MINERVA HOUSE, HATTON GARDEN, LONDON

Acoustic Assessment

REPORT 7346/ AAR
Prepared: 26 August 2016
Revision Number: 1

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Acoustic Assessment

MINERVA HOUSE,

HATTON GARDEN,

LONDON

REPORT 7346/AAR

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Revision	Comment	Date	Prepared By	Approved By
0	First issue of report	24 March 2016	Mike Fuller	Richard Keeble
1	Updated plant design	26 August 2016	Mike Fuller	Richard Keeble

Terms of contract:

RBA Acoustics Ltd has prepared this report in accordance with our Scope of Work 7346/MF dated 2 March 2016. RBA Acoustics Ltd shall not be responsible for any use of the report or its contents for any purpose other than that for which it was provided. Should the Client require the distribution of the report to other parties for information, the full report should be copied. No professional liability or warranty shall be extended to other parties by RBA Acoustics Ltd without written agreement from RBA Acoustics Ltd.

The recommendations within this report relate to acoustics performance only and will need to be integrated within the overall design by the lead designer to incorporate all other design disciplines such as fire, structural integrity, setting-out, etc. Similarly, any sketches appended to this report illustrate acoustic principles only and again will need to be developed in to full working drawings by the lead designer to incorporate all other design disciplines.

In line with our Environmental Policy, up to two hard copies of the report will be provided upon request. Additional copies of the report, or further hard copies of revised reports, would be subject to an administrative cost of £20.00 (+VAT) per copy.

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1.0 INTRODUCTION

It is proposed to refurbish the existing Minerva House building, 25-26 Hatton Garden, London to provide new offices over ground to fifth floor level with the inclusion of new building services plant, a new fourth floor and side lightwell extensions to the rear and amenity terrace spaces serving the offices. As part of the planning application, the London Borough of Camden requires consideration be given to atmospheric noise emissions from the proposed equipment at the nearest noise-sensitive property.

RBA Acoustics have been commissioned to undertake measurements of the prevailing noise conditions at the site and to determine the atmospheric noise emissions in accordance with London Borough of Camden's requirements. This report presents the results of the noise measurements, associated criteria and provides the required plant noise assessment. In addition an assessment of the terrace area noise impact on the nearest noise sensitive residences has been made.

This report is based upon application drawings and details and is suitable for submission with the planning application.

2.0 ENVIRONMENTAL NOISE SURVEY

2.1 General

In accordance with the requirements of the Local Authority, monitoring of the prevailing background noise was undertaken over the following periods:

Monday 14th to Tuesday 15th March 2016

During the survey periods the weather conditions were generally appropriate for the noise measurement exercise, it being dry with light winds.

Measurements were made of the L_{A90}, L_{Amax} and L_{Aeq} noise levels over sample periods of 15 minutes duration. Measurements were undertaken in full accordance with BS7445.

2.2 Measurement Locations

Position 1

Measurements were undertaken with the microphone positioned 1m from the façade at fifth floor level to the front of Minerva House along Hatton Garden. This measurement position was considered as being representative of the noise climate as experienced at the closest residential receptors to the proposed plant on the roof of the property. The prevailing noise climate was noted to consist of noise associated with the road traffic movements along Hatton Garden and the wider surrounding area.

Position 2

Measurements were undertaken with the microphone positioned on a tripod 1.2m above roof level to the rear of the property. This measurement position was considered as being representative of the noise climate as experienced at the closest residential receptors to plant located to the rear of the property. Noise levels at this measurement position were affected by road traffic along the wider surrounding area and building services plant belonging to the existing adjacent offices, however, the measurement position was chosen to minimise the influence of these where possible.

The measurement positions are also illustrated on the attached Site Plans 7346/SP1 and Photographs 7346/P1 and 7346/P2.

2.3 Instrumentation

The following equipment was used for the measurements.

Table 7346/T1 – Equipment Details

Manufacturer	Model Type	Serial No.	Calibration	
			Certificate No.	Expiry Date
01dB A&V Type 1 Sound Level Meter	Black Solo 01	65687	U20775	16 February 2018
01dB A&V Pre Amplifier	PRE 21 S	20799		
01dB A&V ½" Microphone	MCE 212	94043		
01dB-Stell Calibrator	Cal 21	51231453(2013)	U20774	16 February 2018
Norsonic Type 1 Sound Level Meter	Nor140	1406262	471261961	17 March 2017
Norsonic Pre Amplifier	1209	20487		
Norsonic ½" Microphone	1225	225566		
Norsonic Sound Calibrator	1251	34429	CAL 022-2015-5348	20 May 2017

The sound level meters were calibrated both prior to and on completion of the survey with no calibration drifts observed.

3.0 RESULTS

The noise levels at the measurement positions are shown as time-histories on the attached charts 7346/G1 to G4

In order to ensure a worst case assessment the lowest background L_{A90} noise levels measured have been used in our analyses. The lowest L_{A90} and the period averaged L_{Aeq} dB noise levels measured are summarised below. In addition the lowest measured L_{Aeq} dB noise levels are shown for comparison in the assessment of terrace noise.

Table 7346/T2 – Measured Levels

Measurement Period	Position 1			Position 2		
	L_{eq} (dBA)	Lowest L_{eq} (dBA)	L_{90} (dBA)	L_{eq} (dBA)	Lowest L_{eq} (dBA)	L_{90} (dBA)
Daytime (07:00 – 23:00)	61	54	48	53	47	46
Night-time (23:00 – 07:00)	55	48	44	47	44	43
Office hours (08:00-20:00)	61	58	51	54	49	48

4.0 PLANT NOISE ASSESSMENT

Our assessment has been based upon the following information:

4.1 Plant Operating Hours

We understand the plant items are to operate during office hours (08:00-20:00 hours); as such, our assessment of the plant has been based on the prevailing noise levels measured during this time period at the site.

