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Comms Room, Institute of Education University College London (UCL)

Plant Noise Break-Out Assessment

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Contents

1 Introduction **5**

1.1 Content 5

1.2 Camden Borough Guidelines 6

1.3 Reference Codes & Standards 6

2 Site and External Noise Survey Results **7**

2.1 Introduction 7

2.2 Measurement Location 7

2.3 Noise Sensitive Receptors 8

2.4 Noise Survey Results 8

2.5 Discussion 8

3 Plant Noise Break-Out **9**

3.1 Introduction 9

3.2 Design Criteria 9

3.3 External Plant Noise Limits at the Nearest NSRs 9

3.4 Plant Noise Levels at the Nearest NSRs 10

4 Conclusion **11**

Table of Figures

Figure 1—1 Acoustics sub-discipline **5**

Figure 2—1 Site map showing the noise measurement locations, and noise-sensitive receptors (NSRs) (Source: Google Earth) **7**

Figure 2—2 Closest NSR to the west of the site **8**

Figure 3—1 Service road tunnel opening (4 by 5 meters) **9**

Figure 3—2 Length of service road tunnel (plant location) **9**

Figure 3—3 Nearest NSR façade to tunnel opening measurement **10**

Figure 3—4 Tunnel opening to condenser unit location measurement **10**

Table of Tables

Table 2—1 Noise survey results **8**

Table 3—1 Limiting rating levels based on measured background noise levels **9**

Table 4—1 Plant room breakout noise calculation **11**

Glossary

Term	Definition
Ambient Noise (as defined in BS 4142:2014+A1 2019)	Totally encompassing noise in a given situation at a given time; it is usually composed of noise from many sources, near and far.
Background Noise (as defined in BS 4142:2014+A1 2019)	A-weighted sound pressure level of the residual noise at the assessment position that is exceeded for 90% of a given time interval, T, measured using the Fast time weighting and quoted to the nearest whole number of decibels.
Decibel, dB	Decibel (dB) is a dimensionless unit commonly used to demonstrate sound levels. It is derived from the logarithm of the ratio between the measured level and the reference value. For sound pressure level (L_p) the reference value is $2x10^{-5}$ pascals. For sound power (L_w) reference value is $1x10^{-12}$ Watts.
Frequency	Number of cycles per second, measured in hertz (Hz), related to sound pitch.
$L_{90,T}$ ($L_{A90,T}$)	The sound pressure level exceeded for 90% of the measurement period. Referred to as background noise level.
$L_{Ar,T}$	Rating Noise Level (as defined in BS 4142:2014+A12019), the specific noise level plus any adjustment for the characteristic features of the noise.
$L_{eq,T}$ ($L_{Aeq,T}$)	The equivalent continuous noise level of a time-varying noise. It is the steady noise level that, over the period under consideration, contains the same amount of sound energy as the time-varying noise over the same period.
$L_{Fmax,T}$ ($L_{AFmax,T}$)	The maximum sound pressure level measured during the measurement period T using the fast time constant.
L_p	The sound pressure level, in decibels, of a sound is 20 times the logarithm to the base of 10 of the ratio of the sound pressure to the reference pressure ($2x10^{-5}$ pascals). The reference pressure shall be explicitly stated and is defined by the standard.
Specific Noise Level (as defined in BS 4142:2014+A1 2019)	The equivalent continuous A-weighted sound pressure level at the assessment position produced by the specific noise source over a given reference time interval.
Vibration	Force that oscillates about some specified reference point. Vibration is commonly expressed in terms of frequency such as cycles per second (cps), Hertz (Hz), cycles per minute (cpm) or (rpm) and strokes per minute (spm). This is the number of oscillations that occurs in that period. The amplitude is the magnitude or distance of travel of the force.
Weightings (as defined in BS EN 61672:2013):	A-Weighting: Frequency weighting devised to attempt to take into account the fact that human response to sound is not equally sensitive to all frequencies; it consists of an electronic filter in a sound level meter, which attempts to build in this variability into the indicated noise level reading so that it will correlate, approximately, with human response.). C-Weighting: One of the frequency weightings corresponding to the 100-phon contour and the closest to the linear or un-weighted value.

