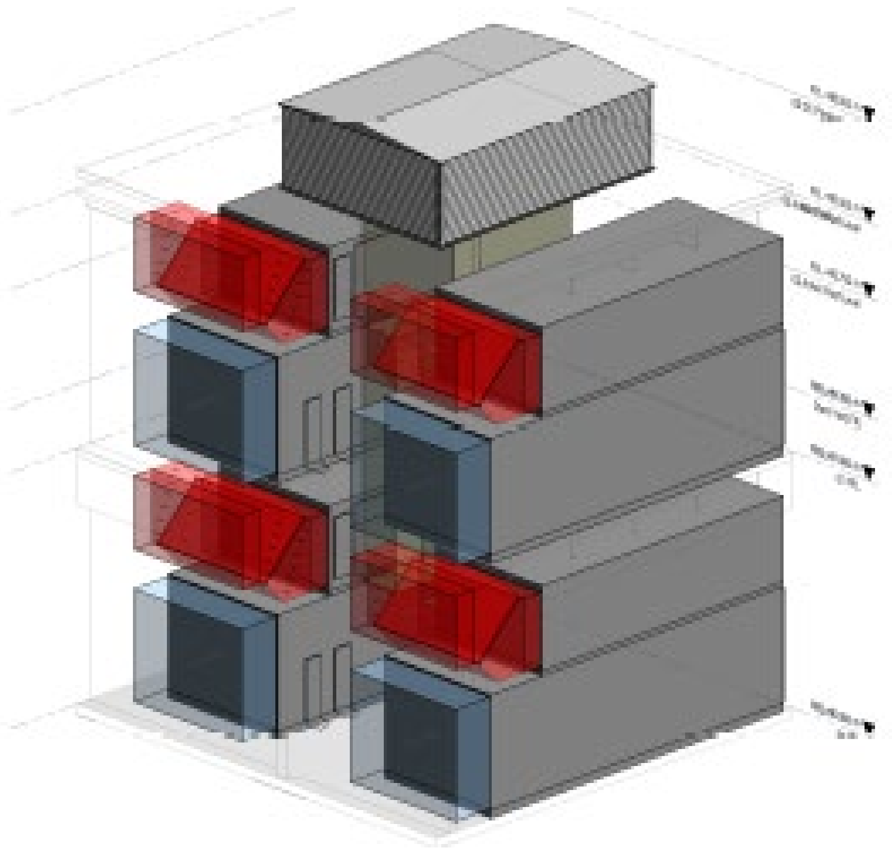

Figure 9D. 1: Figure 9D.1: 3D Image of Group of 4no. Duplex AHUs and Associated Common Exhaust Arrangement

Figure 9D.2: 3D Image of Group of 4no. Duplex AHUs and Associated Common Exhaust Arrangement

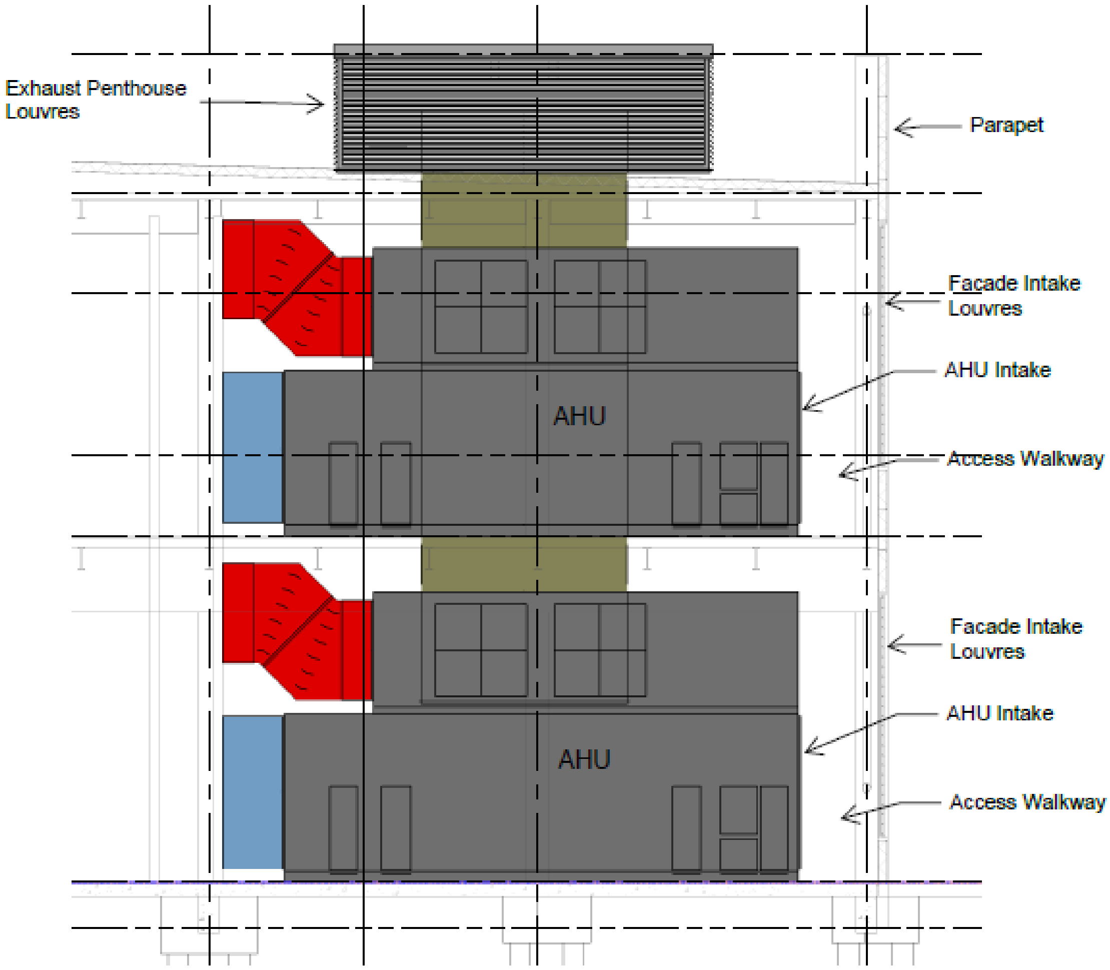

Figure 9D.3: Section Through Group of 4no. Duplex AHU and Associated Common Exhaust Arrangement

AHU Sound Power Level Source Data

The manufacturer acoustic data was provided for the AHU supply and extract fans, but for different duty flow rates from the Proposed Development. Sound power level data was supplied for a bank of the proposed fans with a volumetric flow rate of 42.9 m^3/s.