4.2 Criteria

National Planning Policy Framework

The National Planning Policy Framework (NPPF), March 2012, sets out the Government's planning policies for England. In respect of noise, Paragraph 123 of the NPPF states the following:

Planning policies and decisions should aim to:

- Avoid noise from giving rise to significant adverse impacts on health and quality of life as a result of new development;
- Mitigate and reduce to a minimum other adverse impacts on health and quality of life arising from noise from new development, including through the use of conditions;
- Recognise that development will often create some noise and existing businesses wanting to develop in continuance of their business should not have unreasonable restrictions put on them because of changes in nearby land uses since they were established;
- Identify and protect areas of tranquillity which have remained relatively undisturbed by noise and are prized for their recreational and amenity value for this reason.

The above presents no quantitative guidance on a site's suitability for residential development and we have therefore, for the purposes of this assessment, made reference to the following documents.

Noise Policy Statement for England

The Department for Environment Food and Rural Affairs published the Noise Policy Statement for England (NPSE) in March 2010. The explanatory note of NPSE defines the following terms used in the NPPF:

NOEL – No Observed Effect Level
This is the level below which no effect can be detected. In simple terms, below this level, there is no detectable effect on health and quality of life due to the noise.

LOAEL – Lowest Observed Adverse Effect Level
This is the level above which adverse effects on health and quality of life can be detected.

Extending these concepts for the purpose of this NPSE leads to the concept of a significant observed adverse effect level.

SOAEL – Significant Observed Adverse Effect Level
This is the level above which significant adverse effects on health and quality of life occur."

The NPSE does not define any of the above effect levels numerically.

The NPSE presents the Noise Policy Aims as:
"Through the effective management and control of environmental, neighbour and neighbourhood noise within the context of Government policy and sustainable development:

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

It can be seen that the first two bullet points are similar to Section 11 of the NPPF, with a third aim that seeks to improve health and quality of life. The NPSE later expands on the Noise Policy Aims, stating:

The first aim of the NPSE states that significant adverse effects on health and quality of life should be avoided while also taking into account the guiding principles of sustainable development.

The second aim of the NPSE refers to the situation where the impact lies somewhere between LOAEL and SOAEL. It requires that all reasonable steps should be taken to mitigate and minimise adverse effects on health and quality of life while also taking into account the guiding principles of sustainable development. This does not mean that such adverse effects cannot occur.

This aim (the third aim), seeks where possible, positively to improve health and quality of life through the pro-active management of noise while also taking into account the guiding principles of sustainable development, recognising that there will be opportunities for such measures to be taken and that they will deliver potential benefits to society. The protection of quiet places and quiet times as well as the enhancement of the acoustic environment will assist with delivering this aim."

It is clear that noise described in the NPSE as SOAEL that would lead to significant adverse effects should be avoided, although there is no definition as to what constitutes a significant adverse effect. Similarly, noise should be mitigated where it is high enough to lead to adverse effects, termed the LOAEL, but not so high that it leads to significant adverse effects.

Camden Local Development Framework

The general requirements of Camden Council for noise from mechanical plant items are outlined within the Camden Local Development Framework: Camden Development Policies (2010). Table E: *Noise levels from plant and machinery at which planning permission will not be granted.* This table is reproduced in Table 7346/T3 for convenience.

Table 7346/T3 – Table E from Camden LDF (2010)

Noise Description and measurement location	Period	Time	Noise Level
Noise at 1 metre external to a sensitive façade	Day, evening and night	0000 - 2400	5dB(A) <LA90
Noise that has a distinguishable discrete continuous note (whine, hiss, screech, hum) at 1 metre external to a sensitive façade.	Day, evening and night	0000 - 2400	10dB(A) <LA90
Noise that has distinct impulses (bangs, clicks, clatters, thumps) at 1 metre external to a sensitive façade.	Day, evening and night	0000 - 2400	10dB(A) <LA90
Noise at 1 metre external to a sensitive façade where LA90>60dB	Day, evening and night	0000 - 2400	55dB L_{Aeq}

In-line with the Camden Council's requirements, we propose that L_{Aeq} average noise levels at the nearest noise sensitive façade should be 5dB below the minimum $L_{A90,15min}$ noise level measured during the proposed plant operating hours.

Based on the standard Camden Council criteria, noise levels at the nearest noise sensitive façade should therefore be below the criteria provided in Table 7346/T4

Table 7346/T4 – Plant Noise Emission Level Criteria

Measurement Period	Position 1	Position 2
Office Hours (08:00 – 20:00)	46	43

In terms of the NPSE meeting the above criteria should be considered as equivalent to the NOEL.

4.3 Proposed Plant Items

Front roof

7No. Mitsubishi PURY-EP350YLM-A(-BS) Condensing Units
1No. Nuaire ES-OPUSDC Toilet Extract Fan (Internal, ducted to roof)

Rear roof

1No. Nuaire XBOXER XBC45-H-EES Air Handling Unit with manufacturer's 1050mm attenuators
1No. Nuaire AVT6-X Toilet Extract Fan (External)

4.4 Position of Units

The condenser units are generally to be located on the fifth floor roof of the front section of the building along Hatton Garden. In addition, a single toilet extract fan is to be located internally and ducted to the front roof. The air handling unit and the AVT6-X toilet extract fan are to be located on the rear roof at fourth floor level. The equipment positions are indicated on the attached Site Plans 7346/SP1 and 7346/SP2.