1 Introduction

Buro Happold (acoustics) has been appointed by University College London (UCL) to provide acoustics consultancy on the proposed addition of condenser units, located on the service road that runs beneath the Institute of Education (IoE) building, 20 Bedford Way, London. These proposed wall-mounted outdoor units will be surrounded by residential flats, offices, grass squares, and other associated spaces. An acoustic assessment is required to demonstrate that the noise emissions associated with the operation of the proposed condenser units are in line with the Local Planning Policy. This planning report should therefore be submitted to Camden Borough Council, the Local Planning Authority to demonstrate the potential impact of plant noise emissions on the surrounding Noise Sensitive Receptors (NSRs).

It is understood the scheme does not yet have planning permission, but that a planning application will be made promptly, depending on the outcome of this noise assessment. On this basis, it is suggested that the plant noise limits and noise survey methodology should comply with Camden Borough Council guidance and the standards which it references.

The acoustic parameters covered in this report fall under the sub-discipline of building services noise, highlighted in Figure 1—1.

1.1 Content

This report covers the following elements:

- External noise levels (from the survey)
- Required maximum permissible noise impact levels for plant
- Local Planning Authority (LPA) targets compliance
- Required limiting levels for external plant
- Noise impact assessment.

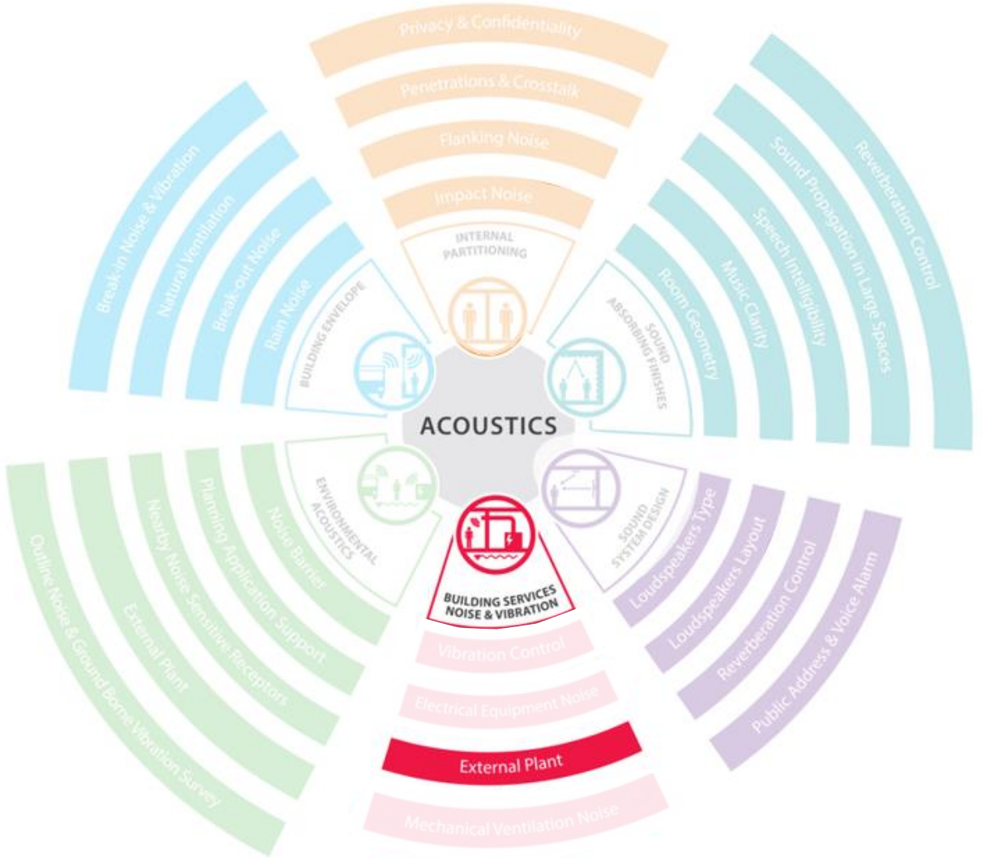


Figure 1—1 Acoustics sub-discipline

1.2 Camden Borough Guidelines

Camden Planning Guidance – Amenity (2019) highlights how any development involving external air extraction and conditioning equipment requires a formal acoustic assessment. It goes on to 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 report."

The Camden Local Plan also asks for BS4142 to be used for cases relating to industrial and commercial noise sources and states that:

"For such cases, a 'Rating Level' of 10 dB below background (15 dB if tonal components are present) should be considered as the design criterion)."

The client specifically requested for Buro Happold to utilise BS 7445-1:2003, which BS 4142 complies with, therefore both have been referenced in this report.

