parkerjones acoustics

Cavendish School

31 Inverness Street, Camden Town, NW1 7HB

Plant Noise Assessment

23rd March 2021
First Issue

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Revision History

Version	Comments	Author	Date
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Executive Summary and Conclusions

This document, a Plant Noise Assessment, has been written to assess the risk of adverse impact from noise 'pollution' generated by the installation of a new external air conditioning unit to provide cooling to a server cupboard at the Cavendish School, 31 Inverness Street, Camden Town, NW1 7HB.

The objective is to ensure that the risk of noise impact will be controlled sufficiently and that noise emissions are controlled to a level that is acceptable to neighbouring noise-sensitive buildings. The aim is to maintain appropriate internal noise levels in the bedrooms and living areas of residential dwellings which support good quality sleeping and living conditions – and similarly for good working conditions in nearby offices.

The noise emissions from the proposed plant have been conducted using accurate 3D noise modelling software to enable noise levels to be predicted at all noise-sensitive properties in the surrounding area.

The emissions have been assessed based upon the criteria of several guidelines, including BS 8233:2014, WHO noise guidelines, and the AVO guide. These documents are commonly used to assess the noise impact on residential dwellings across the UK. These targets are considered to be appropriate limits at which the level of adverse impact should be no higher than the LOAEL (Lowest Observed Adverse Effect Level) defined in National Planning Policy. The assessment has also referenced the BS 4142:2014+A1:2019 guideline for assessing plant noise – though a baseline noise survey has not been conducted, as a survey was previously conducted at the site in 2016.

In summary, the predicted noise emissions are very low, at 23 dB L_{Aeq} outside the worst affected residential window; and 29 dB L_{Aeq} outside the worst affected office window.

These are comfortably below the criteria from the aforementioned standards, and is also expected to be at least 10 dB, if not 20 dB below pre-existing baseline noise levels outside the nearest residential window.

By assessing against all of the aforementioned guidelines, the clear conclusion is that there is only likely to be a very negligible impact, and that occupants of noise-sensitive neighbouring buildings are unlikely to perceive noise from the new plant over pre-existing noise sources, let alone be disturbed by it.

Therefore, noise should not pose a constraint to achieving planning permission.

Contents

1.0 Introduction

ParkerJones Acoustics Limited (PJA) has been instructed to undertake a Plant Noise Assessment to accompany a planning application for the installation of a new external air conditioning unit to provide cooling to a server cupboard at the Cavendish School, 31 Inverness Street, Camden Town, NW1 7HB.

1.1 Scope of Report

This Report has been written to assess the risk of adverse impact from noise 'pollution' generated by the new proposed plant on noise-sensitive properties in the wider surrounding area once it is fully operational.

The objective is to ensure that the risk of noise impact will be controlled sufficiently and that noise emissions are controlled to a level that is acceptable to neighbouring noise-sensitive buildings. The aim is to maintain appropriate internal noise levels in the bedrooms and living areas of residential dwellings which support good quality sleeping and living conditions – and similarly for good working conditions in nearby offices.

Therefore, the purpose of this report is to demonstrate whether the proposals have been designed correctly to minimise the risk of adverse impact.

Whilst every attempt has been made to ensure that this report communicates effectively to a reader who might not have much knowledge of acoustics, some parts are necessarily technical. A glossary of acoustic terminology and concepts is provided in Appendix A.

1.2 Regulations and Guidelines

This report takes national planning policies into consideration including the National Planning Policy Framework (NPPF), the Noise Policy Statement for England (NPSE) and the Planning Practice Guidance on Noise (PPG-N) (summarised in Appendix B), which outline the purpose and long-term vision of planning policy with respect to noise.

More specifically, the assessment has been undertaken in reference to the noise criteria from BS 8233:2014 'Guidance on Sound Insulation and Noise Reduction for Buildings', the WHO Environmental Noise Guidelines for the European Region and the Acoustics, Ventilation and Overheating Guide ('AVO Guide'). These standards are used across the UK to define suitable internal ambient noise levels in residential bedrooms and living spaces, and suitable noise levels for offices.

BS 4142:2014 'Methods for rating and assessing industrial and commercial sound' has also been referenced, which assesses the risk of an adverse impact of noise pollution from a sound source (or sources) of a commercial or industrial nature (i.e. mechanical/electrical plant).

2.0 Site and Development Description

The site of the proposed plant is upon the single-storey roof of the Gym Store at the Cavendish School in Camden Town.

