PLANT NOISE ASSESSMENT

LINCOLN'S INN FIELDS

DSA Engineering

2062658-RSKA-RP-001-(01)

General notes

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Contents

1 Introduction

1.1 Rationale for Acoustic Surveying Works

Internal refurbishment works including a new roof terrace are proposed for the existing 6-storey building at 20-23 Lincoln Inn Fields, WC2A 3ED, London. It is also proposed to replace all associated external plant equipment.

As part of the planning application, RSK Acoustics have been approached to provide an assessment of atmospheric noise emissions from the proposed plant installation in line with relevant requirements from Camden Council.

This report details a noise survey undertaken at the site to quantify the existing noise climate and derive atmospheric plant noise emissions limits in accordance with the requirements of the Local Authority. A subsequent assessment of the plant noise emission levels of the proposed installation has been undertaken to determine if any mitigation is required to meet the plant noise limits.

2 Project Overview

2.1 Site Description

The site is an existing 6-storey office building at 20-23 Lincoln's Inn Fields, located within the Borough of Camden in London. The proposed mechanical ventilation strategy involves replacing all of the external plant equipment currently installed on the roof of the building.

At the time of the noise survey, one floor of the building is occupied as an operating office space.

The site is located at 60 metres from High Holborn Road (A40), which has heavy traffic throughout the day (especially during office hours).

The nearest noise-sensitive receptor has been identified as the residence of 17-19 Lincoln's Inn Fields with a rear balcony noted at 4th floor, nominally 16 m diagonally west and below the site roof level (as a conservative estimated distance). The Rosewood Hotel lies further west (nominally 25 m). No other noise-sensitive receptors have been identified in the vicinity of the site.

By demonstrating compliance with the relevant noise requirements at this location, it is expected that noise emissions to more distant receptors will also be compliant. Figure 1 shows the locations of the NSR, the site and the proposed plant approximate location.

2.2 Project Proposals

The proposed mechanical ventilation strategy involves replacing all of the external plant equipment currently installed on the roof of the building.

A rooftop scheme layout showing the proposed new plant locations is in Appendix B.

The plant selection included in this atmospheric noise emissions assessment is summarised below.

- AHU-01 – DAIKIN ADT05FCD1
- AHU-02 – DAIKIN ADT05FCD1
- 13 No. VRF Condensers – REYQ18U
- 2 No. DX Condenser (1 per AHU) – ERQ140AV1
- 2 No. Kitchenette Extract Fan – NUAIRE AVT3-R
- 2 No. DX Condensers for Comms / UPS – 5MXM90N9
- 2 No. DX Condensers for DHW – EMRQ14AB
- 1 No. Toilet Extract Fan - NUAIRE AVT7-R

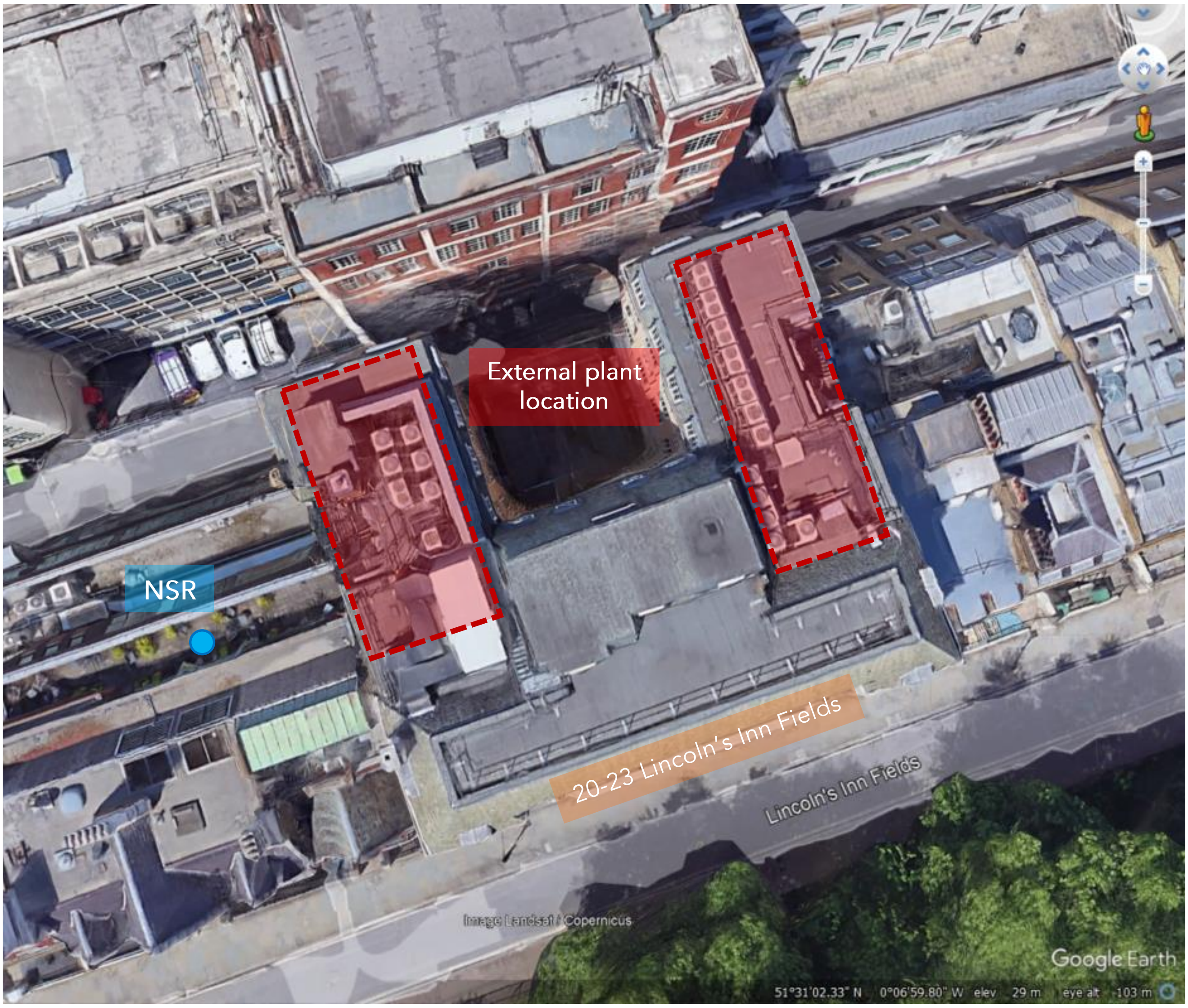


Figure 1 Plant location and nearest noise sensitive receptors (imagery from Google Earth)

3 Acoustic Requirements for Planning

3.1 Local Planning Policy

The Local Plan issued by Camden London Borough Council (July 2017), states the following regarding amenity protection from noise pollution within Policy A4: Noise and Vibration:

"The Council will seek to ensure that noise and vibration is controlled and managed.

Development should have regard to Camden Noise Vibration Thresholds (Appendix 3). We will not grant planning permission for:

A) developments likely to generate unacceptable noise and vibration impacts; or

B) development sensitive to noise in locations which experience high levels of noise, unless appropriate attenuation measures can be provided and will not harm the continued operation of existing uses.

We will only grant permission for nose generating development, including any plant and machinery, if it can be operated without causing harm to amenity. We will also seek to minimise the impact on local amenity from deliveries and from the deliveries and construction phases of development."

Within Appendix 3 of the Camden Local Plan, the following is stated regarding industrial and commercial noise sources:

"A relevant standard or guidance document should be referenced when determining values for LOAEL and SOAEL for non-anonymous noise. Where appropriate and within the scope of the document it is expected that British Standard 4142:2014 'Methods for rating and assessing industrial and commercial sound' (BS 4142) will be used. For such cases a 'Rating Level' of 10 dB below background (15dB if tonal components are present) should be considered as the design criterion."