1.3 Reference Codes & Standards

This acoustic design report references the following list of codes and standards:

- **BS 7445-1:2003 Description and measurement of environmental noise – Part 1: Guide to quantities and procedures:** provides guidelines for specifying noise limits and methodology for assessing environmental noise
- **BS 4142:2014+A1:2019 Methods for rating and assessing industrial and commercial sound:** used for assessing the noise impact of industrial and commercial sources on noise-sensitive receptors (NSRs) and provides guidance as to the likely community response (BS 7445 compliant)
- **Camden Planning Guidance – Amenity (2019):** outlines what the local authority expects to see in this acoustic report
- **Local Planning Authority Criteria (Camden Local Plan):** specifies noise and vibration thresholds for noise-sensitive residential areas.

2 Site and External Noise Survey Results

2.1 Introduction

Buro Happold Engineering conducted external noise surveys on 15th and 16th September 2021 within the vicinity of the development site, relating to the design of the building and its associated services plant.

This survey was undertaken to capture the existing background noise levels ($L_{A90,T}$ dB) at the site and nearby NSRs. This allows for the specification of limiting noise levels for any externally located (or external terminations of the) external plant.

In this instance, the limiting plant noise levels are to be used to control noise emissions associated with the operation of the proposed condenser units. Where plant noise emissions are limited, this should see that the installation will not unduly increase existing noise levels in the vicinity of the site in line with pertinent criteria. Noise measurements were made using the following equipment (listed under their respective test durations):

- Long-term (minimum 24-hours):
    - Class 1 sound level meter, Rion NL-52 (serial number: 01265411)
    - Calibrator CEL-84/2 (serial number: 3/01818662)
    - Microphone 01 dB PRE 21 (serial number: 14038).

The sound level meter was checked before and after use with an acoustic calibrator. No significant drift was witnessed. Laboratory calibration certificates for all items of equipment are available upon request.

The weather conditions during the attended noise survey were noted as being 16°C in temperature with no rain and wind speeds not typically exceeding 5 ms^{-1} across both days. The 15th was overcast whereas the 16th was sunny with a clear blue sky.

2.2 Measurement Location

A single measurement location was undertaken to support this assessment. The measurement location is detailed below and marked on an annotated aerial image (see Figure 2—1):

- **Location 1** – Long-term (unattended) noise measurement, located on a service road that runs underneath the institute building. Meter placed approximately 1.5 metres above the local ground level and 1.0 metre away from a wall (a 3 dB façade enhancement correction has been applied to the results).

Figure 2—1 Site map showing the noise measurement locations, and noise-sensitive receptors (NSRs) (Source: Google Earth)

The values measured on-site were undertaken over relevant measurement periods, the key descriptor adopted in this instance is the **$L_{A90,15mins}$ dB**. This is commonly referred to as the background noise level.

The $L_{A90,T}$ dB can be described as an A-weighted sound pressure level exceeded for 90% of the measurement period i.e. a level that would be perceived as a constant, background noise level. Typically, largely unaffected by local traffic pass-by or by transient events. More usually attributable to constantly-running building services plant or distant road traffic. What you would hear when there is no local traffic present (or other readily-identifiable noise sources).

For this statistical value, the mode of the measurement values calculated every 15 minutes has been chosen to represent the 'typical' value for the range identified. The 15 minute duration is considered appropriate to provide the most common background noise level across the duration of the survey.

It is acknowledged that averaging statistical quantities interferes with their statistical basis, however, it is proposed that this practice has merit in representing a typical value for use in assessment.

2.3 Noise Sensitive Receptors

The following noise-sensitive receptors (NSRs) have been identified; these have been marked in green on the annotated aerial image (see Figure 2—1):

- Hotel rooms located adjacent to the eastern boundary of the IoE building on Bedford Way
- Residential, commercial, and academic buildings adjacent to the southern boundary of the IoE building on Russell Square
- Residential, commercial, and academic buildings are located adjacent to the western boundary of the IoE building on Thornaugh Street and Woburn Square.

For this report, the building in between Woburn square and the western face of IoE have been identified as the most susceptible to plant noise (detailed in Figure 2—2), hence the decision to measure background noise level at Location 1 (see Section 2.2).

2.4 Noise Survey Results

As outlined in Section 1.2, the Camden Borough Council states that noise emitted from the proposed plant and machinery should not exceed 10 dB below the typical external background noise level measured at 1 m outside any window of a noise-sensitive receiver. Therefore, the results reported in Table 2—1 provide a reference level for setting the maximum permissible plant noise levels at nearby NSRs.

