CLEAR
ACOUSTIC DESIGN

Report

Rayne Institute, University College London

Environmental Noise Assessment

Document History

Issue Status	Author	Checked/Approved by	Issue Date
Initial	Nathan Matthews BSc (Hons)	Stefan Hannan BSc (Hons) PGDip MIOA	09/12/2024
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Revision 2			
Revision 3			

Additional Comments

Issue Status	Comments
Initial	Initial issue of report
Revision 1	Sound power level adjusted to manufacturer's datasheet spectrum in line with operational capacity. Attenuator insertion loss values adjusted for daytime background noise level.
Revision 2	
Revision 3	

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1.0 Introduction

1.1 Brief

Clear Acoustic Design has been appointed to carry out a noise impact assessment in relation to the proposed mechanical plant installation at Rayne Institute, 5 University Street, London, WC1E 6JF.

Proposals are for the installation of one air source heat pump to replace an existing chiller.

A noise impact assessment has been requested in order to safeguard the amenity of the surrounding receptors. The noise impact assessment is in line with BS 4142: 2014 + A1: 2019 *Methods for Rating and Assessing Industrial and Commercial Sound*. These criteria are seen to be appropriate in assessing and mitigating noise impact from this source.

1.2 Report Summary

The report will show that the noise level from mechanical plant will not exceed the existing background noise level at the nearest noise sensitive receptor. This is considered an acceptable outcome, in line with the local authority requirements and BS 4142: 2014 + A1: 2019.

1.3 Credentials

This report has been approved and issued by Stefan Hannan of Clear Acoustic Design. Stefan is a Company Director with 17 years of acoustic consulting experience. Stefan is also a full corporate member of the Institute of Acoustics (MIOA).

1.4 Glossary

A supporting glossary of acoustic terms can be found in Appendix C.

2.0 Legislative and Policy Framework

2.1 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".

2.2 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.

2.3 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.

Perception	Examples of outcomes	Increasing effect level	Action
NOEL - No Observed Effect Level [1]			
Not noticeable	No Effect	No Observed Adverse 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.		
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.			

Table 2.1: Noise exposure hierarchy based on the likely average response – adapted from PPG-N

2.4 BS 4142: 2014 + A1: 2019

BS 4142: 2014 + A1: 2019 *Methods for Rating and Assessing Industrial and Commercial Sound,* also referred to as "BS 4142", is a method of assessing the noise impact of sources of industrial and/or commercial noise on sensitive receptors such as residential buildings. This is done by comparing the rating level of the industrial noise ($L_{A,rT}$) against the existing level of background noise (L_{A90}), depending on the context.

The background sound level is an underlying level of sound over a period, *T*, and might in part be an indication of relative quietness at a given location. It does not reflect the occurrence of transient and/or higher sound level events and is generally governed by continuous or semi-continuous sounds.

BS 4142 uses the term 'low' to describe an acceptable impact of commercial/industrial noise at a receptor. This is typically applicable when the rating level does not exceed the existing background noise level.

The BS 4142: 2014 + A1: 2019 Technical Note, dated March 2020, produced by the Acoustic & Noise Consultants Working Group (ANC), looks to address any content regarded as ambiguous in the original standard by contextualising the information within it. It also states that, there are many instances in the application of BS 4142 where professional judgement is required and where a range of interpretations is possible.

2.5 Local Authority Requirements

Camden Council state that "Developments proposing plant, ventilation, air extraction or conditioning equipment and flues will need to provide the system's technical specifications to the Council accompanying any acoustic report. 'BS4142 Method for rating Industrial and Commercial Sound' contains guidance and standards which should also be considered within the acoustic report."

It is deemed that an assessment to BS 4142: 2014 + A1: 2019 *Methods for Rating and Assessing Industrial and Commercial Sound* is therefore appropriate for this proposal.

The Camden Local Plan details that the rating level from the proposed mechanical plant should not exceed a level that is 10 dB below the existing background noise level at the façade of the nearest noise sensitive receptor.

3.0 Environmental Noise Survey

3.1 Proposal

The proposal involves the installation of one air source heat pump unit which is to be located within the plant room of the Rayne Institute. The plant room is situated on the roof of the building. There are extract cowls to atmosphere from to the unit on the roof. It is understood these will also be replaced and a new attenuator fitted.

The heat pump is replacing at existing chiller unit within the same location.

Proposed plans of the location of the unit can be seen in Appendix B.

In order to meet the local authority's requirements, the noise level from the heat pump at the nearest receptors should not exceed the 10 dB below the existing background noise level.

3.2 Identification of Receptors

In order to assess the impact of the proposed noise source on the existing noise levels, an environmental noise survey has been undertaken by Clear Acoustic Design at a location representative of the nearest noise sensitive receptors.

