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Consultants in Acoustics, Noise & Vibration

14463-R11-A

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The Honourable Society of Lincoln's Inn

Western Service Yard

Plant noise assessment

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Summary

Sandy Brown has been commissioned to provide acoustic advice in relation to the development works at The Honourable Society of Lincoln's Inn, London, WC2A.

An environmental noise survey was previously undertaken at the site and is documented in Sandy Brown document '*14463-R02-B Environmental noise survey report',* dated 22 July 2015. Further attended sample measurements were taken on 3 February 2016.

The site lies within the London Borough of Camden, and has been granted conditional planning consent, subject to demonstration that the noise emissions from new plant items are at least 10 dB below the existing background noise level when assessed at nearby noise-sensitive receptors.

An assessment has been undertaken based on the locations and noise level data of new items of building services plant located with the Western Service Yard.

The calculated noise level at nearby noise sensitive receptors resulting from the operation of new building services plant within the Western Service Yard meets the requirements of Planning Condition 10.

Contents

1 Introduction

Sandy Brown has been appointed by the Honourable Society of Lincoln's Inn (HSLI) to provide acoustic advice in relation to the development works at the Inn, which is located within the London Borough of Camden (LBC).

The development works included the installation of new building services plant, which results in environmental noise egress. Noise emissions from the plant items are subject to Planning Condition 10 (LBC ref 2015/4402/P), which states that emissions should be at least 10 dB below the existing background noise level.

This document details an environmental noise assessment of the installed plant in order to demonstrate compliance with Planning Condition 10.

2 Site description

2.1 The site and its surrounding

Lincoln's Inn is located in Holborn, in the London Borough of Camden (LBC). Today it stands as one of the four Inns of Court in London.

Lincoln's Inn is a society of lawyers situated in around 11 acres. 'Lincoln's Inn' thus refers both to the Society and the place.

As well as housing the Society's own facilities, Lincoln's Inn is the location of many barristers' chambers and some solicitors' offices. It faces the Royal Courts of Justice and the Lincoln's Inn Fields across the road to the west.

Lincoln's Inn is bounded by Chancery Lane to the east and Carey Street to the south. The south-facing rear of buildings along High Holborn overlooks Lincoln's Inn.

As well as the Inn's general facilities, there are also residences located within the boundary of the site in the following locations:

- 1-8 Stone buildings
- 8-15 Old Square
- Hardwick building
- 16-26 Old buildings
- 3 New Square.

The site in relation to its surrounding is shown in Figure 1. The Great Hall is highlighted in green. The Western Service Yard is highlighted in blue. Nearby noise sensitive receptors are also indicated.