2.5 Discussion

As can be seen from the measurement results, the daytime background noise level is slightly greater than the night-time background noise level with modal values being $L_{A90,15minutes}$ 50 dB and $L_{A90,15minutes}$ 48 dB respectively. This indicates a near constant level of plant noise at the IoE from existing air conditioning equipment, with a slight increase in the day due to trucks driving past to unload goods on the service road.

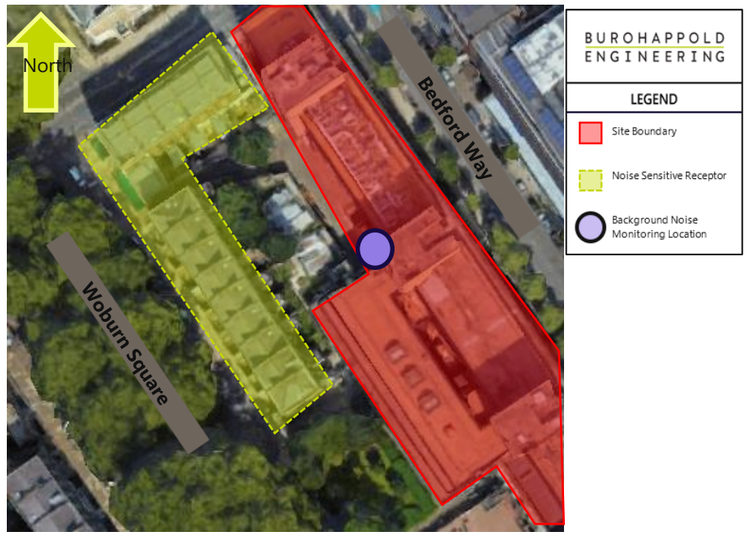


Figure 2—2 Closest NSR to the west of the site

Table 2—1 Noise survey results

Noise measurements (15th and 16th September 2021)				
Period	**Start time**	**End time**	**$L_{A90,15minutes}$ - dB**	**Comments**
Day	15/09/2021 10:00-23:00 hours	16/09/2021 07:00-10:00 hours	50	Occasional van driving through, unloading, and loading of goods on wheeled carts. Opposite a constantly running existing plant. (See Appendix A for full graphical representation of the results)
Night	15/09/2021 23:00-00:00 hours	16/09/2021 00:00-07:00 hours	48	

3 Plant Noise Break-Out

3.1 Introduction

Any newly introduced external plant associated with the refurbishment works should be controlled to see that the Camden Borough Council requirements are achieved and that noise emissions do not cause an adverse impact upon existing NSRs. This section outlines suitable noise limits and if this proposed plant noise emissions associated with the condensers are compliant with these limits.

3.2 Design Criteria

Target values to limit the impact of noise break-out from a noise-generating plant at nearby NSRs are detailed in Camden Councils' guidelines presented in Section 1.2. The design criteria are reproduced below for reference:

- The rating level ($L_{Ar,Tr}$ dB)) (calculated in accordance to BS 4142:2014+A1:2019) is at least 10 dB below the lowest background noise level ($L_{A90,15mins}$ dB) for the proposed operating period; and
- The rating level ($L_{Ar,Tr}$ dB) (calculated in accordance to BS 4142:2014+A1:2019) is at least 15 dB below the lowest background noise level ($L_{,A90,15mins}$ dB) for the proposed operating period should plant be identified as having "acoustic features" (e.g. intermittency, tonal characteristics, and impulsivity).

Individual plant items may need to be designed to a lower limit such that the overall total achieves the stated criteria above. This is because the plant rating limits are representative of the cumulative noise emissions of all plant items operating at the development.

3.3 External Plant Noise Limits at the Nearest NSRs

Based on the background noise levels during the day and night-time periods (see Section 2.4), cumulative limiting plant noise levels at the nearby noise-sensitive receptors have been set, as displayed in Table 3—1.

It is understood that there are no tonal elements associated with the proposed plant and other acoustic characteristics, such as intermittency. The condensers are expected to operate for 24 hours a day and therefore a rating limit that is 10 dB below the background noise level is recommended by Buro Happold as this is in line with Camden Borough Council criteria.