There are deemed to be two receptors closest to the proposed heat pump location. Receptor R1 is deemed to be the top floor façade belonging to the Cotton Rooms hotel. This receptor is approximately 22 metres from the proposed noise source.

Receptor R2 is deemed to be the top floor façade belonging to the Mortimer Market Centre. This receptor is approximately 18 metres from the proposed noise source.

The survey location which representative of this receptor is marked as F1 in figure 3.1 and 3.2.

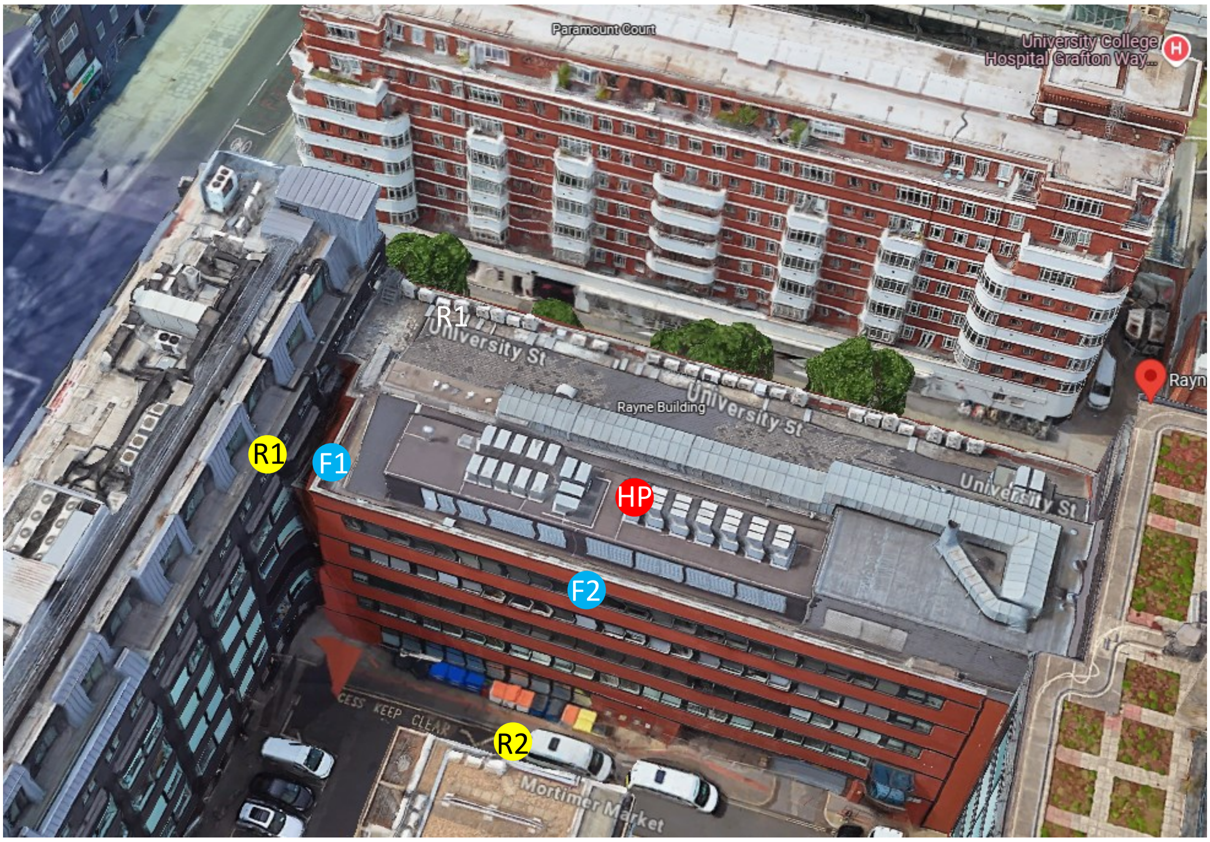

Figure 3.1 Aerial view of site with survey location (F1, F2 blue), nearest receptor façades (R1, R2, yellow), and proposed ASHP location (red)

Figure 3.2 Aerial view of site with survey location (F1, F2 blue), nearest receptor façades (R1, R2, yellow), and proposed ASHP location (red)

3.3 Noise Monitoring Position and Methodology

Given the location of receptor R1, it is possible to take noise measurements at a location representative of the façade of the building receptor.

Noise levels were measured between 19/11/24 and 20/11/24 using a single noise monitor, known as F1.

A sound level meter was attached to a tripod and positioned 2 metres above ground level in a location as possible to the identified receptor approximately 3 metre from the building façade.

