Appendix 8.1

Google Ireland Limited
Grange Castle Business Park South
Baldonnel Road
Dublin 22
D22 X602

Inspector Oliver Gray
Environmental Protection Agency
PO Box 3000,
Johnstown Castle Estate,
Co. Wexford

12 April 2024

RE: Condition 7.2.1

Dear Mr. Gray,

Google Ireland Limited is required to submit a report to the EPA on options to decrease or offset the use of fossil fuel energy at its Google Ireland Data Centre in line with condition 7.2.2 of the Industrial Emissions Licence (Reg No. P1189-01).

Google is dedicated to the transition to a more sustainable future and have set ambitious goals to address the company's carbon footprint. We are targeting net-zero emissions across our operations and value chain by 2030. We will achieve this through a focus on energy efficiency and development of carbon-free energy options for our data centres.

At the Google Ireland Data Centre in Grange Castle, energy efficiency is incorporated into the site specific Energy Management System (EnMS) implemented at the site. Energy use is continuously monitored and reviewed, including regular cross-functional management reviews and is subject to both internal and external audits. As part of the EnMS, objectives and targets over the short, medium and long-term are set out to continuously improve energy management and reduce environmental impact.
Energy efficiency is considered at all possible points during the detailed design of proposed new facilities at the site.

Power Usage Effectiveness (PUE) is continuously monitored in both buildings with alarms generated if it starts trending the wrong way. PUE results are published on the company's sustainability web site - https://www.google.com/about/datacenters/efficiency/

The following sustainable design features in relation to electrical services are included in the Google Ireland Data Centre:

- Data halls in both buildings are completely free air cooled by air handling units with highly efficient electronically commutated (EC) fan motors. No water or direct expansion (DX) refrigeration systems are used to cool the servers.

- Waste heat is reused to heat the supply air to the data halls, offices and ancillary spaces in the Data Centre.
- Outdoor lighting installed at the facility consists of column mounted and building mounted energy efficient luminaires within the car park and loading bay areas.
- The internal lighting installed at Building 1 is fluorescent lighting LED and in Building 2 is LED. All lighting is locally switched on in all areas with absence detection for energy efficiency.
- Emergency and exit lighting consists of self-contained high efficiency luminaires.
- High-efficiency power supplies are used to minimise the number of times power is converted from one type of electrical current to another and keep power supplies as close to the load as possible.

Google Ireland is also a participant in the EU Code of Conduct for Data Centres Energy Efficiency (https://e3p.jrc.ec.europa.eu/communities/data-centres-code-conduct).

Google Ireland Limited has investigated the following carbon-free energy solutions for its Google Ireland Data Centre:

Hydrotreated Vegetable Oil (HVO) Fuel:

Hydrotreated Vegetable Oil, is a renewable diesel that reduces up to 90% of net CO_2 emissions and can be stored for up to 10 years. It can be used as a direct replacement for conventional diesel to fuel the back-up generators without any modification to existing infrastructure and would also reduce emissions of Nitrous Oxides (NO_x) and Particulate Matter (PM). For these reasons Google plans to switch to using HVO to fuel back-up generators at the Google Ireland Data Centre as soon as possible.

However, as HVO mass-production is in its infancy, an accessible, steady, and sustainable supply of HVO is not yet available to proceed with the changeover. Due to the supply issues, the current relatively high cost of HVO is prohibitive also.

As awareness of HVO builds, production of the raw goods increases, and supply issues improve, the justification for global HVO use will increase. Major fuel refiners are now making sizable investments in HVO refining and production which will increase supply.

Google is actively monitoring HVO supply and prices. A cost benefit analysis has been carried out to determine that the price difference with conventional diesel must be within \$2/US gal to make the changeover feasible. At current rates, the price difference is at \$4.24/US gal.

Prior to making the changeover to HVO fuel for the backup generators, Google will seek approval from the EPA as required under Condition 3.16.2 of IE Licence Reg. No. P1189-01. This request for approval will include required assessments to demonstrate that the use of HVO will not cause an increase in emissions from the installation and will not give rise to any breach of Air Quality Standards.

Solar Arrays:

In September 2023, Google recently signed a 58 MW solar power purchase agreement (PPA) in Ireland. The agreement made with Power Capital Renewable Energy was for

58 MW of new-to-the grid capacity from the Tullabeg Solar Farm. Current projections indicate that once operational, this PPA will help the Google Ireland Data Centre to reach 60 percent carbon-free energy in 2025 when measured on an hourly basis. Google will continue to support the development of additional clean energy resources on the Irish grid to achieve our goal of operating on 100% carbon-free energy, every hour of every day.

A Total Cost of Ownership (TCO) analysis has been performed on the installation of roof mounted Photovoltaic (PV) arrays (Refer to Table 1). With a payback period of 9 years it was decided not to proceed this year. The project will be reviewed again for 2026, when more roof space and ground locations could be potentially available for a larger array with a better payback period.