Table 3—1 Limiting rating levels based on measured background noise levels

Measurement Period	Modal background noise level $L_{A90,15\text{-minute}}$ dB	Plant Rating Limit at 1 meter from nearest NSR façades $L_{Ar,Tr}$ dB
Day-time (07:00-23:00 hours)	50	40
Night-time (23:00-07:00 hours)	48	38

Figure 3—1 Service road tunnel opening (4 by 5 meters)

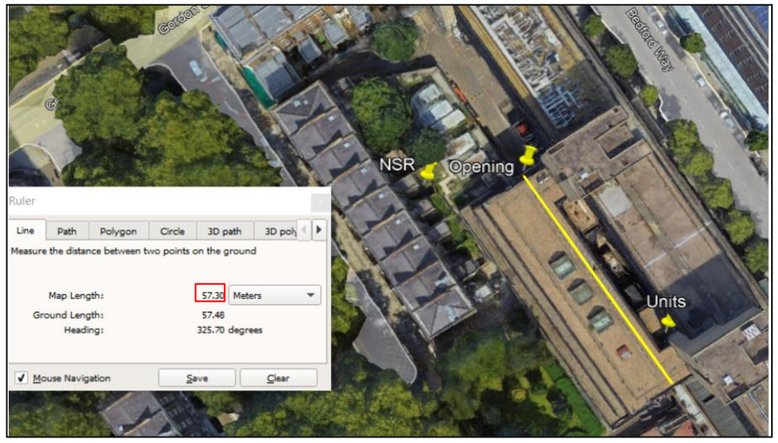


Figure 3—2 Length of service road tunnel (plant location)

3.4 Plant Noise Levels at the Nearest NSRs

Due to the plant being in a semi-enclosed tunnel (see Figure 3—1), both direct sound and reverberant reflected sound exiting the tunnel needs to be considered. This has been calculated by using distance measurements extracted from street map data (Figure 3—2, Figure 3—3 and Figure 3—4), the condenser unit sound power level of L_w 66 dB(A) (presented in Appendix B), and the following assumptions that are considered to represent a robust scenario:

- The NSRs facing plant items head-on at the opening of the tunnel (0° degree viewing angle)
- The tunnel is a highly reverberant space with a low absorption coefficient (average room coefficient, $\bar{\alpha}$=0.08)
- All 3 condenser units are next to two reflective surfaces (floor and wall).

Table 4—1 presents the values used in the calculation and predicts a noise level of $L_{Ar,Tr}$ 34 dB at the nearest NSR.

If any changes that could affect the credibility of these measurements and assumptions arise, i.e. modification to plant type or location, Buro Happold should be informed so that a review of calculations can be undertaken.