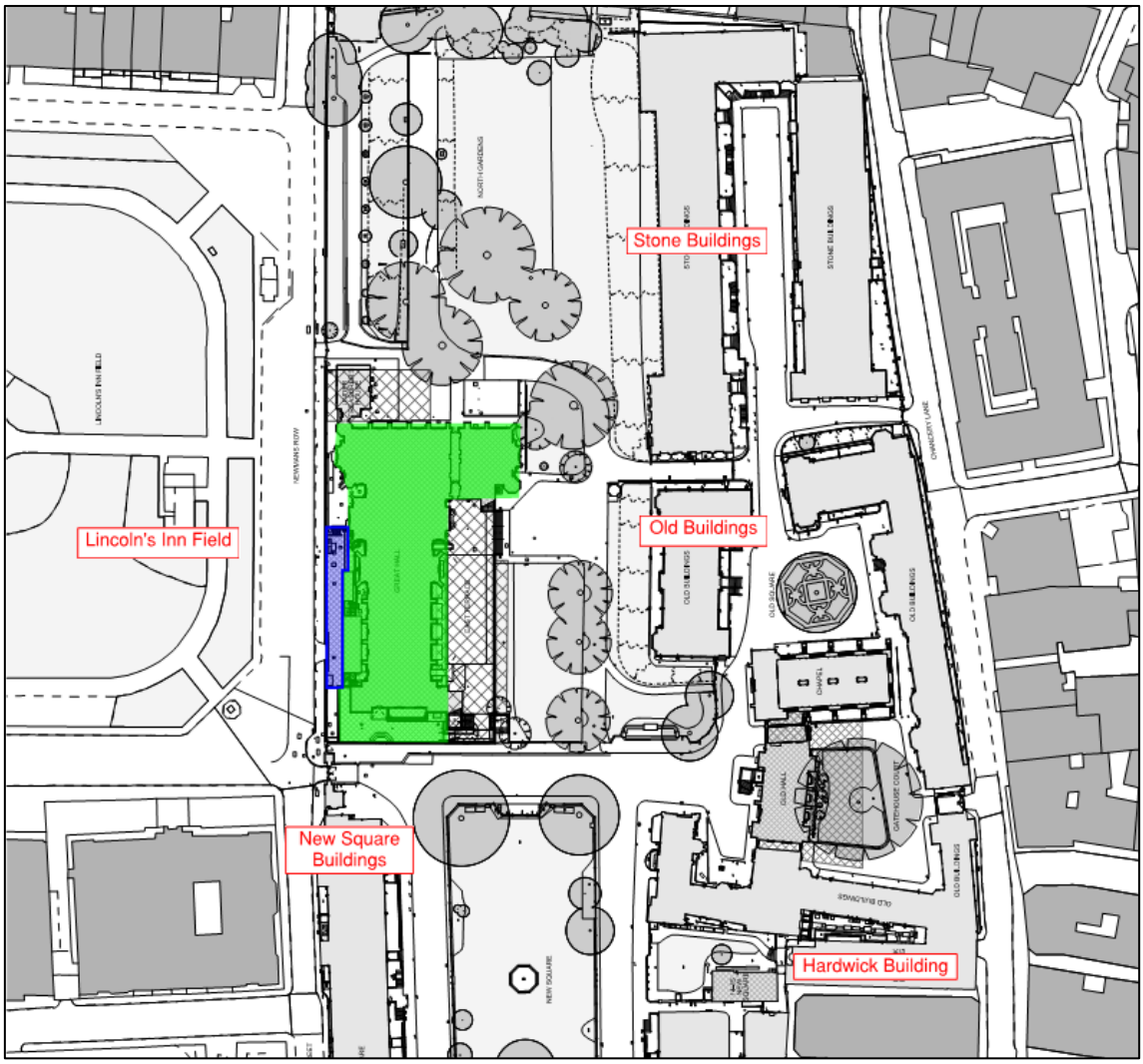

Figure 1 Site plan showing the approximate extent of the Great Hall and surround area

2.2 Adjacent noise sensitive premises

Camden Council provides the definition of 'noise sensitive developments in their Local Plan 2017. This definition (from paragraph 6.95 of the Camden Local Plan 2017) is set out below:

> *'Noise sensitive development includes housing, schools and hospitals as well as offices, workshops and open space. The impacts on external amenity spaces such as gardens and balconies will also be considered. Our supplementary planning document provides further information on how'*

Therefore, nearby residential, educational, medical, and commercial premises need to be considered in this assessment. Noise limits at residential premises and hospitals are applicable over the full operational hours of the plant, as they are generally occupied at all times of the day and night. Noise limits at other noise sensitive premises are typically applicable over the hours of occupation of the sensitive premises.

For the purposes of this assessment, the nearest noise sensitive premises are understood to be:

- Lincoln's Inn Fields, approximately 30 m to the west
- New Square Chambers, approximately 30 m to the south
- Residences and chambers within Old Buildings, approximately 80 m to the east.

3 Plant noise criteria

3.1 Local authority criteria

Planning Condition 10 (LBC ref 2015/4402/P) stipulates the following:

"Prior to operation, details shall be submitted to and approved in writing by the Council, of the external noise level emitted from plant machinery and mitigation measures as stated in report ref: 14463, dated 22nd July 2015 The measures shall ensure that the external noise level emitted from plant equipment will be lower than the lowest existing background noise level by at least 10 dBA as assessed according to BS4142:2014 at the nearest and/or most affected noise sensitive premises, with all machinery operating together at maximum capacity. Approved details shall be implemented prior to occupation of the development and thereafter shall be permanently retained."