Roof Mounted PV Arrays - TCO Analysis Sept 2023			
Project Site:	Ireland	**Discount Rate:**	8%
Project Start:	2024	**Labor Inflation:**	1.80%
Operation Start:	2024	**Material Inflation:**	2.00%
TCO Time Horizon (yrs):	15	**Utility Escalation:**	0.02%

Summary	Existing	Vendor A	Vendor B
TCO	**€1,855,220.26**	**€1,847,728.19**	**€1,700,917.64**
Capital Investment	€0.00	€1,654,613.75	€1,518,652.50
Capacity (MW)	1.423	1.423	1.423
TCO/Watt	$1.30	$1.30	$1.20
$/KW/month	$7.24	$7.21	$6.64
Remaining Useful Life	-1	5	5
Residual Value	$0	$413,653	$379,663
Payback Period	N/A	9.0	8.0

TCO Breakdown (for TCO in 15 years)	Existing	Vendor A	Vendor B
Capital Cost	€0	€1,786,647	€1,639,836
Electricity	€1,855,220	€0	€0
Water	€0	€0	€0
Gas	€0	€0	€0
Consumables & Staffing	€0	€0	€0
M&R	€0	€61,081	€61,081
Replacement	€0	€0	€0
Total	**€1,855,220**	**€1,847,728**	**€1,700,918**

Table 1: Total Cost of Ownership analysis on the installation of roof mounted Photovoltaic (PV) arrays at the Google Ireland Data Centre.

B2 Heat Pump System:

A Total Cost of Ownership analysis has also been performed on a heat pump system, to replace electric heaters on back-up generators (Refer to Table 2). A detailed design will be completed this year and installation will take place in 2025 if the payback period is still favourable.

B2 Heatpump Project - TCO Analysis Aug 2023			
Project Site:	Ireland	**Discount Rate:**	8%
Project Start:	2024	**Labor Inflation:**	1.80%
Operation Start:	2024	**Material Inflation:**	2.00%
TCO Time Horizon (yrs):	15	**Utility Escalation:**	0.02%

Summary	Existing	Daikin	Mitsubishi
TCO	**€766,789.32**	**€719,240.10**	**€612,682.59**
Capital Investment	€0.00	€422,510.41	€393,425.97
Capacity (MW)	16.000	16.000	16.000
TCO/Watt	$0.05	$0.04	$0.04
$/KW/month	$0.27	$0.25	$0.21
Remaining Useful Life	-1	0	0
Residual Value	$0	$0	$0
Payback Period	N/A	8.0	7.0

TCO Breakdown (for TCO in 15 years)	Existing	Daikin	Mitsubishi
Capital Cost	€0	€457,758	€426,247
Electricity	€766,789	€230,267	€155,220
Water	€0	€0	€0
Gas	€0	€0	€0
Consumables & Staffing	€0	€0	€0
M&R	€0	€31,216	€31,216
Replacement	€0	€0	€0
Total	**€766,789**	**€719,240**	**€612,683**

Table 2: Total Cost of Ownership analysis for a heat pump system to replace electric heaters on back-upstandby generators

Google's sustainability efforts are continuously focused on identifying opportunities to increase the use of solar power, sustainable biofuels and other renewable energy options including energy storage to assist in the transition to a clean energy future for our operations. As has been presented above, feasibility studies have been carried out for these renewable energy options for the Google Ireland Data Centre with some progressing to detailed design and implementation where feasible. Google will continue to monitor and pursue clean energy options for the site as technology, accessibility and affordability of these options improve.

Yours sincerely,

James Morris

James Morris
Installation Manager

Appendix 9.1 Glossary of Acoustic Terminology

- **ambient noise** The totally encompassing sound in a given situation at a given time, usually composed of sound from many sources, near and far.
- **background noise** The steady existing noise level present without contribution from any intermittent sources. The A-weighted sound pressure level of the residual noise at the assessment position that is exceeded for 90 per cent of a given time interval, T (LAF90,T).
- **broadband** Sounds that contain energy distributed across a wide range of frequencies.
- **dB** Decibel - The scale in which sound pressure level is expressed. It is defined as 20 times the logarithm of the ratio between the RMS pressure of the sound field and the reference pressure of 20 micro-pascals (20 µPa).
- **dB L_{pA}** An 'A-weighted decibel' - a measure of the overall noise level of sound across the audible frequency range (20 Hz — 20 kHz) with A-frequency weighting (i.e. 'A'—weighting) to compensate for the varying sensitivity of the human ear to sound at different frequencies.
- **Hertz (Hz)** The unit of sound frequency in cycles per second.
- **impulsive noise** A noise that is of short duration (typically less than one second), the sound pressure level of which is significantly higher than the background.
- **$L_{Aeq,T}$** This is the equivalent continuous sound level. It is a type of average and is used to describe a fluctuating noise in terms of a single noise level over the sample period (T). The closer the LAeq value is to either the L F1 or L F9 value indicates the relative impact of the intermittent sources and their contribution. The relative spread between the values determines the impact of intermittent sources such as traffic on the background.
- **L_{AFN}** The A-weighted noise level exceeded for N% of the sampling interval. Measured using the "Fast" time weighting.
- **L_{AFmax}** is the instantaneous slow time weighted maximum sound level measured during the sample period (usually referred to in relation to construction noise levels).
- **$L_{Ar,T}$** The Rated Noise Level, equal to the LAeq during a specified time interval (T), plus specified adjustments for tonal character and impulsiveness of the sound.
- **L_{AF90}** Refers to those A-weighted noise levels in the lower 90 percentile of the sampling interval; it is the level which is exceeded for 90% of the measurement period. It will therefore exclude the intermittent features of traffic and is used to estimate a background level. Measured using the "Fast" time weighting.
- **L_{AT}(DW)** equivalent continuous downwind sound pressure level.
- **L_{fT}(DW)** equivalent continuous downwind octave-band sound pressure level.
- **L_{day}** L_{day} is the average noise level during the day time period of 07:00hrs to 19:00hrs
- **L_{night}** L_{night} is the average noise level during the night-time period of 23:00hrs to 07:00hrs.
- **low frequency noise** LFN - noise which is dominated by frequency components towards the lower end of the frequency spectrum.