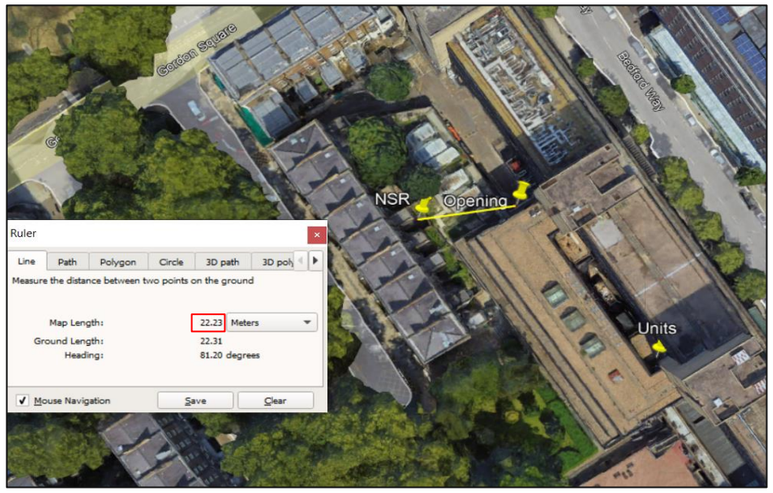


Figure 3—3 Nearest NSR façade to tunnel opening measurement

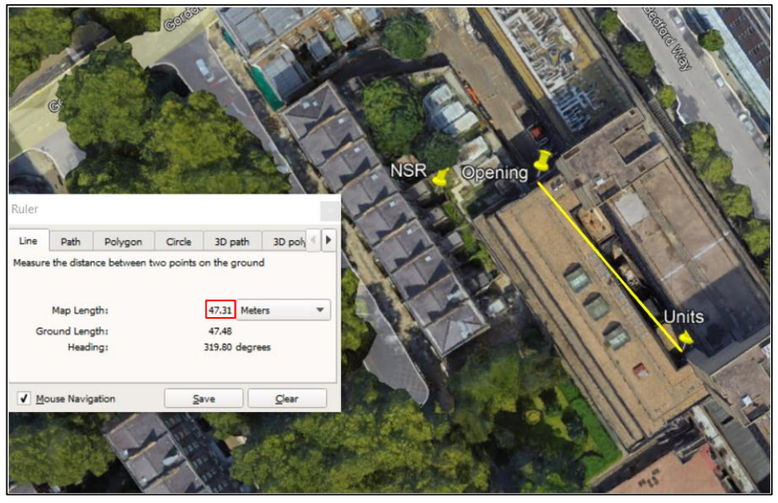


Figure 3—4 Tunnel opening to condenser unit location measurement

4 Conclusion

An acoustic survey was conducted in the vicinity of the development site to assess the existing noise climate. Analysis of the typically measured background noise levels has been undertaken. The noise impact on the nearest NSR façade was then calculated using a combination of site measurement results, manufacturer sound power level data and assumptions such as room dimensions.

As can be seen from the long-term measurements, the external plant should be limited to $L_{A90,15mins}$ 40 dB(A) / 38 dB during daytime and night-time periods, respectively.

The acoustic calculations presented in Section 3.4 suggest that if 3 condenser units are installed in the agreed location, then the worst-case noise impact on the closest NSRs to the west of the IoE could be up to $L_{Ar,Tr}$ 34 dB.

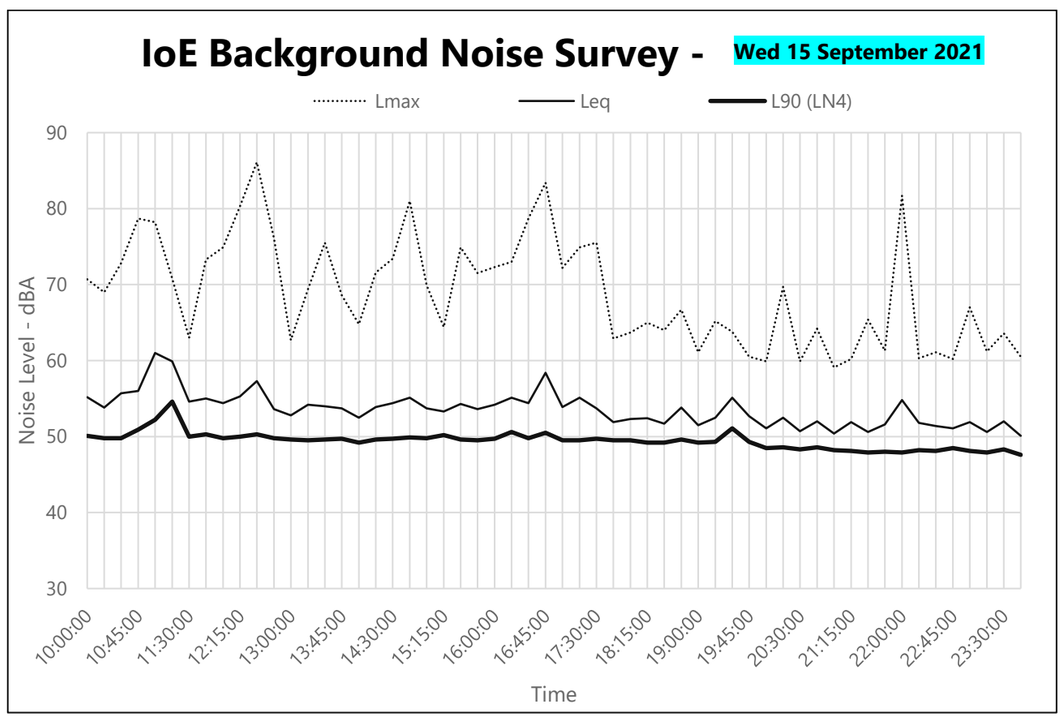
This level complies with Camden Borough Council requirements, which state that new plant noise emissions should be 10 dB below the background noise level. The proposed development is therefore likely to be non-disruptive, and acoustic concerns are not considered to represent any barrier to development.