4.5 Noise Levels

Information regarding the noise levels of the proposed plant has been provided by the manufacturers of the units. The octave band noise levels of the units are detailed as follows:

Table 7346/T5 – Manufacturer's Noise Levels

Unit	Parameter	Sound Level (dB) at Octave Band Centre Frequency (Hz)							
		63	125	250	500	1k	2k	4k	8k
Mitsubishi PURY-EP350YKM-A (Standard Mode)	Lp at 1m (Anechoic)	73.5	68.5	64.5	61.5	55.5	48.0	43.0	37.5
Nuaire ES-OPUSDC40-2M (Front Toilet Extract Fan)	Lw induct outlet	64	64	56	53	52	49	42	34
Nuaire XBOXER XBC45-H-EES Air Handling Unit	Lw induct intake	77	69	69	58	58	56	47	39
	Lw induct discharge	82	75	79	65	66	66	60	58
	Lw Casing Radiated	68	59	56	41	39	38	34	23
Nuaire AVT6-X Toilet Extract Fan (Rear)	Lw induct outlet	76	78	71	68	59	57	53	46
	Lw Casing Radiated	68	65	54	42	25	23	27	16

Review of the octave band data concludes that there are no tonal characteristics associated with the proposed plant.

4.6 Location of Nearest Residential Windows

The closest residential windows to the proposed condenser roof plant location are understood to be the sixth and seventh windows of 87 Hatton Garden, approximately 25m from the plant locations. The closest residential windows to the toilet extract fan on the rear fourth floor rear are understood as belonging to the rear of 35 Greville Street, approximately 9m from the plant items.

4.7 Mitigation Measures

In order to ensure compliance with the target noise criteria, we recommend the 7No. condenser units have an acoustically louvred surrounding screen. The louvres should be capable of achieving the octave band transmission loss values shown in Table 7346/T6; an example of such an enclosure is Allaway Acoustics's AL1515 150mm deep louvre.

Table 7346/T6 – Required Condenser Louvred Surround Transmission Loss

Transmission Loss (dB) at Octave Band Centre Frequency (Hz)							
63	125	250	500	1k	2k	4k	8k
4.0	4.0	5.0	8.0	12.0	16.0	15.0	13.0

Adoption of the above screen would ensure that noise levels from the condensers are within the target criteria at the closest noise-sensitive receptor.

4.8 Calculation of Noise Levels at Nearest Residential Window

Our calculation method for predicting noise levels from the proposed air conditioning units at the nearest residential window, based on the information stated above, is summarised below.

- Source Term SPL
- Reflections
- 20LogR Distance Attenuation
- Louvred screen attenuation

Our calculation method for predicting noise levels from the proposed air handling units at the nearest residential window, based on the information stated above, is summarised below.

- Source Term Induct Lw
- Grille end reflections
- Reflections
- SWL to SPL correction
- 20LogR Distance attenuation
- Screening via building edge

Calculation sheets are attached for further information in Appendix B.

The results of the calculations indicate the following noise levels at the nearest affected residential windows with mitigation measures:

Table 7346/T7 – Predicted Noise Levels

Operating Period	Position 1		Position 2	
	Prediction	Criterion	Prediction	Criterion
Office Hours (08:00 – 20:00)	42	46	38	43

Table 7346/T7 illustrates that noise from the proposed plant items satisfies the target criteria at the closest noise-sensitive residential receivers, provided that the mitigation measured described in Sections 4.7 are employed. In terms of the NPSE meeting the criterion could be considered as equivalent to the NOEL.

4.9 Vibration Control

In addition to the control of airborne noise transfer, it is also important to consider the transfer of noise as vibration to adjacent properties (as well as to any sensitive areas of the same building).

We would typically advise the condenser units and extract fan be isolated from the supporting structure by means of rubber pads. The AHU and toilet extract fans should have neoprene in shear isolators achieving a static deflection of 4mm beneath the fan/motor frame and isolated externally with pads achieving 2mm (min) deflection. For particularly sensitive locations, or when on lightweight structures the mounts should ideally be caged and be of the restrained type.

It is important the isolation is not "short-circuited" by associated pipework or conduits. To this end, any conduits should be looped and flexible connectors should be introduced between the condenser and any associated pipework. Pipework should be supported by brackets containing neoprene inserts.

5.0 TERRACE NOISE IMPACT ASSESSMENT CRITERIA

5.1 Institute of Environment Management & Assessment (IEMA) and Institute of Acoustics Guidelines on Noise Impact Assessment

When assessing the subjective impact of any development it is important to consider the specific circumstances of the site. The characteristics of the various sources must therefore be considered in addition to factors common to all noise impact assessments such as existing background noise level comparisons.

The joint Institute of Acoustics (IOA) and Institute of Environmental Management and Assessment (IEMA) document "Guidelines For Environmental Noise Impact Assessment" gives guidance as to how basic noise changes may be categorised.

Table 7346/T8 has been adopted to categorise the change between the measured levels.

Table 7346/T8- Significance of Noise Level Change

Noise Change (dBA)	Effect
0.0-2.9	Not Significant
3.0 – 4.9	Moderate
5.0 – 9.9	Substantial
10.0 and above	Very Substantial

In addition to the comparison of the difference in ambient noise levels it is important to understand the potential subjective effect of such changes in the noise level. Table 7346/T9 compares the subjective response of typical subjects to variations in sound pressure level.

Table 7346/T9 – Subjective Response to Noise Levels

Change In Sound Level (dB)	Change in Power		Apparent Change in Loudness
	Decrease	Increase	
3	1/2	2	Just Perceptible
5	1/3	3	Clearly Noticeable
10	1/10	10	Half or Twice as Loud
20	1/100	100	Much Quieter or Louder

5.2 WHO Community Noise Guidelines

To put the predicted levels into context, it is important to consider the recommendations stated in the World Health (WHO) Organisation document "Guidelines for Community Noise". This document describes guideline levels that are "essentially values for the onset of health effects from noise exposure".

A table of guideline values is included, relating to adverse health effects, referred to as any temporary or long term deterioration in physical, psychological, or social functioning that is associated with noise exposure. The following is an extract from the Table 4.1: Guideline values for community noise in specific environments, as stated in the WHO document.