This location is seen to be representative of the ambient and background noise levels at the identified receptor façade of R1.

Additional measurements were taken at F2 to ascertain likely background noise levels at receptor R2, as it was not possible to access a suitable location at the façade of this receptor. Given this receptor's direct sight line to the mechanical plant on the roof of the Rayne Institute building, it is reasonable to suggest that noise from this source is the dominant noise source at receptor R2. As such, noise measurements were taken at the roof level of the Rayne Institute and a distance attenuation calculation undertaken in order to obtain the existing background noise level at receptor R2.

Due to distances and screening, compliance at these receptors guarantees compliance at all other receptor locations.

3.4 Measurement Equipment and Environmental Conditions

The weather was dry and overcast for the duration of the survey with a high temperature of 5°C during the day and a low of -2°C during the night.

Wind speeds were below 5m/s for the duration of the noise surveying periods.

The conditions were seen to be good for conducting noise measurements.

The following noise measurement equipment as seen in table 3.2 was used for the survey.

Equipment	Serial Number	Calibration Date
Svantek SV 971A Type 1 Sound Level Meter	113218	15/09/23
Svantek SV 18A Preamplifier	113711	15/09/23
ACO 7152 Microphone	80617	15/09/23

Table 3.2 Measuring Equipment Used for Survey

3.5 Fixed Noise Monitoring Graph – F1

Figure 3.3 below provides a graph of the measured noise levels at survey position F1. The ambient (L_{Aeq}) and background (L_{A90}) noise levels are shown. Measurements were taken over 15-minute periods.

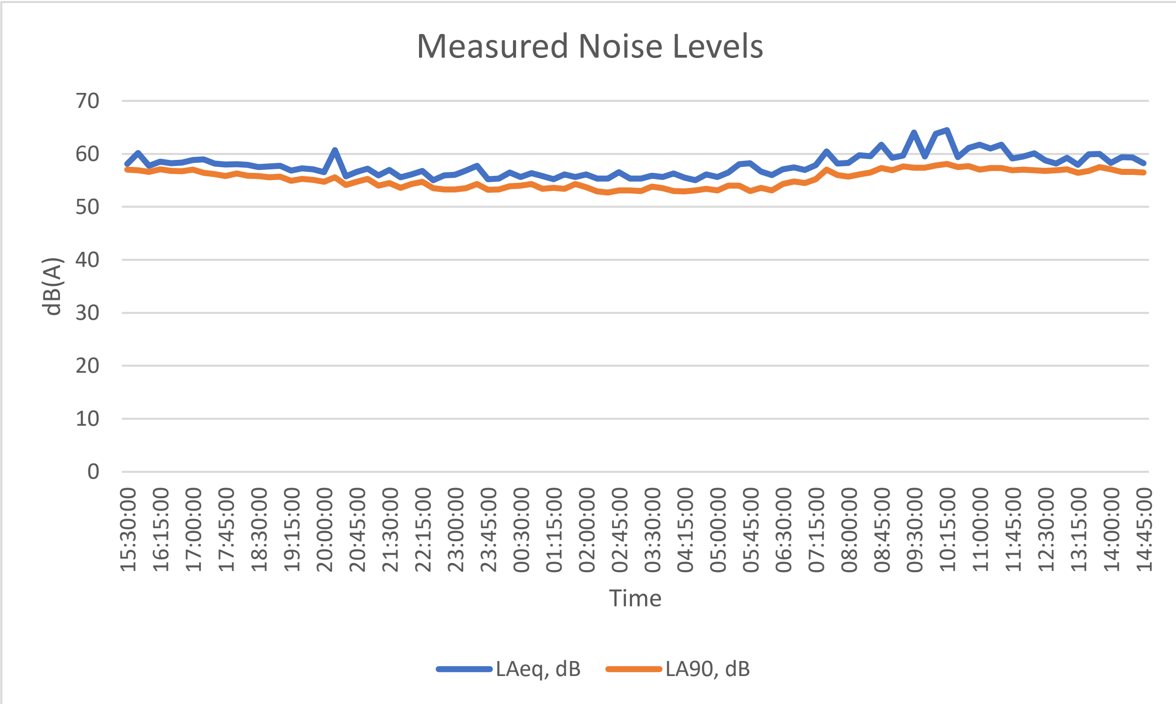

Figure 3.3 Long Term Measurement Graph – F1

3.6 Measured Noise Levels from Survey

To conduct an assessment in line with BS 4142, it is necessary to extrapolate the lowest typical representative background noise levels from the long-term survey data. These background daytime and night-time noise levels are presented in table 3.4 for receptor R1 and table 3.5 for receptor R2 below.