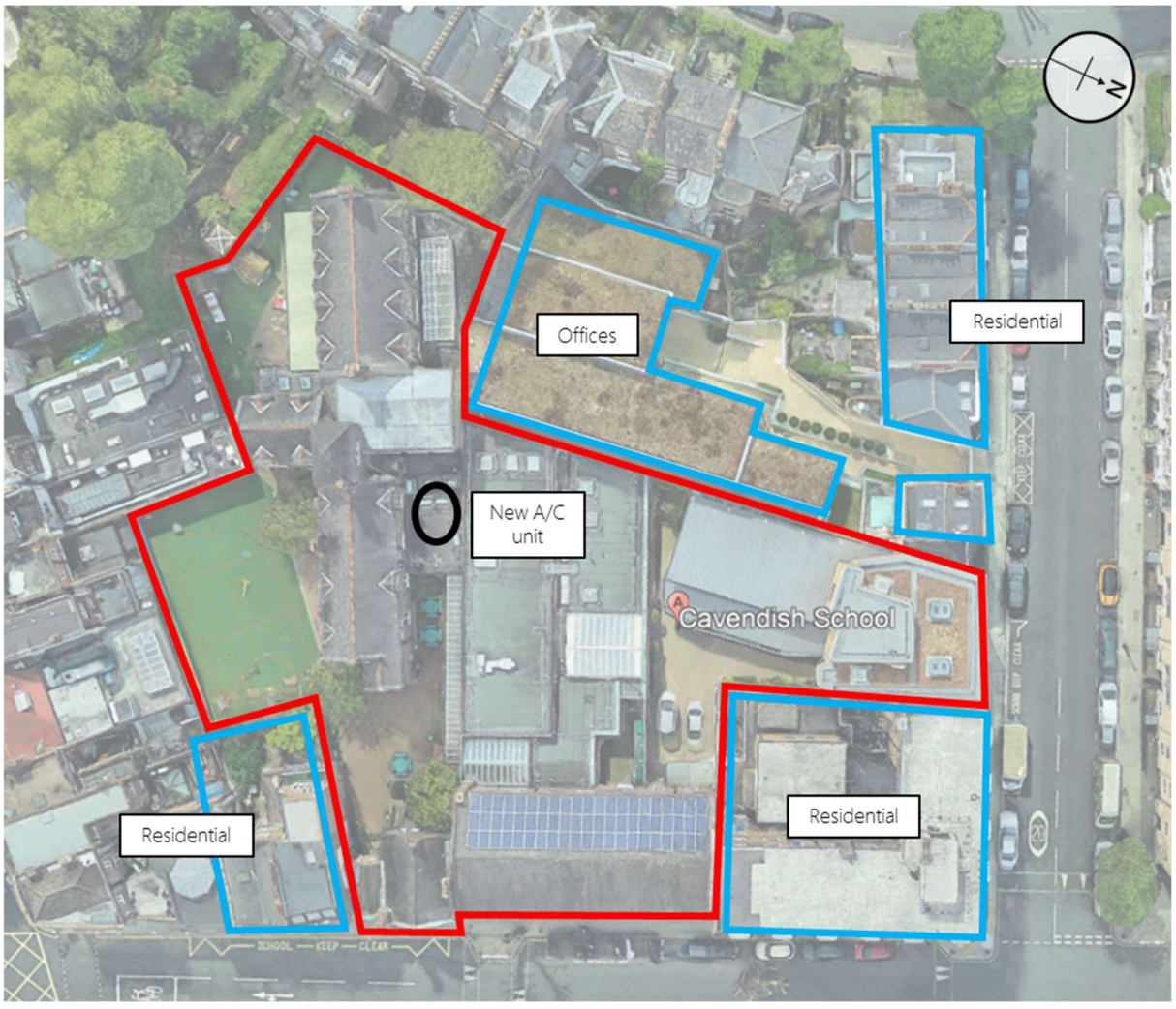
As shown overleaf in Figure 2.1, the plant is sited centrally in the school boundaries, approximately:

- 10 – 15m from the offices at 35 Inverness Street; the closest neighbouring building (outside of the school boundaries);
- 25m from residential properties at 177 Arlington Road; and
- 35 – 40 from residential properties along Inverness Street either side of the school entrance.

The proposed external air conditioning plant is a small domestic type system that will be used solely to cool the school's server room. The external unit is a Mitsubishi SRC35ZS-W condenser – of which further details are given in Appendix C.

It is expected that the condenser will run for up to 24 hours a day.

Figure 2.1 – Site location and locations of the nearest noise-sensitive properties



3.0 Relevant Guidelines

3.1 BS 8233:2014

3.1.1 Residential

BS 8233:2014 '*Guidance on Sound Insulation and Noise Reduction for Buildings*' suggests appropriate criteria and limits for different situations. This includes internal noise criteria for residential developments. The limits with BS 8233:2014 are similar to those in the WHO's '*Guidelines for Community Noise* and *Night Noise Guidelines for Europe*' document. Table 4 of BS 8233:2014 provides internal ambient noise level (IANL) limits for dwellings from "*steady external noise sources*". These are summarised in Table 3.1 below.

Table 3.1 – BS 8233:2014 internal ambient noise level (IANL) upper limits - residential

Activity	Location	Daytime (07:00 – 23:00)	Night-time (23:00 – 07:00)
Resting	Living Room	35 dB $L_{Aeq,16hr}$	-
Dining	Dining Room/Area	40 dB $L_{Aeq,16hr}$	-
Sleeping (daytime resting)	Bedroom	35 dB $L_{Aeq,16hr}$	30 dB $L_{Aeq,8hr}$

Annex G.1 of BS 8233:2014 suggests that "*if partially open windows were relied upon for background ventilation, the insulation would be reduced to approximately 15 dB*". Therefore, a noise limit directly outside of the nearest residential windows could be set based upon the values above plus 15 dB.

Therefore, to meet internal noise targets in nearby residential dwellings, noise from the proposed plant should not exceed 50 dB L_{Aeq} during the daytime and 45 dB L_{Aeq} during the night-time when measured/calculated directly outside of a residential bedroom or living room window.

3.1.2 Offices

BS 8233:2014 also provides internal targets for non-residential spaces, such as offices – see Table 3.2.