Table 7346/T10 – Guideline Values for Community Noise

Specific Environment	Critical Health Effect(s)	L_{Aeq} (dB)	Time Base (hours)	$L_{Amax,f}$ (dB)
Outdoor living area	Serious annoyance, daytime and evening	55	16	-
	Moderate annoyance, daytime and evening	50	16	-
Dwelling, indoors	Speech intelligibility and moderate annoyance, daytime and evening	35	16	-
Inside bedrooms	Sleep disturbance, night-times	30	8	45
Outside bedrooms	Sleep disturbance, window open (outdoor values)	45	8	60

6.0 TERRACE NOISE IMPACT ASSESSMENT

It is proposed to refurbish to provide new terrace areas at both the roof of the fourth floor extension and a smaller terrace at fourth floor level along Greville Street.

As there are nearby existing residential dwellings to the rear of 35 Greville Street consideration needs to be given to the noise associated with the occupants within the rear terrace area at these nearest noise sensitive properties. As such, assessments have been made of noise emission levels at the adjacent properties based on the proposed layouts.

6.1 Assumptions

From our site visit and the location plans it is understood the closest windows will be those of the 35 Greville Street.

6.2 CadnaA Model

A detailed 3-dimensional model of the proposed terrace area noise propagation has been made in the acoustic modelling software CadnaA to predict and assess the associated noise levels. The software calculates the propagation of noise using the methods set out in ISO 9613-2: 1996 Attenuation of sound during propagation outdoors. The model allows computation of noise levels taking into account effects such as edge diffraction, reflections, barrier attenuation and atmospheric conditions.

The models have been used to predict the noise levels at the neighbouring properties for the following situation and sources under a worst-case assessment:

- Main roof terrace – 20No. patrons speaking concurrently
- Smaller fourth floor roof terrace – 10No. patrons speaking concurrently

The following octave band sound power levels (L_w) for speech have been used in this assessment (from the ANSI 3.5:1997 and acoustic modelling program ODEON) which have been verified against measurements made on previous projects:

Table 7346/T11 – Speech Noise Levels

Source	Parameter	Sound Power Level (dB) at Octave Band Centre Frequency (Hz)							
		63	125	250	500	1k	2k	4k	8k
Normal Voice	Lw	45	55	65	69	63	56	50	45

6.3 Results

The results of the assessment are shown below and visually on the attached image CadnaA 7346/Cad1.

Table 7346/T12 – Predicted Noise Levels

Worst-case Receiver	Worst-case Noise Level at Nearest Residential Windows		
	Lowest measured $L_{Aeq,15minute}$ noise level (08:00-20:00 hours) (dB)	Predicted Receive Noise Level (dB)	Resultant Change in L_{eq} (dB)
35 Greville Street Rear Windows	49	40	0.5

6.4 Discussion

According to the IEMA and IOA Significance of Noise Level Change criteria outlined in Table 7346/T8, the noise emissions from the proposed terrace areas are therefore in the category of *"Not Significant"* in the worst case and there would be no perceptible change to the local noise climate at the worst affected adjacent properties. As such, it is considered that the noise levels from the proposed roof terraces are not likely to unduly affect the nearest residences and planning permission should not be refused on the basis of noise disturbance.

7.0 CONCLUSION

Measurements of the existing background noise levels at Minerva House, London have been undertaken. The results of the measurements have been used in order to determine the required criteria for atmospheric noise emissions from the future plant installations and for comparison to predicted noise levels from occupants of the proposed terrace areas.

The results of the assessment indicate atmospheric noise emissions from the plant are within the criteria required by the London Borough of Camden providing the outlined mitigation measures outlined herein are implemented. As such, the proposed plant installations should be considered acceptable with the London Borough of Camden criteria and NPPF.

In addition, noise emissions from occupants of the proposed terraces have been assessed are considered to have negligible impact on the adjacent residences, under worst-case assumptions.

Appendix A - Acoustic Terminology

dB	Decibel - Used as a measurement of sound pressure level. It is the logarithmic ratio of the noise being assessed to a standard reference level.
dB(A)	The human ear is more susceptible to mid-frequency noise than the high and low frequencies. To take account of this when measuring noise, the 'A' weighting scale is used so that the measured noise corresponds roughly to the overall level of noise that is discerned by the average human. It is also possible to calculate the 'A' weighted noise level by applying certain corrections to an un-weighted spectrum. The measured or calculated 'A' weighted noise level is known as the dB(A) level. Because of being a logarithmic scale noise levels in dB(A) do not have a linear relationship to each other. For similar noises, a change in noise level of 10dB(A) represents a doubling or halving of subjective loudness. A change of 3dB(A) is just perceptible.
L_{eq}	L_{eq} is defined as a notional steady sound level which, over a stated period of time, would contain the same amount of acoustical energy as the actual, fluctuating sound measured over that period (1 hour).
L_{Aeq}	The level of notional steady sound which, over a stated period of time, would have the same A-weighted acoustic energy as the A-weighted fluctuating noise measured over that period.
L_{An} (e.g L_{A10}, L_{A90})	If a non-steady noise is to be described it is necessary to know both its level and the degree of fluctuation. The L_n indices are used for this purpose, and the term refers to the level exceeded for n% of the time, hence L_{10} is the level exceeded for 10% of the time and as such can be regarded as the 'average maximum level'. Similarly, L_{90} is the average minimum level and is often used to describe the background noise.
$L_{max,T}$	The instantaneous maximum sound pressure level which occurred during the measurement period, T. It is commonly used to measure the effect of very short duration bursts of noise, such as for example sudden bangs, shouts, car horns, emergency sirens etc. which audibly stand out from the general level of, say, traffic noise, but because of their very short duration, maybe only a very small fraction of a second, may not have any effect on the L_{eq} value.