Table 1 summarises the noise criteria based on Planning Condition 10.

Table 1 Local authority noise emission criteria

Noise description and location of measurement	Period	Time	Noise level
Noise at 1 metre external to a sensitive facade	Day, evening and night	00:00 – 24:00	10 dBA < $L_{A90,15\ min}$
Noise that has a distinguishable, discrete continuous note (whine, hiss, screech, hum) at 1 metre external to a sensitive facade	Day, evening and night	00:00 – 24:00	15 dBA < $L_{A90,\ 15\ min}$
Noise that has distinct impulses (bangs, clicks, clatters, thumps) at 1 metre external to a sensitive facade	Day, evening and night	00:00 – 24:00	15 dBA < $L_{A90,\ 15\ min}$

3.2 Environmental noise surveys

3.2.1 Unattended logging survey

An environmental noise survey was carried out to determine the existing background noise levels in the area to use as a basis for setting appropriate plant noise limits in line with the requirements of LBC.

The noise survey was performed between 11:00 on 25 February 2015 and 11:00 on 3 March 2015 at three locations around the site. The survey is described in detail in SBA report 14463-R02-B *Environmental noise survey report* dated 22 July 2015.

One of the three survey positions is relevant for the purposes of this assessment, which was at roof level of the south-western corner of the Stone Buildings, approximately 12 m above ground. This is considered to be representative of the noise climate on the western facade of the Old Buildings.

The minimum background noise levels measured at this location were $L_{A90,5min}$ 45/43 dB during the day/night periods.

3.2.2 Attended sample measurements

Additional attended sample measurements were made on 3 February 2016 in order to determine the background noise levels at New Square Chambers and Lincoln's Inn Fields.

These were made over two periods: between 10:43 and 11:48 in the morning, and between 14:03 and 15:10 in the afternoon.

Appendix A summarises the measurement positions, equipment, procedure and results.

Table 2 presents the lowest measured $L_{A90,15\ min}$ (dB) representative of the existing noise levels at the two receptors to the west of the Great Hall.

Table 2 Lowest $L_{A90,15\ min}$ from the attended sample measurements

Location	Lowest measured daytime (07:00 - 23:00) $L_{A90,\ 15\ min}$ (dB)
Facade of New Square Chambers	57
Lincoln's Inn Fields	54

3.3 Plant noise limits

Based on the Planning Condition noise criteria and the survey measurement results, the cumulative noise level resulting from the operation of all new plant at the most affected noise-sensitive receptors should not exceed the limits as set out in Table 3.

Table 3 Plant noise limits at 1 m from the nearest noise sensitive premises

Area of site	Maximum free-field sound pressure level at noise-sensitive receptor, (L_{Aeq} dB)[1]	
	Daytime (07:00-23:00)	Night (23:00-07:00)
North facade of New Square Chambers	47	N/A[2]
Lincoln's Inn Fields	44	N/A[3]

1 If the noise emitted by plant items is tonal or attention-catching in character these limits would be 5 dB lower (refer to Table 1).

2 New Square Chambers are commercial properties and are not expected to be occupied during the night time period.

3 Lincoln's Inn Fields closes at sunset so is not considered sensitive during the night period.

4 Assessment

The plant noise assessment has been based on the as-built information issued by the Mechanical Engineer (Clearwater). The plant items included in the assessment are summarised below. Appendix B presents the full calculation details to the external receptors.

4.1 Plant installation

4.1.1 Plant layout

Externally located plant items within the Western Service Yard are highlighted in Figure 2.