- **noise** Any sound, that has the potential to cause disturbance, discomfort or psychological stress to a person exposed to it, or any sound that could cause actual physiological harm to a person exposed to it, or physical damage to any structure exposed to it, is known as noise.
- **noise sensitive location** NSL - Any dwelling house, hotel or hostel, health building, educational establishment, place of worship or entertainment, or any other facility or other area of high amenity which for its proper enjoyment requires the absence of noise at nuisance levels.
- **octave band** A frequency interval, the upper limit of which is twice that of the lower limit. For example, the 1,000Hz octave band contains acoustical energy between 707Hz and 1,414Hz. The centre frequencies used for the designation of octave bands are defined in ISO and ANSI standards.
- **rating level** See $L_{Ar,\,T}$.
- **sound power level** The logarithmic measure of sound power in comparison to a referenced sound intensity level of one picowatt (1pW) per m2 where:

$$L_w = 10 \log \frac{P}{P_0} dB$$

Where: P is the rms value of sound power in pascals; and P_0 is 1 pW.

- **sound pressure level** The sound pressure level at a point is defined as:

$$L_P = 20 \log \frac{P}{P_0} dB$$

- **specific noise level** A component of the ambient noise which can be specifically identified by acoustical means and may be associated with a specific source. In BS 4142, there is a more precise definition as follows: 'the equivalent continuous A-weighted sound pressure level at the assessment position produced by the specific noise source over a given reference time interval ($L_{Aeq,\,T}$)'.
- **tonal** Sounds which cover a range of only a few Hz which contains a clearly audible tone i.e. distinguishable, discrete or continuous noise (whine, hiss, screech, or hum etc.) are referred to as being 'tonal'.
- **1/3 octave analysis** Frequency analysis of sound such that the frequency spectrum is subdivided into bands of one—third of an octave each.

Appendix 9.2 Noise Modelling Details and Assumptions

9.2.1 Inputs into Construction Noise Calculations

The sound power levels, number of plant items, and percentage on times presented in Table 1 have been used to calculate the predicted construction noise level at nearby sensitive receptors.

Table 1: Construction noise model inputs

Activity	Equipment	Data Source	Sound Power Level dB(A)	Number of plant Items	% Plant On Time
Site preparation Works	Tracked Excavator (Loading Dump Truck)	BS5228 Table C 1-10	113	6	35
	Dump Truck (Empty)	BS5228 Table C 2-31	115	4	35
	Excavator mounted rock breaker	BS5228 Table C 9-12	113	2	15
	Wheeled Loader (loading lorry)	BS5228 Table C 6-33	110	1	15
	Diesel Generator	BS5228 Table C 4-78	94	2	50
	Electric Drills	Estimated	113	2	10
	Gas Cutter	BS5228 Table C 1-18	107	1	5
	Electric Bolter	Estimated	107	6	15
	Road Sweeper	BS5228 Table C 4-90	104	1	90
	Road Lorry (Full)	BS5228 Table C 6-21	108	10	20
Substructure (preparation)	Tracked Excavator (Loading Dump Truck)	BS5228 Table C 1-10	113	2	35
	Dump Truck (Empty)	BS5228 Table C 2-31	115	2	35
	Excavator mounted rock breaker	BS5228 Table C 9-12	113	2	15
	Diesel Generator	BS5228 Table C 4-78	94	2	50
	Road Sweeper	BS5228 Table C 4-90	104	1	90
	Road Lorry (Full)	BS5228 Table C 6-21	108	5	15
	Hand-held Hydraulic Breaker	BS5228 Table C 1-7	121	3	20
	Site fork lift trucks	BS 5228 Table D 7-94	116	3	90
	Water Pump	BS5228 Table C 2-45	93	3	15
	Compressor for Hand-held Pneumatic Breaker	BS5228 Table C 5-5	93	2	20
	Tower Crane	BS5228 Table C 4-49	105	1	90
	Wheeled Mobile Crane	BS5228 Table C 4-43	98	6	75
Substructure (Pouring)	Diesel Generator	BS5228 Table C 4-78	94	2	50
	Road Sweeper	BS5228 Table C 4-90	104	1	90
	Road Lorry (Full)	BS5228 Table C 6-21	108	5	15
	Water Pump	BS5228 Table C 2-45	93	3	15
	Truck Mounted Concrete Pump + Boom Arm	BS5228 Table C 4-29	108	1	25