Table 3.2 – BS 8233:2014 internal ambient noise level (IANL) upper limits - offices

Activity/Objective	Location	Design range dB $L_{Aeq,T}$
Study and work requiring concentration	Staff/meeting room	35 - 45
	Executive office	35 - 40
Typical noise levels for acoustic privacy in shared spaces	Open plan office	45 - 50

3.2 World Health Organisation (WHO) Environmental Noise Guidelines

The WHO document *Guidelines for Community Noise 1999* has recently been superseded by the *Environmental Noise Guidelines for the European Region*. However, the updated guidance states that *'all WHO guidelines for community noise (CNG) indoor guideline values and any values not covered by the current guidelines (such as industrial noise and shopping areas) should remain valid'*.

The document sets out guidance as to noise levels at which there will be an unacceptable impact on the local community. WHO guidelines state:

- To protect the majority of people from being seriously annoyed during the daytime, the sound pressure level on balconies, terraces, outdoor living areas should not exceed 55 dB L_{Aeq} for steady, continuous noise.
- To protect the majority of people from being moderately annoyed during the daytime, the outdoor sound pressure level should not exceed 50 dB $L_{Aeq.}$

Therefore, noise from the proposed plant should not exceed 50 dB L_{Aeq} during the daytime when measured or calculated within a residential garden, patio, or balcony.

3.3 Acoustics, Ventilation, and Overheating (AVO) Residential Design Guide

The Acoustics, Ventilation and Overheating Guide ('AVO Guide') recommends an approach for "good acoustic design" which regards the "interdependence of provisions for acoustics, ventilation and overheating".

The AVO Guide gives considerably more detailed guidance than other noise guideline documents regarding the impact of noise ingress when windows are open to reduce overheating. It indicates that slightly elevated internal noise levels over the internal targets of BS 8233:2014 as a result of opening windows may be an acceptable compromise to provide thermal comfort.

The table identifies the relationship between the external noise level and the risk of adverse impact (from the 'Level 1' assessment methodology outlined in the standard.

This reiterates that designing to a limit outside of residential windows of 50 dB L_{Aeq} during the daytime and 45 dB L_{Aeq} should mean a low risk of adverse impact.

Table 3.3 – AVO relationship of internal noise levels with open windows to a risk of adverse impact

External Free-Field Noise Level		Examples of Outcomes	Risk (of Adverse Impact) Category for Level 1 Assessment
Daytime $L_{Aeq,T}$ (07:00 – 23:00)	Night-time $L_{Aeq,8h}$ (23:00 – 07:00)		
≤ 52 dB	≤ 47 dB	Noise can be heard and causes small changes in behaviour and/or attitude, e.g. turning up the volume of television; speaking more loudly; where there is no alternative ventilation, having to close windows for some of the time because of the noise. Potential for some reported sleep disturbance. Affects the acoustic character of the area such that there is a perceived change in the quality of life.	Low
> 52 dB and ≤ 62 dB	> 47 dB and ≤ 55 dB	Increasing risk of adverse effect due to the impact on reliable speech communication during daytime or sleep disturbance at night. Although noise levels at the lower end of this category will cause changes in behaviour, they may still be considered suitable. Noise levels at the upper end of this category will result in more significant changes in behaviour and are only likely to be considered suitable if they occur for limited periods.	Medium
> 62 dB	> 55 dB	The noise causes a material change in behaviour and/or attitude, e.g. avoiding certain activities during periods of intrusion; where there is no alternative ventilation, having to keep windows closed most of the time because of the noise. Potential for sleep disturbance resulting in difficulty in getting to sleep, premature awakening and difficulty in getting back to sleep. Quality of life diminished due to a change in acoustic character of the area.	High

3.4 BS 4142:2014

BS 4142:2014 *'Methods for rating and assessing industrial and commercial sound'* is intended to be used to assess the potential adverse impact of sound of an industrial and/or commercial nature, at nearby noise-sensitive receptor (NSR) locations (i.e. residential windows) within the context of the existing sound environment.

The method is based upon assessing the predicted noise emissions from plant/equipment against the existing background sound levels at NSRs, the latter of which is determined by a noise survey conducted at the site. The predicted noise emissions are termed as a 'rating level', which is the 'specific sound level' from plant (the actual measurable noise level), plus 'penalties' which account for whether the noise has distinguishing characteristics such as tonality, intermittency, impulsivity, or is generally distinguishable from the ambient noise environment. Such features may attract attention and be considered annoying, hence sounds with these qualities should be penalised over sounds at the same specific noise level which is less intrusive.

The general aim is for the 'rating level' (plant noise emissions) to not exceed the existing background sound levels outside of residential windows. BS 4142:2014 states that *"the lower the rating level is relative to the measured background sound level, the less likely it is that the specific sound source will have an adverse impact or a significant adverse impact. Where the rating level does not exceed the background sound level, this is an indication of the specific sound source having a low impact, depending on the context."*

4.0 Noise Assessment

4.1 Proposed Plant

The make/model information and the modelled source noise emission data (based on manufacturer datasheets – supplied separately to this report) for the external A/C unit is outlined in the table below.

Table 4.1 – Source noise emission data for the proposed external A/C unit

Model	Sound Power Levels (SWL), dB									Sound Pressure Level (SPL) @ 1m
	Octave Band Centre Frequencies, Hz								dB(A)	dB(A)
	63	125	250	500	1 k	2 k	4 k	8 k		
Mitsubishi SRC35ZS-W cooling mode	62	53	49	47	45	42	35	28	61	50

4.2 Predicted Noise Levels outside Windows

The noise predictions within this report have been undertaken using the proprietary software CadnaA® by DataKustik, a 3-D noise mapping package that implements a wide range of national and international standards, guidelines and calculation algorithms, including those set out in ISO 9613-2:1996.