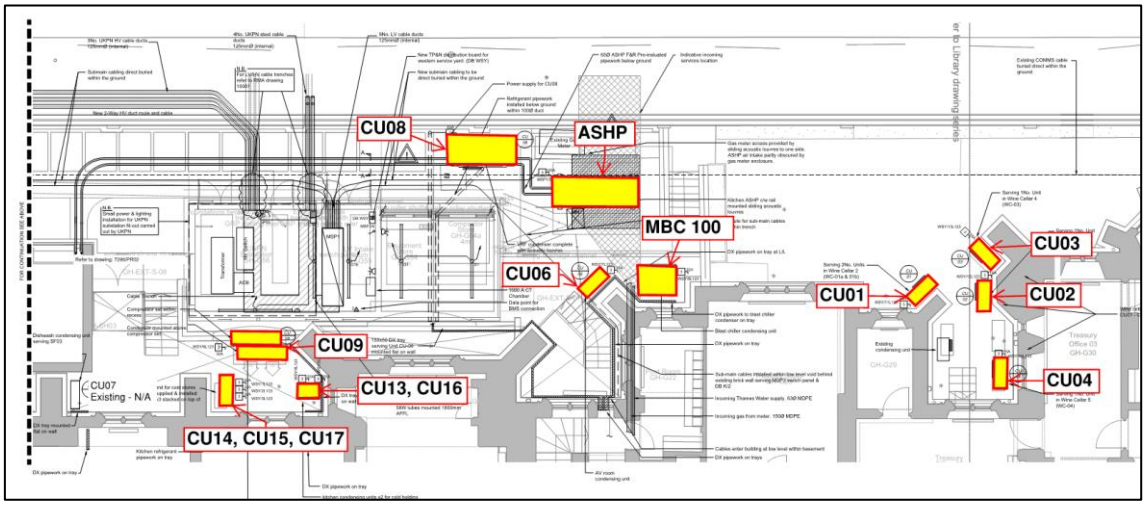

Figure 2 Western Service Yard external plant layout

AHU terminations are highlighted in Figure 3.

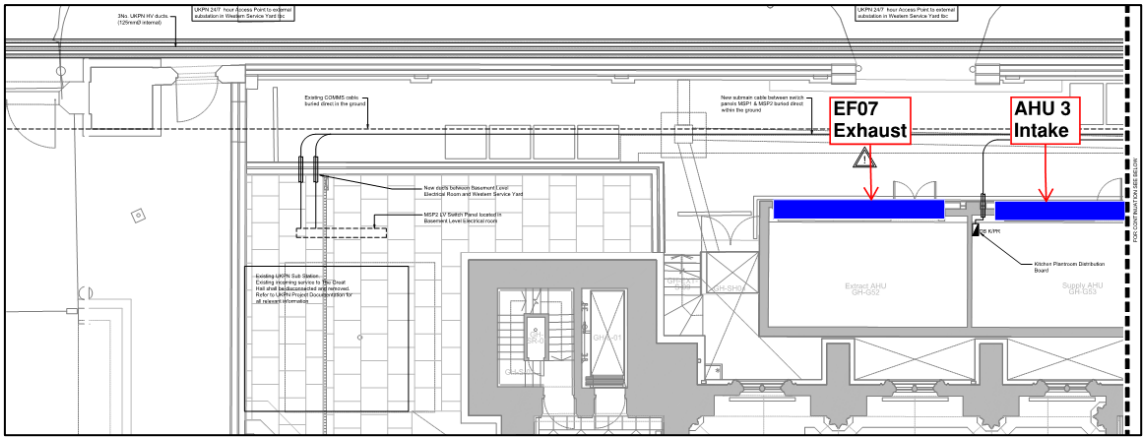

Figure 3 Louvre terminations within the Western Service Yard

4.1.2 Plant noise data

A summary of the plant is provided in Table 4.