Activity	Equipment	Data Source	Sound Power Level dB(A)	Number of plant Items	% Plant On Time
	Hydraulic Vibratory Compactor (Tracked Excavator)	BS5228 Table C 2-42	106	2	10
	Mini Planer	BS5228 Table C 5-9	96	2	10
	Tower Crane	BS5228 Table C 4-49	105	1	90
	Wheeled Mobile Crane	BS5228 Table C 4-43	98	6	75
	Concrete pump + Cement Mixer truck (Discharging)	BS5228 Table C 4-24	95	6	35
Superstructure	Excavator mounted rock breaker	BS5228 Table C 9-12	113	2	15
	Diesel Generator	BS5228 Table C 4-78	94	2	50
	Electric Drill	BS5228 Table C 4-69	113	2	15
	Gas Cutter	BS5228 Table C 1-18	107	1	5
	Electric Bolter	Estimate	107	6	15
	Road Sweeper	BS5228 Table C 4-90	104	1	90
	Road Lorry (Full)	BS5228 Table C 6-21	108	5	15
	Site fork lift trucks	BS 5228 Table D 7-94	116	3	90
	Compressor for Hand-held Pneumatic Breaker	BS5228 Table C 5-5	93	2	25
	Truck Mounted Concrete Pump + Boom Arm	BS5228 Table C 4-29	108	3	25
	Tower Crane	BS5228 Table C 4-49	105	1	90
	Lifting Platform	BS5228 Table C 4-57	95	6	90
	Hand-Held Welder (Welding Piles)	BS5228 Table C 3-31	101	1	5
	Wheeled Mobile Crane	BS5228 Table C 4-43	98	6	75
	Concrete Pump + Cement Mixer Truck (Discharging)	BS5228 Table C 4-24	95	6	15
Internal Works / Fit out	Diesel Generator	BS5228 Table C 4-78	94	2	25
	Electric Drills	Estimate	107	2	15
	Road Lorry (Full)	BS5228 Table C 6-21	108	2	25
	Truck Mounted Concrete Pump + Boom Arm	BS5228 Table C 4-29	108	1	5
	Concrete Pump + Cement Mixer Truck (Discharging)	BS5228 Table C 4-24	95	4	10

Activity	Equipment	Data Source	Sound Power Level dB(A)	Number of plant Items	% Plant On Time
External Works (preparation)	Tracked Excavator (Loading Dump Truck)	BS5228 Table C 1-10	113	2	75
	Dump Truck (Empty)	BS5228 Table C 2-31	115	2	75
	Excavator mounted rock breaker	BS5228 Table C 9-12	113	1	20
	Diesel Generator	BS5228 Table C 4-78	94	2	50
	Road Sweeper	BS5228 Table C 4-90	104	1	90
	Compressor	BS5228 Table C 5-5	93	1	10
	Site fork lift trucks	BS 5228 Table D 7-94	116	2	90
	Water Pump	BS5228 Table C 2-45	93	3	20
	Road Breaker (Hand-held Pneumatic)	BS5228 Table C 5-3	110	2	15
External Works (Pouring)	Diesel Generator	BS5228 Table C 4-78	94	2	50
	Road Sweeper	BS5228 Table C 4-90	104	1	90
	Site fork lift trucks	BS 5228 Table D 7-94	116	2	90
	Truck Mounted Concrete Pump + Boom Arm	BS5228 Table C 4-29	108	2	30
	Bar Bender, Cutter	CNP 021	90	2	10

9.2.2 Tolerances and Limitations of the Assessment

Tolerances and limitations of the assessment, which may result in predicted plant noise levels differing from those presented above, are listed below:

- Generator run orders for the monthly, annual, and worst-case maintenance scenarios (scenarios 1-3) are the theoretical worst-case for noise emissions, in terms of the number of generators tested during the assessment period and which generators are grouped together. It is unlikely that these specific combinations of generators would run in this order, and therefore, both the maximum and average noise emissions are anticipated to be typically lower than the values reported.
- Similar to the above, source sound power levels for other plant items on-site are representative of the design duty. It is unlikely that any particular plant item will be consistently operating at the design duty, and it is also unlikely that all plant items in a given operating scenario will operate at the design duty simultaneously (as the modelling represents).
- The sound pressure levels predicted using ISO 9613-2 are under moderate downwind conditions between each source and receiver point, which may be a conservative assumption compared with the prevailing wind conditions at a prospective site.
- Source sound power levels used for the air cooled chillers are representative of the unit when installed on a reflective base. As the intended installation is on a mesh gantry with a high percentage free area, noise radiating from the case of the unit may be up to 3dB lower than modelled.
- A-weighted sound power levels obtained by testing mechanical units and implemented in the model may vary from the levels stated in datasheets by up to ±3dB, as per section VII of Eurovent RS6/C/003-2016.