The following table is illustrated within the Camden Local Plan (Appendix 3, Table C):

Existing Noise sensitive receptor	Assessment Location	Design Period	LOAEL (Green)	LOAEL to SOAEL (Amber)	SOAL (Red)
Dwellings**	Garden used for main amenity (free field) and Outside living or dining or bedroom window (façade)	Day	'Rating level' 10dB* below background	'Rating level' between 9dB below and 5dB above background	'Rating level' greater than 5dB above background
Dwellings**	Outside bedroom window (façade)	Night	'Rating level' 10dB* below background and no events exceeding 57dBL_{Amax}	'Rating level' between 9dB below and 5dB above background or noise events between 57dB and 88dB L_{Amax}	'Rating level' greater than 5dB above background and/or events exceeding 88dBL_{Amax}

Figure 2 Camden Local Plan 2017, Appendix 3, Table C

The following commentary is provided to the above table:

> *"*10dB should be increased to 15dB if the noise contains audible tonal elements. (day and night). However, if it can be demonstrated that there is no significant difference in the character of the residual background noise and the specific noise from the proposed development then this reduction may not be required. In addition, a frequency analysis (to include, the use of Noise Rating (NR) curves or other criteria curves) for the assessment of tonal or low frequency noise may be required.*
>
> ***levels given are for dwellings, however, levels are use specific and different levels will apply dependent on the use of the premises.*
>
> *The periods in Table C correspond to 0700 hours to 2300 hours for the day and 2300 hours to 0700 hours for the night. The Council will take into account the likely times of occupation for types of development and will be amended according to the times of operation of the establishment under consideration."*

3.2 BS 4142:2014+A1:2019

British Standard 4142:2014+A1:2019 *'Methods for rating and assessing industrial and commercial sound'* describes the methods for rating and assessing noise from industrial or commercial sources. The standard is applicable to the assessment of sound affecting residential receptors, through the determination of a specific level of an industrial or commercial noise source.

Where certain acoustic features are present at the assessment location, a character correction should be applied to the specific sound level to give the rating level to be used in the assessment. Acoustic features can include tones, impulsivity, intermittency or a type of noise that is distinct from the existing noise environment.

The assessment of the impact from a commercial or industrial sound can be carried out as follows:

- A difference of around +10 dB or more, between the rating and background noise levels, is likely to be an indication of a significant adverse impact, depending on the context.
- A difference of around +5 dB is likely to be an indication of adverse impact depending on the context.
- 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.

3.3 BS 7445-1-2-3

The three-part British Standard, BS 7445, provides the framework within which environmental noise should be quantified. Part 1 provides a guide to quantities and procedures and Part 2 provides a guide to the acquisition of data pertinent to land use. Part 3 provides a guide to the application of noise limits.

BS 7445 also refers to a further standard, BS EN 61672, which prescribes the equipment necessary for such measurements.

Whilst BS 7445 does not prescribe the meteorological conditions under which noise measurements should or should not be taken, it does (part 2, para 5.4.3.3) recommend that in order *"…to facilitate the comparison of results (measurements of noise from different sources), it may be necessary to carry out measurements under selected meteorological conditions which are reproducible and correspond to quite stable propagation conditions."*

These conditions include:

- Wind speed not exceeding 5 m/s (measured at a height of 3 to 11 m above the ground);
- No strong temperature inversions near the ground; and
- No heavy precipitation.

4 Noise Survey

An unattended survey has been undertaken from Monday 1st to Thursday 4th July 2024, to measure the existing noise environment at the proposed development site surroundings.

The datasets obtained from the noise survey have been used to establish suitable plant noise emission limits for the proposed plant installation.

4.1 Methodology

The baseline monitoring was undertaken in accordance with British Standard (BS) 7445-1:2003 'Description of Environmental Noise – Guide to Quantities and Procedures', and the equipment used will conform to the requirements of BS EN 61672-1:2013 'Electroacoustics. Sound Level Meters. Specifications'.

4.1.1 Equipment

Measurements of L_{Aeq}, L_{A90}, and L_{Amax} were recorded over consecutive 15-minute periods for the duration of the survey. Table 1 below shows details of the equipment used in the survey.

Item	Model	Serial number	Last calibration date
Sound level meter	Rion NL-52	00620866	28/04/2023
Pre-amplifier	Rion NH-25	20926	28/04/2023
Microphone	Rion UC-59	06266	28/04/2023
Calibrator	Rion NC-74	34625617	28/04/2023
Weatherproof windshield	Rion WS-15	-	-

Table 1 Equipment used on noise survey

The measurement was taken from a single position, which is shown in Figure 3.

The microphone was fitted within a weatherproof windshield and the sound level meter was calibrated before and after the survey with no significant drift noted.

The sound level meter microphone was fixed at the end of a pole, which was installed through an open window (as shown in Figure 4) at the top floor of the site building. The pole was adjusted and fixed so as to position the microphone 1 m from the façade. From site observations, this location is considered adequate to represent the noise climate at adjacent noise sensitive receptors.

Figure 4 shows photos of the sound level meter installed for unattended monitoring.

4.1.2 Site Conditions

The soundscape at the site is characterised by traffic noise, building services plant noise from the surrounding area, and waste management from commercial units along Whetstone Park Road. During installation and collection of the meter, plant noise from the roof of the adjacent building to the West was audible.

The weather conditions during the day of installation were cloudy, with a light breeze, dry and mild temperatures. According to publicly available weather data, the weather for the duration of the survey was dry, with no precipitation. Wind speeds were predominantly below 5 m/s.

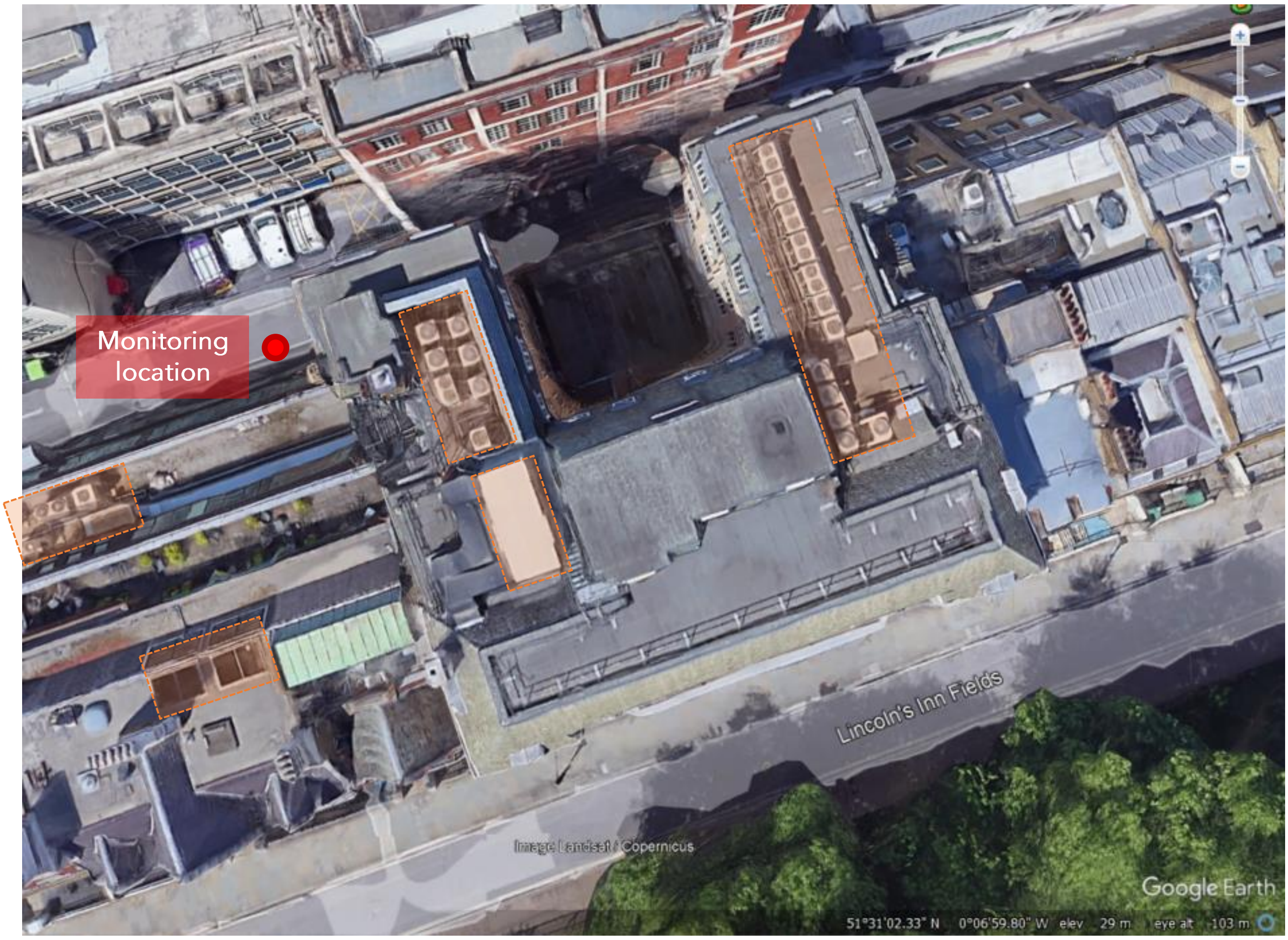


Figure 3 Map of the area indicating monitoring location (imagery from Google Earth)

Figure 4 Sound level meter installed for unattended monitoring

4.2 Noise Survey Results

A summary of the recorded noise levels from the unattended monitoring are shown in Table 2 below.

