LCY-10 (The Point) Environmental noise impact assessment

FT Squared (FT2)

Isle of Dogs, London

February 2021

Industrial Noise & Vibration Centre Ltd

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Executive Summary

INVC was engaged to completed an assessment of potential noise emission from the proposed LCY-10 (The Point) data centre facility located at the Isle of Dogs in the London Borough of Tower Hamlets.

The significant noise sources associated with the development were identified to be rooftop cooling plant and ground floor emergency generators. Noise impacts were considered for all of the potential operating scenarios including normal operation, testing of emergency generators, minor grid outages and catastrophic grid outages.

The results of the assessment show compliance with the criteria for all operating scenarios at all of the residential receptor locations. The proposed development therefore meets the acoustic requirements agreed with LBTH.

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1.0 Introduction

The Industrial Noise & Vibration Centre (INVC) was engaged by FT[2] to provide an environmental noise impact assessment of the mechanical plant associated with the proposed data centre facility located at LCY-10 'The Point', Greenwich View Place, Isle of Dogs, London.

The proposed development comprises alterations and modifications to the existing building, including the construction of an additional floor level. The significant noise sources will include mechanical cooling plant located on the rooftop and emergency generators located within the ground floor level. It is understood that any noise generated by equipment within the building will be mitigated by the building fabric and will not contribute to the external noise assessment.

The results of the noise assessment are intended to demonstrate that the proposed development complies with the noise emission criteria agreed with the London Borough of Tower Hamlets (LBTH).

This report presents the details of the noise sources, nearby receptors, noise modelling results and assessment against the criteria.

2.0 Criteria

The London Borough of Tower Hamlets set out the following noise criteria in the planning conditions for the LCY-10 development in 2012, ref PA/12/02055:

- *'Noise emission should be 'designed to a level of 10dB below the lowest measured background noise (LA90,15min) as measured one meter from the nearest affected window of the nearest residential property…'*
- *'The plant shall not create an audible tonal noise nor cause perceptible vibration to be transmitted through the structure of the building'.*

INVC discussed the establishment of suitable noise limits with the LBTH. The LBTH principal noise officer, Paul Murphy, agreed that the criteria should be based on the noise survey data prepared by Applied Acoustic Design (2016), where typical background noise levels are established in accordance with the latest version of British Standard BS4142: 2014 + A1: 2019 *Methods for rating and assessing industrial and commercial sound*.

Table 1 – Background noise levels (AAD 2016)

Time period	Typical background noise level, L_{A90} dB(A)
Daytime (07:00 – 23:00)	47
Night-time (12:00 – 07:00)	44

The modes of operation of the plant equipment were discussed with LBTH. It was agreed that typical operations would comprise the following scenarios:

1. **Normal operation**: Rooftop plant operates 24 hours a day.
2. **Weekly testing of emergency generators**: Daytime testing of generators, one to three generators at a time.
3. **Emergency operation during a minor power grid outage**: Potentially less than once per annum event where three generators operate.
4. **Emergency operation due to a catastrophic grid failure**: Potentially a one in 20-year event where all generators operate.

The following noise limits were established for rooftop mechanical cooling plant.

Table 2 – Rooftop mechanical cooling plant noise limits

Time period	Plant noise limit at nearest residential receptors, L_{Aeq} dB(A)
Daytime (07:00 – 23:00)	37
Night-time (12:00 – 07:00)	34

The following noise limits were established for the operation of ground floor emergency generators.

Table 3 – Emergency generator noise limits

Generator operation	Time period	Plant noise limit at nearest residential receptors, L_{Aeq} dB(A)
Weekly test	Daytime (07:00 – 23:00)	37
Emergency operation – minor grid outage	Daytime (07:00 – 23:00)	44
	Night-time (12:00 – 07:00)	41
Emergency operation – catastrophic grid failure	Daytime (07:00 – 23:00)	47
	Night-time (23:00 – 07:00)	44

3.0 Site and surrounds

The site is located at Greenwich View Place, Isle of Dogs, along the waterfront of the Millwall outer dock. The site is surrounded by nearby residential developments. The nearest residential receptor locations agreed with LBTH were the following:

Table 4 – Residential receptor locations

Address	Description	Approximate distance from the site
Omega Close	3 storey townhouses to the west of the site.	65 m
Pepper Street	5 storey residential apartments to the north east of the site.	40 m
Selsdon Way	7 storey residential apartment block to the south east of the site	115 m

It is understood that residential moorings have been proposed to be built along the dockside adjacent to the LCT-10 facility, however it was agreed with LBTH that the moorings would not be considered as a receptor location for the purpose of this assessment.

The LCY-10 facility comprises two buildings joined by an air bridge. The northern part of the building is referred to as GV1. The southern part of the building is referred to as GV4.

An aerial map of the site and receptor locations is presented below.

Figure 1 – Aerial map of the site and nearest residential receptor locations

4.0 Noise sources

4.1 Rooftop cooling plant

The main noise generating plant located on the rooftop are dry air coolers and their associated pump equipment. Ten units are to be located on the GV4 rooftop and five units are to be located on the GV1 rooftop. Layout drawings are presented in Figure 2 and Figure 3.