The Proposed Development will comprise 56 duplex AHUs, each with a total volumetric flow rate of 40.44 m3/s.

Fan noise is roughly proportional to the fifth power of fan speed (and therefore volumetric flow rate). As such, adjustment for the difference in duty was calculated using the following equation (9D.1):

$$dB\ Duty\ Adjustment = 50 \times \log_{10}\left(\frac{D}{D_0}\right) \qquad (9D.1)$$

Where D is the new fan duty and D_0 is the reference fan duty, both in m^3/s.

Sound power levels were also adjusted as required for number of fans using the calculation (9D.2):

$$dB\ No.Fans\ Adjustment = 10 \times \log_{10}\left(\frac{N}{N_0}\right) \qquad (9D.2)$$

Where N is the desired number of fans and N_0 is the reference number of fans.

SOUND CALCULATION SHEET

Customer:									Rev G	11.01.19
Project:	Mid-frequency Octave Band (Hz)									
AHU Tag: **MAIN AHU**	**63**	**125**	**250**	**500**	**1k**	**2k**	**4k**	**8k**	**Total**	**Total**
Duty m3/s: **Colo 1 - Normal - (42.9m³/s)**	db	db	db	db	db	db	db	db	db	db(A)
(Single Fan, SWL)	**71**	**78**	**80**	**74**	**74**	**73**	**82**	**78**	**87**	**85**
System: **Supply Inlet (Fresh)** ***(12x Fans)***	**82**	**89**	**90**	**85**	**85**	**84**	**93**	**89**	**98**	**96**
Internal Losses (From FWT Testing)	0	1	15	12	12	18	33	41		
A-Weight: Yes	-26.2	-16.1	-8.6	-3.2	0	1.2	1	-1.1		
At AHU Supply Inlet (db(A), SWL):	**56**	**71**	**67**	**69**	**73**	**67**	**61**	**47**		**77**
At AHU Supply Inlet (db(A), SPL @ 1m):	**41**	**56**	**52**	**54**	**57**	**52**	**46**	**32**		**62**
At AHU Supply Inlet (db(A), SPL @ 3m):	**31**	**46**	**42**	**44**	**47**	**42**	**36**	**22**		**52**
(Single Fan, SWL)	**81**	**72**	**67**	**74**	**70**	**65**	**60**	**58**	**82**	**75**
System: **Extract Outlet** ***(8x Fans)***	**90**	**81**	**76**	**83**	**79**	**74**	**69**	**67**	**91**	**84**
Fan Instalation Correction Factor	-4	-13	-15	-4	-8	-8	-6	-3		
Fan Inlet Accoustic Grid	1	8	5	3	0	-2	-1	0		
Attenuator - 600mm Deep - 150mm Spacing	5	7	11	17	24	20	13	11		
A-Weight: Yes	-26.2	-16.1	-8.6	-3.2	0	1.2	1	-1.1		
At AHU Exhaust Outlet (db(A), SWL):	**61**	**63**	**66**	**64**	**63**	**65**	**64**	**58**		**73**
At AHU Exhaust Outlet (db(A), SPL @ 1m):	**46**	**48**	**51**	**49**	**48**	**50**	**49**	**43**		**58**
At AHU Exhaust Outlet (db(A), SPL @ 3m):	**36**	**38**	**41**	**39**	**38**	**40**	**39**	**33**		**48**

Figure 9D.4: AHU Noise Source Reference Data

AHU Air Intake Noise Data

Normal Operation

For 'normal operation' of each data hall, each of the 8 vertical area sources represents 7 duplex AHUs, each duplex AHU with a volumetric flow rate of 40.44 m³/s. All AHUs are in operation and each vertical area source represents a total of 84 supply fans. Calculation of the sound power attributed to each vertical area source is detailed in Table 9D.1.

Table 9D.1 Calculation of AHU Supply Fan Sound Power Levels (Normal Operation)

	Un-Weighted L_W Spectrum Centre Frequency, Hz								Overall
	63	125	250	500	1k	2k	4k	8k	L_W, dBA
AHU 12 Supply Fans @ 42.9 m³/s duty Reference Sound Power Level, dB	82	89	90	85	85	84	93	89	96
Internal Losses, dB	0	-1	-15	-12	-12	-18	-33	-41	
Correction from 42.9 m³/s to 40.44 m³/s, dB	-1	-1	-1	-1	-1	-1	-1	-1	
Correction from 1no. to 7no. Duplex AHUs, dB	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5	
AHU 7no. Duplex AHUs @ 40.44 m³/s duty Supply Fans Sound Power Level, dB	89	95	82	80	80	73	67	55	85

Emergency Operation

'Emergency operation' refers to a situation where 4 of the duplex AHUs across one data centre building (one duplex AHU in 4 different data halls) are out of service (e.g. for maintenance) and the duty on the remaining AHUs is increased to compensate. In practice, this means that, across each data hall, 24 supply fans are not in operation and the remaining 624 supply fans will operate with an increased duty. Each of the 52 remaining operational duplex AHUs will operate with an increased duty of 43.6 m^3/s.