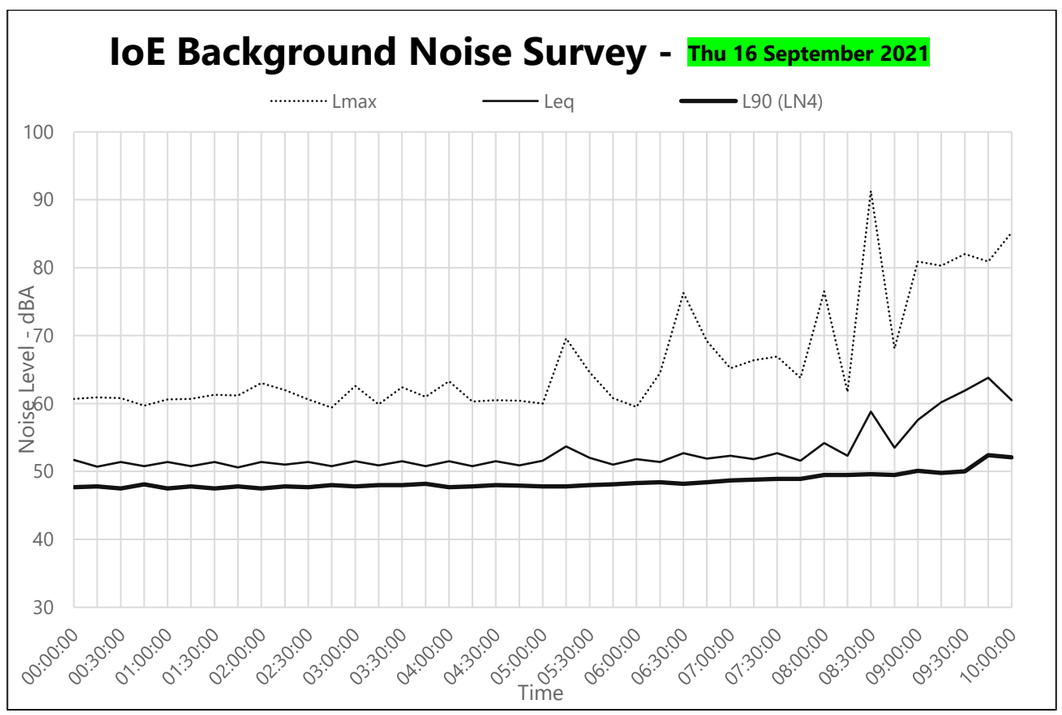
Table 4—1 Plant room breakout noise calculation

PLANT ROOM FAÇADE BREAKOUT NOISE CALCULATION									
Project name	UCL IoE (Comms Room)								
Room or space	Service road (semi-enclosed tunnel) - worst-case scenario assumptions								
Date	21/09/2021								
PLANT ROOM DIMENSIONS AND CHARACTERISTICS									
Plant room width (m)	5								
Plant room length (m)	57								
Plant room height (m)	4								
Area of façade louvre (m2)	20								
Width or Height of Louvre (m)	5.5								
Horizontal or vertical angle to noise sensitive receptor (degrees)	0								
Distance to noise sensitive receptor (m)	22								
Volume (m3)	1140								
Plant Room Alpha	"Live room" (α=0.08)								
PLANT ITEMS		**Lw OBCF (Hz)**							
		63Hz	**125Hz**	**250Hz**	**500Hz**	**1000Hz**	**2000Hz**	**4000Hz**	**8000Hz**
RZAG100MV1 Unit		0.0	50.0	59.0	62.0	64.1	55.0	49.0	44.0
RZAG100MV1 Unit		0.0	50.0	59.0	62.0	64.1	55.0	49.0	44.0
RZAG100MV1 Unit		0.0	50.0	59.0	62.0	64.1	55.0	49.0	44.0
Lp,rev Reverberant Calculation									
Rc	92.7								
Lp,rev		-7.6	41.1	50.1	53.1	55.2	46.1	40.1	35.1
Lp,dir Direct Calculation (room side)									
Lp,dir at louvre due to plant item 1		-38.0	12.0	21.0	24.0	26.1	17.0	11.0	6.0
Lp,dir at louvre due to plant item 2		-38.0	12.0	21.0	24.0	26.1	17.0	11.0	6.0
Lp,dir at louvre due to plant item 3		-38.0	12.0	21.0	24.0	26.1	17.0	11.0	6.0
Total Lp at louvre (Lp,rev+Lp,dir room side)		-4.8	41.1	50.1	53.1	55.2	46.1	40.1	35.1
Lw incident on louvre		8.2	54.1	63.1	66.1	68.2	59.1	53.1	48.1
Louvre sound reduction index 'R' (dB) (insert if available)		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Correction inside (diffuse) to outside (free-field) (dB)		-6.0	-6.0	-6.0	-6.0	-6.0	-6.0	-6.0	-6.0
Directivity correction (dB)		4.0	4.5	4.5	4.5	4.5	4.5	4.5	4.5
Distance attenuation loss to NSR (dB)		**-34.8**	**-34.8**	**-34.8**	**-34.8**	**-34.8**	**-34.8**	**-34.8**	**-34.8**
Resulting Lp at NSR (dB)		-29	18	27	30	32	23	17	12
dB(A) without louvre		-55	2	18	27	32	24	18	11
Required louvre insertion loss		0	0	0	0	-3	0	0	0
dB(A) with louvre		-55	2	18	27	29	24	18	11
		Resultant Noise Level					**Compliance**		
		34dB					**YES**		