Appendix B – Plant calculations

Example Calculation 1 - Condenser Units

Unit	Octave band Noise Level (dB) per frequency (Hz)								
	63	125	250	500	1000	2000	4000	8000	dBA
Manufacturer's Lp at 1m	73.5	68.5	64.5	61.5	55.5	48	43	37.5	62.5
Number of units correction (7No.)	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5	
Reflections	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	
Distance Loss (25m)	-28.0	-28.0	-28.0	-28.0	-28.0	-28.0	-28.0	-28.0	
Acoustic Louvre Transmission loss	-4.0	-4.0	-5.0	-8.0	-12.0	-16.0	-15.0	-13.0	
Received Noise Level	56.0	51.0	46.0	40.0	30.0	18.5	14.5	11.0	41.9

Example Calculation 2 - Air Handling Unit Discharge Noise

Unit	Octave band Noise Level (dB) at Octave Band Centre Frequency (Hz)								
	63	125	250	500	1000	2000	4000	8000	dBA
AHU Atmospheric discharge Lw	82	75	79	65	66	66	60	58	
Grille End Reflection	-10	-5	-2	0	0	0	0	0	
Reflections (hemispherical)	3	3	3	3	3	3	3	3	
Lw to Lp correction	-11	-11	-11	-11	-11	-11	-11	-11	
Distance Loss (9m)	-19.1	-19.1	-19.1	-19.1	-19.1	-19.1	-19.1	-19.1	
Directivity	-1.5	-2	-3.5	-7.5	-9	-8.5	-8	-8	
Screening	-5.0	-5.0	-5.0	-5.0	-5.1	-5.1	-5.3	-5.6	
Receive Noise Level	38.4	35.9	41.4	25.4	24.8	25.3	19.6	17.4	34.9

Noise Emissions to Front Summary

Unit	Octave band Noise Level (dB) per frequency (Hz)								
	63	125	250	500	1000	2000	4000	8000	dBA
Condenser Units	56.0	51.0	46.0	40.0	30.0	18.5	14.5	11.0	41.9
Toilet Extract Fan Discharge	16.0	21.2	16.2	15.0	10.0	4.0	-2.5	-10.5	15.8
Cumulative Received Noise Level*	56	51	46	40	30	19	15	11	42

*Please note rounding has been applied to the final receive level only.

Noise Emissions to Rear Summary

Unit	Octave band Noise Level (dB) per frequency (Hz)								
	63	125	250	500	1000	2000	4000	8000	dBA
AHU Discharge	38.4	35.9	41.4	25.4	24.8	25.3	19.6	17.4	34.9
AHU Intake	33.4	29.9	31.4	18.4	16.8	15.3	6.6	-1.6	25.5
AHU Casing Radiated	35.9	26.9	23.9	8.9	6.9	5.8	1.6	-9.6	18.5
Toilet Extract Fan Discharge	33.9	39.9	35.4	32.9	19.8	16.3	12.6	5.4	32.6
Toilet Extract Fan Casing Radiated	35.9	32.9	21.9	9.9	-7.1	-9.2	-5.4	-16.6	19.3
Condenser Units	43.6	36.7	29.2	20.4	7.4	-6.1	-10.1	-13.6	25.3
Cumulative Received Noise Level*	46	43	43	34	27	26	21	18	38

*Please note rounding has been applied to the final receive level only.

Minerva House, Hatton Garden, London

L_{Aeq} Time History

Measurement Position 1 - Hatton Garden (front), Monday 14 to Tuesday 15 March 2016

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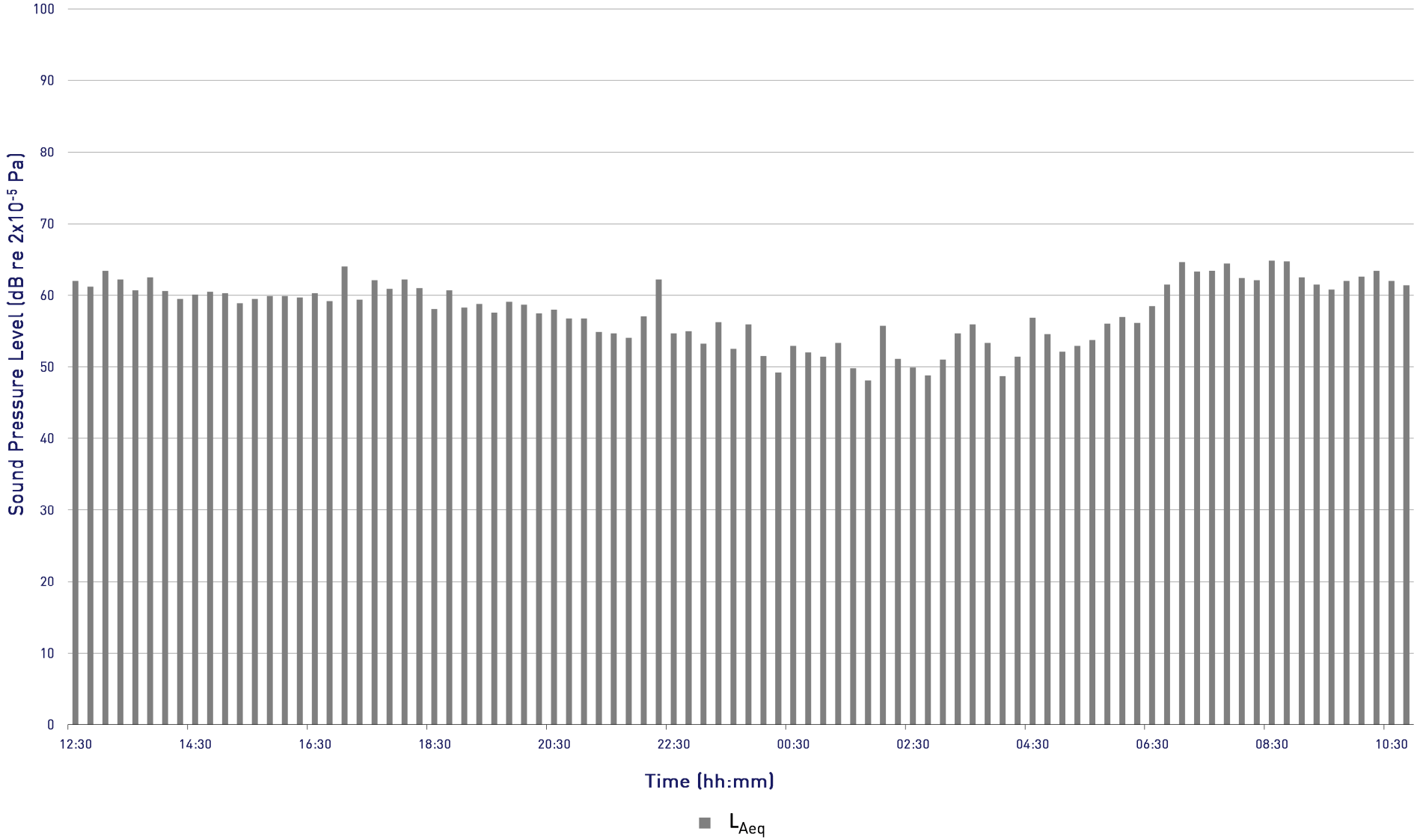
Graph 7346/G1