Table 4 Summary of plant information

Reference	System/ space served	Make and model
ASHP	Kitchen air source heat pump	Flakt Woods KCBJ-502 with Alloway Acoustics AA303S attenuator package
MBC100	Blast chiller	RCS BC/255-4S/AC16
CU-01	Wine cellar 2	J+E Hall – JEHS-0300-B2-M-3
CU-02	Wine cellar 3	J+E Hall – JEHS-0300-B2-M-3
CU-03	Wine cellar 4	J+E Hall – JEHS-0200-B2-M-3
CU-04	Wine cellar 5	J+E Hall – JEHS-0200-B2-M-3
CU-06	AV/ Server room	Mitsubishi – PUHZ-ZRP100YKA
CU-08	VRF condenser	Mitsubishi – PURY-P450YLM-A1
CU-09	Larder, pastry prep and chilled room	Roller – DHN 403 Condenser Robert C Scutt – SCR-S2-630 Compressor
CU-13	Cold holding, pastry cold room	Robert C Scutt – QH1-25-50 NSP
CU-14	Cold stores, deep freeze	J+E Hall – JEHR-0100-B1-M-1 V3
CU-15	Cold stores, deep freeze	J+E Hall – JEHR-0050-B1-M-1 V3
CU-16	Cold holding, pastry cold room	J+E Hall – JEHS-0200-B2-M3 V3
CU-17	Cold stores, deep freeze	J+E Hall – JEH2-0225-L3 V2
AHU-03	Kitchen supply AHU	Flakt Woods – eQ056
EF-07	Kitchen extract fan	Flakt Woods – HT100JM/40/4/9/17

Acoustic data has been received from Clearwater, taken from the manufacturer's equipment datasheets. Where octave band data is available, this has been used in the assessment of noise egress. Where broadband acoustic information has been provided, this has been used in the assessment.

Broadband acoustic data is provided in Table 5.

Table 5 Broadband plant noise data

Plant reference	Broadband noise level (dB)	Descriptor
CU-01	36	L_{Aeq} at 10 m
CU-02	36	L_{Aeq} at 10 m
CU-03	33	L_{Aeq} at 10 m
CU-04	33	L_{Aeq} at 10 m
CU-09 (compressors)	44	L_{Aeq} at 10 m
CU-13	29	L_{Aeq} at 10 m
CU-14	30	L_{Aeq} at 10 m
CU-15	30	L_{Aeq} at 10 m
CU-16	33	L_{Aeq} at 10 m
CU-17	38	L_{Aeq} at 10 m

Table 6 provides a summary of the available octave band acoustic data.

Table 6 Octave band plant noise data

Plant reference	Descriptor	Octave-band centre frequency (Hz)							
		63	125	250	500	1000	2000	4000	8000
CU-06	L_{eq} at 1 m (dB)	54	54	53	49	46	41	36	29
CU-08	L_{eq} at 1 m (dB)	73	70	65	61	56	51	47	41
CU-09 Condenser	L_{wA} at 960 rpm[1] (dB)	46	62	67	73	77	74	68	60
AHU-3 Inlet	L_w (dB)	73	81	82	79	69	69	65	60
AHU-3 Case radiated	L_w (dB)	67	71	66	56	46	48	44	30
EF-07 Exhaust	L_w (dB)	106	102	103	102	97	97	96	88
EF-07 Case radiated	L_w (dB)	96	79	75	75	70	68	75	65
ASHP	L_w (dB)	62	78	83	77	75	77	69	65
MBC100	L_{Aw} (dB)	55	63	66	66	70	71	69	63

[1] Design speed is 870 rpm. Acoustic data closest to design speed is 960 rpm

The atmosphere side connections of AHU 3 and EF-07 have attenuators connected to them. The insertion loss of the attenuators is provided in Table 7.

Table 7 Attenuator performances

Plant reference	Descriptor	Octave-band centre frequency (Hz)							
		63	125	250	500	1k	2k	4k	8k
ATT-09, AHU-3 Inlet Caice SG01H/3C/L/S 1200 mm long	Insertion loss, (dB)	6	9	16	32	46	32	21	16
ATT-17, EF-7 Exhaust Caice SG02V/2C/L/SM 2400 mm long	Insertion loss, (dB)	12	18	32	55	55	46	27	17

4.2 Receptors

4.2.1 External receptors

The locations of nearby noise-sensitive receptors are indicated in Figure 1.