It is understood the unit will operate at full capacity during the daytime, and then at a reduced capacity (low noise mode) during the nighttime period,

The noise level from the heat pump should therefore not exceed 47 dB(A) at receptor R1 and 35 dB(A) at receptor R2 during the day, and 43 dB(A) and 34 dB(A) respectively at night.

Measurement Time Period	Assessment Background Noise Level, L_{A90}, dB
Day (07:00-23:00)	57
Night (23:00-07:00)	53

Table 3.4 Survey Noise Levels – Receptor R1

Measurement Time Period	Assessment Background Noise Level, L_{A90}, dB
Day (07:00-23:00)	45
Night (23:00-07:00)	44

Table 3.4 Survey Noise Levels – Receptor R2

4.0 Noise Impact Assessment of Proposed Plant

4.1 Noise Source - Daikin REYA8A7Y1B

The proposed installation is of one Daikin REYA8A7Y1B air source heat pump.

The sound power level of one Daikin REYA8A7Y1B unit at 100% operational capacity is presented in table 4.1 below.

The spectrum is based on the manufacturer's datasheet.

	Octave Band Frequency							
Noise Source	63 Hz	125 Hz	250 Hz	500 Hz	1 kHz	2 kHz	4 kHz	L_w, dB(A)
Daikin REYA8A7Y1B (100% capacity)	82	81	81	78	71	70	65	79

Table 4.1: Full capacity operation - Noise Source, Sound Power Level, dB

The unit will run at a lower capacity mode during the nighttime period. During this time, the unit will not operate at higher than 90% capacity (also known as low noise mode 1). The sound power level of the unit in this mode is presented in table 4.2 below.

	Octave Band Frequency							
Noise Source	63 Hz	125 Hz	250 Hz	500 Hz	1 kHz	2 kHz	4 kHz	L_w, dB(A)
Daikin REYA8A7Y1B (90% capacity)	78	77	77	74	68	64	61	75

Table 4.2: 90% capacity operation - Noise Source, Sound Power Level, dB

4.2 Rating Penalties

BS 4142: 2014 + A1: 2019 states that penalties can be applied to the rating level if acoustic features that increase the significance of the noise impact are present.

Rating penalties are determined based on tonality, impulsivity, and intermittency. The unit's frequency spectrum is generally broadband in nature and is not deemed to be tonal.

The noise from the unit is not deemed to be readily distinguishable against the existing acoustic environment, as determined by the assessment outcome below. Furthermore, the unit will generally operate without impulse or intermittency that would be perceivable at the receptor.

Therefore, it does not incur any rating penalties in this assessment.

4.3 Attenuator

The minimum insertion loss values should be achieved when selecting a suitable attenuator for the proposal so that the noise does not exceed 10 dB below the background noise level at each receptor.

An attenuator is to be supplied and installed by others, based on this specification. Alternatively, an attenuator manufacturer or installer may provide a specification and corresponding product, which will achieve the required noise attenuation and noise level at the receptor.

	Octave Band Frequency						
Attenuator	63 Hz	125 Hz	250 Hz	500 Hz	1 kHz	2 kHz	4 kHz
Minimum insertion loss values of attenuator	3	4	9	15	16	16	14

Table 4.3 Insertion Loss of attenuator

4.4 Assessment Outcome

Calculations have been undertaken to determine the noise level of the proposed heat pump at full capacity during the daytime period at the receptor in its proposed position with the insertion loss of the attenuator accounted for in table 4.3.

Calculations show that when the mechanical plant is operational in its proposed location the rating level at the receptor R1 will be 36 dB(A).

Calculations show that when the mechanical plant is operational in its proposed location with the rating level at the receptor R2 will be 35 dB(A).

The results are summarised in table 4.5 below. Supporting calculations can be seen in Appendix A.

The noise from the proposed unit is at least 10 dB below the existing background noise level during the day. In line with the guidance from BS 4142: 2014 + A1: 2019 and the Camden Local Plan, the noise from the proposal is therefore deemed to be acceptable.

Supporting calculations can be seen in Appendix A.

Receptor	Assessment Background Noise Level (Daytime), L_{A90}, dB	Target Rating Level (-10 dB), L_{A90}, dB	Rating Level at Receptor, $L_{Ar,Tr}$, dB	Difference between Rating Level and Target Rating Level, dB
R1	57	47	36	-11
R2	45	35	35	-10

Table 4.5: Results of Assessment to BS 4142 – 100% capacity (proposed location)

Calculations have been undertaken to determine the noise level of the proposed heat pump at 90% capacity during the nighttime period at the receptor in its proposed position with the insertion loss of the attenuator accounted for in table 4.3.

Calculations show that when the mechanical plant is operational in its proposed location the rating level at the receptor R1 will be 32 dB(A).