The specific AHUs which will be out of service will vary as required, and it has been assumed that the increase in sound power level associated with the remaining fans has been evenly spread across the 8 vertical area sources which represent the fresh air supply louvres, with a total of 78 supply fans contributing to the sound power level of each louvred area/vertical area source.

The adjustments made to the supply fan source sound power data to represent the emergency operation scenario are shown in Table 9D.2 along with the total sound power level (L_W) for the 78 supply fans.

Table 9D.2: Calculation of AHU Supply Fan Sound Power Levels (Emergency Operation)

	Un-Weighted L_W Spectrum Centre Frequency, Hz								Overall
	63	125	250	500	1k	2k	4k	8k	L_W, dBA
AHU 12 Supply Fans @ 42.9 m^3/s duty Reference Sound Power Level, dB	82	89	90	85	85	84	93	89	96
Internal Losses, dB	0	-1	-15	-12	-12	-18	-33	-41	
Correction from 42.9 m^3/s to 43.6 m^3/s, dB	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	
Correction from 12 to 78 fans, dB	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	
78 supply fans 43.6 m3/s duty Sound Power Level, dB	90.5	96.5	83.5	81.5	81.5	74.5	68.5	56.5	86

AHU Exhaust Noise Data

Exhaust penthouse louvres were modelled as point sources at a height of 3m above roof level. As shown in Figure 9D.5, each exhaust point/penthouse louvre serves either 2no. or 4no. duplex AHUs across the ground and first floors. Each point source represents either 16no. or 32no. individual extract fans.

Normal Operation

For normal operational conditions, the penthouse louvre point sources represent the exhaust fan noise from 2no. or 4no. duplex AHUs, with a duty of 40.44 m^3/s per duplex AHU. This equates to 16no. or 32no. individual extract fans per point source.

The reference extract fan sound power level (L_W) shown in Table 9D.3 already includes the installation correction factor, fan inlet acoustic grid and attenuator, which are detailed in the reference source data within Figure 9D.4.

Table 9D.3: Calculation of AHU Extract Fan Sound Power Levels (Normal Operation)

	Un-Weighted L_W Spectrum Centre Frequency, Hz								
	63	125	250	500	1k	2k	4k	8k	L_W, dBA
AHU 8 Extract Fans 42.9 m^3/s duty (includes installation correction factor, fan inlet acoustic grid and attenuator)	88	79	75	67	63	64	63	59	72.7
Correction to 40.44 m3/s	-1.3	-1.3	-1.3	-1.3	-1.3	-1.3	-1.3	-1.3	
Correction to 2 Duplex (16 fans)	3	3	3	3	3	3	3	3	
Correction to 4 Duplex (32 fans)	6	6	6	6	6	6	6	6	
Extract Outlet for 2 Duplex (16 Fans)	89.7	80.7	76.7	68.7	64.7	65.7	64.7	60.7	74.4

Extract Outlet for 4 Duplex (32 Fans)	92.7	83.7	79.7	71.7	67.7	68.7	67.7	63.7	77.4