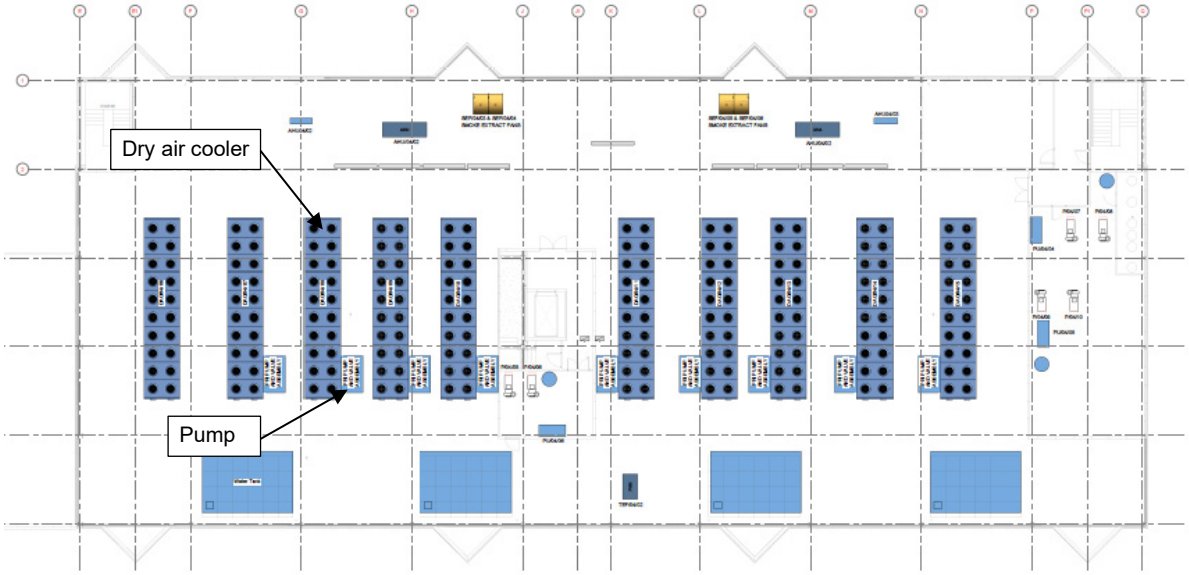


Figure 2 – Mechanical plant layout – GV4 rooftop

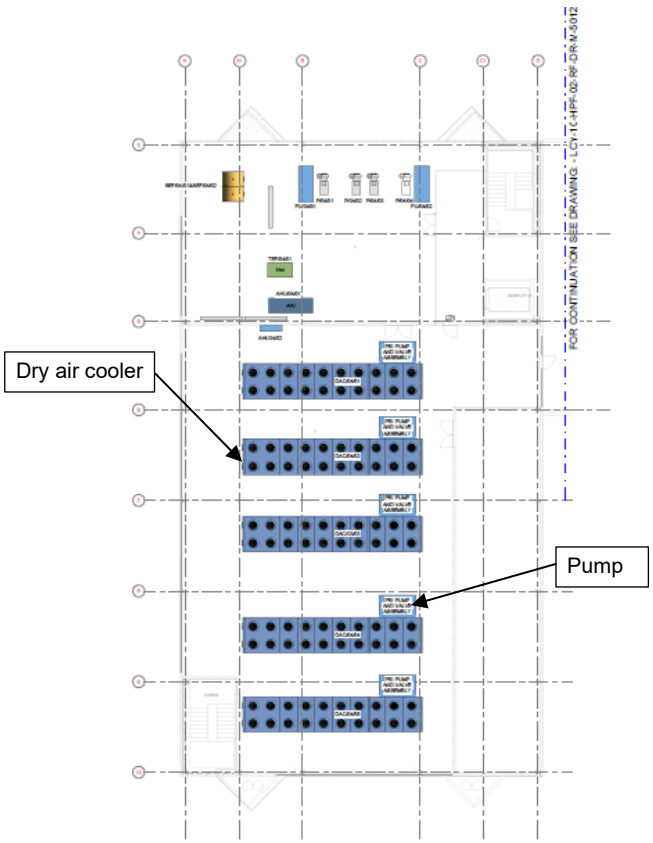


Figure 3 – Mechanical plant layout – GV1 rooftop

Specifications and noise data for the plant equipment are provided in APPENDIX A.

The dry air cooler design incorporates very sophisticated control systems so that the cooler fan speed is continuously varied depending on the ambient temperature to ensure that noise levels are always minimised. As the ambient temperature decreases, the cooler noise also decreases.

The highest ambient temperatures during the daytime and night time, based on weather data over a 10 year period, are expected to be:

- 34 °C during daytime (07:00 – 23:00)
- 23 °C during night time (23:00 – 07:00)

Refence data is presented in APPENDIX A.

Noise data has been provided by the manufacturer for the dry air cooling units operating at different speeds according to the ambient air temperature, presented in APPENDIX A. The lowest ambient temperature data provided by the manufacturer is 26°C, however, noise levels have been extrapolated for an ambient air temperature of 23°C. Accordingly, the assessment has been based on noise levels corresponding to 34°C during the daytime and 23 °C during night time.

Noise data for the Grundfos pumps was provided for multiple operating speeds. The assessment was based on the highest noise levels (at the highest operating speed of 1800 RPM).

4.2 Ground floor emergency generators

Emergency backup power generators are located within the ground floor level. There are to be four generators located in GV1 and five generators located in GV4. The generators are provided with acoustic silencers at the air inlets and outlets of the rooms. The rooms will be lined with acoustic absorbent to aid in reducing the internal noise levels. Each generator has an exhaust flue that is ducted to the rooftop and vented 7.4m above the roof level.

Noise data for the plant equipment are provided in APPENDIX B.

Noise from the generators will be emitted from the building through louvres providing airflow to the generator rooms. The locations of the louvres are shown in Figure 4.

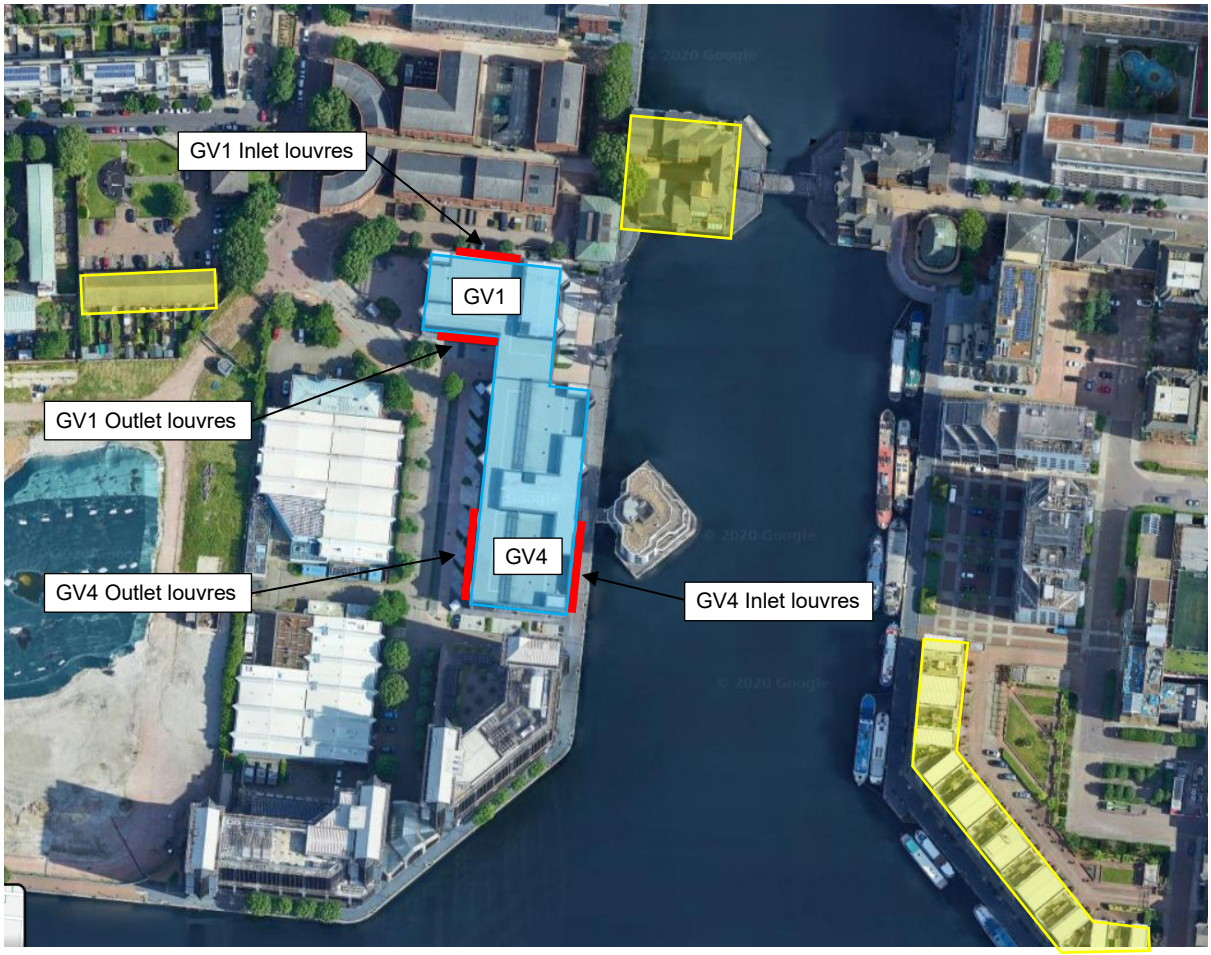


Figure 4 – Location of ground floor louvres serving emergency generators

5.0 Acoustic model

Noise emission from the proposed development was predicted using CadnaA 3D acoustic modelling software. The noise model takes into account noise sources, receptor locations, and intervening features including buildings, barriers, topography and ground type. The software calculates the noise propagation from each noise source an determines the total noise contribution at each receptor location.

Images of the acoustic model are presented in Figure 5 and Figure 6 below.