Figure D.2 in Appendix D shows the predicted plant noise emissions ($L_{Aeq,15min}$) outside of windows to properties in the surrounding area. The receptor points in the model represent the highest noise level on each façade (receptors are placed at ground floor, 1st floor, 2nd floor etc, with the number on the map showing the highest value from the most exposed floor level).

In summary, the highest external noise levels are:

- 29 dB $L_{Aeq,15min}$ outside the office windows at no. 35 Inverness Street;
- 20 dB $L_{Aeq,15min}$ outside no. 177 Arlington Road (a residential property); and
- 23 dB $L_{Aeq,15min}$ outside the residential block at the corner of Arlington Road and Inverness Street.

These levels are achieved without any mitigation applied to the A/C unit.

4.3 Assessment of Adverse Impact

The predicted noise emissions are:

- 23 dB L_{Aeq} outside the worst affected residential window, which is:
  - comfortably within the recommended upper limits of 50 dB and 45 dB $L_{Aeq,T}$ outside of an open bedroom/living room window for the daytime and night-time respectively to meet BS 8233:2014 internal noise level criteria (and categorised as a low level of risk of impact by the AVO guidelines);
  - comfortably below the lower limit of 50 dB in an external amenity area (garden), referenced by BS 8233:2014 and WHO guidelines.

- 29 dB L_{Aeq} outside the worst affected office window, which is:
  - below the *internal* noise targets for offices spaces from BS 8233:2014 and would be considerably below these targets once the noise and transmitted through the façade/open window.

The targets are set to define a 'low' risk of adverse impact based upon the guidelines summarised in Section 3 and are also considered to be appropriate limits at which the level of adverse impact should be no higher than the LOAEL (Lowest Observed Adverse Effect Level) defined in National Planning Policy (see Appendix B).

The level of sound reduction achieved across an open window is typically taken to be 15 dB. Based on this, the internal noise level from the plant would be ≤14 dB L_{Aeq} inside the nearest office, and ≤8 dB L_{Aeq} inside the nearest residential dwelling. **These are exceptionally low levels that are effectively inaudible (the majority of people will not perceive a sound that is <17 dB L_{Aeq} inside their dwelling).**

PJA also believe that if a full BS 4142:2014+A1:2019 assessment was to be conducted, with a baseline noise survey taken at the site, the risk of impact would again be shown to be very low. A full noise survey has not been conducted in this case as the low specific noise levels suggest it is not required. PJA has however noted that a full survey was conducted previously in 2016 as part of the successful planning application (ref: 2016/1668/P) for a new teaching block at the school, which include a range of rooftop plant and air intakes/exhausts.

A noise survey was conducted in 2016 by *Applied Acoustic Design* to discharge planning condition no. 13, with baseline noise levels monitored at the south corner of the residential building at the corner of Arlington Road and Inverness Street. The survey was conducted over several days and found an absolute lowest background noise level of **43 dB $L_{A90,15min}$**. The calculations subsequently showed a specific noise level of **35 dB L_{Aeq}** from the proposed plant at the time, to the rear of these residential dwellings.

Therefore, with a specific noise level outside the worst affected dwelling of **23 dB L_{Aeq}**, this would suggest the new plant noise contribution would be 10 dB below the existing background noise level at the very least, if not 20 dB below. This would appear compliant with the conditions usually applied by Camden Council to plant in the area – and suggests a minimal risk of adverse impact.

In conclusion, the assessment has demonstrated that plant noise emissions will be controlled to a low enough level to avoid anything greater than a 'low' risk of adverse impact.

Appendix A – Acoustic Terminology and Concepts

A.1 – Glossary

Table A.1 – Glossary of acoustic terminology

Term	Description
dB (decibel)	The scale on which sound pressure level is expressed. It is defined as 20 times the logarithm of the ratio of the root-mean-square pressure of the sound and a reference pressure (2x10-5 Pa).
dB(A)	A-weighted decibel. This is a measure of the overall level of sound across the audible spectrum with a frequency weighting (i.e. 'A' weighting) to compensate for the varying sensitivity of the human ear to sound at different frequencies.
Frequency	Sound can occur over a range of frequencies extending from the very low, such as the rumble of thunder, up to the very high such as the crash of cymbals. Sound is generally described over the frequency range from 63Hz to 4000Hz (4kHz). This is roughly equal to the range of frequencies on a piano.
$L_{Aeq,T}$	L_{Aeq} is defined as the notional steady sound level which, over a stated period of time, would contain the same amount of acoustical energy as the A-weighted fluctuating sound measured over that period. This parameter is typically considered as a good representation of the 'average' overall noise level. It is referred to technically as the A-weighted equivalent continuous sound level and is a dB(A) as defined above.
$L_{A90,T}$	The A-weighted noise level that is exceeded for 90% of the measurement period T. This parameter is often considered as the 'average minimum level'.
$L_{A10,T}$	The A-weighted noise level that is exceeded for 10% of the measurement period T. This parameter is often considered as the 'average maximum level';
$L_{AFmax,T}$	The maximum A-weighted noise level during the measurement period T.