Calculations show that when the mechanical plant is operational in its proposed location with the rating level at the receptor R2 will be 31 dB(A).

The results are summarised in table 4.5 below. Supporting calculations can be seen in Appendix A.

The noise from the proposed unit is more than 10 dB below the existing background noise level during the night. In line with the guidance from BS 4142: 2014 + A1: 2019 and the Camden Local Plan, the noise from the proposal is therefore deemed to be acceptable.

Supporting calculations can be seen in Appendix A.

Receptor	Assessment Background Noise Level (Nighttime), L_{A90}, dB	Target Rating Level (-10 dB), L_{A90}, dB	Rating Level at Receptor, $L_{Ar,Tr}$, dB	Difference between Rating Level and Target Rating Level, dB
R1	53	43	32	-11
R2	44	34	31	-13

Table 4.5: Results of Assessment to BS 4142 - 90% capacity (proposed location)

5.0 Conclusion

5.1 Summary

Clear Acoustic Design has been appointed to carry out a noise impact assessment in relation to the proposed mechanical plant installation at Rayne Institute, 5 University Street, London, WC1E 6JF.

Proposals are for the installation of one air source heat pump to replace an existing chiller.

The noise survey has been conducted to obtain the existing background noise level at each nearest noise sensitive receptor façade.

BS 4142: 2014 + A1: 2019 states that a rating level that does not exceed the existing background noise level is considered to have a low noise impact. This is typically deemed an acceptable outcome. The local authority requires a rating level that is 10 dB below the existing background noise level.

5.2 Outcome

It is understood that a new duct attenuator may be installed as part of the proposal. At present, this has not been specified. The insertion loss of a suitable attenuator has been determined in section 4.3.

Calculations have been undertaken to determine the noise level of the proposed mechanical plant at the façade of the nearest receptors. The insertion loss of the attenuator specified in table 4.3 has been considered in the calculations.

An attenuator is to be supplied and installed by others, based on this specification. Alternatively, an attenuator manufacturer or installer may provide a specification and corresponding product, which will achieve the required noise attenuation and noise level at the receptor.

With the specified attenuator, the noise level from the mechanical plant will not exceed a noise level of 10 dB(A) below the background noise level, during both the daytime and nighttime periods. The results are summarised in table 4.4 and 4.5 and full calculations can be found in Appendix A.

The noise impact at the nearest receptor is deemed to be 'low', as the rating level from the proposed plant does not exceed the existing background noise level.

This is an acceptable outcome in line with guidance from the local authority and BS 4142: 2014. BS 4142: 2014 + A1: 2019.

Appendix A – Calculations

		Calculation of Noise to Atmosphere							
System Name		Octave Band Centre Frequencies, Hz							
		63	**125**	**250**	**500**	**1000**	**2000**	**4000**	**L_{WA}**
Enter Fan Sound Power Level		82	81	81	78	71	70	65	**79**
Enter Filter / Coil Losses 1		0	0	0	0	0	0	0	
Enter Filter / Coil Losses 2		0	0	0	0	0	0	0	
Enter Attenuator Insertion Loss		3	4	9	15	16	16	14	
Enter Discharge Width, mm	900								
Enter Discharge Height, mm	800								
End Reflection		5	2	1	0	0	0	0	
Louvre/Duct Directivity		5	5	6	7	7	8	8	
Distance to Receptor	20m	37.0	37.0	37.0	37.0	37.0	37.0	37.0	
Screening Loss		0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Façade Reflection		+0	+0	+0	+0	+0	+0	+0	
Sound Pressure Level at Receptor		42	43	40	33	25	25	22	**36**

Figure 1: Calculated rating level at receptor R1 (proposed location) – 100% capacity

		Calculation of Noise to Atmosphere							
System Name		Octave Band Centre Frequencies, Hz							
		63	**125**	**250**	**500**	**1000**	**2000**	**4000**	**L_{WA}**
Enter Fan Sound Power Level		82	81	81	78	71	70	65	**79**
Enter Filter / Coil Losses 1		0	0	0	0	0	0	0	
Enter Filter / Coil Losses 2		0	0	0	0	0	0	0	
Enter Attenuator Insertion Loss		3	4	9	15	16	16	14	
Enter Discharge Width, mm	900								
Enter Discharge Height, mm	800								
End Reflection		5	2	1	0	0	0	0	
Louvre/Duct Directivity		4	4	5	5	6	6	6	
Distance to Receptor	18m	36.0	36.0	36.0	36.0	36.0	36.0	36.0	
Screening Loss		0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Façade Reflection		+0	+0	+0	+0	+0	+0	+0	
Sound Pressure Level at Receptor		42	43	40	32	25	24	21	**35**