- No corrections to predicted noise emission levels for acoustic character have been applied, which may be included as part of assessment methodologies such as BS 4142. This is because several different noise sources operating simultaneously and continuously, would not be envisaged to cause sound (during normal operation) that would be perceived as tonal, impulsive, or intermittent. This includes when cumulative noise emissions include transformer noise, which has a negligible contribution to the overall A-weighted level. However, it is possible that noise emissions from maintenance scenarios that include emergency generators could be perceived as tonal.

- If a maintenance scenario was perceived as tonal, BS 4142 advises a correction of 2dB where a tone is ‘just perceptible’, 4dB where a tone is ‘clearly perceptible’ and 6dB where it is ‘highly perceptible’. Generator noise will always be experienced in combination with broadband noise from cooling and other air-handling plant, as well as experienced against the site-specific ambient noise.

9.2.3 Operational Noise Model

A 3D computer-based prediction model has been prepared in order to quantify the noise level associated with the proposed building. Detailed sound power level inputs to the model are presented in this section.

9.2.4 Source Sound Power Data

The noise modelling competed indicates the following limits in relation to various items of plant associated with the overall Proposed Development site development. Plant items will be selected in order to achieve the stated noise levels and or appropriate attenuation will be incorporated into the design of the plant/building in order that the plant noise emission levels are achieved on the Proposed Development site (including any system regenerated noise). A 3D render of the noise model is presented in Figure 1.

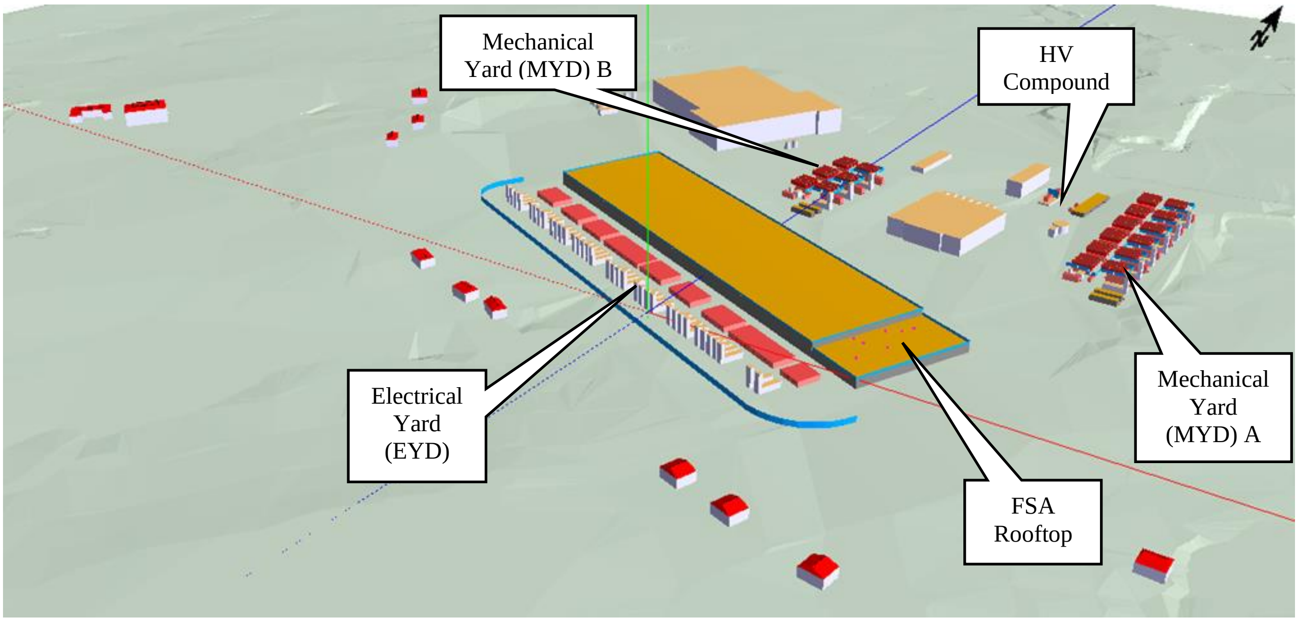

Figure 1: Image of the acoustic model – site overview.

Appendix 9.3 Source Sound Power Levels

9.3.1 Source Sound Power Levels for Normal Operational Plant Items

Table 2 provides source sound power levels used within the noise emissions model that are anticipated to be active during all known operating scenarios, but may vary by day or night periods where set-back conditions would be applied.

Sound power levels are the cumulative levels combining all individual noise sources, elements or radiating faces for the plant item. Sound power levels for each face / element of the unit can be supplied on request.