Date at beginning of period	Daytime (07:00-23:00)			Night time (23:00-07:00)		
	$L_{Aeq,16h}$	L_{Afmax} (highest)	$L_{A90,15min}$ (lowest)	$L_{Aeq,8h}$	L_{Afmax} (highest)	$L_{A90,15min}$ (lowest)
01/07/2024*	55	83	49	54	89	48
02/07/2024	59	98	51	54	88	48
03/07/2024	58	98	50	54	85	49
04/07/2024*	59	86	49	-	-	-
*Partial daytime period (less than 16 hours)						

Table 2 Summary of measured average noise levels

The daytime $L_{Aeq,16h}$ values were generally nearing 60 dB(A), and recorded night time $L_{Aeq,8h}$ consistently 54 dB(A). Very high L_{Afmax} values were registered. By reviewing audio recordings done by the sound level meter, we concluded these are due to moments of constant honking from vehicles, and waste management from the commercial units along Whetstone Park Road.

A time-history plot of 15-minute period survey data is presented in Appendix A. It is seen from the chart that background sound levels sharply increase at around 04:30 – 05:00 each day and this is likely from building services plant emissions or other environmental noise from the surrounding area.

Following the Camden Local Plan guidance, representative $L_{A90,15min}$ background noise levels have been calculated as per the methodology described in British Standard 4142:2014. A rating level of 10 dB below background has been considered as the design criteria for No Observed Adverse Effect Level (NOAEL), as no tonal components are identified in the proposed plant noise emission data.

The representative background noise levels and plant noise emission limits for the daytime and night time periods are shown in Table 3 below.

Day period	Representative background sound level $L_{A90,15min}$ (dB)	Plant atmospheric noise emission limits (dB)
Daytime (07:00 – 23:00)	55	45
Night-time (23:00 – 07:00)	50	40

Table 3 Background sound levels and NOAEL used for assessment.

4.2.1 Existing Plant Noise Contribution

The office building is currently partially occupied, and the existing external plant was operational below typical duty throughout the survey. As in the design proposals this equipment would be removed, it was aimed to estimate the background noise climate without a significant contribution of the existing plant.

To assess the influence of existing operating roof plant at the measurement position, the building services engineer switched off all building services plant during the period from 16h55 to 18h05, at each day of the unattended survey.

$L_{A90,15min}$ levels are expected to show any variations of influential continuous mechanical sound sources. Analysis of the datasets obtained has found that the recorded levels were consistent across the periods where the plant was operational or deactivated, with no significant variation.

This indicates that the measurement was not significantly affected by existing operating roof plant from the site itself, meaning the background sound levels measured are considered representative of the underlying sound climate.

5 Plant Noise Assessment

5.1 Plant Description

The scheme involves the removal of existing rooftop plant which currently comprises various condenser units on both east and west wings of the roof and Air Handling Unit (AHU). The proposals are to replace all plant with new condenser units and two AHU units.

The proposed scheme is generally a replacement of similar plant capacity with additional screening than the existing installation, and with two housed AHU units, one on each wing of the roof, with atmosphere exhaust and supply ducted via north-facing louvre.

It would be expected that the replacement of existing plant with suitably selected units and embedded mitigation should not increase noise emissions in the local environment.

5.2 Equipment Selection

A rooftop scheme layout showing the proposed new plant locations is in Appendix B.

The plant equipment schedule and relevant noise level data are summarised in Table 4. The data shown has been ascertained from manufacturer's documentation and relate to the highest operating modes, to assess a worst-case scenario.

Item	Model	Data	Level (dB)
AHU-01 AHU-02	DAIKIN ADT05FCD1	Exhaust outlet sound power L_{wA}	87
		Supply air inlet sound power L_{wA}	78
13 No. VRF Condensers	DAIKIN REYQ18U	Sound pressure at 1 m, L_{pA}	63
		Sound pressure at 1 m, L_{pA} (quiet mode)	56
2 No. DX Condensers (1 per AHU)	DAIKIN ERQ140AV1	Sound power L_{wA}	69
2 No. Kitchenette Extract Fans	NUAIRE AVT3-R	Sound power L_{wA}	76
2 No. DX Condensers for Comms / UPS	DAIKIN 5MXM90N9	Sound pressure at 1 m, L_{pA}	52
2 No. DX Condensers for DHW	DAIKIN EMRQ14AB	Sound power L_{wA}	83
1 No. Toilet Extract Fan	NUAIRE AVT7-R	Sound power L_{wA}	78

Table 4 Plant sound data used for assessment.

5.3 Plant Screen

Plant screens are proposed around the perimeter of each wing, as shown in Appendix B. It is our understanding that, at this stage, design details of the screens have not been finalised.

5.4 Predicted Plant Noise Emissions

5.4.1 Calculation Methodology

A simple assessment based on single-figure sound data has been carried out based on currently available information including layouts and manufacturer's datasheets. A summary of the calculations undertaken to obtain predicted atmospheric noise emission levels is provided in Appendix C.

The predicted plant noise emissions are based on simple calculations, with provisional assumptions and exclusions where design details have not been finalised.

Nominal screening losses have been applied where line-of-sight is obscured or partially obscured to the receptor from the building profile. A correction factor to account for façade reflections have also been included.

Distance attenuation losses has been calculated for the relative positions between each of the plant items and the receptor.

5.4.2 Exclusions

It should be noted that detailed design has not been finalised at this stage. In order to keep assumptions conservative, some elements that could provide additional attenuation have not been accounted for in this round of calculations, namely:

- specific noise reduction provided by duct losses, end reflections or louvred terminations for the AHU atmosphere side ducts;
- attenuation provided by roof perimeter plant screen.

5.5 Results with no mitigation

The predictions with no mitigation are considered conservative (worst-case assessment) and with all plant assumed to be operating continuously and simultaneously at the highest design duty.

The atmospheric plant noise emissions level predicted at the receptor, with the considerations described above, is shown alongside the target criteria in Table 5. It is noted that the cumulative level was significantly above the established noise limits.

Cumulative predicted level at the receptor, dB L_{pA}	Atmospheric plant noise emission limits	
	Daytime (07:00 – 23:00)	Night-time (23:00 – 07:00)
59	45	40

Table 5 Cumulative noise level due to proposed plant predicted at the receptor.

5.6 Design Recommendations

Acceptable noise levels can be achieved using straight-forward embedded mitigation measures comprising suitably selected in-duct AHU attenuators and fan units. The proposed screening of condenser plant on each roof wing is viewed as favourable for controlling noise emissions, and improving the current level of screening of existing plant.

Minimum attenuation performance has been assigned to these elements, in order to meet the criteria for both daytime and night-time periods. A summary is provided in Table 6.

Element	Proposed mitigation strategy	Minimum overall noise reduction requirement, dB
Plant screen	Design to minimum insertion loss	10
AHU-1 (supply inlet)	Implement in-duct silencer	15
AHU-1 (exhaust outlet)	Implement in-duct silencer	25
AHU-2 (exhaust outlet)	Implement in-duct silencer	10
Kitchenette extractor fan (west wing)	Implement acoustic air vent/grille	20

Table 6 Summary of acoustic design recommendations.