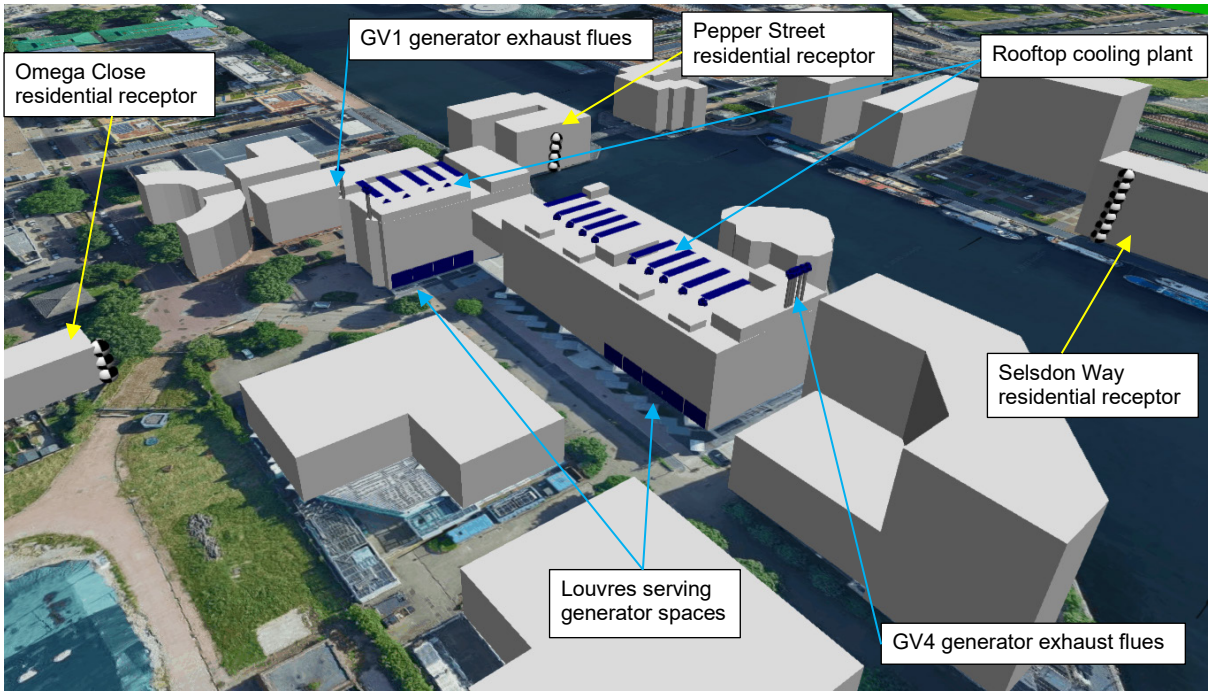


Figure 5 – Acoustic model, view from the south west of the site

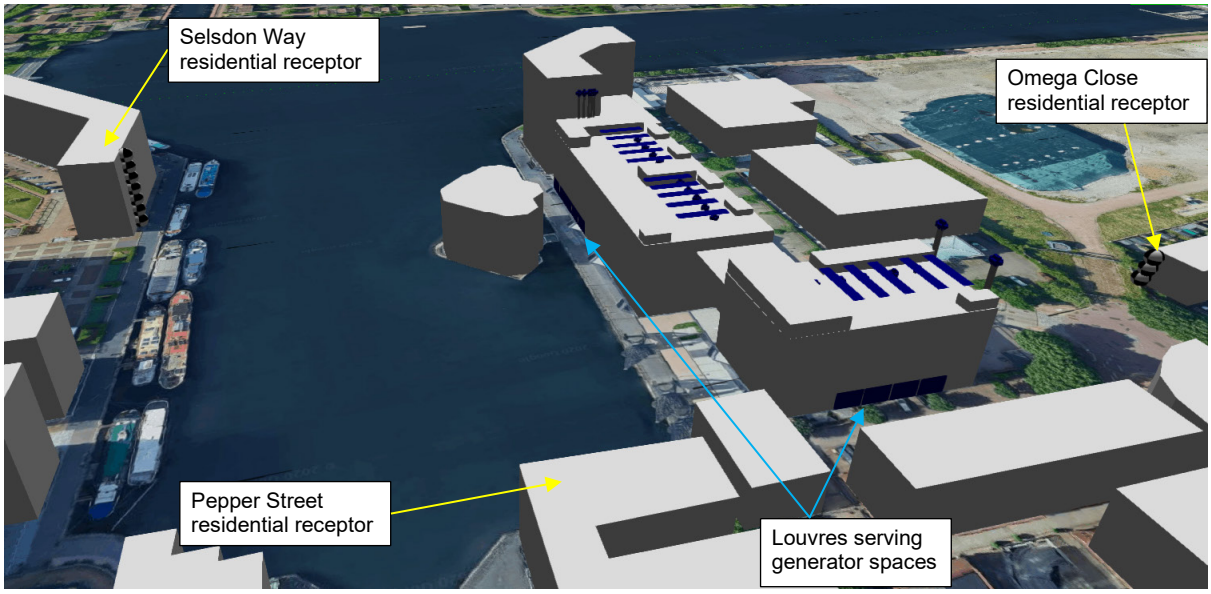


Figure 6 - Acoustic model, view from the north east of the site

The acoustic model was set up to run multiple scenarios based on the following potential operating situations:

Table 5 – Modelling scenarios

Scenario	Description	Time period	Criteria L_{Aeq} dB(A)
Normal operation	All rooftop plant	Daytime	37
		Night time	34
Weekly testing of emergency generators	One GV1 generator + all rooftop plant	Daytime only	37
	One GV4 generator + all rooftop plant	Daytime only	37
Minor grid outage	Three GV1 generators + all rooftop plant	Daytime	44
		Night time	41
	Three GV4 generators + all rooftop plant	Daytime	44
		Night time	41
catastrophic grid failure	All generators + all rooftop plant	Daytime	47
		Night time	44

The acoustic model was based on the following assumptions:

- The top of the dry air coolers is located approximately 2.9 m above the roof deck.
- Visual barriers around the rooftop parapet do not provide any acoustic screening.
- Generator exhaust flue stacks terminate 7.4 m above the roof deck.
- Residential building heights are based on 3m floor level hights.
- Other items of mechanical plant located on the rooftop are acoustically insignificant compared to the dry air coolers, pumps and flues, and do therefore not contribute to the overall noise emission.
- Plant rooms on the rooftop are approximately 3 m high.

6.0 Results

The results for the acoustic modelling of each of the operating scenario are presented in the following tables along with an assessment against the relevant criteria.

The results are presented for the top floor of each receptor location, representing the worst affected location.

Table 6 – Assessment results, normal operation and weekly testing of generators

Scenario		Criteria (normal operation & weekly test)		Rooftop plant only (normal operation)		1x GV1 generator + all rooftop plant (weekly test)	1x GV4 generator + all rooftop plant (weekly test)	Compliance achieved for all scenarios?
	Assessment height (top floor)	Day	Night	Day	Night	Day	Day	
Nearest residential receptor location	**m**	**dB(A)**	**dB(A)**	**dB(A)**	**dB(A)**	**dB(A)**	**dB(A)**	
Pepper Street	10.5 m	37	34	34	32	34	35	**YES**
Selsdon Way	19.5 m	37	34	33	32	32	34	**YES**
Omega Close	7.5 m	37	34	34	32	35	34	**YES**

Table 7 – Assessment results, minor grid outage

Scenario		Criteria (minor outage)		3x GV1 generator + all rooftop plant (minor outage)	3x GV1 generator + all rooftop plant (minor outage)	3x GV4 generator + all rooftop plant (minor outage)	3x GV4 generator + all rooftop plant (minor outage)	Compliance achieved for all scenarios?
	Assessment height - top floor	Day	Night	Day	Night	Day	Night	
Nearest residential receptor location	**m**	**dB(A)**	**dB(A)**	**dB(A)**	**dB(A)**	**dB(A)**	**dB(A)**	
Pepper Street	10.5 m	44	41	35	33	35	33	**YES**
Selsdon Way	19.5 m	44	41	33	32	33	32	**YES**
Omega Close	7.5 m	44	41	35	34	34	32	**YES**