Lincoln's Inn Fields and New Square Chambers are the most affected nearby noise sensitive receptors. All other receptors are either further from the Western Service Yard or heavily screened by the massing of the Great Hall.

4.3 Predicted noise levels

The predicted noise levels at external receptors and at the facade of the Great Hall are summarised in this section. The full calculations to external receptors are included in Appendix B. Calculations have taken into account the distance between plant items and receptors, reflections and screening.

The reduction in noise from barriers due to screening has been calculated based on the site geometry. Where only broadband acoustic plant information is available, the attenuation from barriers at 500 Hz has been used in the calculations.

4.3.1 Predicted noise levels

The predicted maximum noise levels at the most affected noise-sensitive receptors, assuming the worst-case scenario of all plant operating simultaneously, are summarised in Table 8.

Table 8 Predicted sound pressure levels at noise sensitive receptor

Location		Planning noise limit	
	Predicted sound pressure level, L_{Aeq} (dB)	Night time (23:00 – 07:00) $L_{Aeq,8\ hr}$ (dB)	Daytime (07:00 – 23:00) $L_{Aeq,16\ hour}$ (dB)
Lincoln's Inn Fields	42	N/A	44
New Square Chambers	42[1]	N/A	47

[1] The predicted noise levels at building facades include a +3 dB facade effect.

The planning noise limits are not expected to be exceeded at any point during the day or night time periods.

5 Discussion and conclusion

An assessment of noise emissions from installed items of building services plant associated with the Western Service Yard has been undertaken, based on as-built information provided by Clearwater.

The assessment demonstrates that the installed plant is compatible with the local authority planning requirements for noise egress., as stipulated in Planning Condition 10.

Appendix A

Attended sample measurements

Measurement locations

The measurement locations are marked-up in Figure 4.