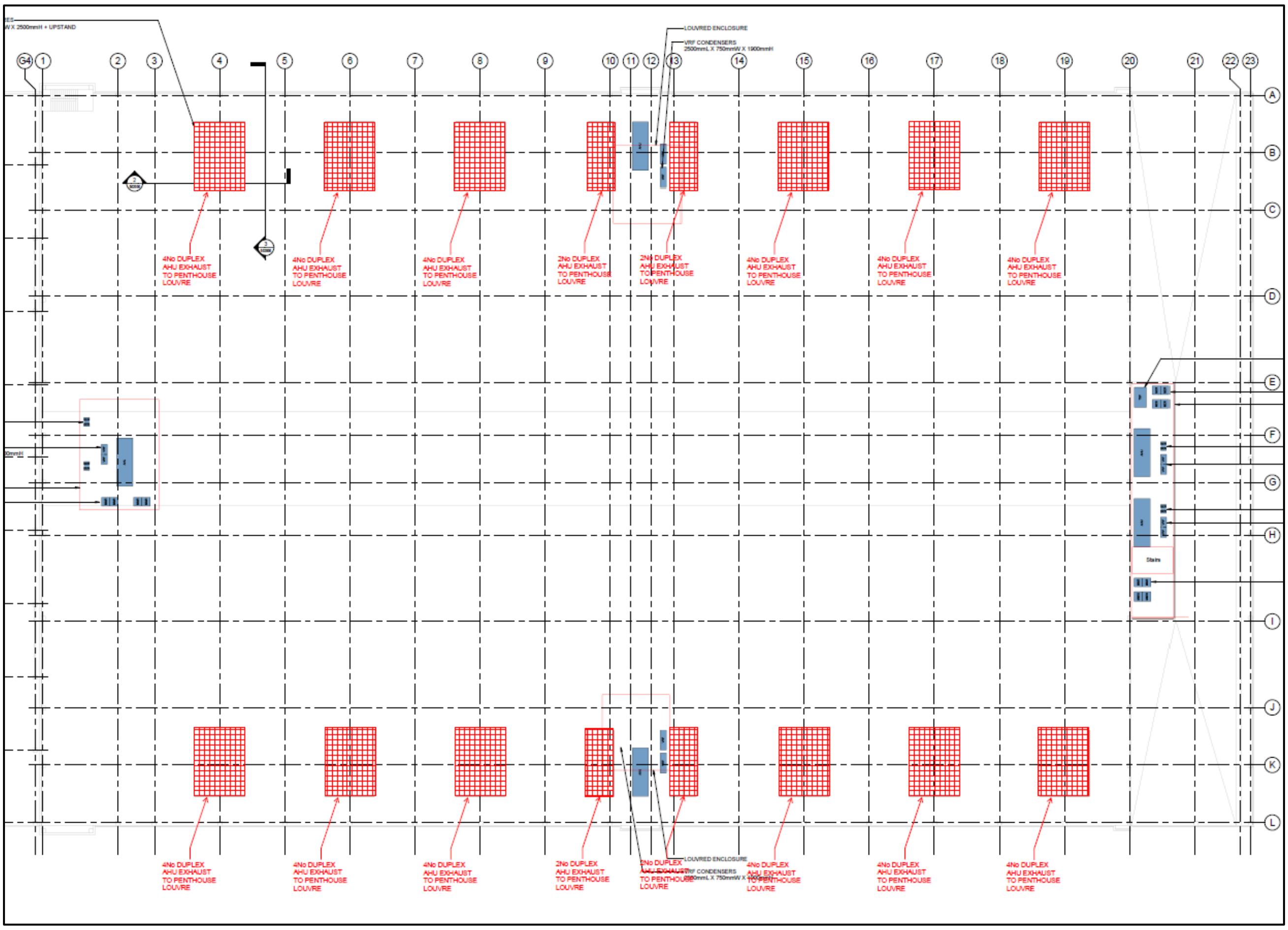

Figure 9D.5: AHU Exhaust Penthouse Louvre Arrangement

Emergency Operation

For the emergency operational scenario, 4 duplex AHUs are assumed to be out of service. The location of the non-operational AHUs will vary. For the purposes of the model, an average location has been assumed and 2 of the central AHUs on each of the long facades have been assumed to be out of service. The remaining AHUs operate with an increased duty of 43.6 m³/s.

The sound power level (L_W) of each penthouse louvre has been calculated as per Table 9D.4 for the emergency operation scenario.

Table 9D.4: Calculation of AHU Extract Fan Sound Power Levels (Emergency Operation)

	Un-Weighted L_W Spectrum Centre Frequency, Hz								
	63	125	250	500	1k	2k	4k	8k	L_W, dBA
AHU 8 Extract Fans 42.9 m³/s duty (includes installation correction factor, fan inlet acoustic grid and attenuator)	88	79	75	67	63	64	63	59	72.7
Correction to 40.44 m3/s	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	
Correction to 2 Duplex (16 fans)	3	3	3	3	3	3	3	3	
Correction to 4 Duplex (32 fans)	6	6	6	6	6	6	6	6	

Extract Outlet for 2 Duplex (16 Fans)	91.4	82.4	78.4	70.4	66.4	67.4	66.4	62.4	76.1
Extract Outlet for 4 Duplex (32 Fans)	94.4	85.4	81.4	73.4	69.4	70.4	69.4	65.4	79.1

With 56 AHUs across the Proposed Development, it is expected that the ‘emergency scenario’ may apply to a significant proportion of the time, particularly during the day when scheduled maintenance will take place. As such, it has been assumed that ‘emergency mode’ will apply to the AHUs in all of the modelling scenarios for all data halls.

Data Centre External Plant Compounds

Power generation and battery storage plant and equipment are located in an external plant compound adjoining each data centre building. The roof of the plant area will be open, to allow for ventilation and cooling. One side of the plant area will adjoin the main data centre external wall, The plant area will be enclosed with IAC FS/S Noishield Barrier panels (or a similar), including all external walls and the internal treatment of the wall that abuts the data centre building. The proposed barrier type is shown in Figure 9D.7. The assumed sound transmission loss and absorbency coefficient for the IAC FS/S panels have been taken from the manufacturer datasheet, as shown in Figure 9D.6.

Sound Transmission Loss Data, dB

1/1 Octave Band Centre Frequency, Hz	63	125	250	500	1k	2k	4k	8k	STC
FS/S and SFS/S	18	20	32	39	32	31	28	35	30
FSt/S	21	23	36	40	32	33	30	33	33
FS/A and SFS/A	17	23	30	44	51	51	39	39	43

Sound Absorptive Coefficients

1/1 Octave Band Centre Frequency, Hz	125	250	500	1k	2k	4k	8k	NRC
FS/S FS/A & FSt/S	1.12	1.12	1.10	1.01	0.89	0.76	0.57	1.05
SFS/S & SFS/A	0.49	1.04	1.14	1.05	0.96	0.95	0.87	1.05
C12/S & C12/A	0.48	1.08	1.10	0.99	0.92	0.83	0.78	1.00
C38/S & C38/A	0.68	1.19	1.10	1.03	0.90	0.81	0.76	1.05

Figure 9D.6: IAC Noishield Barrier Acoustic Performance

Figure 9D.7: IAC Noishield Barriers

The external plant area has been modelled as a semi-reverberant space with an open roof. The model has been calibrated to determine the reverberant sound pressure level at the internal facades and free-field sound pressure level at the 'roof' level. The façade sound pressure levels were calculated using the sound power levels for plant and equipment within the plant area. Absorption and sound transmission loss were applied to the model where appropriate, as per the values in Figure 9D.6.

The external plant area walls were modelled as vertical area sources and an area source was used for the open roof. In addition to this 'break-out' noise from the plant area, exhaust ducting and stack tip noise were modelled as line sources and point sources respectively.

The plant and equipment source data included in the acoustic model are detailed in the following sections. Note that the plant shown is per data centre, with identical layout and equipment for each of the six data centre plant areas.

Gas Turbine Generators

Each data centre external plant area contains 8no. gas turbine generators.

The primary noise sources associated with gas turbines are:

- Turbine casing;
- Pipework/ductwork to exhaust;
- Exhaust stack tip.

An indicate gas turbine package elevation is shown in Figure 9D.8.