Table 8 – Assessment results, catastrophic grid failure

Scenario		Criteria (catastrophic grid failure)		All generators + all rooftop plant (catastrophic grid failure)		Compliance achieved for all scenarios?
	Assessment height - top floor	Day	Night	Day	Night	
Nearest residential receptor location	m	dB(A)	dB(A)	dB(A)	dB(A)	
Pepper Street	10.5 m	47	44	36	35	YES
Selsdon Way	19.5 m	47	44	34	33	YES
Omega Close	7.5 m	47	44	36	35	YES

The results are also presented graphically with noise contours to show how the noise propagates from the site. Noise contour maps are presented for three scenarios:

1. Normal operation of rooftop plant
2. Typical weekly generator testing
3. Catastrophic grid failure

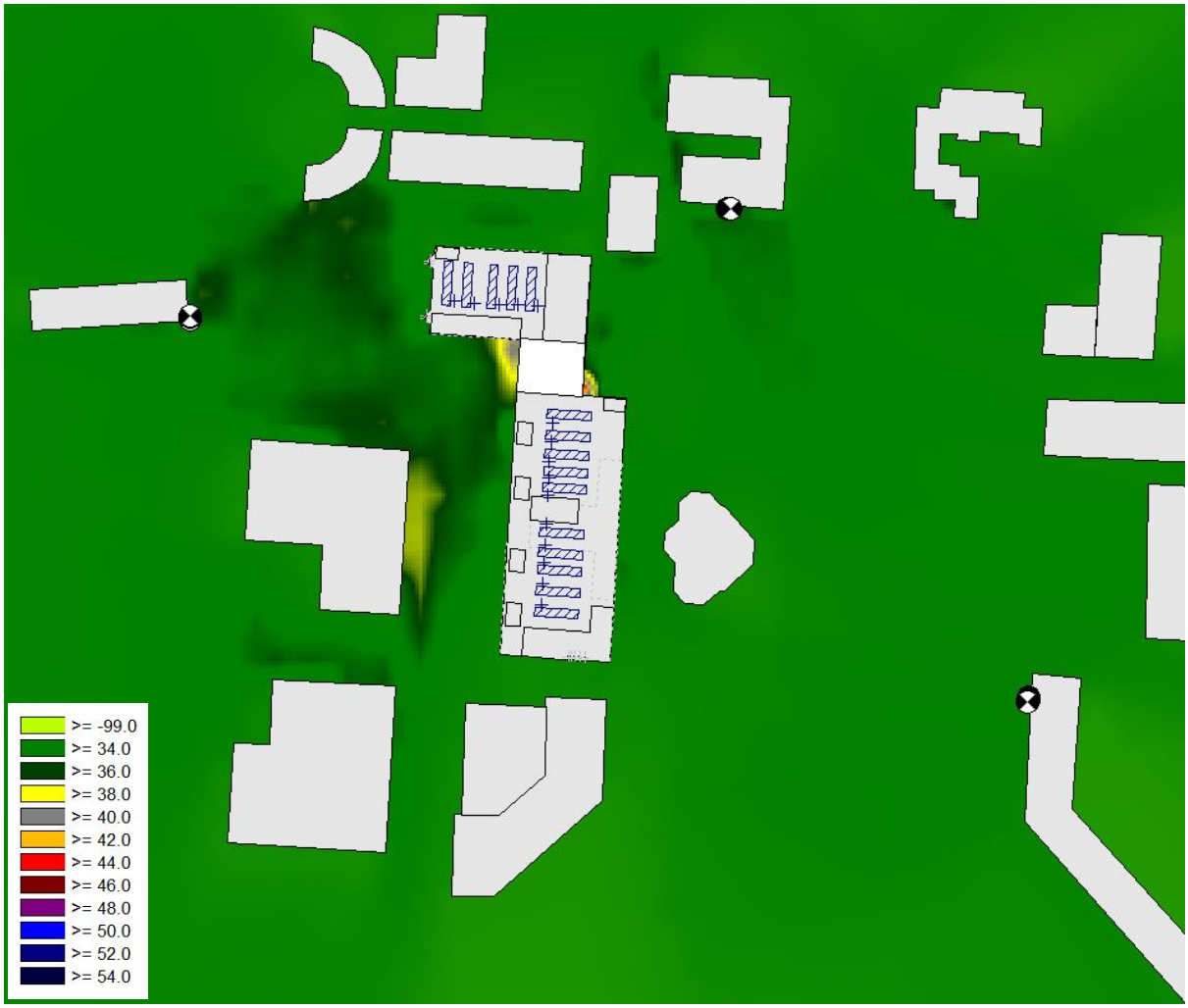


Figure 7 – Noise contour map, normal operation scenario: all rooftop plant. Contour height 7.5m

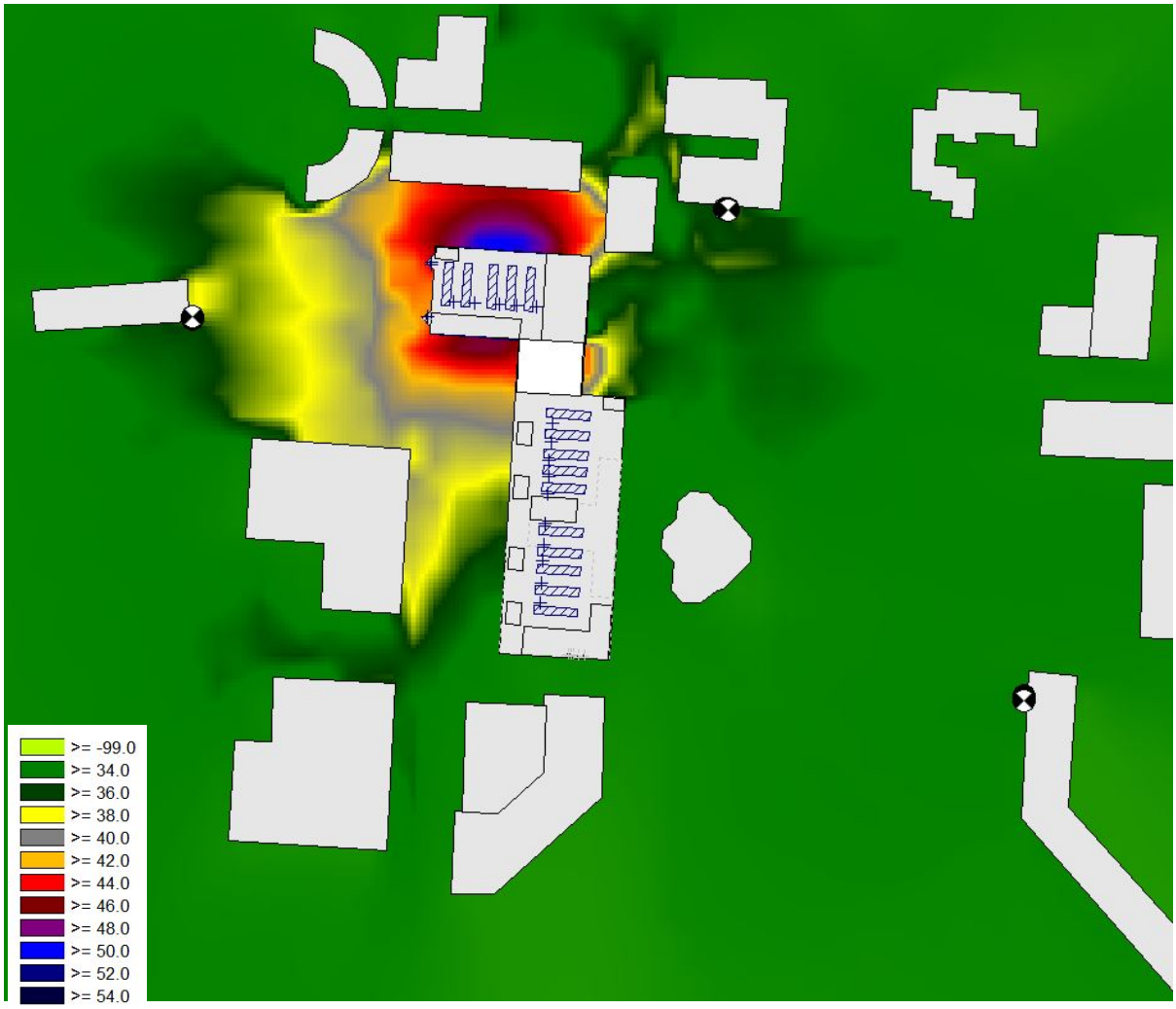


Figure 8 – Noise contour map, weekly test scenario: 1 x GV1 generator + all rooftop plant. Contour height 7.5m