Figure 2: Calculated rating level at receptor R2 (proposed location) – 100% capacity

		Calculation of Noise to Atmosphere							
System Name		Octave Band Centre Frequencies, Hz							
		63	125	250	500	1000	2000	4000	L_{WA}
Enter Fan Sound Power Level		78	77	77	74	68	64	61	75
Enter Filter / Coil Losses 1		0	0	0	0	0	0	0	
Enter Filter / Coil Losses 2		0	0	0	0	0	0	0	
Enter Attenuator Insertion Loss		3	4	9	15	16	16	14	
Enter Discharge Width, mm	900								
Enter Discharge Height, mm	800								
End Reflection		5	2	1	0	0	0	0	
Louvre/Duct Directivity		5	5	6	7	7	8	8	
Distance to Receptor	20m	37.0	37.0	37.0	37.0	37.0	37.0	37.0	
Screening Loss		0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Façade Reflection		+0	+0	+0	+0	+0	+0	+0	
Sound Pressure Level at Receptor		38	39	36	29	22	19	18	32

Figure 3: Calculated rating level at receptor R1 (proposed location) – 90% capacity

		Calculation of Noise to Atmosphere							
System Name		Octave Band Centre Frequencies, Hz							
		63	125	250	500	1000	2000	4000	L_{WA}
Enter Fan Sound Power Level		78	77	77	74	68	64	61	75
Enter Filter / Coil Losses 1		0	0	0	0	0	0	0	
Enter Filter / Coil Losses 2		0	0	0	0	0	0	0	
Enter Attenuator Insertion Loss		3	4	9	15	16	16	14	
Enter Discharge Width, mm	900								
Enter Discharge Height, mm	800								
End Reflection		5	2	1	0	0	0	0	
Louvre/Duct Directivity		4	4	5	5	6	6	6	
Distance to Receptor	18m	36.0	36.0	36.0	36.0	36.0	36.0	36.0	
Screening Loss		0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Façade Reflection		+0	+0	+0	+0	+0	+0	+0	
Sound Pressure Level at Receptor		38	39	36	28	22	18	17	31

Figure 4: Calculated rating level at receptor R2 (proposed location) – 90% capacity