A.2 – Subjective Changes in Noise Level

Table A.2 – Subjective loudness from an increase or decrease in sound pressure level

Change in sound pressure level	Relative change in sound power energy (multiplier)		Change in apparent subjective loudness (for mid-frequency range)
	Decrease	Increase	
3 dB	1/2	2	'Just perceptible'
5 dB	1/3	3	'Clearly noticeable'
10 dB	1/10	10	'Half or twice as loud'
20 dB	1/100	100	'Much quieter, or louder'

Appendix B – Relevant Planning Policies and Guidelines

B.1 – National Planning Policy Framework (NPPF)

The National Planning Policy Framework (NPPF) sets out the Government's planning policies for England and how these are expected to be applied. The NPPF provides a framework within which local people and their council can produce their own distinctive local and neighbourhood plans. With explicit reference to noise, the NPPF states that *"Planning policies and decisions should contribute to and enhance the natural and local environment by … preventing new and existing development from contributing to, being put at unacceptable risk from … noise pollution"*.

B.2 - Noise Policy Statement for England (NPSE)

The NPPF refers to the Noise Policy Statement for England (NPSE), which applies to most forms of noise including environmental noise. The NPSE sets out the long-term vision of Government policy which is to *"Promote good health and a good quality of life through the effective management of noise within the context of Government policy on sustainable development."*. It aims that *"Through the effective management and control of environmental, neighbour and neighbourhood noise within the context of Government policy on sustainable development:*

- *avoid significant adverse impacts on health and quality of life;*
- *mitigate and minimise adverse impacts on health and quality of life; and*
- *where possible, contribute to the improvement of health and quality of life."*

The use of the terms *"significant adverse"* and *"adverse"* are key phrases within the NPSE. The guidance establishes the concept of how the level of adverse effect on health and quality of life can be referenced including:

- NOEL – No Observed Effect Level - This is the level below which no effect can be detected. In simple terms, below this level, there is no detectable effect on health and quality of life due to the noise.
- LOAEL – Lowest Observed Adverse Effect Level - This is the level above which *adverse* effects on health and quality of life can be detected.
- SOAEL – Significant Observed Adverse Effect Level - This is the level above which *significant adverse* effects on health and quality of life occur.

Under the first aim of the NPSE ("avoid significant adverse impacts on health and quality of life"), an impact in line with SOAEL should be avoided. Under the second aim ("mitigate and minimise adverse impacts on health and quality of life"), where the impact lies somewhere between LOAEL and SOAEL, requiring that all reasonable steps are taken to mitigate and minimise adverse effects on health and quality of life while also taking into account the guiding principles of sustainable development, but does not mean that such adverse effects cannot occur.

B.3 - Planning Practice Guidance on Noise (PPG-N)

The Planning Practice Guidance on Noise (PPG-N) is part of a suite of web-based guidance which is intended to support the implementation of the policies in the NPPF and the NPSE.

It aids in expanding on the definitions form the NPSE of NOEL, LOAEL and SOAEL, by linking these terms to 'examples of outcomes', i.e. changes in behaviour and/or attitude to noise. The table below summarises the guidance from PPG-N in this regard.

Table B.1 – Noise exposure hierarchy based on the likely average response – adapted from PPG-N

Perception	Examples of outcomes	Increasing effect level	Action
NOEL - No Observed Effect Level [1]			
Not noticeable	No Effect	No Observed Effect	No specific measures required
Noticeable and not intrusive	Noise can be heard but does not cause any change in behaviour or attitude. Can slightly affect the acoustic character of the area but not such that there is a perceived change in the quality of life.	No Observed Adverse Effect	No specific measures required
LOAEL - Lowest Observed Adverse Effect Level			
Noticeable and intrusive	Noise can be heard and causes small changes in behaviour and/or attitude, e.g. turning up the volume of television; speaking more loudly; where there is no alternative ventilation, having to close windows for some of the time because of the noise. Potential for some reported sleep disturbance. Affects the acoustic character of the area such that there is a perceived change in the quality of life.	Observed Adverse Effect	Mitigate and reduce to a minimum
SOAEL - Significant Observed Adverse Effect Level			
Noticeable and disruptive	The noise causes a material change in behaviour and/or attitude, e.g. avoiding certain activities during periods of intrusion; where there is no alternative ventilation, having to keep windows closed most of the time because of the noise. Potential for sleep disturbance resulting in difficulty in getting to sleep, premature awakening and difficulty in getting back to sleep. Quality of life diminished due to a change in the acoustic character of the area.	Significant Observed Adverse Effect	Avoid
Noticeable and very disruptive	Extensive and regular changes in behaviour and/or an inability to mitigate the effect of noise leading to psychological stress or physiological effects, e.g. regular sleep deprivation/awakening; loss of appetite, significant, medically definable harm, e.g. auditory and non-auditory	Unacceptable Adverse Effect	Prevent

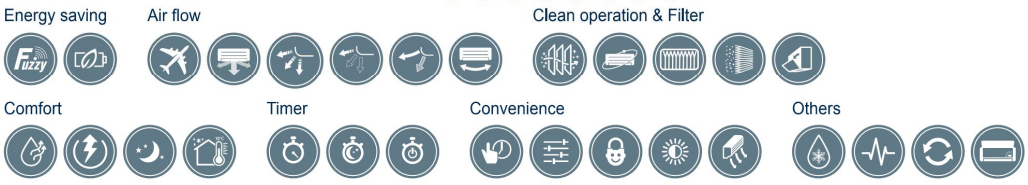
[1] This line is an assumption of the adverse effect level and is not explicitly referenced by PPG-N, though this appears to be a safe assumption.