The required attenuation levels for each element are achievable by a variety of products widely available, including:

- Fitting of atmospheric side attenuators to all AHU terminations to reduced sound power emission by 20-25 dBA.
- Installation of a solid or acoustically rated louvre screen around the plant area with a minimum insertion loss of 10 dB. This should generally extend above the equipment by a minimum of 300 mm to ensure that optimum attenuation is achieved.

It is also recommended that the plant screen is extended on the west wing side, as shown in Figure 5, to screen the receptor from the nearest VRF condensers.

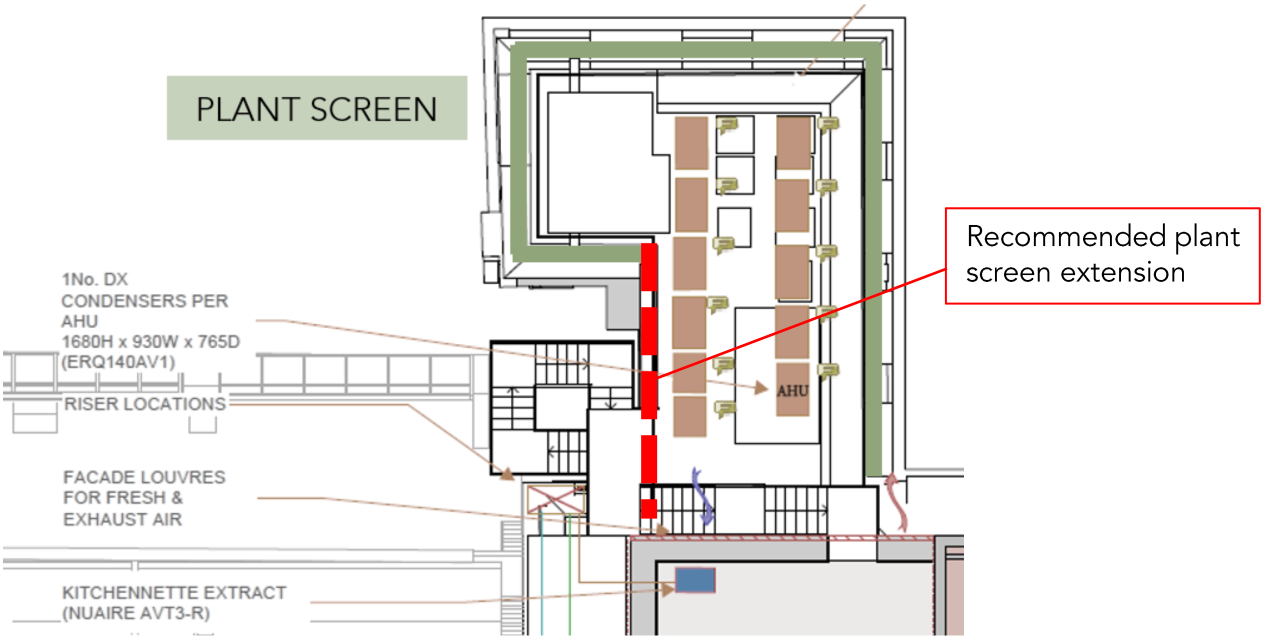


Figure 5 Proposed plant screen extension

5.7 Final Results

By implementing the minimum attenuation levels shown in Table 6, the atmospheric plant noise emissions levels predicted at the receptor are as shown in Table 7. A summary of the calculations is shown in

Appendix D.

For the night-time period calculations, all plant items were still considered operational, with the VRF condensers on 'quiet mode'.

Day period	Cumulative predicted level at the receptor, dB L_{pA}	Plant emission noise limits, dB $L_{A90,15min}$
Daytime (07:00 – 23:00)	43	45
Night-time (23:00 – 07:00)	39	40

Table 7 Cumulative noise level due to proposed plant predicted at the receptor (after mitigation).

6 Predicted Noise Impact and Planning

While a draft new local plan is understood to be in progress, the current Camden Local Plan as adopted in 2017 describes noise impacts and planning, in relation to national planning guidance and determining values for LOAEL and SOAEL for non-anonymous noise.

Following Camden Local Plan Appendix 3, Table C, the predicted noise emissions fall within the LOAEL ('green') category, where the rating level is predicted as 10 dB below representative background sound levels.

The impacts of the proposed development have therefore been deemed acceptable with respect to overarching planning guidance and Camden local policy.

It is expected that sound resulting from the proposed development will be largely unnoticeable at the assessment receptor location such that the sound is not expected to cause any change in behaviour or attitude. The development is not expected to change the character of the acoustic environment and may reduce its impact, based on the replacement of existing plant for new suitably selected plant with screening and straight-forward embedded mitigation.

7 Conclusions

A plant noise assessment has been carried out in relation to proposed items of mechanical building services plant proposed as part of the full office refurbishment at 20-23 Lincoln Inn Fields, WC2A 3ED.

Atmospheric noise emissions have been calculated based on the proposed plant selection and using manufacturers' sound data where available. Predictions have been made using simple calculation methods and worst-case assumptions. Conservative assumptions have been applied where detailed design information is not available at this stage. Nominal acoustic losses have been applied for simple calculations.

The predicted noise emissions have been assessed to criteria in accordance to Camden Local Plan guidance. Design recommendations have been provided, including straight-forward embedded mitigation typical for the AHU units and minimum insertion loss values for louvred screens.

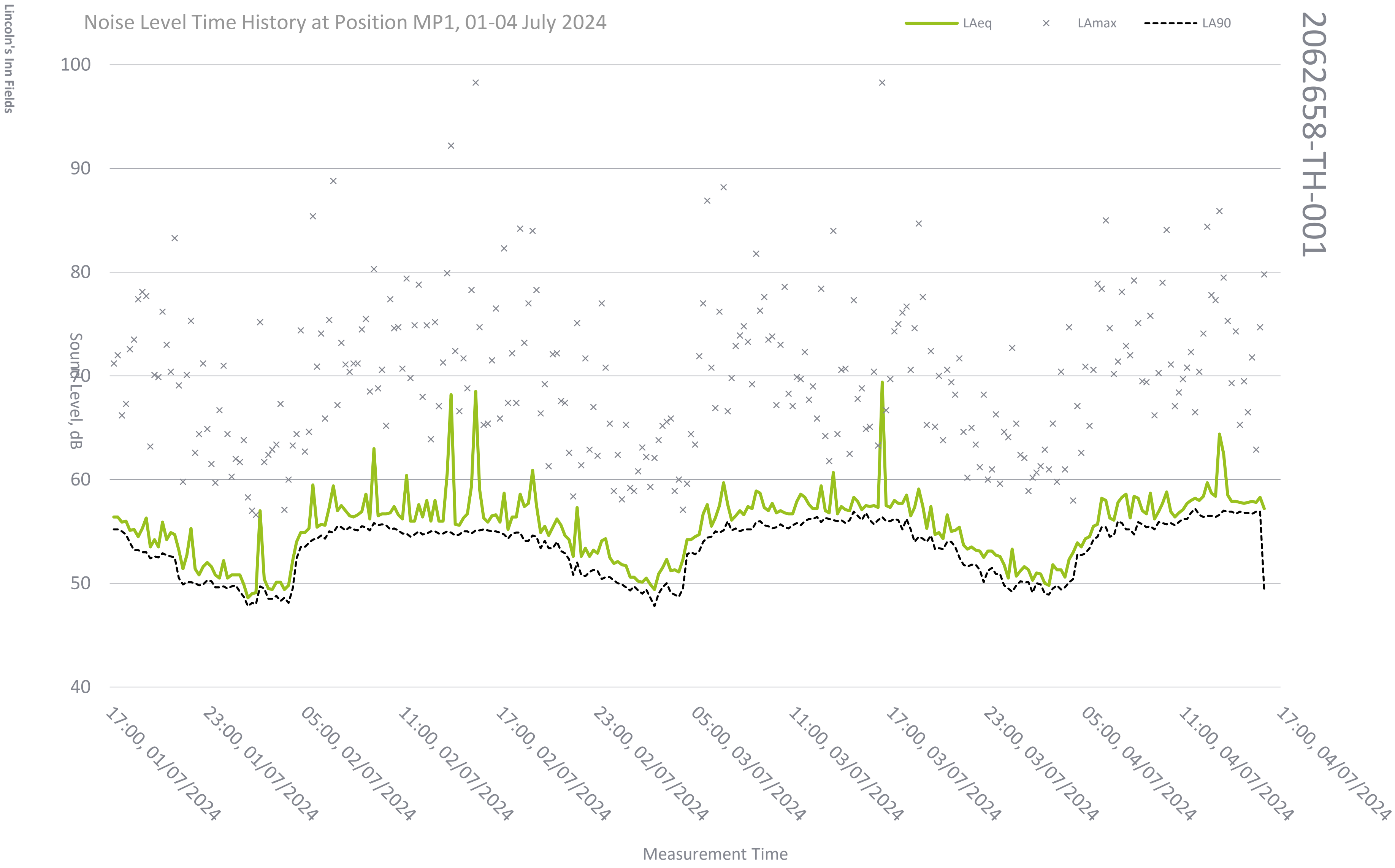
The assessment has indicated that predicted impact falls within LOAEL 'green', where noise emissions rating levels at least 10 dB below representative background levels at the nearest noise sensitive receptor are achievable with straight-forward design recommendations.