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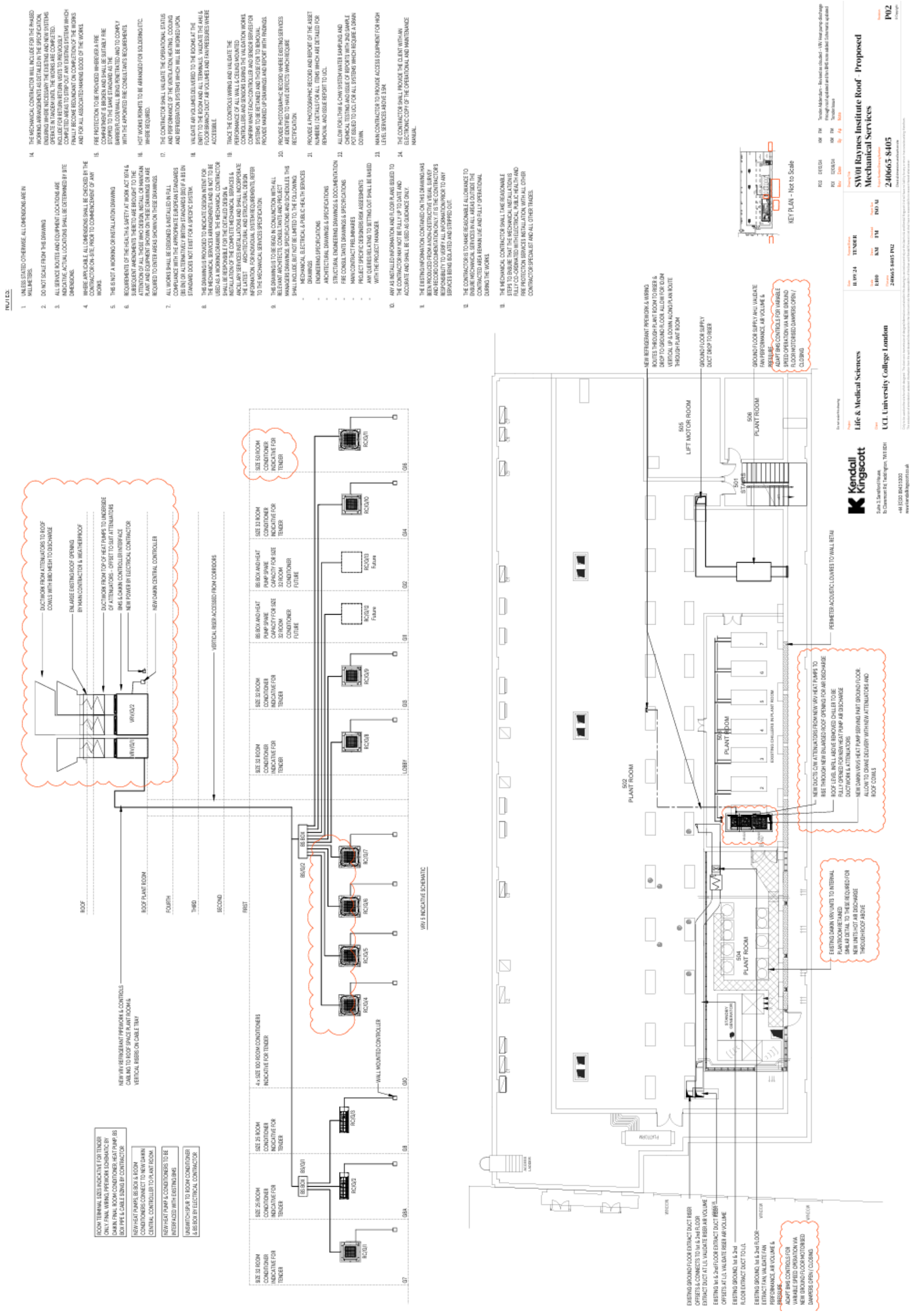
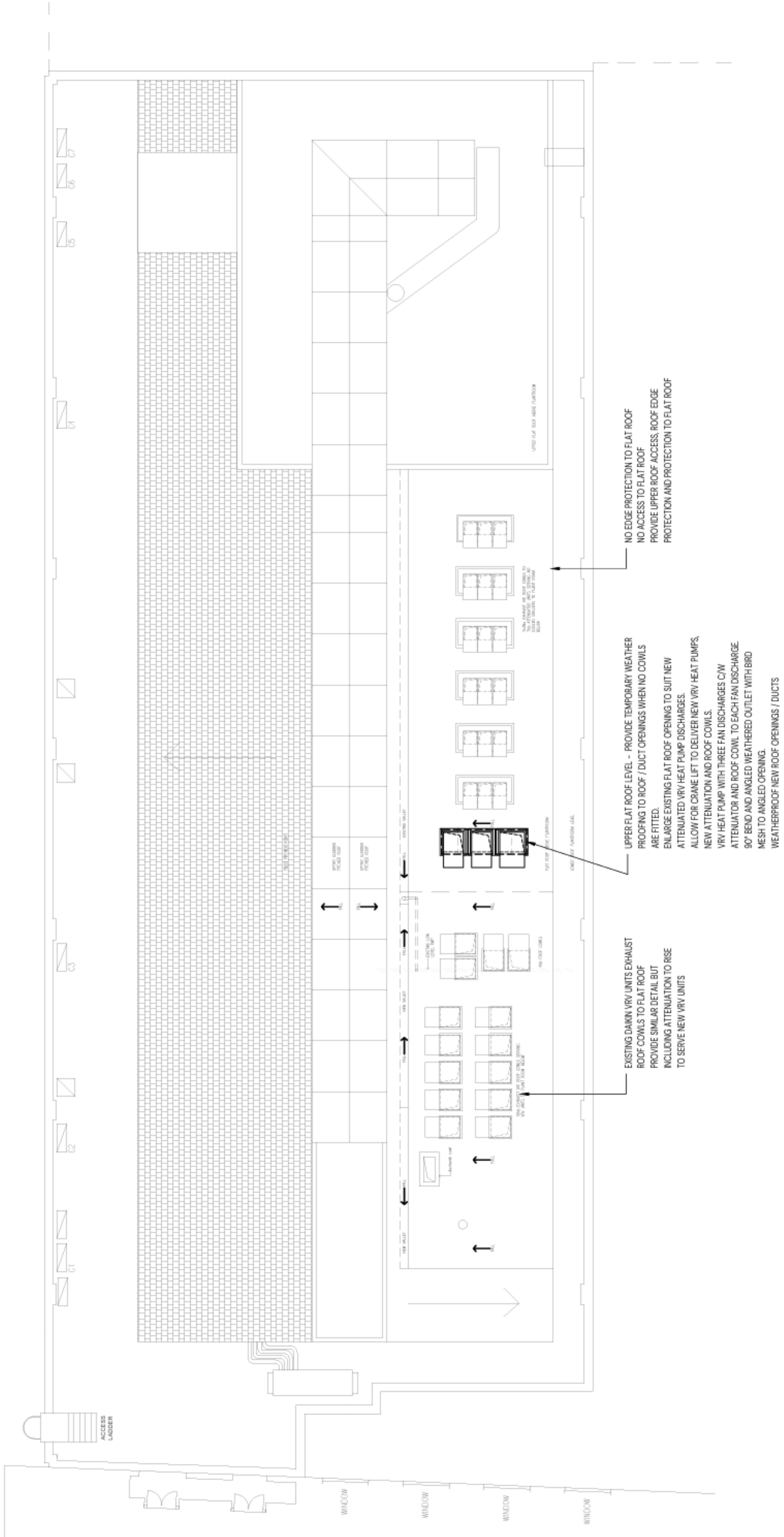
Appendix B – Site Plans