Appendix C – Proposed Plant

R32 R410A SRK-ZS-W series can be selected for use both R32 and R410A outdoor unit.

Single Multi SRK-ZS-W series can be selected for use as indoor units in the combination with SCM Multi System outdoor unit.

FUNCTIONS



SPECIFICATIONS

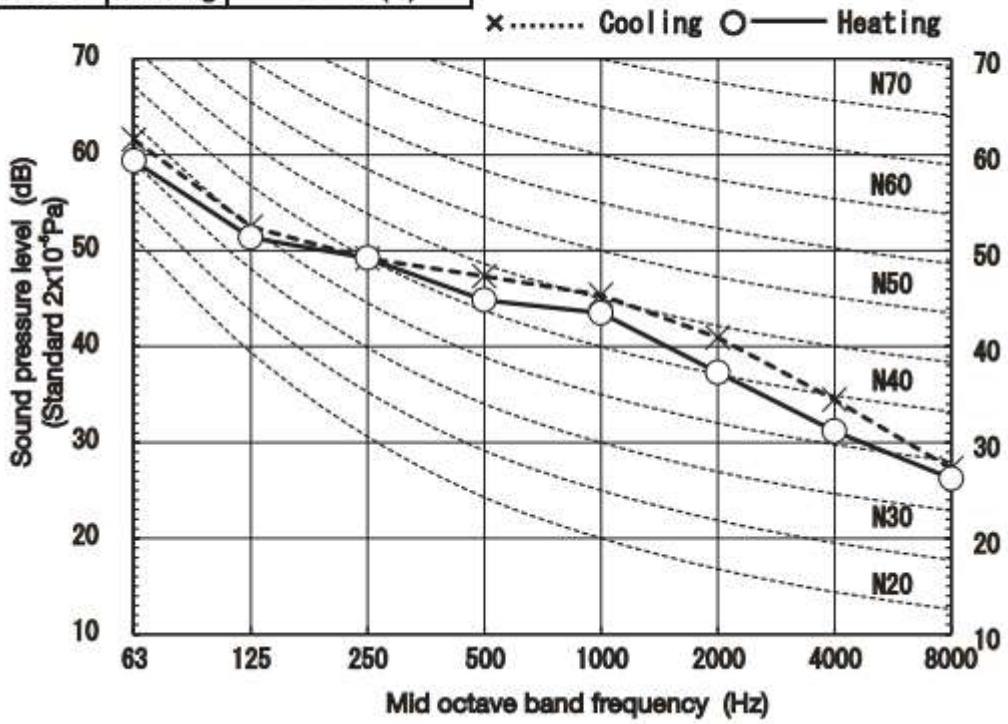
Indoor unit				SRK20ZS-W,-WB,-WT	SRK25ZS-W,-WB,-WT	SRK35ZS-W,-WB,-WT	SRK50ZS-W,-WB,-WT
Outdoor unit				SRC20ZS-W	SRC25ZS-W	SRC35ZS-W	SRC50ZS-W
Power source				1 Phase, 220 - 240V, 50Hz			
Nominal cooling capacity (Min~Max)			kW	2.0(0.9~2.9)	2.5(0.9~3.1)	3.5(0.9~4.0)	5.0(1.3~5.5)
Nominal heating capacity (Min~Max)			kW	2.7(0.9~4.3)	3.2(0.9~4.5)	4.0(0.9~5.0)	5.8(1.3~6.6)
Power consumption		Cooling/Heating	kW	0.44 / 0.59	0.62 / 0.74	0.89 / 0.94	1.35 / 1.56
EER/COP		Cooling/Heating		4.55 / 4.58	4.03 / 4.32	3.93 / 4.26	3.70 / 3.72
Max.running current			A	9	9	9	14.5
Sound power level	Indoor	Cooling/Heating	dB(A)	48 / 50	50 / 53	54 / 56	59 / 60
	Outdoor	Cooling/Heating		56 / 56	56 / 58	61 / 61	61 / 63
Sound pressure level	Indoor	Cooling (Hi/Me/Lo/Ulo)		34 / 25 / 22 / 19	36 / 28 / 23 / 19	40 / 32 / 26 / 22	46 / 36 / 29 / 22
		Heating (Hi/Me/Lo/Ulo)		36 / 29 / 23 / 19	39 / 30 / 24 / 19	41 / 36 / 25 / 19	46 / 37 / 31 / 24
	Outdoor	Cooling/Heating		45 / 45	46 / 46	50 / 48	51 / 52
Air flow	Indoor	Cooling (Hi/Me/Lo/Ulo)	m^3/min	9.3 / 7.0 / 5.9 / 5.0	9.9 / 8.0 / 5.9 / 5.0	11.3 / 8.7 / 7.0 / 5.0	12.1 / 9.9 / 7.4 / 5.9
		Heating (Hi/Me/Lo/Ulo)		10.0 / 8.5 / 6.5 / 5.9	11.3 / 8.7 / 6.7 / 5.9	12.3 / 10.0 / 7.6 / 5.6	13.9 / 11.2 / 9.1 / 7.4
	Outdoor	Cooling/Heating		27.4 / 23.6	27.4 / 23.6	31.5 / 27.8	32.8 / 32.8
Exterior dimensions	Indoor	HeightxWidthxDepth	mm	290 x 870 x 230			
	Outdoor			540 x 780(+62) x 290			595 x 780(+62) x 290
Net weight	Indoor / Outdoor		kg	9.5 / 31.0		9.5 / 34.5	10.0 / 36.0
Refrigerant		Type/GWP		R32 / 675			
		Charge	kg/TCO_2Eq	0.62 / 0.419		0.78 / 0.527	1.05 / 0.709
Refrigerant piping size		Liquid/Gas	ø mm	6.35(1/4") / 9.52(3/8")			6.35(1/4") / 12.7(1/2")
Refrigerant line (one way) length			m	Max. 20			Max. 25
Vertical height differences		Outdoor is higher/lower	m	Max. 10 / Max. 10			Max. 15 / Max. 15
Outdoor operating temperature range		Cooling	°C	-15~46			
		Heating		-15~24			
Clean filter				Allergen Clear Filter x 1, Photocatalytic Washable Deodorizing Filter x 1			