Glossary

dB	Decibel. Scale for expressing sound pressure level. It is defined as 20 times the logarithm of the ratio between the root mean square pressure of the sound field and a reference pressure i.e. $2x10^{-5}$ Pascal.
dB(A)	A-weighted decibel. This provides a measure of the overall level of sound across the audible spectrum with a frequency weighting to compensate for the varying sensitivity of the human ear to sound at different frequencies.
Frequency	The repetition rate of a sound wave. The subjective equivalent in music is pitch. The unit of frequency is the Hertz (Hz), which is identical to cycles per second. A thousand hertz is often denoted as kHz, e.g. 2 kHz = 2000 Hz. Human hearing ranges approximately from 20 Hz to 20kHz.
$L_{Aeq,T}$	This is defined as the notional steady sound level over a stated period of time (T), would contain the same amount of acoustical energy as the A-weighted fluctuating sound measured over that period.
NR	Noise rating. A set of curves based on the sensitivity of the human ear. They are used to give a single-figure rating for a range of frequencies.
Rating level	Specific sound level of a source plus any adjustment for the characteristic features of the sound.
Reverberation time (T_{60})	The time, in seconds, taken for a sound within a space to decay by 60 dB after the sound source has stopped.
Sound absorption	Process whereby sound energy is converted in to heat. Sound absorption properties is expressed as the sound absorption coefficient α or the sound absorption class (A-E).
Sound insulation	The reduction or attenuation of airborne sound by a solid element between source and receiver.

Table A 1 Glossary of Acoustic Terms

Appendix A



Lincoln's Inn Fields
Noise Level Time History at Position MP1, 01-04 July 2024
LAeq
LAmax
LA90
100
90
80
70
60
50
40
Sound Level, dB
17:00, 01/07/2024
23:00, 01/07/2024
05:00, 02/07/2024
11:00, 02/07/2024
17:00, 02/07/2024
23:00, 02/07/2024
05:00, 03/07/2024
11:00, 03/07/2024
17:00, 03/07/2024
23:00, 03/07/2024
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11:00, 04/07/2024
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Measurement Time
2062658-TH-001

Appendix B

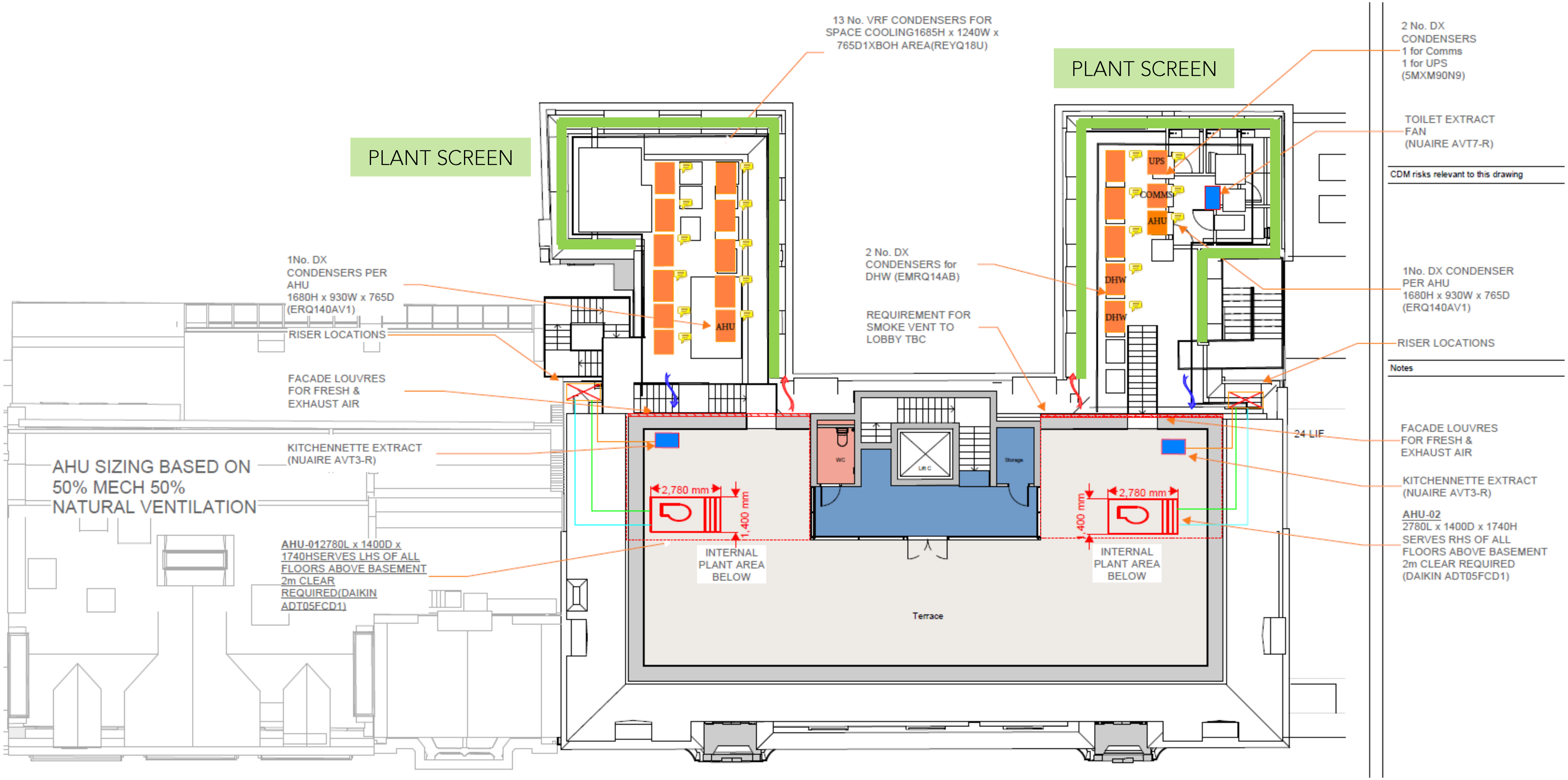

Figure B1 Schematic of external plant equipment layout at roof level (produced by DSA Engineering)