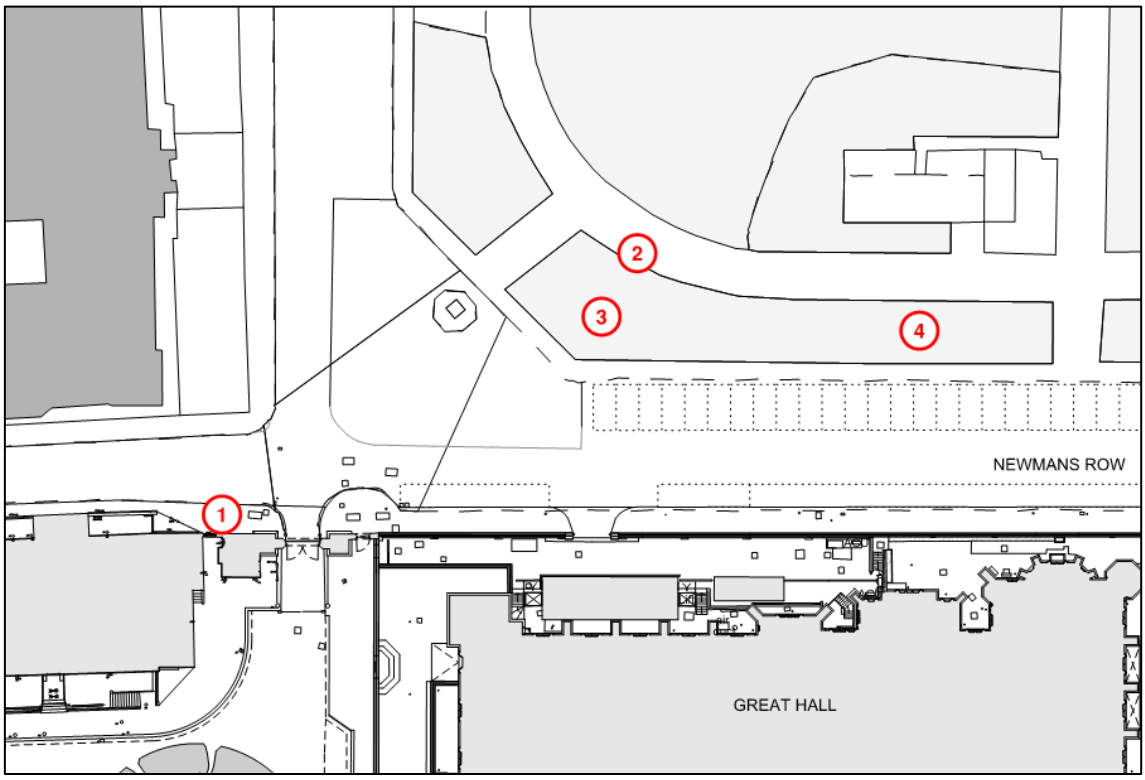

Figure 4 Sample measurement locations

Figure 5 to Figure 9 present photos taken of each measurement position.

Figure 5 Measurement position 1 - AM

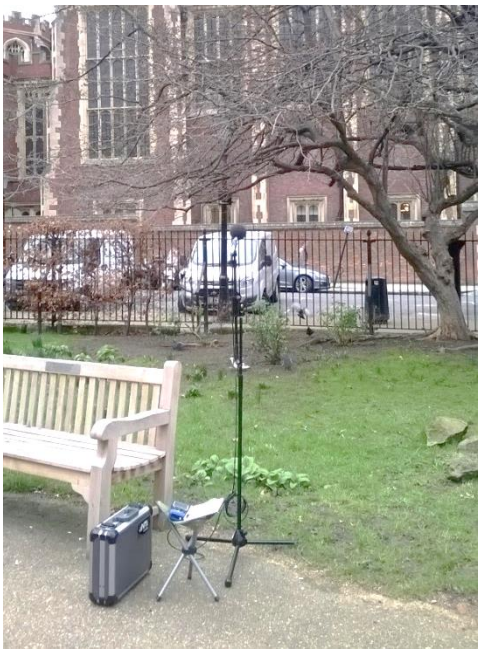

Figure 6 Measurement position 2 - AM

Figure 7 Measurement position 3 - PM

Figure 8 Measurement position 1 - PM

Figure 9 Measurement position 4 - PM

Measurement procedure

The microphone was mounted on a tripod or microphone stand at least 1.2 m above the ground, as shown in Figure 5 to Figure 9.

At position 1 the microphone was approximately 1 m from the facade, at the other positions the microphone was more than 1 m from any reflective surfaces.

Measurements of L_{eq} and L_{90} were made over 15 minute periods in 1/3 octave frequency bands between 20 Hz and 20 kHz.

Measurement results

Table 9 presents the measurement results from the attended sample measurements.

Table 9 Attended measurement results summary

Measurement	Position	Start time	Duration (minutes)	$L_{A90,\ 15\ min}$ (dB)	$L_{Aeq,\ 15\ min}$ (dB)
1	1	10:43	15	58	66
2	2	11:00	15	56	61
3	1	11:17	15	57	64
4	2	11:33	15	57	61
5	3	14:03	15	54	59
6	1	14:20	15	58	66
7	4	14:38	15	54	59
8	1	14:55	15	58	65

Equipment and calibration information

The test equipment listed in Table 10 was used for the measurements.

Table 10 Equipment used for sound insulation measurements

Equipment description	Type/serial number	Manufacturer	Calibration expiry	Calibration certification number
Sound level meter	NL-52/00242702	Rion	4 Jun 17	1506331
Microphone	UC-59/06185	Rion	4 Jun 17	1506331
Pre-amp	NH-25/32730	Rion	4 Jun 17	1506331
Calibrator	CAL200/4499	Larson Davis	4 Jun 17	1506327
Sound level meter	XL2-TA/A2A-09251-E0	NTi Audio	26 Apr 17	1503196
Microphone	MC230/8391	NTi Audio	26 Apr 17	1503196
Pre-amp	MA220/5159	NTi Audio	26 Apr 17	1503196
Calibrator	SVA30A/10565	Svantek	27 Jan 17	1501063

Calibration of the sound level meters used for the tests is traceable to UKAS accredited laboratories. The calibration certificates for the sound level meters used in this survey are available upon request.