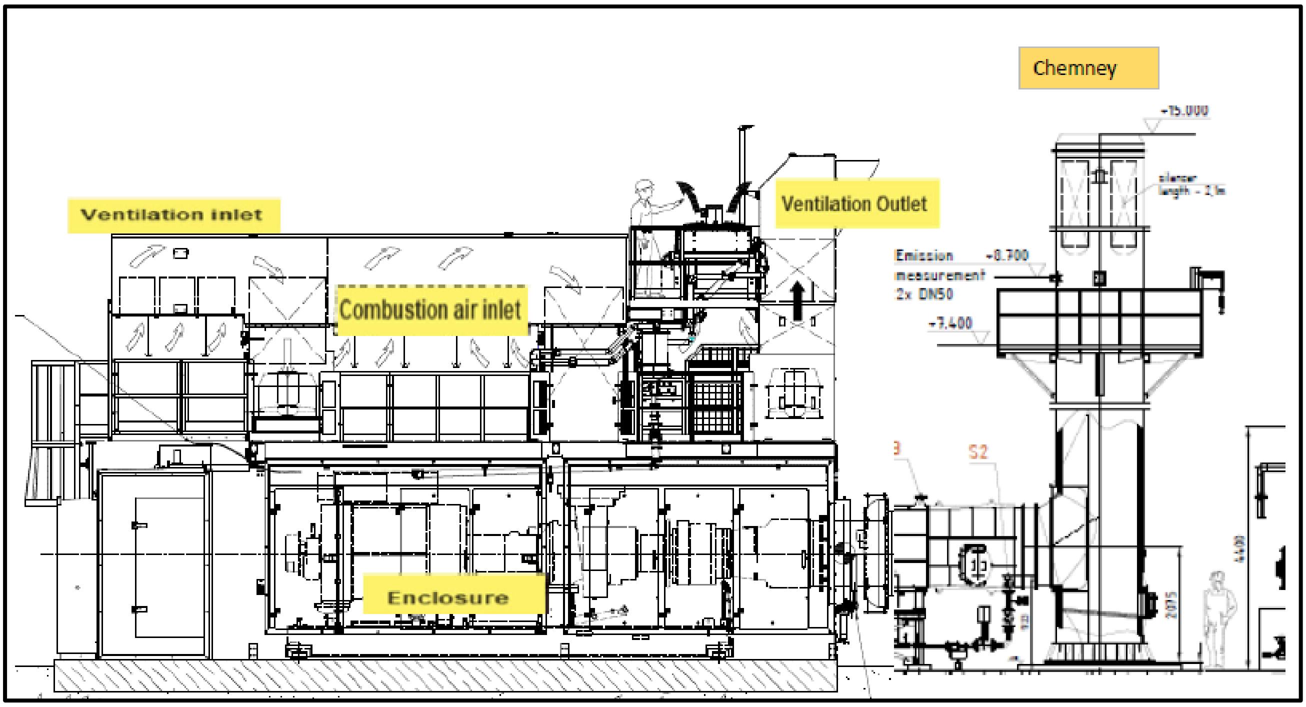

Figure 9D.8: Typical Solar Gas Turbine Elevation

Turbine Enclosure

The proposed turbine type is the Solar Taurus 60 gas turbine package, which will benefit from a bespoke acoustic enclosure which will surround the main turbine casing. The acoustic enclosure will include inspection windows, removable panelling for maintenance and silencers on the ventilation air inlet/outlet and combustion air inlet.

The main package enclosure is expected to achieve a sound pressure level of 69 dBA @1m. These are based on measurements of similar packages and a measurement height of 1.5m above ground level. It is assumed that the same sound pressure level can be assumed at 1m from all facades of the turbine enclosure.

The external dimensions of the turbine enclosure will be approximately 12.5m (L) x 6.5m (W) x 3.5m (H). At a sound pressure level of 69 dBA, this equates to a total sound power level (denoted as L_W for the turbine enclosure of 94.2 dBA.

Exhaust Duct and Stack Tip

Exhaust noise has been considered both in terms of break-out noise from ductwork and noise emission from the stack tip The combustion exhaust will be fitted a silencer which will achieve a sound pressure level of 66 dBA @1m from the exhaust stack ducting and 66 dBA @1m perpendicular to the exhaust stack tip. It is assumed that the exhaust stack will discharge at a height of 20m above external plant room ground level, (1m above the parapet height).

Gas Turbine Model Noise Model Input Summary

A summary of model inputs for the gas turbines is presented in Table 9D.5. Sound power levels were determined for each element of the gas turbine system (enclosure, exhaust stack ducting and exhaust stack tip) using the project-specific sound pressure level at 1m listed below and the physical dimensions of the equipment. The project-specific sound pressure level for each aspect of the gas turbine package have been agreed with the manufacturer, who will provide the appropriate enclosure, silencer and duct lagging specification to achieve the follow sound pressure levels when measured at 1m:

- 69 dBA @ 1m from turbine enclosure
- 66 dBA @ 1m from stack ducting
- 66 dBA @1m from stack tip (at 90°)

The spectral shape for each noise source was provided by the turbine manufacturer based on measurements, and applied to the project-specific sound pressure level for each element of the turbine package.

Table 9D.5: Gas Turbine Sound Power Level Model Inputs

Centre Frequency, Hz:	63	125	250	500	1K	2K	4K	8K	Overall L_W, dBA
	Sound Power Level, L_W dBZ								
Enclosure	99.2	96.2	97.2	91.2	88.2	83.2	83.2	77.2	94.3
Chimney Stack/Duct	92.0	87.0	85.0	80.0	80.0	80.0	81.0	77.0	87.3
Stack Tip	83.0	84.0	80.0	74.0	68.0	65.0	67.0	64.0	77.1

Gas Reciprocating Engines

Each external plant area will have 10 reciprocating gas engines (5 as standby units). It is expected that these 1MW gas engines will achieve a sound pressure level of 69 dBA @ 1m from the main engine package and 69 dBA @ 1m from the exhaust tip. Sound power levels for these items have been calculated based on the anticipated sound pressure levels and the physical dimensions of the packages. The total sound power level for the gas reciprocating engines which have been adopted within the acoustic model are:

Table 9D.6: Reciprocating Gas Engine Sound Power Level Model Inputs

Item	Sound Pressure Level @ 1m, dB L_{Aeq}	Sound Power Level, dB L_{WA}
Gas Engine Enclosure	66	87.3
Gas Engine Stack Tip	66	77.1

Battery Energy Storage System

The Battery Energy Storage System (BESS) will generate noise by way of the cooling fans associated with the inverters.