Appendix C

Calculations Summary – Initial Assumptions

West Wing Plant

direct path to NSR		Manufacturer's source data, L_{pA}, dB	63	REYQ18U at 1 m
4 No.VRF Condensers	4	Distance to receptor, m	12	4th floor rear balcony
REYQ18U		Distance attenuation, dB	-22	Geometric Spreading = 20log(r)
		Façade correction, dB	3	façade reflections
		Sound level at receptor (one unit), L_{pA} dB	44	NSR 1
		Sound level at receptor, L_{pA} dB	**50.4**	**all units**
partially obscured from NSR by roof profile/screen		Manufacturer's source data, L_{pA}, dB	63	REYQ18U at 1 m
4 No. VRF Condensers	4	Screening attenuation, dB	-5	partially obscured by building profile
REYQ18U		Distance to receptor, m	12	4th floor rear balcony
		Distance attenuation, dB	-22	Geometric Spreading = 20log(r)
		Façade correction, dB	3	façade reflections
		Sound level at receptor (one unit), L_{pA} dB	39	NSR 1
		Sound level at receptor, L_{pA} dB	**45.4**	**all units**
fully obscured from NSR by roof profile/screen		Manufacturer's source data, L_{pA}, dB	63	REYQ18U at 1 m
2 No. VRF Condensers	2	Screening attenuation, dB	-10	Fully obscured by building profile /screen
REYQ18U		Distance to receptor, m	12	4th floor rear balcony
		Distance attenuation, dB	-22	Geometric Spreading = 20log(r)
		Façade correction, dB	3	façade reflections
		Sound level at receptor (one unit), L_{pA} dB	34	NSR 1
		Sound level at receptor, L_{pA} dB	**37.4**	**all units**
partially obscured from NSR by roof profile/screen		Manufacturer's source data, L_{wA}, dB	69	ERQ140AV1
1 No. DX Condenser		Screening attenuation, dB	-5	partially obscured by building profile
ERQ140AV1		Distance to receptor, m	12	4th floor rear balcony
		Distance attenuation, dB	-30	Geometric Spreading = 20log(r) +10log(Q) -11
		Façade correction, dB	3	façade reflections
		Sound level at receptor, L_{pA} dB	**37**	

AHU-01 Atmos Supply		Manufacturer's source data, L_{wA}, dB	78	DAIKIN ADT05FCD1 / unit inlet
DAIKIN ADT05FCD1		Screening attenuation, dB	-5	partially obscured by building profile
		Distance to receptor, m	10	4th floor rear balcony
		Distance attenuation, dB	-28	Geometric Spreading = 20log(r) +10log(Q) -11
		Façade correction, dB	3	façade reflections
		Specific sound level at receptor, L_{pA} dB	**48**	
AHU-01 Atmos Exhaust		Manufacturer's source data, L_{wA}, dB	87	DAIKIN ADT05FCD1 / unit outlet
DAIKIN ADT05FCD1		Screening attenuation, dB	-5	partially obscured by building profile
Supply/ Unit Inlet		Distance to receptor, m	10	4th floor rear balcony
		Distance attenuation, dB	-28	Geometric Spreading = 20log(r) +10log(Q) -11
		Façade correction, dB	3	façade reflections
		Specific sound level at receptor, L_{pA} dB	**57**	

Kitchenette Extract		Manufacturer's source data, L_{wA}, dB	76	NUAIRE AVT3-R / Outlet
		Screening attenuation, dB	-10	Fully obscured by building profile /screen
NUAIRE AVT3-R		Distance to receptor, m	10	4th floor rear balcony
Extract/ Outlet		Distance attenuation, dB	-28	Geometric Spreading = 20log(r) +10log(Q) -11
		Façade correction, dB	3	façade reflections
		Specific sound level at receptor, L_{pA} dB	**41**	

West Wing - cumulative	**Sound level at receptor, L_{pA} dB**	59

East Wing Plant

3 No. VRF Condensers	3	Manufacturer's source data, L_{pA}, dB	63	REYQ18U at 1 m
REYQ18U		Screening attenuation, dB	-15	Fully obscured by building profile /screen
		Distance to receptor, m	25	4th floor rear balcony
		Distance attenuation, dB	-28	Geometric Spreading = 20log(r)
		Façade correction, dB	3	
		Sound level at receptor (one unit), L_{pA} dB	23	NSR 1
		Sound level at receptor, L_{pA} dB	**27.8**	**all units**
2 No. DX Condenser	2	Manufacturer's source data, L_{wA}, dB	52	5MXM90N9
5MXM90N9		Screening attenuation, dB	-15	Fully obscured by building profile /screen
		Distance to receptor, m	25	4th floor rear balcony
		Distance attenuation, dB	-28	Geometric Spreading = 20log(r)
		Façade correction, dB	3	
		Sound level at receptor (one unit), L_{pA} dB	12	NSR 1
		Sound level at receptor, L_{pA} dB	**15.1**	**all units**
2 No. DX Condenser	2	Manufacturer's source data, L_{wA}, dB	83	EMRQ14AB
EMRQ14AB		Screening attenuation, dB	-15	Fully obscured by building profile /screen
		Distance to receptor, m	25	4th floor rear balcony
		Distance attenuation, dB	-36	Geometric Spreading = 20log(r) +10log(Q) -11
		Façade correction, dB	3	façade reflections
		Sound level at receptor (one unit), L_{pA} dB	35	NSR 1
		Sound level at receptor, L_{pA} dB	**38.1**	**all units**
1 No. DX Condenser	1	Manufacturer's source data, L_{wA}, dB	69	ERQ140AV1
ERQ140AV1		Screening attenuation, dB	-15	Fully obscured by building profile /screen
		Distance to receptor, m	25	4th floor rear balcony
		Distance attenuation, dB	-36	Geometric Spreading = 20log(r) +10log(Q) -11
		Façade correction, dB	3	façade reflections
		Sound level at receptor, L_{pA} dB	**21**	
AHU-02 Atmos Supply		Manufacturer's source data, L_{wA}, dB	78	DAIKIN ADT05FCD1 / unit inlet
		Screening attenuation, dB	-15	Fully obscured by building profile /screen
DAIKIN ADT05FCD1		Distance to receptor, m	25	4th floor rear balcony
Supply/ Unit Inlet		Distance attenuation, dB	-36	Geometric Speading = 20log(r) +10log(Q) -11
		Façade correction, dB	3	façade reflections
		Specific sound level at receptor, L_{pA} dB	**30**	
AHU-02 Atmos Exhaust		Manufacturer's source data, L_{wA}, dB	87	DAIKIN ADT05FCD1 / unit outlet
		Screening attenuation, dB	-15	Fully obscured by roof profile / parapet
DAIKIN ADT05FCD1		Distance to receptor, m	25	4th floor rear balcony
Extract/ Outlet		Distance attenuation, dB	-36	Geometric Speading = 20log(r) +10log(Q) -11
		Façade correction, dB	3	façade reflections
		Specific sound level at receptor, L_{pA} dB	**39**	
Kitchenette Extract		Manufacturer's source data, L_{wA}, dB	76	NUAIRE AVT3-R / Outlet
NUAIRE AVT3-R		Screening attenuation, dB	-15	Fully obscured by building profile /screen
		Distance to receptor, m	25	4th floor rear balcony
		Distance attenuation, dB	-36	Geometric Speading = 20log(r) +10log(Q) -11
		Façade correction, dB	3	façade reflections
		Specific sound level at receptor, L_{pA} dB	**43**	
Toilet Extract Fan		Manufacturer's source data, L_{wA}, dB	78	NUAIRE AVT7-R / Outlet
NUAIRE AVT7-R		Screening attenuation, dB	-15	Fully obscured by building profile /screen
		Distance to receptor, m	20	4th floor rear balcony
		Distance attenuation, dB	-34	Geometric Speading = 20log(r) +10log(Q) -11
		Façade correction, dB	3	façade reflections
		Specific sound level at receptor, L_{pA} dB	**32**	
East Wing - cumulative		**Sound level at receptor, L_{pA} dB**	46	

Appendix D

Calculations Summary – Final Results (daytime)