Table 2 Source sound power levels of plant items that are active during all scenarios.

Plant item	Location	Total number of units	Sound power level per unit, dB A-weighted overall level and un-weighted levels at octave band centre frequencies (Hz)								
			dBA	63	125	250	500	1k	2k	4k	8k
Air cooled chiller (daytime) **[Total]**	EYD & MYD	63	101	95	106	102	99	96	91	88	87
Air cooled chiller (daytime) **[Case-radiated - area sources]**	EYD & MYD		91	72	83	74	83	80	78	87	84
Air cooled chiller (daytime) **[Fans – Area sources]**	EYD & MYD		101	95	106	102	98	96	91	82	84
Air cooled chiller **(night)** **[Total]**	EYD & MYD	63	93	91	91	93	90	86	83	82	81
Air cooled chiller **(night)** **[Case-radiated - area sources]**	EYD & MYD		86	72	72	74	80	78	77	81	80
Air cooled chiller **(night)** **[Fans – area sources]**	EYD & MYD		91	91	91	93	90	86	81	75	73
Electrical room type 2 **[Container breakout - area sources]**	MYD	9	80	74	91	86	69	71	54	32	28
Electrical room type 2 **[External AC unit radiated - Point sources]**	MYD	45 (27 active)	84	82	83	83	82	80	76	72	66
Air cooled plant **[Container Breakout – Area sources]**	MYD	9	90	85	88	88	84	89	78	59	48

Plant item	Location	Total number of units	Sound power level per unit, dB A-weighted overall level and un-weighted levels at octave band centre frequencies (Hz)								
			dBA	63	125	250	500	1k	2k	4k	8k
Air cooled plant **[External AC unit – Point sources]**	MYD	9	71	76	73	72	71	63	57	54	50
Water treatment building **[Container breakout – area sources]**	MYD	9	64	57	57	57	57	57	57	57	57
Water treatment building **[External AC unit – Point sources]**	MYD	9	71	76	73	72	71	63	57	54	50
Electrical room type 1 **[External AC unit radiated – point sources]**	MYD	16 (8 active)	72	70	71	71	70	68	64	60	54
Data centre hall AHU wall mounted **[Point sources]**	FSA Rooftop	3	71	-	67	61	59	70	60	46	42
FSA rooftop unit (daytime) **[Point sources]**	FSA Rooftop	1	93	90	92	92	91	89	85	81	75
FSA rooftop unit (night-time) **[Point sources]**	FSA Rooftop	1	91	88	90	90	89	87	83	79	73
FSA rooftop AHU - condensers (Daytime) **[Point sources]**	FSA Rooftop	4 (2 active)	90	87	88	88	87	85	81	77	71
FSA rooftop DCH – condensers (night-time) **[Point sources]**	FSA Rooftop	4 (1 active)	90	87	88	88	87	85	81	77	71
FSA rooftop - condensers 01 (Daytime) **[Point sources]**	FSA Rooftop	1	84	93	84	82	84	77	74	74	70
FSA rooftop - condensers 02 (Daytime) **[Point sources]**	FSA Rooftop	1	84	90	85	83	81	77	75	76	68
FSA rooftop - condensers 01 (night-time)	FSA Rooftop	1	74	76	75	74	74	68	63	61	57

Plant item	Location	Total number of units	Sound power level per unit, dB A-weighted overall level and un-weighted levels at octave band centre frequencies (Hz)								
			dBA	63	125	250	500	1k	2k	4k	8k
[Point sources]											
FSA rooftop - condensers 02 (night-time) **[Point sources]**	FSA Rooftop	1	75	78	78	71	70	70	68	66	57
FSA AHU Condensers 01-06 **[Point sources]**	FSA Rooftop	6	81	79	80	80	79	77	73	69	63
FSA AHU - Condensers 07-10 **[Point sources]**	FSA Rooftop	4	66	63	64	64	63	61	57	53	47
FSA AHU Condensers 11-23 Computer Room Air Conditioning (CRAC) units **[Point sources]**	FSA Rooftop	13	81	79	80	80	79	77	73	69	63
FSA rooftop DCH AHU **[Point sources]**	FSA Rooftop	1	70	80	71	63	64	56	59	65	65
FSA Rooftop – Data Centre Hall (DCH)-AHU **[Point sources]**	FSA Rooftop	2 (1 active)	77	100	89	69	62	59	55	48	59
Electrical plant rooms small [Container breakout - area sources]	EYD	1	77	81	80	78	76	72	61	43	33
Electrical plant rooms small [Louvred openings (intake) - area sources]	EYD	6	71	71	70	76	69	61	56	51	51
Electrical plant rooms small [Louvred openings (outlet) - Area sources]	EYD	6	78	78	77	83	76	68	63	58	58
Electrical plant rooms large [Container breakout - Area sources]	EYD	2	80	85	83	81	79	75	64	46	37
Electrical plant rooms large [Louvred openings	EYD	15	71	71	70	76	69	61	56	51	51