Minerva House, Hatton Garden, London

$L_{Amax,f}$ and L_{A90} Time History

Measurement Position 1 - Hatton Garden (front), Monday 14 to Tuesday 15 March 2016

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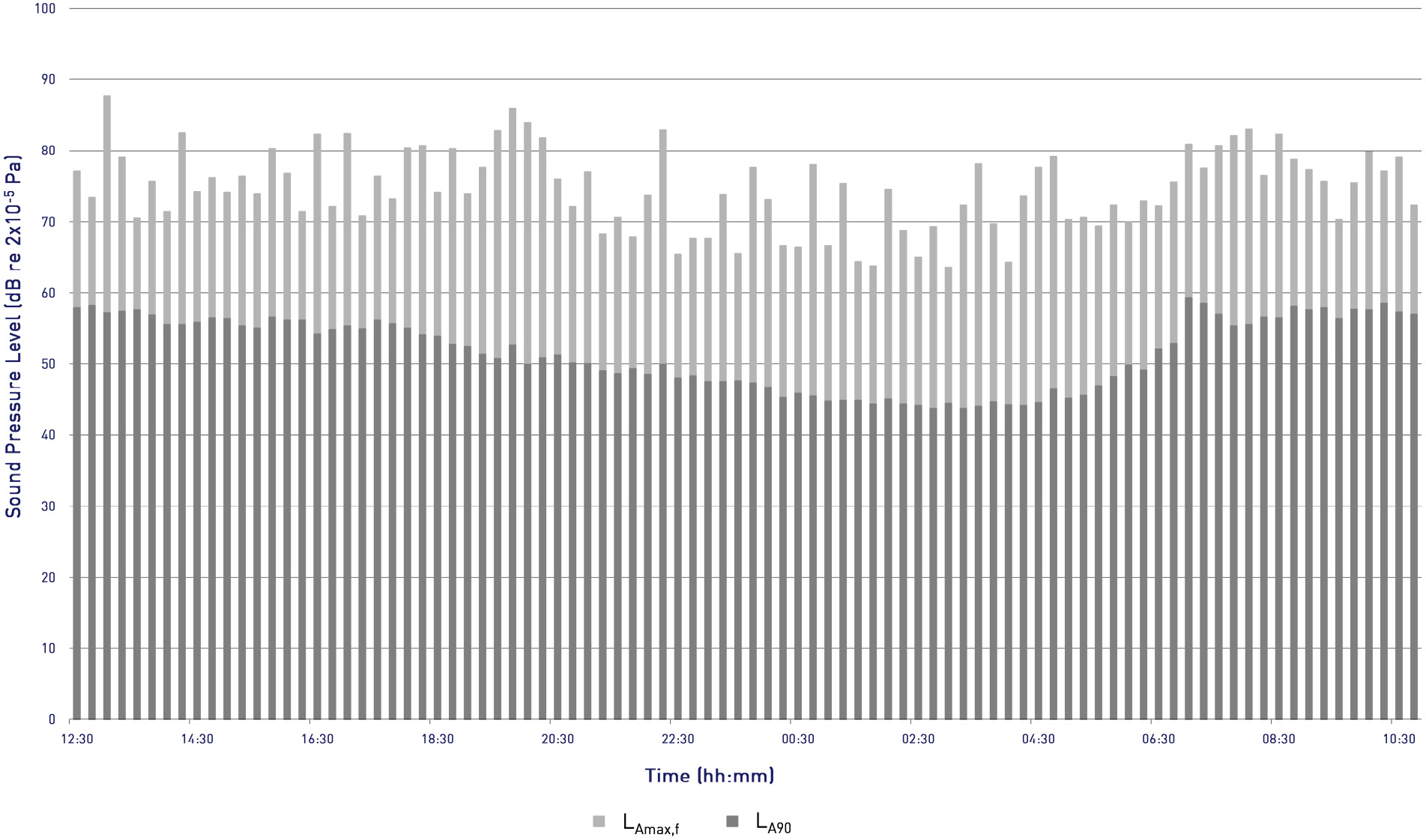
Graph 7346/G2