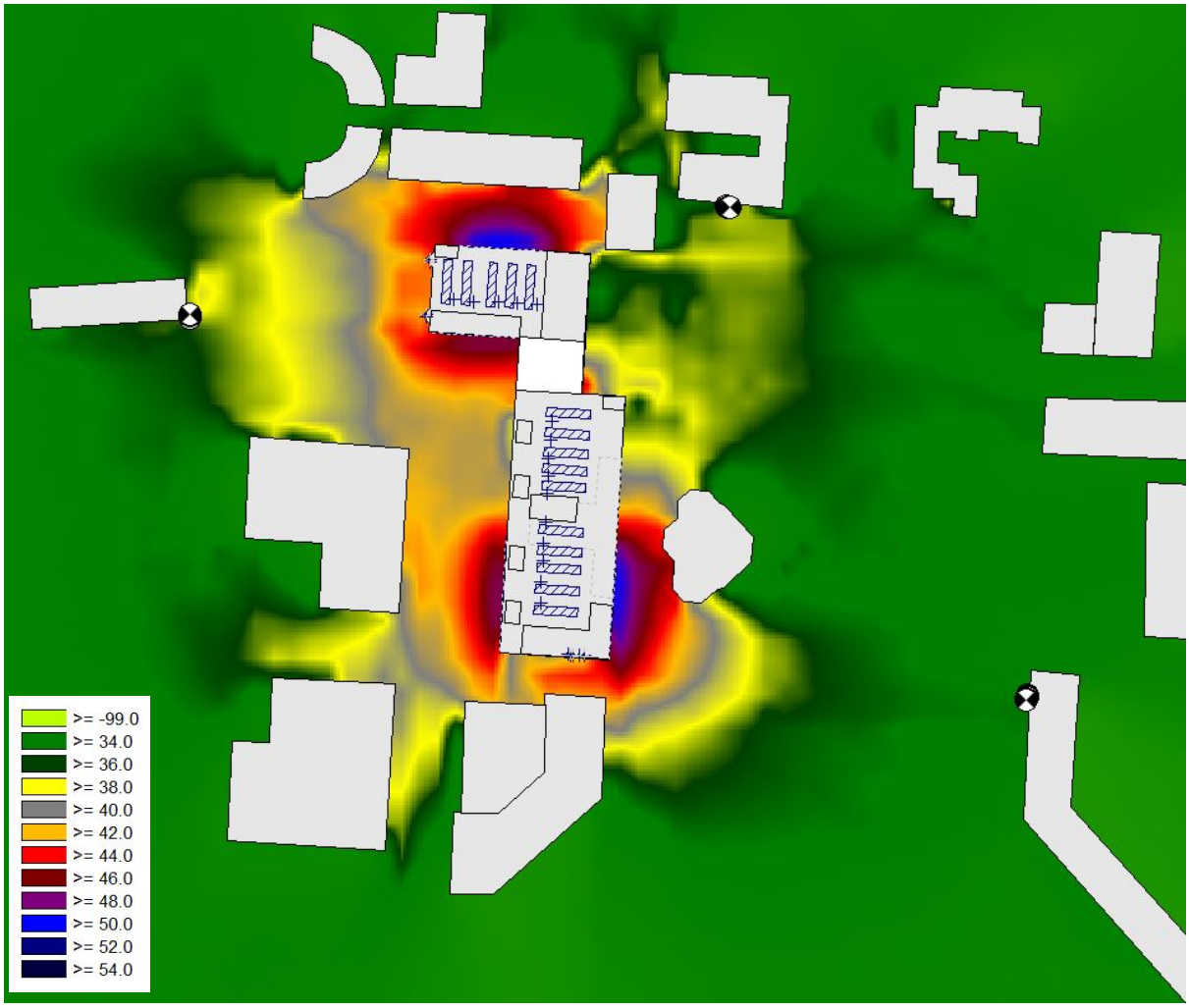


Figure 9 - Noise contour map, catastrophic grid failure: all generators + all rooftop plant. Contour height 7.5m

The results presented in Table 6 to Table 8 show that noise emission from the LCY-10 building comply with the criteria for all of the operating scenarios at all of the receptor locations. The development therefore meets the requirements set out by the London Borough of Tower Hamlets.

The potential for tonal noise issues were considered. The octave band noise levels at the receptor locations give no indication of the likelihood of tonal characteristics from the LCY-10 mechanical plant.

The sound power data for the dry air chillers indicate low frequency tonal characteristics. However, the noise modelling results show that the noise levels at the receptor locations are below the threshold of hearing for the low frequency octave bands and are therefore inaudible.

Where items of plant are found to exhibit tonal characteristics upon installation, it is unlikely that the noise levels at the receptor locations would exceed the established background noise levels and would therefore be considered to be low impact in accordance with BS 4142: 2014 *Methods for rating and assessing industrial and commercial sound.*

7.0 Conclusion

INVC have completed an assessment of potential noise emission from the proposed LCY-10 (The Point) data centre facility located at the Isle of Dogs in the London Borough of Tower Hamlets.

The significant noise sources associated with the development were identified to be rooftop cooling plant and ground floor emergency generators. Noise impacts were considered for all of the potential operating scenarios including normal operation, testing of emergency generators, minor grid outages and catastrophic grid outages.

The results of the assessment showed compliance with the criteria for all operating scenarios at all of the residential receptor locations. The proposed development therefore meets the acoustic requirements agreed with LBTH.

APPENDIX A ROOFTOP PLANT NOISE DATA

	Telephone		Reference
	Fax		Position

TECHNICAL DATA

DRY COOLER (5) **SJGQ21090.B5/03 (EC)S** Number of circuits 112

EUROVENT CERTIFIED PERFORMANCE www.eurovent-certification.com

PERFORMANCE (SINGLE UNIT)

Real Capacity	1087.00kW

TUBE SIDE

Fluid (10)	ETHYLENE GLYCOL 20%		
Inlet Fluid Temp.	51.0°C	Outlet Fluid Temp.	45.0°C
Fluid flow rate	161.73m³/h	Fluid Velocity	2.0m/s
Massic Fluid Flow	163874kg/h	Pressure drops	117kPa

AIR SIDE

Inlet Air Temp [MAX]	40.0°C	Outlet Air Temp.	48.1°C
Inlet relative hum.	30.0%	Outlet relative hum.	19.7%
		Altitude	0m
		ESP	0.0Pa
		Flow Direction	N/A
Air Flow	420562m³/h	Air Velocity	2.07m/s