NO EDGE PROTECTION TO FLAT ROOF
NO ACCESS TO FLAT ROOF
PROVIDE UPPER ROOF ACCESS, ROOF EDGE PROTECTION AND PROTECTION TO FLAT ROOF
UPPER FLAT ROOF LEVEL - PROVIDE TEMPORARY WEATHER PROOFING TO ROOF / DUCT OPENINGS WHEN NO COWLS ARE FITTED.
ENLARGE EXISTING FLAT ROOF OPENING TO SUIT NEW ATTENUATED VRV HEAT PUMP DISCHARGES.
ALLOW FOR CRANE LIFT TO DELIVER NEW VRV HEAT PUMPS, NEW ATTENUATION AND ROOF COWLS.
VRV HEAT PUMP WITH THREE FAN DISCHARGES C/W ATTENUATOR AND ROOF COWL TO EACH FAN DISCHARGE.
90° BEND AND ANGLED WEATHERED OUTLET WITH BIRD MESH TO ANGLED OPENING.
WEATHERPROOF NEW ROOF OPENINGS / DUCTS
EXISTING DAIKIN VRV UNITS EXHAUST ROOF COWLS TO FLAT ROOF
PROVIDE SIMILAR DETAIL BUT INCLUDING ATTENUATION TO RISE TO SERVE NEW VRV UNITS
ACCESS LADDER
WINDOW
WINDOW
WINDOW
WINDOW

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Appendix C – Glossary

Decibel (dB)

A relative unit for the measurement of sound. The dB is a logarithmic ratio between the measured level and a reference (threshold) level of 0dB.

dB(A)

The 'A' weighted sound pressure level, denoted as dB(A), is frequency filtering system which approximates under defined conditions the frequency response of the human ear. This weighting has been shown to correlate with a human's subjective response to noise.

Free field

The sound pressure level away from any reflecting surfaces. Measurements made 1.5m above the ground and at least 3m away from other reflecting surfaces are usually regarded as free field.

Hertz (Hz)

The frequency (or pitch) of a sound. 1 Hz = 1 cycle per second, 1 kHz = 1000 Hz, 2 kHz = 2000 Hz, etc.

$L_{Aeq, T}$

The equivalent continuous sound level is a notional steady state level which over a quoted time period would have the same acoustic energy content as the actual fluctuating noise measured over that period. $L_{Aeq,16hour}$ (07:00 to 23:00 hours) and $L_{Aeq,8hour}$ (23:00 to 07:00 hours) are used to qualify daytime and night-time noise levels. Also known as the ambient noise level.

$L_{Ar,Tr}$

The 'rating level', as described in BS 4142: 2014 + A1: 2019 is the specific noise source plus any adjustment for the characteristic features of the sound.

L_{A90}

The A-weighted sound level which is exceed for 90% of the measurement period. i.e. The level exceeded for 54 minutes of a 1 hour measurement – used as a measure of the 'background noise level'.

Maekawa Formula

A method for predicting the barrier attenuation arising from diffraction, developed by Maekawa, based on path difference.

Sound Pressure Level (L_p)

A logarithmic measure of the effective pressure of a sound relative to a reference value, defined in dB (decibel). Sound pressure is the local deviation from the ambient air pressure caused by a sound wave. As the pressures to which the human ear responds can range from 20 μPa to 200 Pa, a linear measurement of sound levels would involve many orders of magnitude. Consequently, the pressures are converted to a logarithmic scale and expressed in decibels (dB) as follows:

$$L_p = 20 \log_{10}(p/p_0)$$

Where L_p = sound pressure level in dB; p = RMS sound pressure in Pa; and p_0 = reference sound pressure (20 μPa).

Sound Power Level (L_w)

The total sound energy radiated by a sound source. This is a property of the noise-emitting object itself and does not change depending on where you are in relation to said object.

Source Directivity

A measure of the directional characteristic of a sound source. It is often expressed as a Directivity Index in decibels, or as a dimensionless value of Q. The directional characteristics of a sound source are highly influenced by nearby reflecting surfaces.