The sound level meters and microphones were calibrated at the beginning and end of the measurements using their respective sound level calibrators. No significant deviation in calibration occurred.

Appendix B

Calculations to external receptors

Where several noise sources share a common propagation path to the external receptors, they have been grouped together into 'clusters' which are summarised in Table 11. Where octave band acoustic data has been provided for the units, these have been used in the calculations; the summary presented here shows the equivalent broadband level for the units.

Table 11 Clusters of plant for assessment

Noise source	
Cluster 1	L_{Aeq} 36 dB at 10 m
CU-01	L_{Aeq} 36 dB at 10 m
CU-02	L_{Aeq} 36 dB at 10 m
CU-04	L_{Aeq} 36 dB at 10 m
Total	L_{Aeq} 41 dB at 10 m
Cluster 2	
CU-06	L_{Aeq} 31 dB at 10 m
MBC100	L_{Aeq} 47 dB at 10 m
Total	L_{Aeq} 47 dB at 10 m
Cluster 3	
CU-08	L_{Aeq} 42 dB at 10 m
ASHP [1]	L_{Aeq} 32 dB at 10 m
Total	L_{Aeq} 43 dB at 10 m
Cluster 4	
CU-13	L_{Aeq} 29 dB at 10 m
CU-14	L_{Aeq} 30 dB at 10 m
CU-15	L_{Aeq} 30 dB at 10 m
CU-16	L_{Aeq} 33 dB at 10 m
CU-17	L_{Aeq} 38 dB at 10 m
Total	L_{Aeq} 40 dB at 10 m
CU-09 (1) Condenser	L_{Aeq} 54 dB at 10 m
CU-09 (2) Compressors	L_{Aeq} 44 dB at 10 m
AHU-03 Intake(including case radiated noise)[1]	L_{Aeq} 31 dB at 10 m
EF-07 Exhaust (including case radiated noise) [1]	L_{Aeq} 50 dB at 10 m

[1] The sound pressure level includes the effect of the attenuation package / attenuators

The calculations of the noise levels at external receptors are detailed in Table 12 and Table 13.

Lincoln's Inn Fields

Table 12 Calculation to Lincoln's Inn Fields

	Noise source							
	Cluster 1	Cluster 2	Cluster 3	Cluster 4	CU-09 (1)	CU-09 (2)	AHU-3	EF-7
L_{Aeq} (dB) at 10 m	41	47	43	40	54	44	31	50
Distance (m)	27	27	24	30	28	28	25	25
Distance attenuation re 10 m	-9	-9	-8	-10	-9	-9	-8	-8
Reflections (dB)	6	6	6	6	6	6	3	3
Screening (dB)	-11	-10	-13	-12	-16	-14	-5	-5
Level at receptor, L_{Aeq} (dB)	27	32	30	24	33	27	21	40

The total noise level from the operation of all new plant items at Lincoln's Inn Field is L_{Aeq} 42 dB.

New Square Chambers

Table 13 Calculation to New Square Chambers

	Noise source							
	Cluster 1	Cluster 2	Cluster 3	Cluster 4	CU-09 (1)	CU-09 (2)	AHU-3	EF-7
L_{Aeq} (dB) at 10 m	41	47	43	40	54	44	31	50
Distance (m)	81	66	66	56	56	56	47	43
Distance attenuation re 10 m	-17	-16	-16	-15	-15	-15	-13	-13
Reflections (dB)	6	6	6	6	6	6	3	3
Screening (dB)	-6	-13	-	-16	-13	-11	-5	-5
Level at receptor, L_{Aeq} (dB)	24	24	32	15	32	24	16	35

The total noise level from the operation of all new plant items at New Square Chambers is L_{Aeq} 42 dB; this includes a 3 dB correction for the facade effect.