West Wing Plant

direct path to NSR		Manufacturer's source data, L_{pA}, dB	63	REYQ18U at 1 m
4 No.VRF Condensers	4	Screening attenuation, dB	-10	screen/bulding screening
REYQ18U		Distance to receptor, m	12	4th floor rear balcony
		Distance attenuation, dB	-22	Geometric Spreading = 20log(r)
		Façade correction, dB	3	façade reflections
		Sound level at receptor (one unit), L_{pA} dB	34	NSR 1
		Sound level at receptor, L_{pA} dB	**40.4**	**all units**

partially obscured from NSR by roof profile/		Manufacturer's source data, L_{pA}, dB	63	REYQ18U at 1 m
4 No. VRF Condensers	4	Screening attenuation, dB	-15	perimeter screen - recommended insertion loss
REYQ18U		Distance to receptor, m	12	4th floor rear balcony
		Distance attenuation, dB	-22	Geometric Spreading = 20log(r)
		Façade correction, dB	3	façade reflections
		Sound level at receptor (one unit), L_{pA} dB	29	NSR 1
		Sound level at receptor, L_{pA} dB	**35.4**	**all units**

fully obscured from NSR by roof profile/scr		Manufacturer's source data, L_{pA}, dB	63	REYQ18U at 1 m
2 No. VRF Condensers	2	Screening attenuation, dB	-15	perimeter screen - recommended insertion loss
REYQ18U		Distance to receptor, m	12	4th floor rear balcony
		Distance attenuation, dB	-22	Geometric Spreading = 20log(r)
		Façade correction, dB	3	façade reflections
		Sound level at receptor (one unit), L_{pA} dB	29	NSR 1
		Sound level at receptor, L_{pA} dB	**32.4**	**all units**

partially obscured from NSR by roof profile/	Manufacturer's source data, L_{wA}, dB	69	ERQ140AV1
	Screening attenuation, dB	-15	perimeter screen - recommended insertion loss
1 No. DX Condenser	Distance to receptor, m	12	4th floor rear balcony
ERQ140AV1	Distance attenuation, dB	-30	Geometric Spreading = 20log(r) +10log(Q) -11
	Façade correction, dB	3	façade reflections
	Sound level at receptor, L_{pA} dB	**27**	

AHU-01 Atmos Supply	Manufacturer's source data, L_{wA}, dB	78	DAIKIN ADT05FCD1 / unit inlet
DAIKIN ADT05FCD1	Screening attenuation, dB	-5	Partial screening
	Proprietary attenuator, dB	-15	Recommended overall attenuation performance
	Distance to receptor, m	10	4th floor rear balcony
	Distance attenuation, dB	-28	Geometric Spreading = 20log(r) +10log(Q) -11
	Façade correction, dB	3	façade reflections
	Specific sound level at receptor, L_{pA} dB	**33**	

AHU-01 Atmos Exhaust	Manufacturer's source data, L_{wA}, dB	87	DAIKIN ADT05FCD1 / unit outlet
DAIKIN ADT05FCD1	Screening attenuation, dB	-5	Partial screening
Supply/ Unit Inlet	Proprietary attenuator, dB	-25	Recommended overall attenuation performance
	Distance to receptor, m	10	4th floor rear balcony
	Distance attenuation, dB	-28	Geometric Spreading = 20log(r) +10log(Q) -11
	Façade correction, dB	3	façade reflections
	Specific sound level at receptor, L_{pA} dB	**32**	

Kitchenette Extract	Manufacturer's source data, L_{wA}, dB	76	NUAIRE AVT3-R / Outlet
NUAIRE AVT3-R	Screening attenuation, dB	-25	partial screening plus attenuator (20dB)
Extract/ Outlet	Distance to receptor, m	10	4th floor rear balcony
	Distance attenuation, dB	-28	Geometric Spreading = 20log(r) +10log(Q) -11
	Façade correction, dB	3	façade reflections
	Specific sound level at receptor, L_{pA} dB	**26**	

West Wing - daytime cumulative	**Sound level at receptor, L_{pA} dB**	43

East Wing Plant

3 No. VRF Condensers	3	Manufacturer's source data, L_{pA}, dB	63	REYQ18U at 1 m
REYQ18U		Screening attenuation, dB	-20	Double screening by building profile/louvres
		Distance to receptor, m	25	4th floor rear balcony
		Distance attenuation, dB	-28	Geometric Spreading = 20log(r)
		Façade correction, dB	3	façade reflections
		Sound level at receptor (one unit), L_{pA} dB	18	NSR 1
		Sound level at receptor, L_{pA} dB	**22.8**	**all units**
2 No. DX Condenser	2	Manufacturer's source data, L_{wA}, dB	52	5MXM90N9
5MXM90N9		Screening attenuation, dB	-20	Double screening by building profile/louvres
		Distance to receptor, m	25	4th floor rear balcony
		Distance attenuation, dB	-28	Geometric Spreading = 20log(r)
		Façade correction, dB	3	façade reflections
		Sound level at receptor (one unit), L_{pA} dB	7	NSR 1
		Sound level at receptor, L_{pA} dB	**10.1**	**all units**
2 No. DX Condenser	2	Manufacturer's source data, L_{wA}, dB	83	EMRQ14AB
EMRQ14AB		Screening attenuation, dB	-20	Double screening by building profile/louvres
		Distance to receptor, m	25	4th floor rear balcony
		Distance attenuation, dB	-36	Geometric Spreading = 20log(r) +10log(Q) -11
		Façade correction, dB	3	façade reflections
		Sound level at receptor (one unit), L_{pA} dB	30	NSR 1
		Sound level at receptor, L_{pA} dB	**33.1**	**all units**
1 No. DX Condenser	1	Manufacturer's source data, L_{wA}, dB	69	ERQ140AV1
ERQ140AV1		Screening attenuation, dB	-20	Double screening by building profile/louvres
		Distance to receptor, m	25	4th floor rear balcony
		Distance attenuation, dB	-36	Geometric Spreading = 20log(r) +10log(Q) -11
		Façade correction, dB	3	façade reflections
		Sound level at receptor, L_{pA} dB	**16**	
AHU-02 Atmos Supply		Manufacturer's source data, L_{wA}, dB	78	DAIKIN ADT05FCD1 / unit inlet
		Screening attenuation, dB	-20	Double screening by building profile/louvres
DAIKIN ADT05FCD1		Proprietary attenuator, dB	0	Recommended overall attenuation performance
Supply/ Unit Inlet		Distance to receptor, m	25	4th floor rear balcony
		Distance attenuation, dB	-36	Geometric Speading = 20log(r) +10log(Q) -11
		Screening, dB	-3	Louvred screen
		Façade correction, dB	3	façade reflections
		Specific sound level at receptor, L_{pA} dB	**22**	
AHU-02 Atmos Exhaust		Manufacturer's source data, L_{wA}, dB	87	DAIKIN ADT05FCD1 / unit outlet
DAIKIN ADT05FCD1		Screening attenuation, dB	-20	Double screening by building profile/louvres
Extract/ Outlet		Proprietary attenuator, dB	-10	Recommended overall attenuation performance
		Distance to receptor, m	25	4th floor rear balcony
		Distance attenuation, dB	-36	Geometric Speading = 20log(r) +10log(Q) -11
		Façade correction, dB	3	façade reflections
		Specific sound level at receptor, L_{pA} dB	**24**	
Kitchenette Extract		Manufacturer's source data, L_{wA}, dB	76	NUAIRE AVT3-R / Outlet
NUAIRE AVT3-R		Screening attenuation, dB	-20	Double screening by building profile/louvres
		Distance to receptor, m	25	4th floor rear balcony
		Distance attenuation, dB	-36	Geometric Speading = 20log(r) +10log(Q) -11
		Façade correction, dB	3	façade reflections
		Specific sound level at receptor, L_{pA} dB	**23**	
Toilet Extract Fan		Manufacturer's source data, L_{wA}, dB	78	NUAIRE AVT7-R / Outlet
NUAIRE AVT7-R		Screening attenuation, dB	-20	Double screening by building profile/louvres
		Distance to receptor, m	20	4th floor rear balcony
		Distance attenuation, dB	-34	Geometric Speading = 20log(r) +10log(Q) -11
		Façade correction, dB	3	façade reflections
		Specific sound level at receptor, L_{pA} dB	**27**	
East Wing - daytime cumulative		**Sound level at receptor, L_{pA} dB**	35	

Calculations Summary – Final Results (night-time)