There will be 40no. Battery Energy Storage Inverters packages within each external plant area. Manufacturer noise data is shown in Figure 9D.9 for the inverters based on maximum fan speed. The typical operating speed for the inverter fans is expected to be 50-70% of the maximum fan speed for these units. As fan noise is roughly proportional to the 5^{th} power of fan speed, actual operational levels are likely to be 8-11 dB lower than at full speed.

Additionally, circular silencers will be installed to the fans cooling the inverters, which will provide further attenuation of inverter fan noise.

A conservative 6 dB overall reduction in manufacturer sound power levels shown in Figure 9D.9 due to fan speed reduction and silencer performance. This resulted in a sound power level of 82 dB being assigned to each battery storage inverter in the noise model.

Table 9D.7: Indicative Noise Reduction with Fan Speed Reduction

Fan Speed Reduction	Noise reduction
10%	2dB
20%	5dB
30%	8dB
40%	11dB
50%	15dB

Sound pressure level measurements were conducted according to IEC 60076-10:2016 in the TVO Olkiluoto BESS site on 2022-10-03.

The operating conditions of the unit during measurements, measurement details and measured A-weighted equivalent noise levels L_{Aeq} [dB] are presented in *Figure 1*.

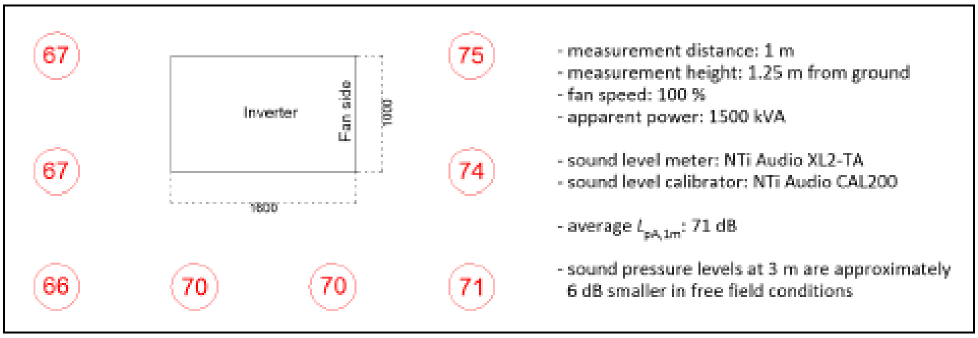

Figure 1. Measured L_{Aeq} [dB] (within red circles), operating condition during the measurements and measurement details.

The sound level meter complies with IEC 61672-1:2013 Class 1 requirements. The sound level calibrator complies with IEC 60942 Class 1 requirements.

The calculated total A-weighted sound power level L_{WA} for this load condition is **88 dB**. The unweighted spectrum of the sound power level in 1/3-octave bands is presented below. The sound power level has been determined according to the spatial average sound pressure level ($L_{pA,1m}$ 71 dB) according to the sound pressure level method defined in IEC 60076-10:2016. The relative sound pressure level differences between the sides shown in *Figure 1* can be used as directivity information in noise mapping.

f [Hz]	50	63	80	100	125	160	200	250	315	400	500	630
L_w [dB]	73.3	70.0	74.2	82.1	76.4	75.7	87.9	79.0	81.2	78.6	78.0	79.3

f [Hz]	800	1k	1.25k	1.6k	2k	2.5k	3.15k	4k	5k	6.3k	8k	10k
L_W [dB]	78.0	77.5	75.9	73.4	72.2	75.7	75.7	67.5	73.2	74.5	71.3	69.3

Figure 9D.9: Battery Energy Storage Inverter Noise Data

110 kV Grid Substation

The onsite 110 kV grid substation is subject to a separate SID planning application, however, as both the data centre and the substation are connected and dependent upon planning being granted, it is important that the noise impact from the proposed substation is assessed in conjunction with the operational data centre development.

The SID application includes a new electricity grid substation compound, a medium voltage switchgear and control equipment building, a building housing indoor high voltage (HV), GIS equipment, high voltage busbar connections, and step-down power transformers, and underground cables connecting the proposal to the existing 110kV overhead lines that cross the proposed development site.

The substation will be located within a compound of concrete hard standing and surrounded by 2.4 high palisade fencing and will comprise a Gas Insulated Substation (GIS) building with a height of approximately 15.5m above ground level and four Medium Voltage (MV) Switchrooms which will be approximately 5.5m high, enclosed within individual buildings.

Four transformers will be located in the centre of the compound and will comply with the ESB specifications, which require that the sound power level of a transformer, including all cooling fans, measured according to IEC60551, shall not exceed 70dBA. The transformers have been included in the noise model on this basis and modelled as buildings with a height of 5m above ground level with noise propagating from the roof and walls.