- The data are measured under the following conditions(ISO-T1, H1). Cooling: Indoor temp. of 27°CDB, 19°CWB, and outdoor temp. of 35°CDB. Heating: Indoor temp. of 20°CDB, and outdoor temp. of 7°CDB, 6°CWB.
- Sound level indicates the value in an anechoic chamber. During operation these values are somewhat higher due to ambient conditions.
- 'tonne(s) of CO_2 equivalent' means a quantity of greenhouse gases- expressed as the product of the weight of the greenhouse gases in metric tonnes and of their global warming potential.

(Outdoor unit)

Model	SRC35ZS-W	
Noise Level	Cooling	50 dB(A)
	Heating	48 dB(A)

●Mike position: at highest noise level in position as mentioned below
Distance from front side 1m



Appendix D – Calculations

The noise predictions within this report have been undertaken using the proprietary software CadnaA® by DataKustik, a 3-D noise mapping package that implements a wide range of national and international standards, guidelines and calculation algorithms, including those set out in ISO 9613-2:1996.

The majority of the objects within the model (buildings, roads, barriers/fences, etc) have been imported from OpenStreetMap – or drawn manually where not possible. The scaled site plan, floor plan, and elevation for the proposed development have also been accounted for in the model.

The noise model has assumed:

- downwind propagation, i.e. a wind direction that assists the propagation of sound from source to receptor, as a worst-case;
- a ground absorption factor of 0 in all areas as a worst-case;
- a maximum reflection factor of three where buildings and barriers are assumed to have a 'smooth' reflective façade, as a worst-case;
- façade receptor points representing the worst-case floor;
- atmospheric sound absorption based upon a temperate of 10°C and a humidity level of 70%, as per Table 2 of ISO 9613-2:1996.

The noise model has been used to predict the resulting L_{Aeq} noise emissions from the proposed plant.

The images on the following pages contain screenshots of the model setup and the results of the mapping.