FANS TECHNICAL DATA

ERP	Yes	UL	No
Fan Number	20N°	Fan Diameter	910mm
Phases-Voltage-Frequency	3-400-50N°/Volt/Hz	Fan type	34050Q91ECB1SMP+AX
Rpm [Nominal data]	800Rpm	Link	EC
Power x 1 [Nominal data]	1550Watt	Current x 1 [Nominal data] (1)	2.50A
Rpm [Working point]	703Rpm	Rpm rate [working point / nominal]	88%
Power x 1 [Working point]	856Watt	Current x 1 [Working point] (1)	1.39A
Total Power x n° [Working point]/ [Nominal data]	17120/31000Watt	Total Current x n° [Working point]/ [Nominal data]	27.80/50.00A
Efficiency Energy Class:nominal calculation Water 40-35°C/Air 25°C		Efficiency Energy Class:calculation on the working point	

FANS NOISE DATA (7)

Sound Pressure Level (4) [Working	52dB(A)	Sound Power Level (4) [Working point]	85dB(A)
At the distance of	10m	in accordance with EN 13487/EN ISO 3744 (7)	

HEAT EXCHANGER DATA (3)

Fin Material (2)	AFS fin Turbo	Tubes Material	Copper
Fin Spacing	1.8mm	Internal Volume	857.0dm³
Fin Thickness	0.1mm	Casing material	Galvanized steel painted
Surface	6090.0m²	Number of passes	3
Inlet Connection	4x4"		
Outlet Connection	4x4"	Connections	Same side
Max Pressure Design	10 bar	Fluid Category	Group 2

DIMENSIONS AND WEIGHT (3)

Length	12490mm	Weight (3)	6192kg
Width	2400mm	Number of fixing point	22
Height	2862mm	LDM (Approximate data)	12.49m

SOUND POWER LEVEL

	Tot.	63Hz	125Hz	250Hz	500Hz	1kHz	2kHz	4kHz	8kHz
Δ [dB(A)]	70	76	67	69	68	64	62	60	54

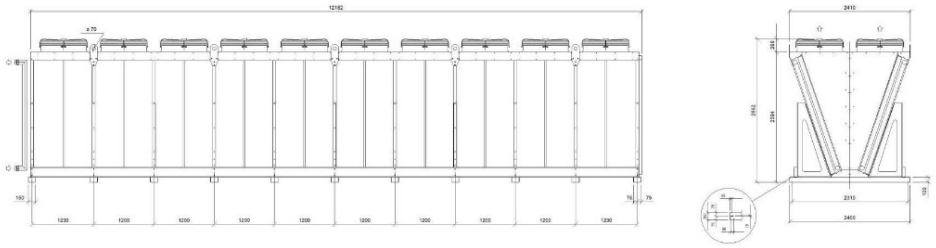
Data refers to one fan. IMPORTANT: the tolerance in any single octave band is +/-5dB. The tolerance in the overall dB(A) level is +/- 2dB.

In case of AC fans working point is defined by fan supplier in nominal curve (delta or star). In case of EC fans is simulated on working point of unit.

Archimede 2019 - Build190418 - made by Unilab Srl - 4580981FB396 - 46B0C2EEK0AAC56F80000000007F66771668 - P5 1 / 7

Figure A1 - Rooftop dry air cooler specifications

Model: SJGQ21090.B5/03 (EC)(AFS)S



Attention: Drawing and dimensions not valid for all accessory options!
The overall dimensions on the datasheet refer only to the unit without regulation(For more detailed information refer to Electrical box Manual). In the units with horizontal air flow the standard position of the connections is left looking at the finned pack (right looking at the fans).

Company		Date	16/3/2020
Attention of		Sw Version	190418
City		Offer	- Rev. 00

Archimede 2019 - Build190418 - made by Unilab Srl - 4580981FB396 - 4680C2EEK0AAC56F80000000007F66771668 - P5 6 / 9

Figure A2 - Rooftop dry air cooler dimensions

LONDON CITY, UNITED KINGDOM (WMO: 037683)

Lat:51.505N Long:0.055E Elev:6 StdP: 101.26 Time zone:-0.00 Period:07-15 WBAN:99999

Annual Heating and Humidification Design Conditions

Coldest Month	Heating DB		Humidification DP/MCDB and HR						Coldest month WS/MCDB				MCWS/PCWD to 99.6% DB	
			99.6%			99%			0.4%		1%			
	99.6%	99%	DP	HR	MCDB	DP	HR	MCDB	WS	MCDB	WS	MCDB	MCWS	PCWD
1	-1.9	-0.9	-5.2	2.4	0.8	-4.2	2.6	1.4	11.7	11.2	10.9	10.7	2.6	20

Annual Cooling, Dehumidification, and Enthalpy Design Conditions

Hottest Month	Hottest Month DB Range	Cooling DB/MCWB						Evaporation WB/MCDB						MCWS/PCWD to 0.4% DB	
		0.4%		1%		2%		0.4%		1%		2%			
		DB	MCWB	DB	MCWB	DB	MCWB	WB	MCDB	WB	MCDB	WB	MCDB	MCWS	PCWD
7	7.5	27.0	17.9	25.1	17.2	23.8	16.7	19.1	24.2	18.2	22.8	17.5	21.7	4.2	210

Dehumidification DP/MCDB and HR									Enthalpy/MCDB						Extreme Max WB
0.4%			1%			2%			0.4%		1%		2%		
DP	HR	MCDB	DP	HR	MCDB	DP	HR	MCDB	Enth	MCDB	Enth	MCDB	Enth	MCDB	
17.1	12.2	21.1	16.2	11.5	20.2	15.8	11.2	19.9	54.0	24.1	51.3	22.9	49.3	21.9	22.4

Extreme Annual Design Conditions

Extreme Annual WS				Extreme Annual Temperature				n-Year Return Period Values of Extreme Temperature							
				Mean		Standard deviation		n=5 years		n=10 years		n=20 years		n=50 years	
1%	2.5%	5%		Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
10.1	9.0	8.1	DB	-3.2	31.1	2.1	1.8	-4.8	32.4	-6.0	33.5	-7.2	34.5	-8.7	35.8
			WB	-3.9	21.4	1.9	1.0	-5.2	22.1	-6.3	22.7	-7.4	23.3	-8.7	24.1

Monthly Climatic Design Conditions

		Annual	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Temperatures, Degree-Days and Degree-Hours	DBAvg	11.9	5.7	5.9	7.8	10.9	13.5	16.4	19.0	18.4	15.9	12.9	9.3	6.6
	DBStd	5.48	3.43	3.16	3.07	2.93	2.86	2.63	2.43	2.05	2.15	2.81	3.12	3.82
	HDD10.0	532	136	117	81	22	5	0	0	0	0	7	48	117
	HDD18.3	2435	391	347	328	222	151	70	21	23	79	170	270	363
	CDD10.0	1226	3	3	11	51	114	193	278	260	176	97	28	12
	CDD18.3	87	0	0	0	0	2	13	41	25	6	1	0	0
	CDH23.3	407	0	0	0	3	11	67	204	87	28	7	0	0

Contacts

ashrae-meteo.info/index.php?lat=51.505&lng=0.055&place=%27%27&wmo=037683 1/2

Figure A3 - Weather data for 10-year maximum day/night temperatures

Ambient Dry Bulb [°C]	Capacity [kW]	Status	Fluid Inlet [°C]	Fluid Outlet [°C]	Fluid Flow [m3/h]	Air Flow [m3/h]	Fan RPM RPM	Fan Power W	Noise Power [dB(A)]
23	1087	Dry	51	45	161.76				59
24	1087	Dry	51	45	161.76				60
25	1087	Dry	51	45	161.76				61
26	1087	Dry	51	45	161.76	134875	241	1113	62
27	1087	Dry	51	45	161.76	141440	252	1236	63
28	1087	Dry	51	45	161.76	148675	264	1379	64
29	1087	Dry	51	45	161.76	156700	277	1544	65
30	1087	Dry	51	45	161.76	165650	292	1751	66
31	1087	Dry	51	45	161.76	175715	309	2008	67
32	1087	Dry	51	45	161.76	187140	328	2320	68
33	1087	Dry	51	45	161.76	200235	349	2695	69
34	1087	Dry	51	45	161.76	215425	374	3198	71
35	1087	Dry	51	45	161.76	233315	403	3852	72
36	1087	Dry	51	45	161.76	254750	438	4763	74
37	1087	Dry	51	45	161.76	281010	480	6032	76
38	1087	Dry	51	45	161.76	314085	532	7898	78
39	1087	Dry	51	45	161.76	357300	601	10999	81
40	1087	Dry	51	45	161.76	416685	696	16608	85

Figure A4 - Dry air cooler noise v temperature data. Values in orange have been extrapolated.