Appendix A Noise Survey Graphs

A.1 Appendix 1: Long-term measurement data (Location 1)





Appendix B Outdoor Condenser Unit Technical Specification

DAIKIN

FAA-A / RZAG-M

R-32 BLUEVOLUTION

Indoor Units			Single Phase		3 Phase	
			FAA71A	FAA100A	FAA71A	FAA100A
Capacity	UK Total Cooling	kW	7.76	10.8	7.76	10.8
	UK Sensible Cooling	kW	5.32	7.44	5.32	7.44
	Nominal Cooling	kW	6.8	9.5	6.8	9.5
	Nominal Heating	kW	7.5	10.8	7.5	10.8
Seasonal Efficiency (EN14825) COOLING	Energy Label		A++	A++	A++	A++
	Pdesign	kW	6.8	9.5	6.8	9.5
	SEER		6.58	6.42	6.58	6.42
	Annual Energy Consumption	kWh	362	518	362	518
Seasonal Efficiency (EN14825) HEATING	Energy Label		A+	A+	A+	A+
	Pdesign	kW	4.7	7.8	4.7	7.8
	SCOP		4.02	4.01	4.02	4.01
	Annual Energy Consumption	kWh	1637	2723	1637	2723
Nominal Efficiency	EER/COP		3.62/4.32	4.43/4.00	3.62/4.32	4.43/4.00
Air Flow Rate (Cooling)	High / Nom / Low	m^3/sec	0.300/0.266/0.233	0.433/0.383/0.316	0.300/0.266/0.233	0.433/0.383/0.316
Dimensions	Height	mm	290	340	290	340
	Width	mm	1050	1200	1050	1200
	Depth	mm	238	240	238	240
Weight		kg	13	17	13	17
Sound Pressure (Cooling)	High / Nom / Low	dBA	45/42/40	49/45/41	45/42/40	49/45/41
Sound Pressure (Heating)	High / Nom / Low	dBA	45/42/40	49/45/41	45/42/40	49/45/41
Sound Power (Cooling)		dBA	61	65	61	65
Outdoor Units			**RZAG71MV1**	**RZAG100MV1**	**RZAG71MY1**	**RZAG100MY1**
Dimensions	Height x Width x Depth	mm	990 x 940 x 320	1430 x 940 x 320	990 x 940 x 320	1430 x 940 x 320
Weight		kg	70	92	70	92
Electrical Details	Power Supply		1ph	1ph	3ph	3ph
	Running Current	A	17.4	26.4	10.8	14.5
	Starting Current	A	-	-	-	-
	Max Fuse Size	A	20	32	16	16
Interconnection Wiring	Core / Cable Size		3+E / 1.5	3+E / 1.5	3+E / 1.5	3+E / 1.5
Piping Connections	Liquid / Gas	inches (mm)	3/8 (9.5) / 5/8 (15.9)	3/8 (9.5) / 5/8 (15.9)	3/8 (9.5) / 5/8 (15.9)	3/8 (9.5) / 5/8 (15.9)
Pipework	Maximum Length	m	55	85	55	85
	Maximum Vertical Rise	m	30	30	30	30
	Precharged to	m	40	40	40	40
	Additional charge	g/m	Refer to Installation Manual		Refer to Installation Manual	
	Holding charge	kg	2.95	3.75	2.95	3.75
Sound Pressure (Cooling)	Nom / Night Quiet	dBA	46/42	47/44	46/42	47/44
Sound Pressure (Heating)	Nom / Night Quiet	dBA	49/42	51/44	49/42	51/44
Sound Power (Cooling)		dBA	64	66	65	66
Operating Range (Cooling)	Min / Max	°CDB	-20/52	-20/52	-20/52	-20/52
Operating Range (Heating)	Min / Max	°CWB	-20/18	-20/18	-20/18	-20/18
Air Flow Rate (Cooling)	Nominal	m^3/sec	0.983	1.166	0.983	1.166
ECA Eligible			●	●	●	●

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