Minerva House, Hatton Garden

L_{Aeq} Time History

Measurement Position 2 - Rear Roof, Monday 15th to Tuesday 16th March 2016

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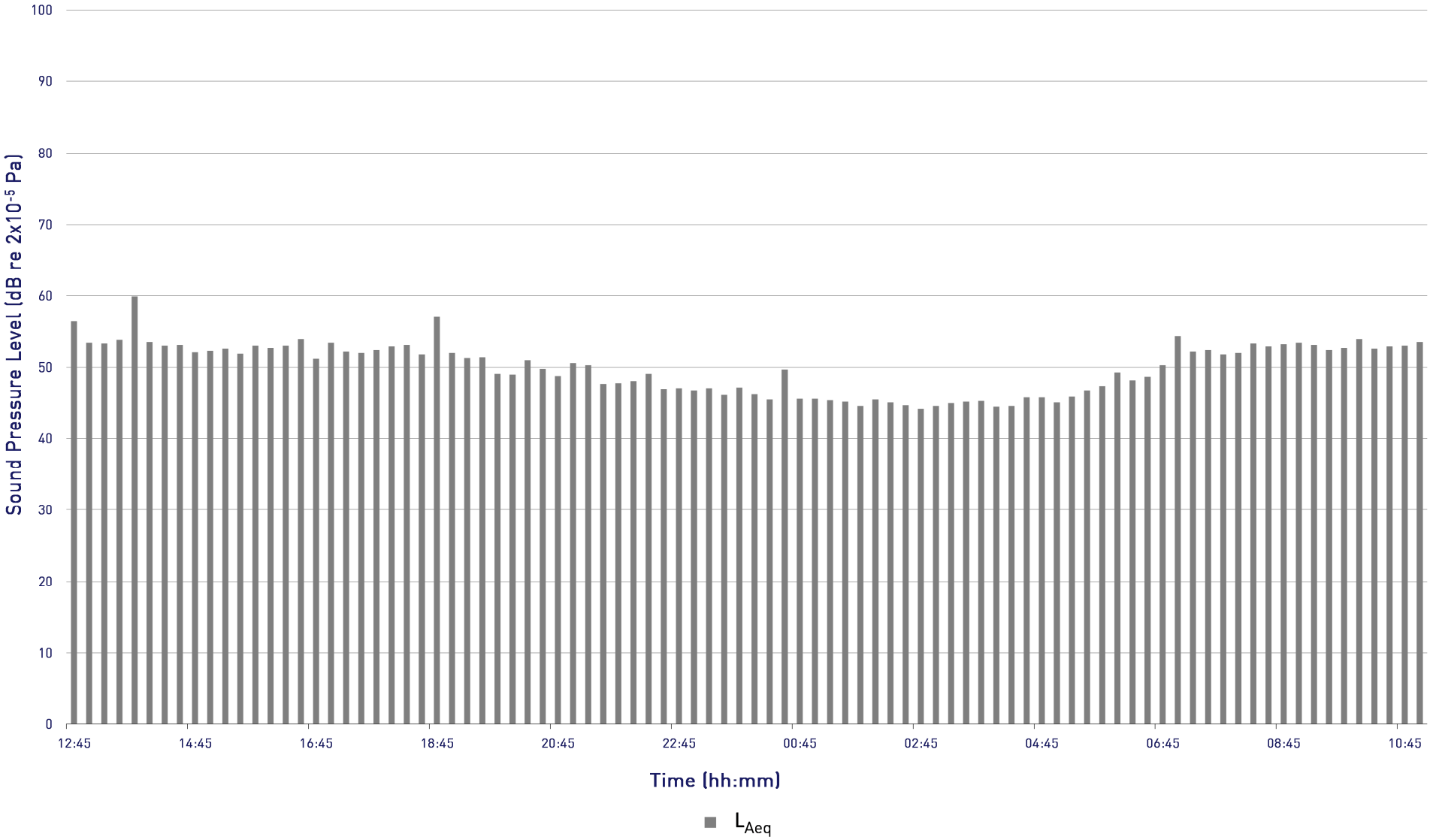
Graph 7346/G3