Plant item	Location	Total number of units	Sound power level per unit, dB A-weighted overall level and un-weighted levels at octave band centre frequencies (Hz)								
			dBA	63	125	250	500	1k	2k	4k	8k
(intake) - Area sources]											
Electrical plant rooms large [Louvred openings (outlet) - Area sources]	EYD	15	78	78	77	83	76	68	63	58	58
Electrical plant rooms medium [Container Breakout - Area sources]	EYD	6	78	83	81	80	77	74	62	44	35
Electrical plant rooms medium [Louvred Openings (intake) - Area sources]	EYD	9	71	71	70	76	69	61	56	51	51
Electrical plant rooms medium [Louvred openings (outlet) - Area sources]	EYD	9	78	78	77	83	76	68	63	58	58
Transformer [Area sources]	HV Compound	2	91	85	100	97	84	84	75	68	69
Auxiliary Transformer [Area sources]	HV Compound	2	67	61	76	73	60	60	51	44	44
MV building with externally mounted HVAC units [External AC unit radiated - Point sources]	HV Compound	10	84	82	83	83	82	80	76	72	66

9.3.2 Source Sound Power Levels for Emergency Operation Plant Items

The following table includes information and sound power levels of plant items included in the acoustic model that are active during routine testing and blackout scenarios only (Scenario 2 and Scenario 3).

Sound power levels have been derived from modelling the sound pressure level at 1m provided in the data source in free-field conditions. Source sound power levels for the flue gas outlet / exhaust have been derived assuming a sound pressure level at 1m at a location 45 degrees off-axis of the exhaust and including typical exhaust directivity characteristics.

Table 3 Source sound power levels for emergency operation plant items.

Plant item	Total number of units	Data source	Sound power level per unit, dB A-weighted overall level and un-weighted levels at octave band centre frequencies								
			dBA	63	125	250	500	1k	2k	4k	8k
Emergency Generator (cumulative noise level) **[Represented using area sources for discharge openings and breakout from container / turning duct; point sources for air inlet, exhaust silencer breakout and exhaust]**	36x in EYD; 9x in MYD	Cumulative sound power level per generator.	99	119	109	100	90	84	80	78	91
Emergency Generator (individual noise sources) **[Represented using area sources for discharge openings and breakout from container / turning duct; point sources for air inlet, exhaust silencer breakout and exhaust]**	36x in EYD; 9x in MYD	Breakout noise through container – motor compartment front (1 per unit)	76	85	89	80	72	58	51	49	63
		Breakout noise through container – motor compartment side (2 per unit)	85	92	97	89	81	69	62	60	73
		Breakout noise through container – motor compartment roof (1 per unit)	88	96	101	92	84	72	65	63	76
		Breakout noise through turning duct – back wall (1 per unit)	74	90	86	78	70	57	51	48	62
		Breakout noise through turning duct – long side (2 per unit)	74	90	86	78	70	56	50	47	61

Plant item	Total number of units	Data source	Sound power level per unit, dB A-weighted overall level and un-weighted levels at octave band centre frequencies								
			dBA	63	125	250	500	1k	2k	4k	8k
		Air inlet (1 per unit)	89	100	100	88	78	71	69	70	86
		Discharge Opening (1 per unit)	95	109	106	98	86	77	74	75	89
		Breakout noise from exhaust silencer (1 per unit)	92	118	86	70	60	46	45	48	57
		Exhaust (1 per unit)	87	107	91	88	78	81	77	71	77

9.3.3 Acoustic Mitigation

To reduce noise emitted from the MYDs, where the associated cooling plant is the primary source of noise during normal operation, combinations of the following acoustic mitigation items have been included in the model.

- To reduce noise from the air cooled chiller compressors and heat exchangers, acoustic louvres, constructed from gantry-level and terminating at least in-line with the air cooled chiller blanking level are to be installed the north, east and south sides of the two MYD gantries. Any doors located within the louvre arrangement should be provided by and installed in accordance with instructions from the manufacturer. The transmission loss for the acoustic louvres outlined in Table 4.

Table 4 Acoustic louvre transmission loss (dB)

Rw	Octave-band centre frequency (Hz)							
	63	125	250	500	1k	2k	4k	8k
14 dB	5	7	11	12	13	14	12	9

- To reduce noise from the air cooled chiller fans, 950mm tall discharge attenuators, with 600mm long splitters, are to be placed on top of each unit. To overcome the additional pressure drop this imposes on the chiller, maximum fan speeds would be increased from 1020RPM to up to 1200RPM in this configuration during daytime and evening hours (7am-11pm). The discharge attenuator provides the octave-band attenuation values outlined in Table 5**.**

Table 5 Fan discharge attenuation (dB).

Octave-band centre frequency (Hz)							
63	125	250	500	1k	2k	4k	8k
-2	-4	-9	-14	-18	-13	-11	-7

These acoustic mitigation items can be seen in Figure 1.