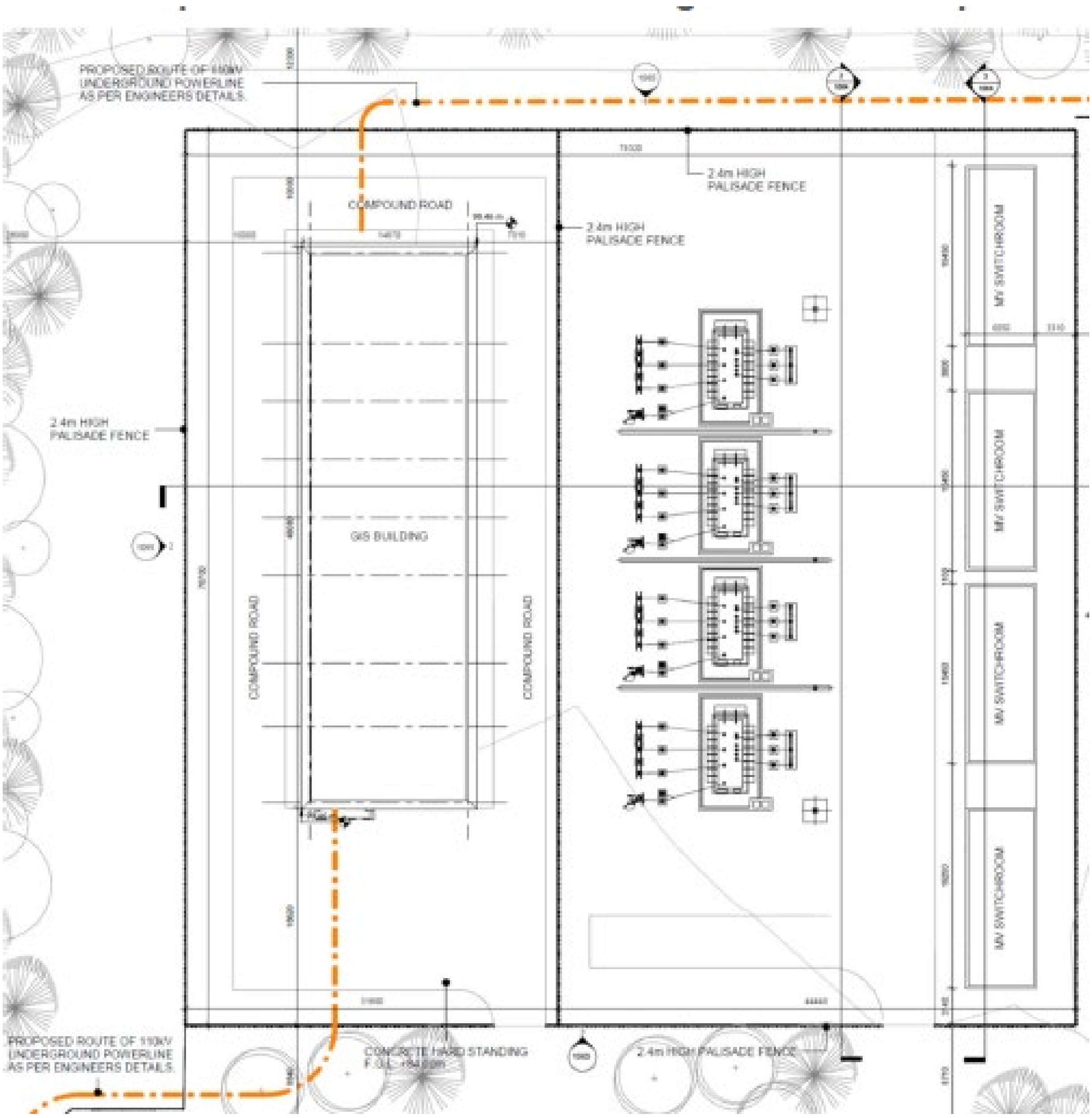

Figure 9D. 10: Proposed Substation Arrangement (Indicative)

Further information regarding the noise impact of the 110 kV grid substation can be found within the Interactions section of Chapter 9: Noise and Vibration.

Operational Power Scenarios

The power requirements of the data centres will typically be met by a minimum of 30% renewable energy from wind/solar farms annually. The remaining energy demands will be fulfilled by a combination of gas turbines and reciprocating gas engines.

Illustrative operational scenarios and associated power sources are shown in Table 9D.8. These will be subject to variability such as power demands from the data centre, availability of renewable energy, availability of fuel and ambient temperature. Scheduled maintenance routines for turbines and engines will be limited to daytime only.

Table 9D.8: Indicative Operational Power Scenarios

No.	Scenario Description	Source Status				Max Source Capacity (MW)				Total Capacity (MW)
	Supply Type	Turbines	Engines	Substation	Solar PV	Turbines	Engines	Substation	Solar PV	
1	Running on turbines only, on gas, no CPPA/PV	8	0	Off	Off	8	0	0.00	0.00	40.00
2	Running on turbines on gas with low level CPPA/PV	7	0	On	Off	7	0	5.00	0.00	40.00
3	Running on turbines and engines on gas with medium level CPPA/PV	6	2	On	Off	6	2	8.00	0.00	40.00
4a	Running on turbines and engines on gas with average level CPPA/PV	5	3	On	Off	5	3	11.75	0.00	39.75
4b	Running on turbines on gas only with available CPPA/PV or grid power	5	0	On	Off	5	0	14.75	0.00	39.75
5	Running with external peak level CPPA/PV, no turbines or engines	0	0	On	On	0	0	65.28	0.50	65.78
6	Running on turbines on gas with low level CPPA/PV, maintenance of one turbine	7	0	On	Off	7	0	5.00	0.00	40.00
7	Running on turbines only, on diesel, no CPPA/PV - test condition	8	0	Off	Off	8	0	0.00	0.00	40.00
8	Running on turbines only, on diesel, no CPPA/PV - emergency condition	8	0	Off	Off	8	0	0.00	0.00	40.00
9	Running on turbines and engines, on diesel with CPPA/PV	5	3	On	On	5	3	11.75	0.09	39.84

The noise modelling results considers the operating conditions for daytime and night-time power scenarios, as per Table 9D.8. Analysis of the power scenarios is shown in the sections that follow, with the most frequently occurring ‘typical’ scenario and ‘worst case’ scenario identified for both daytime and night-time.

Daytime Operation

The power sources associated with all daytime operational scenarios are shown in Table 9D.9 along with an approximated percentage of the daytime hours where each power scenario will take place. Scenarios have been grouped where noise variable sources (i.e. number of gas turbines and gas engines are the same).