GRUNDFOS

Company name:	Grundfos
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Sound Measurement Report
Sound Power measurement according to DS/ISO-3743

Motor type: MGE160LB **Product number:** 86906101 **Fan diameter:** D270 **[mm]**

P2: 15 **[kW]** **U:** 400 **[V]** **Frequency:** 50 **[Hz]**

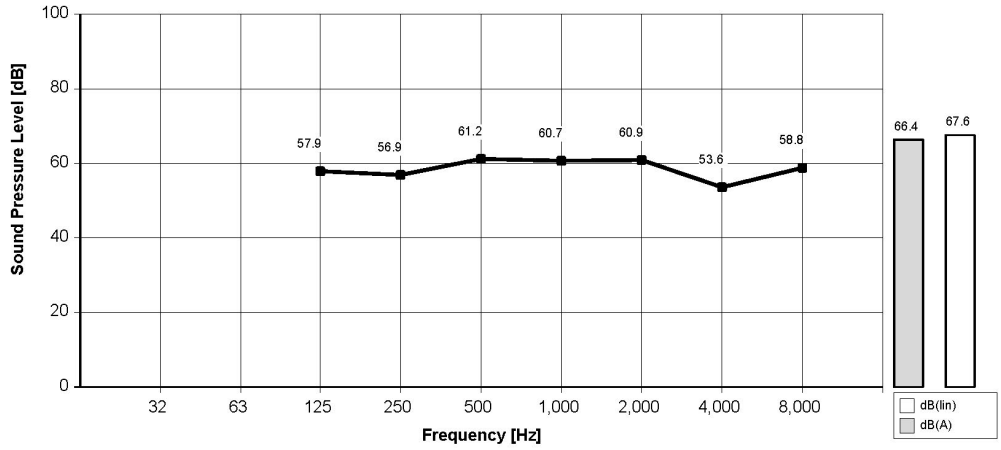
Remarks: The declared noise emission value, does not take production variations and measurement uncertainties into account. The declared value may therefore be up-to 3 dB higher, than the value for the average production unit.

Tested at: 1800 (idle) rpm

Octave Band Level [db]

Center Frequency	125	250	500	1000	2000	4000	8000	dB(A)	dB(lin)
Sound Power Level re: 1 pW	71,0	70,0	74,3	73,8	74,0	66,8	71,9	79,5	80,7
Sound Pressure Average at 1m. re: 20 UPa	57,9	56,9	61,2	60,7	60,9	53,6	58,8	66,4	67,6

Sound Pressure calculated according to ISO/DIS 11203 method Q2



Initials: KIR **File no.:** LY 26.09.2008

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Figure A5 - Rooftop pump noise data

Table A1 - Summary of rooftop plant noise data used in acoustic model

Item	Description	1/1 Octave band sound levels (PWL re: 10-12 Watts or SPL re: 20 µPa) dB								Overall sound power level
		63	125	250	500	1k	2k	4k	8k	dB(A)
Dry air cooler	Daytime - 34 °C	77	68	70	69	65	63	61	55	71
Dry air cooler	Night time - 23 °C	65	56	58	57	53	51	49	43	59
Pump	1800 RPM	71	70	74	74	74	67	72	71	80

APPENDIX B EMERGENCY GENERATOR NOISE DATA

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					Project	The Point		Room 1, 5 sets		Date: 03-Nov-20	
					Engine Type	20V 4000 G94		issue 5			
Lp dBA			63	125	250	500	1k	2k	4k	8k	
Generator Lp			87.6	96.1	102.3	96.0	97.9	100.3	97.2	108.9	
Lw dB			107.8	116.3	122.5	116.2	118.0	112.3	109.2	118.9	
			107.8	116.3	122.5	116.2	118.0	112.3	109.2	118.9	
Generator envelope m2	'A'		104.0	104.0	104.0	104.0	104.0	25.0	25.0	25.0	dB
Correct to *Lw*	10 log 'A'		20	20	20	20	20	12	12	10	dB
Generator *Lw*			108	116	122	116	118	112	109	119	dB
No Generators		5	7	7	7	7	7	7	7	7	dB
Total *Lw*			115	123	129	123	125	119	116	126	dB
Room Correction											
Ceiling area m2 =S			720.0	720.0	720.0	720.0	720.0	720.0	720.0	720.0	m2
Ceiling a			0.3	0.6	1	1	1	1	1	0.9	
Ceiling S a			216	432	720	720	720	720	720	648	
Floor area m2 =S			720.0	720.0	720.0	720.0	720.0	720.0	720.0	720.0	m2
Floor a			0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	
Floor S a			36	36	36	36	36	36	36	36	
Wall area m2 =S			296.4	296.4	296.4	296.4	296.4	296.4	296.4	296.4	m2
Acoustic Wall a			0.3	0.6	1	1	1	1	1	0.9	
Wall S a			89	178	296	296	296	296	296	267	
Engine area m2 =S			220.0	220.0	220.0	220.0	220.0	220.0	220.0	220.0	m2
Engine a			0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	
Engine S a			11	11	11	11	11	11	11	11	
Silencer area m2 =S			114.0	114.0	114.0	114.0	114.0	114.0	114.0	114.0	m2
			0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	
			103	103	103	103	103	103	103	103	
S Sa = A			455	759	1166	1166	1166	1166	1166	1064	
Total S			2070	1956	1956	1956	1956	1956	1956	1956	
Average a			0.22	0.39	0.60	0.60	0.60	0.60	0.60	0.54	
Room correction	10log(4/(A / (1- a))		-21.6	-24.9	-28.6	-28.6	-28.6	-28.6	-28.6	-27.7	
	Reverberant Lp		93.2	98.3	100.9	94.6	96.4	90.7	87.6	98.2	dB
	weighting		-26	-16	-9	-3	0	1	1	-1	
	weighted		67.2	82.3	91.9	91.6	96.4	91.7	88.6	97.2	
Reverberation time			101.8	dBA							
V			-69.3	-69.3	-69.3	-69.3	-69.3	-69.3	-69.3	-69.3	sec
RT = 0.16 V/A			0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	

Inlet attenuator

Attenuator size (face area)	22.8 M^2		Width	Height	Length		Duct resistance		at		
Attenuator Dimensions			6.0	3.8	3		68 Pa		2.6	m/sec	
Additional ducting					0						
	Special order	63	125	250	500	1k	2k	4k	8k	Hz	
attenuation	RAS 10FD	22	34	50	50	50	50	50	41	dB	
Secondary	None	0	0	0	0	0	0	0	0		
SpL2=SpL - R - 6		65	58	45	39	40	35	32	51	dB	
Regenerated noise	RAS 10FD	42	38	42	39	41	44	32	30	dB	
Lw=SpL + 10log S		79	72	60	55	57	58	48	65	dB	66.7
Distance loss - 10log(R) +8		8	8	8	8	8	8	8	8	dB	
Resultant Lp at	1	71	64	52	47	49	50	40	57	dB	
	weighting	-26	-16	-9	-3	0	1	1	-1	dB	
	weighted	44.8	48.0	43.1	44.3	49.3	50.7	41.4	55.8	dB	
Noise level at 1m		58.7	dB(A)								
Noise level at (m)	32	33.4	dB(A)								