West Wing Plant

direct path to NSR		Manufacturer's source data, L_{pA}, dB	56	REYQ18U at 1 m (quiet mode)
4 No.VRF Condensers	4	Screening attenuation, dB	-10	screen/bulding screening
REYQ18U		Distance to receptor, m	12	4th floor rear balcony
		Distance attenuation, dB	-22	Geometric Spreading = 20log(r)
		Façade correction, dB	3	façade reflections
		Sound level at receptor (one unit), L_{pA} dB	27	NSR 1
		Sound level at receptor, L_{pA} dB	**33.4**	**all units**

partially obscured from NSR by roof profile/sc		Manufacturer's source data, L_{pA}, dB	56	REYQ18U at 1 m (quiet mode)
4 No. VRF Condensers	4	Screening attenuation, dB	-15	perimeter screen - recommended insertion loss
REYQ18U		Distance to receptor, m	12	4th floor rear balcony
		Distance attenuation, dB	-22	Geometric Spreading = 20log(r)
		Façade correction, dB	3	façade reflections
		Sound level at receptor (one unit), L_{pA} dB	22	NSR 1
		Sound level at receptor, L_{pA} dB	**28.4**	**all units**

fully obscured from NSR by roof profile/scree		Manufacturer's source data, L_{pA}, dB	56	REYQ18U at 1 m (quiet mode)
2 No. VRF Condensers	2	Screening attenuation, dB	-15	perimeter screen - recommended insertion loss
REYQ18U		Distance to receptor, m	12	4th floor rear balcony
		Distance attenuation, dB	-22	Geometric Spreading = 20log(r)
		Façade correction, dB	3	façade reflections
		Sound level at receptor (one unit), L_{pA} dB	22	NSR 1
		Sound level at receptor, L_{pA} dB	**25.4**	**all units**

partially obscured from NSR by roof profile/sc	Manufacturer's source data, L_{wA}, dB	69	ERQ140AV1
	Screening attenuation, dB	-15	perimeter screen - recommended insertion loss
1 No. DX Condenser	Distance to receptor, m	12	4th floor rear balcony
ERQ140AV1	Distance attenuation, dB	-30	Geometric Spreading = 20log(r) +10log(Q) -11
	Façade correction, dB	3	façade reflections
	Sound level at receptor, L_{pA} dB	**27**	

AHU-01 Atmos Supply	Manufacturer's source data, L_{wA}, dB	78	DAIKIN ADT05FCD1 / unit inlet
DAIKIN ADT05FCD1	Screening attenuation, dB	-5	Partial screening
	Proprietary attenuator, dB	-15	Recommended overall attenuation performance
	Distance to receptor, m	10	4th floor rear balcony
	Distance attenuation, dB	-28	Geometric Spreading = 20log(r) +10log(Q) -11
	Façade correction, dB	3	façade reflections
	Specific sound level at receptor, L_{pA} dB	**33**	

AHU-01 Atmos Exhaust	Manufacturer's source data, L_{wA}, dB	87	DAIKIN ADT05FCD1 / unit outlet
DAIKIN ADT05FCD1	Screening attenuation, dB	-5	Partial screening
Supply/ Unit Inlet	Proprietary attenuator, dB	-25	Recommended overall attenuation performance
	Distance to receptor, m	10	4th floor rear balcony
	Distance attenuation, dB	-28	Geometric Spreading = 20log(r) +10log(Q) -11
	Façade correction, dB	3	façade reflections
	Specific sound level at receptor, L_{pA} dB	**32**	

Kitchenette Extract	Manufacturer's source data, L_{wA}, dB	76	NUAIRE AVT3-R / Outlet
NUAIRE AVT3-R	Screening attenuation, dB	-25	partial screening plus attenuator (20dB)
Extract/ Outlet	Distance to receptor, m	10	4th floor rear balcony
	Distance attenuation, dB	-28	Geometric Spreading = 20log(r) +10log(Q) -11
	Façade correction, dB	3	façade reflections
	Specific sound level at receptor, L_{pA} dB	**26**	

West Wing - night-time cumulative	**Sound level at receptor, L_{pA} dB**	39

East Wing Plant

3 No. VRF Condensers	3	Manufacturer's source data, L_{pA}, dB	56	REYQ18U at 1 m (quiet mode)
REYQ18U		Screening attenuation, dB	-20	Double screening by building profile/louvres
		Distance to receptor, m	25	4th floor rear balcony
		Distance attenuation, dB	-28	Geometric Spreading = 20log(r)
		Façade correction, dB	3	façade reflections
		Sound level at receptor (one unit), L_{pA} dB	11	NSR 1
		Sound level at receptor, L_{pA} dB	**15.8**	**all units**
2 No. DX Condenser	2	Manufacturer's source data, L_{wA}, dB	52	5MXM90N9
5MXM90N9		Screening attenuation, dB	-20	Double screening by building profile/louvres
		Distance to receptor, m	25	4th floor rear balcony
		Distance attenuation, dB	-28	Geometric Spreading = 20log(r)
		Façade correction, dB	3	façade reflections
		Sound level at receptor (one unit), L_{pA} dB	7	NSR 1
		Sound level at receptor, L_{pA} dB	**10.1**	**all units**
2 No. DX Condenser	2	Manufacturer's source data, L_{wA}, dB	83	EMRQ14AB
EMRQ14AB		Screening attenuation, dB	-20	Double screening by building profile/louvres
		Distance to receptor, m	25	4th floor rear balcony
		Distance attenuation, dB	-36	Geometric Spreading = 20log(r) +10log(Q) -11
		Façade correction, dB	3	façade reflections
		Sound level at receptor (one unit), L_{pA} dB	30	NSR 1
		Sound level at receptor, L_{pA} dB	**33.1**	**all units**
1 No. DX Condenser	1	Manufacturer's source data, L_{wA}, dB	69	ERQ140AV1
ERQ140AV1		Screening attenuation, dB	-20	Double screening by building profile/louvres
		Distance to receptor, m	25	4th floor rear balcony
		Distance attenuation, dB	-36	Geometric Spreading = 20log(r) +10log(Q) -11
		Façade correction, dB	3	façade reflections
		Sound level at receptor, L_{pA} dB	**16**	
AHU-02 Atmos Supply		Manufacturer's source data, L_{wA}, dB	78	DAIKIN ADT05FCD1 / unit inlet
		Screening attenuation, dB	-20	Double screening by building profile/louvres
DAIKIN ADT05FCD1		Proprietary attenuator, dB	0	Recommended overall attenuation performance
Supply/ Unit Inlet		Distance to receptor, m	25	4th floor rear balcony
		Distance attenuation, dB	-36	Geometric Speading = 20log(r) +10log(Q) -11
		Screening, dB	-3	Louvred screen
		Façade correction, dB	3	façade reflections
		Specific sound level at receptor, L_{pA} dB	**22**	
AHU-02 Atmos Exhaust		Manufacturer's source data, L_{wA}, dB	87	DAIKIN ADT05FCD1 / unit outlet
DAIKIN ADT05FCD1		Screening attenuation, dB	-20	Double screening by building profile/louvres
Extract/ Outlet		Proprietary attenuator, dB	-10	Recommended overall attenuation performance
		Distance to receptor, m	25	4th floor rear balcony
		Distance attenuation, dB	-36	Geometric Speading = 20log(r) +10log(Q) -11
		Façade correction, dB	3	façade reflections
		Specific sound level at receptor, L_{pA} dB	**24**	
Kitchenette Extract		Manufacturer's source data, L_{wA}, dB	76	NUAIRE AVT3-R / Outlet
NUAIRE AVT3-R		Screening attenuation, dB	-20	Double screening by building profile/louvres
		Distance to receptor, m	25	4th floor rear balcony
		Distance attenuation, dB	-36	Geometric Speading = 20log(r) +10log(Q) -11
		Façade correction, dB	3	façade reflections
		Specific sound level at receptor, L_{pA} dB	**23**	
Toilet Extract Fan		Manufacturer's source data, L_{wA}, dB	78	NUAIRE AVT7-R / Outlet
NUAIRE AVT7-R		Screening attenuation, dB	-20	Double screening by building profile/louvres
		Distance to receptor, m	20	4th floor rear balcony
		Distance attenuation, dB	-34	Geometric Speading = 20log(r) +10log(Q) -11
		Façade correction, dB	3	façade reflections
		Specific sound level at receptor, L_{pA} dB	**27**	
East Wing - night-time cumulative		**Sound level at receptor, L_{pA} dB**	35	

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