Table 9D.9: Daytime Operational Noise Model Power Scenarios

	Gas Turbines	Gas Engines	Approximate proportion of daytime hours in this
Power Scenario 4a & 9	5	3	64%
Scenario 3	6	2	19%
Scenario 2 & 6	7	0	11%
Scenario 5	0	0	5%
Scenario 1,7 & 8	8	0	<1%

Daytime typical operation is represented in the noise modelling by the most frequently occurring power scenario; 5 gas turbines and 3 gas engines operating. This accounts for approximately 64% of the daytime operational hours across the year.

Worst-case power scenario for daytime noise is 8 gas turbines operating, however this is expected to occur for less than 1% of the daytime operational hours throughout the year.

Night-Time Operation

The power sources associated with all daytime operational scenarios are shown in Table 9D.10 along with an approximated percentage of the daytime hours where each power scenario will take place.

Scenarios have been grouped where noise variable sources (i.e. number of gas turbines and gas engines are the same).

Table 9D.10: Night-Time Operational Noise Model Power Scenarios

	Gas Turbines	Gas Engines	Approximate % of night-time hours in
Scenario 4b	5	0	74%
Scenario 5	0	0	22%
Scenario 4a & 9	5	3	< 2%
Scenario 3	6	2	< 2%
Scenario 2 & 6	7	0	< 1%

Night-time typical operation will be represented in the noise modelling by the most frequently occurring power scenario; 5 gas turbines and 0 gas engines operating. This accounts for approximately 74% of the night-time operational hours across the year.

Worst-case power scenario for night-time noise is 7 gas turbines operating, however this is expected to occur for less than 1% of the night-time operational hours throughout the year.

Noise Modelling Results

Daytime Noise Modelling Results

Noise modelling results are shown in Table 9D.11 for typical and worst-case daytime operation scenarios. Daytime predicted sound pressure levels are shown for all 42 noise-sensitive receptors which assume a receptor height of 1.5m above ground height.

The daytime noise model assumes that all BESS inverters, data hall AHUs, substation are also operating with a 100% on time.

Typical operation for daytime includes 5 gas turbines and 3 gas engines running with a 100% on-time.

Worst-case operation for daytime has 8 gas turbines operating with a 100% on-time.

Table 9D.11: Typical Daytime Plant and Equipment $L_{Aeq, T}$ Noise Propagation Modelling Results

Receptor Location	Predicted Typical Daytime Sound Pressure Level 1.5 m Receptor Height, dB $L_{Aeq, T}$	Predicted Worst-Case Daytime Sound Pressure Level 1.5 m Receptor Height, dB $L_{Aeq, T}$
1	42.5	42.7
2	38.7	39
3	37.7	38.1
4	37.4	37.8
5	37	37.3
6	36.5	36.9
7	35.7	36
8	35.3	35.6
9	38.8	39.1
10	40.0	40.4
11	38.9	39.3
12	36.9	37.4
13	35.3	35.8
14	36.6	37
15	37.5	37.9
16	38.6	39
17	38.9	39.3
18	38.8	39.2
19	38.5	38.9
20	39.4	39.9
21	39.7	40.1
22	36.8	37.2
23	31.8	32.1
24	33.2	33.5
25	33.8	34.1
26	34.0	34.3
27	33.3	33.6
28	31.3	31.7
29	33.0	33.4
30	34.7	35
31	31.8	32.2

Receptor Location	Predicted Typical Daytime Sound Pressure Level 1.5 m Receptor Height, dB $L_{Aeq, T}$	Predicted Worst-Case Daytime Sound Pressure Level 1.5 m Receptor Height, dB $L_{Aeq, T}$
32	32.6	32.9
33	31.7	32.1
34	34.8	35.1
35	35.0	35.3
36	35.3	35.6
37	35.5	35.8
38	35.4	35.7
39	35.6	36
40	33.0	33.5
41	31.9	32.4
42	32.9	33.3

Night-Time Noise Modelling Results

Noise modelling results are shown in Table 9D.12 for typical and worst-case night-time operation scenarios. Night-time predicted sound pressure levels are shown for all 42 noise-sensitive assuming a receptor height of 4m above ground height, representing the height of a bedroom window.

The daytime noise model assumes that 25 BESS inverters are operational and all data hall AHUs, substation operational, as detailed within this Appendix.

Typical operation for daytime includes 5 gas turbines and 0 gas engines running with a 100% on-time.

Worst-case operation for daytime has 7 gas turbines operating a with 100% on-time.

Table 9D.12: Typical Night-Time Plant and Equipment $L_{Aeq, T}$ Noise Propagation Modelling Results

Receptor Location	Predicted Typical Night-Time Sound Pressure Level 4 m Receptor Height, dB $L_{Aeq, T}$	Predicted Worst-Case Night-Time Sound Pressure Level 4 m Receptor Height, dB $L_{Aeq, T}$
1	43.2	43.6
2	38.8	39.4
3	37.3	38
4	37.0	37.7
5	36.5	37.1
6	36.1	36.6
7	35.3	35.8
8	35.7	36.2
9	39.5	40.1
10	40.0	40.9
11	39.4	40.3
12	36.2	37.1
13	34.6	35.6
14	36.5	37.4
15	37.4	38.2
16	38.4	39.2
17	38.7	39.5
18	38.5	39.4

Receptor Location	Predicted Typical Night-Time Sound Pressure Level 4 m Receptor Height, dB $L_{Aeq, T}$	Predicted Worst-Case Night-Time Sound Pressure Level 4 m Receptor Height, dB $L_{Aeq, T}$
19	38.2	39.1
20	38.9	39.9
21	39.1	40
22	36.7	37.5
23	31.3	32
24	33.2	33.8
25	33.4	34
26	33.7	34.3
27	33.4	34
28	31.5	32.2
29	33.1	33.8
30	34.8	35.4
31	31.6	32.1
32	32.2	32.8
33	31.2	31.9
34	35.4	35.8
35	35.1	35.5
36	35.1	35.6
37	35.4	35.8
38	35.1	35.6
39	35.2	35.7
40	32.3	33.2
41	31.1	32