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Outlet attenuator

Attenuator size (face area)	26.6 M^2		Width	Height	Length		Duct resistance		at		
			7.0	3.8	4		51 Pa		2.0	m/sec	
Additional ducting					1						
	Special order	63	125	250	500	1k	2k	4k	8k	Hz	
attenuation	RAS 7FD	17	29	41	50	50	50	50	39	dB	
Secondary	RAS 3CD	9	13	21	29	34	30	23	19		
SpL2=SpL - R - 6		67	60	46	23	20	18	22	49	dB	
Regenerated noise	RAS 3CD	24	20	25	20	29	37	24	20	dB	
Lw=SpL + 10log S		82	74	60	39	44	51	40	63	dB	64.8
Distance loss - 10log(R) +8		8	8	8	8	8	8	8	8	dB	
Resultant Lp at	1	74	66	52	31	36	43	32	55	dB	
	weighting	-26	-16	-9	-3	0	1	1	-1	dB	
	weighted	47.7	50.1	43.4	27.9	35.7	44.3	33.5	54.2	dB	
Noise level at 1m		56.8	dB(A)								
		7.0	3.50	51.4	28.3						
Noise level at (m)	50	28.3	dB(A)								

Figure B1 - GV4 Emergency generator noise data

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					Project	The Point		Room 2, 4 sets			
					Engine Type	20V 4000 G94		issue 5		Date: 03-Nov-20	
Lp dBA			63	125	250	500	1k	2k	4k	8k	
Generator Lp			87.6	96.1	102.3	96.0	97.9	100.3	97.2	108.9	
Lw dB			107.8	116.3	122.5	116.2	118.0	112.3	109.2	118.9	
			107.8	116.3	122.5	116.2	118.0	112.3	109.2	118.9	
Generator envelope m2	'A'		104.0	104.0	104.0	104.0	104.0	25.0	25.0	25.0	dB
Correct to *Lw*	10 log 'A'		20	20	20	20	20	12	12	10	dB
Generator *Lw*			108	116	122	116	118	112	109	119	dB
No Generators		4	6	6	6	6	6	6	6	6	dB
Total *Lw*			114	122	129	122	124	118	115	125	dB
Room Correction											
Ceiling area m2 =S			720.0	720.0	720.0	720.0	720.0	720.0	720.0	720.0	m2
Ceiling a			0.3	0.6	1	1	1	1	1	0.9	
Ceiling S a			216	432	720	720	720	720	720	648	
Floor area m2 =S			720.0	720.0	720.0	720.0	720.0	720.0	720.0	720.0	m2
Floor a			0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	
Floor S a			36	36	36	36	36	36	36	36	
Wall area m2 =S			362.0	362.0	362.0	362.0	362.0	362.0	362.0	362.0	m2
Acoustic Wall a			0.3	0.6	1	1	1	1	1	0.9	
Wall S a			109	217	362	362	362	362	362	326	
Engine area m2 =S			176.0	176.0	176.0	176.0	176.0	176.0	176.0	176.0	m2
Engine a			0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	
Engine S a			8.8	8.8	8.8	8.8	8.8	8.8	8.8	8.8	
Silencer area m2 =S			91.6	91.6	91.6	91.6	91.6	91.6	91.6	91.6	m2
			0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	
			82	82	82	82	82	82	82	82	
S Sa = A			452	776	1209	1209	1209	1209	1209	1101	
Total S			2070	1978	1978	1978	1978	1978	1978	1978	
Average a			0.22	0.39	0.61	0.61	0.61	0.61	0.61	0.56	
Room correction	10log(4/(A / (1- a))		-21.6	-25.0	-28.9	-28.9	-28.9	-28.9	-28.9	-27.9	
	Reverberant Lp		92.2	97.2	99.6	93.3	95.1	89.4	86.3	97.0	dB
		weighting	-26	-16	-9	-3	0	1	1	-1	
		weighted	66.2	81.2	90.6	90.3	95.1	90.4	87.3	96.0	
Reverberation time			100.5	dBA							
V			-45.3	-45.3	-45.3	-45.3	-45.3	-45.3	-45.3	-45.3	sec
RT = 0.16 V/A			0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	

Inlet attenuator

Attenuator size (face area)	22.9 M^2		Width	Height	Length		Duct resistance		at		
Attenuator Dimensions			5.8	4.0	4		77 Pa		2.8	m/sec	
Additional ducting					1						
	Special order	63	125	250	500	1k	2k	4k	8k	Hz	
attenuation	RAS 10FD	22	34	50	50	50	50	50	41	dB	
Secondary	None	0	0	0	0	0	0	0	0		
SpL2=SpL - R - 6		64	57	44	37	39	33	30	50	dB	
Regenerated noise	RAS 10FD	44	40	44	42	44	46	35	32	dB	
Lw=SpL + 10log S		78	71	60	57	59	60	50	64	dB	66.8
Distance loss - 10log(R) +8		8	8	8	8	8	8	8	8	dB	
Resultant Lp at 1		70	63	52	49	51	52	42	56	dB	
	weighting	-26	-16	-9	-3	0	1	1	-1	dB	
	weighted	43.9	46.9	43.2	45.6	50.7	53.1	43.1	54.6	dB	
Noise level at 1m		**58.8 dB(A)**									
Noise level at (m) 32		**33.4 dB(A)**									

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Outlet attenuator

Attenuator size (face area)	25.2 M^2		Width	Height	Length		Duct resistance		at		
			6.0	4.2	4		65 Pa		2.3	m/sec	
Additional ducting					1						
	Special order	63	125	250	500	1k	2k	4k	8k	Hz	
attenuation	RAS 7FD	17	29	41	50	50	50	50	39	dB	
Secondary	RAS 3CD	9	13	21	29	34	30	23	19		
SpL2=SpL - R - 6		67	60	46	23	20	18	22	49	dB	
Regenerated noise	RAS 3CD	24	20	25	20	29	37	24	20	dB	
Lw=SpL + 10log S		81	74	60	39	43	51	40	63	dB	64.6
Distance loss - 10log(R) +8		8	8	8	8	8	8	8	8	dB	
Resultant Lp at 1		73	66	52	31	35	43	32	55	dB	
	weighting	-26	-16	-9	-3	0	1	1	-1	dB	
	weighted	47.4	49.9	43.1	27.6	35.5	44.1	33.2	53.9	dB	
Noise level at 1m		**56.6 dB(A)**									
		6.0	3.00	51.8	27.4						
Noise level at (m) 50		**27.4 dB(A)**									

Figure B2 - GV1 Emergency generator noise data

Table B1 - Summary of emergency generator noise data used in acoustic model

Item	No.	Description	1/1 Octave band sound levels (PWL re: 10-12 Watts or SPL re: 20 µPa) dB							
			63	125	250	500	1k	2k	4k	8k
Emergency generators - GV4	5	Inlet louvre	86	79	67	62	64	65	55	72
	5	Outlet louvre	89	81	67	46	51	58	47	70
	3	Inlet louvre	82	75	63	58	60	61	51	68
	3	Outlet louvre	85	77	63	42	47	54	43	66
	1	Inlet louvre	72	65	53	48	50	51	41	58
	1	Outlet louvre	75	67	53	32	37	44	33	56
Emergency generators – GV1	4	Inlet louvre	84	77	66	63	65	66	56	70
	4	Outlet louvre	87	80	66	45	49	57	46	69
	3	Inlet louvre	82	75	64	61	63	64	54	68
	3	Outlet louvre	85	78	64	43	47	55	44	67
	1	Inlet louvre	72	65	54	51	53	54	44	58
	1	Outlet louvre	75	68	54	33	37	45	34	57
Generator exhaust	1	Each flue stack	93	82	78	65	63	58	53	46