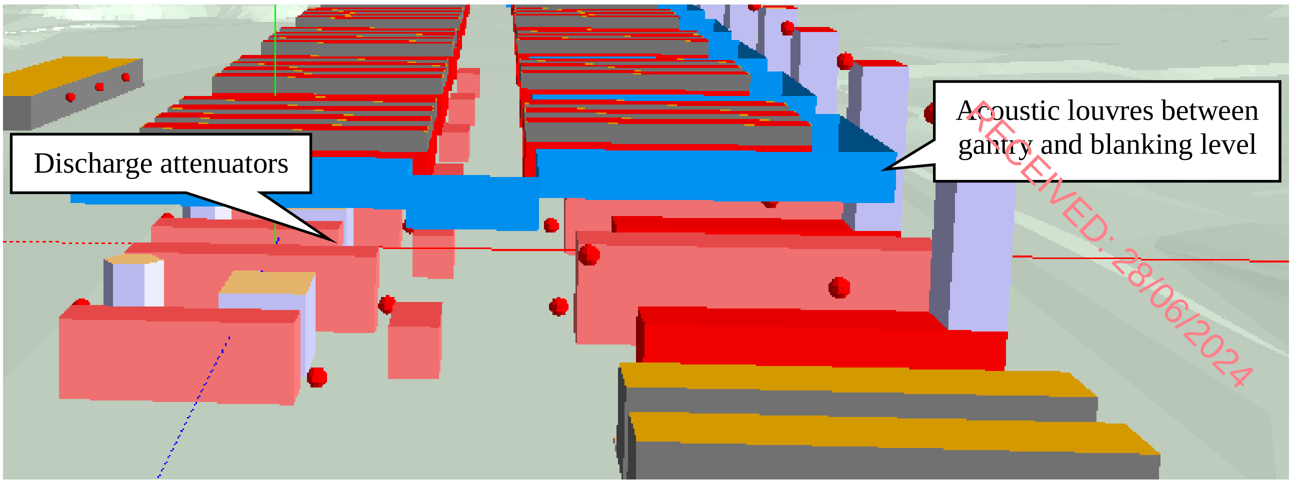

Figure 1 Image of the acoustic model – extent of the acoustic louvres and discharge attenuators in the MYD

- To reduce noise from the electrical yard an acoustic barrier of height 4m is provided on the southern side of the EYD. This barrier is shown in Figure 2 below.

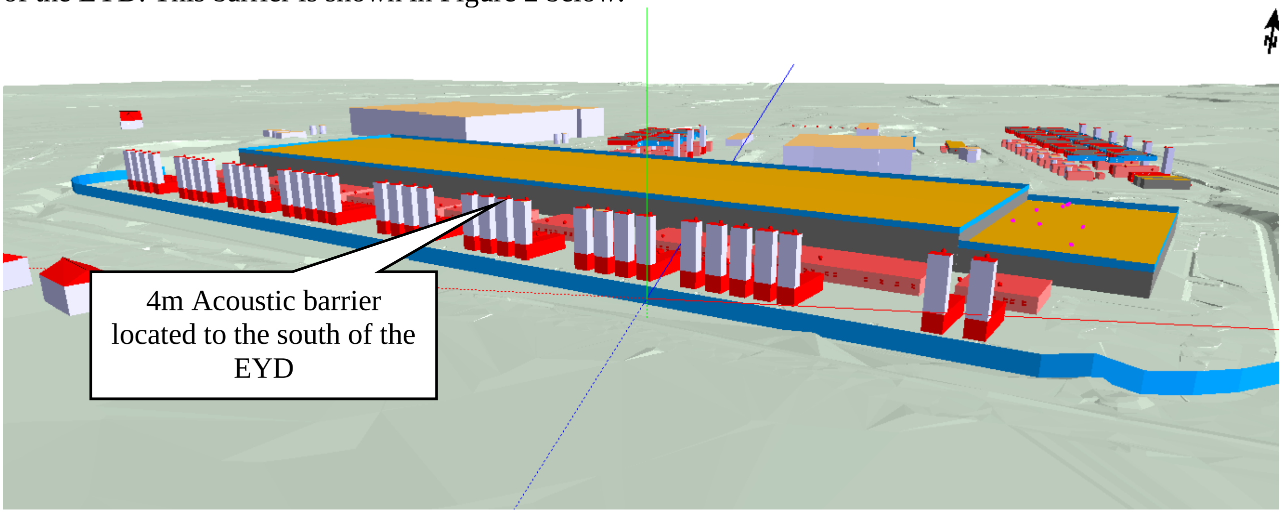

Figure 2 Image from the acoustic model of the 4m noise barrier on the southern side of the EYD.

- To further reduce noise from normal operation during night-time hours specifically (11pm-7am), the following night-specific operating conditions have been applied:
- Air cooled chillers - a setback condition, reducing fan speeds to a maximum of 1020RPM
- FSA rooftop unit - reducing its operational noise by 2dBA
- FSA AHU condenser units - utilising the manufacturer's *Quiet Mode 2*
- Data Centre Hall AHU condensers – reducing the number of units operating from 2x, as in the daytime, to 1x.