Figure D.1 – 3D images from the noise model

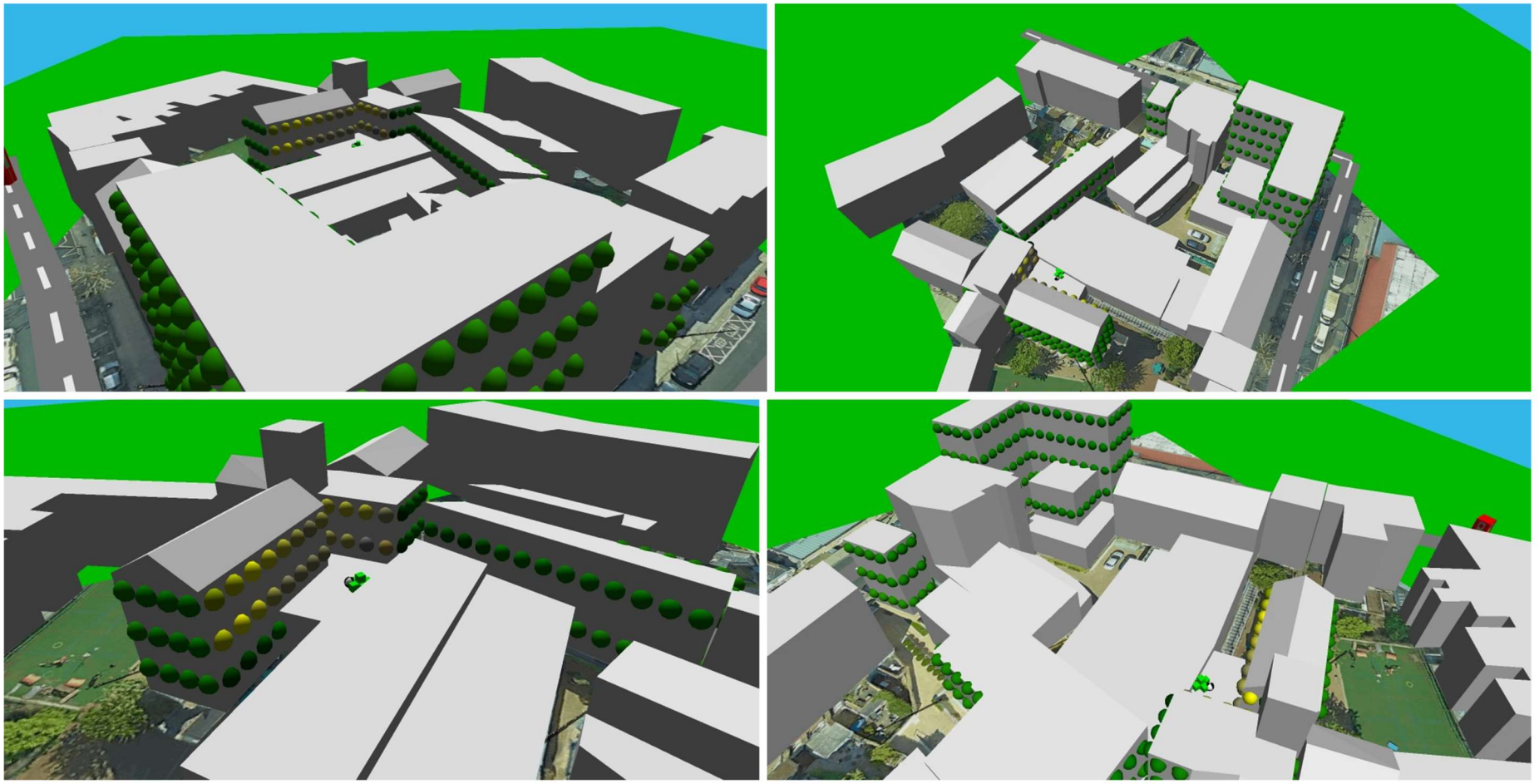
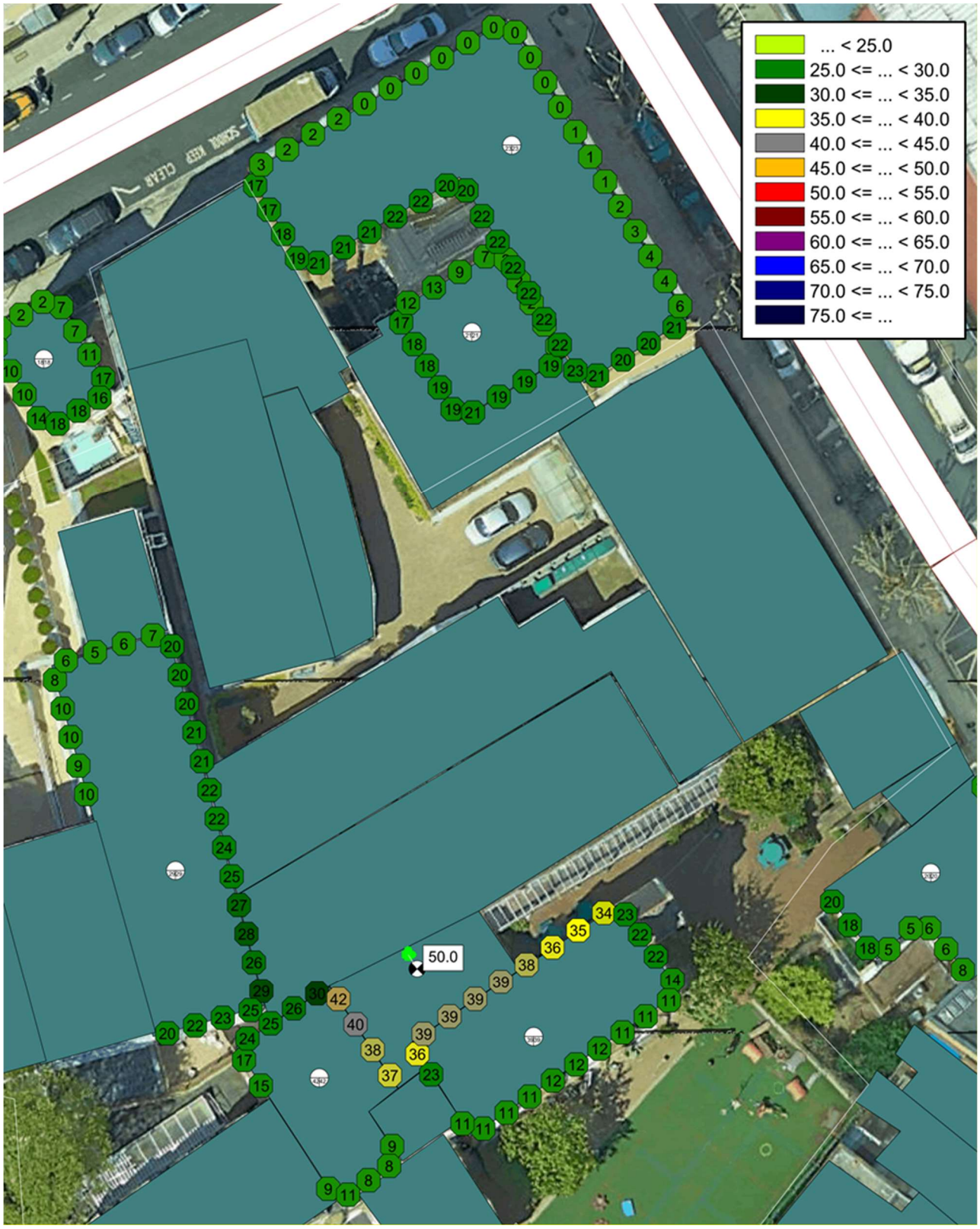


Figure D.2 – Predicted plant noise emissions (dB $L_{Aeq,T}$)



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