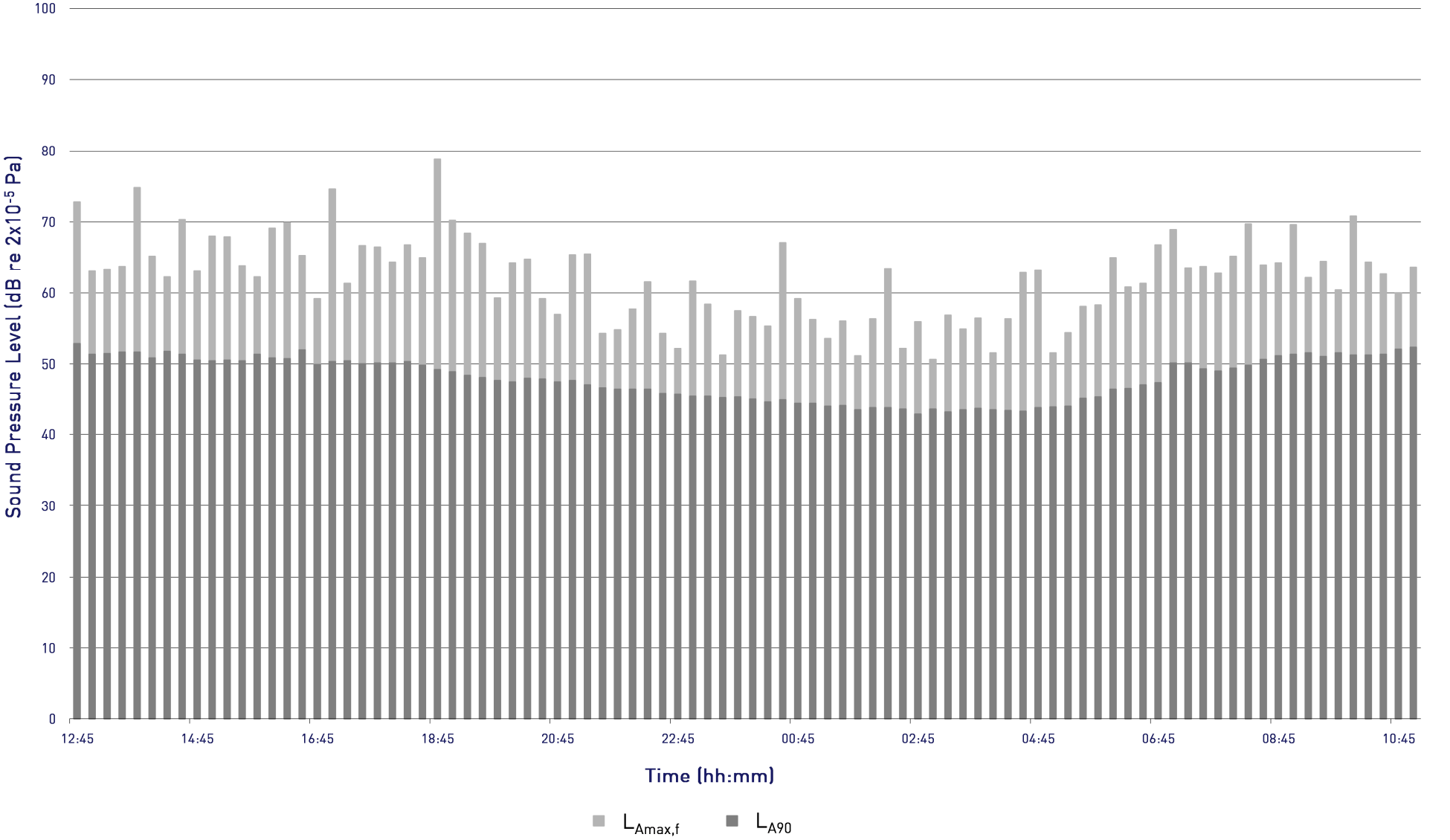
Minerva House, Hatton Garden

$L_{Amax,f}$ and L_{A90} Time History

Measurement Position 2 - Rear Roof, Monday 15th to Tuesday 16th March 2016

RBA ACOUSTICS

Graph 7346/G4



Minerva House, Hatton Garden, London

Measurement Position 1 (Front)

Photograph 7346/P1

24 March 2016

Not to Scale

RBA ACOUSTICS

Minerva House, Hatton Garden, London

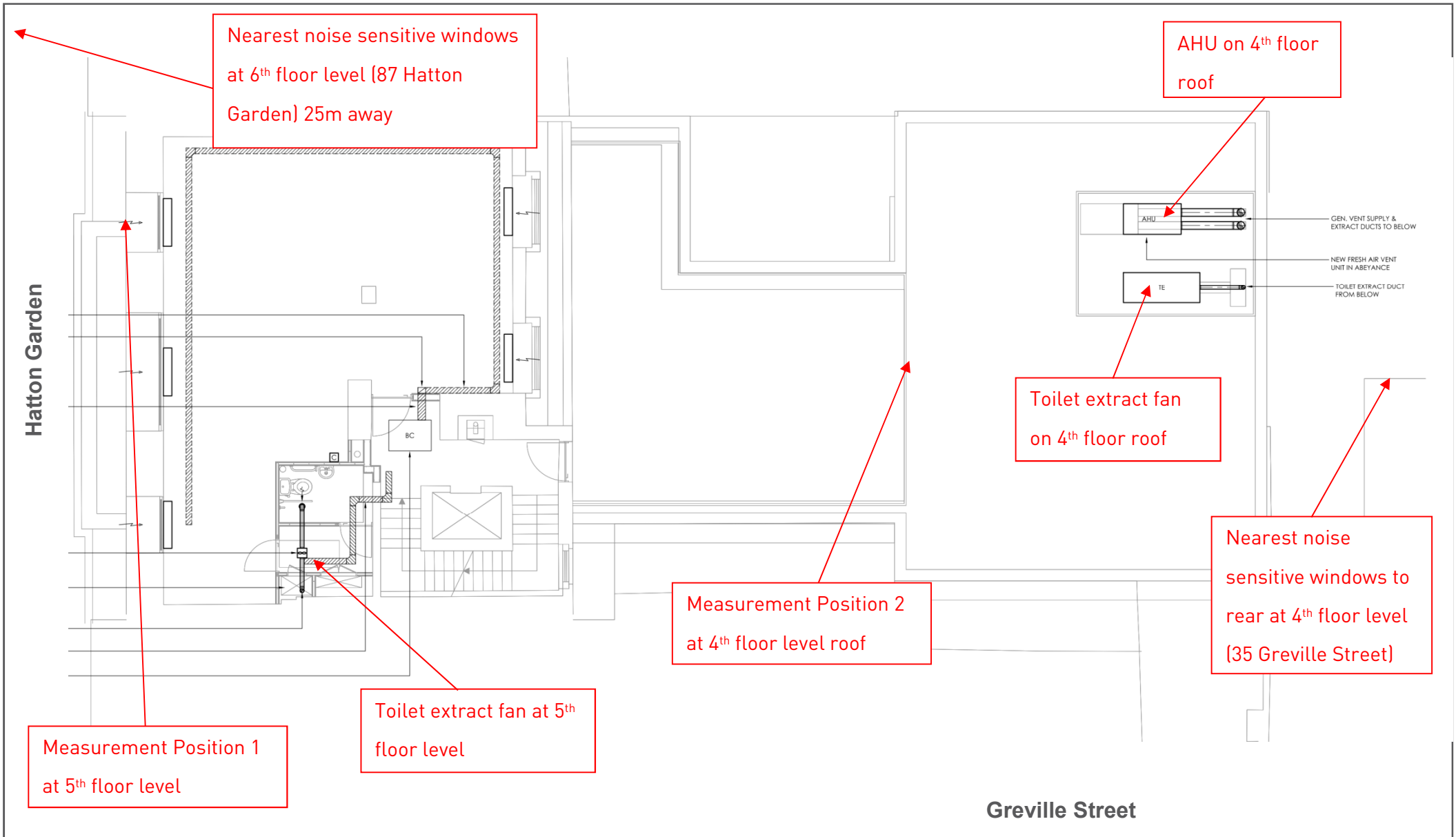
Measurement Position 2 (Rear)

Photograph 7346/P2

24 March 2016

Not to Scale

RBA ACOUSTICS



Minerva House, Hatton Garden, London

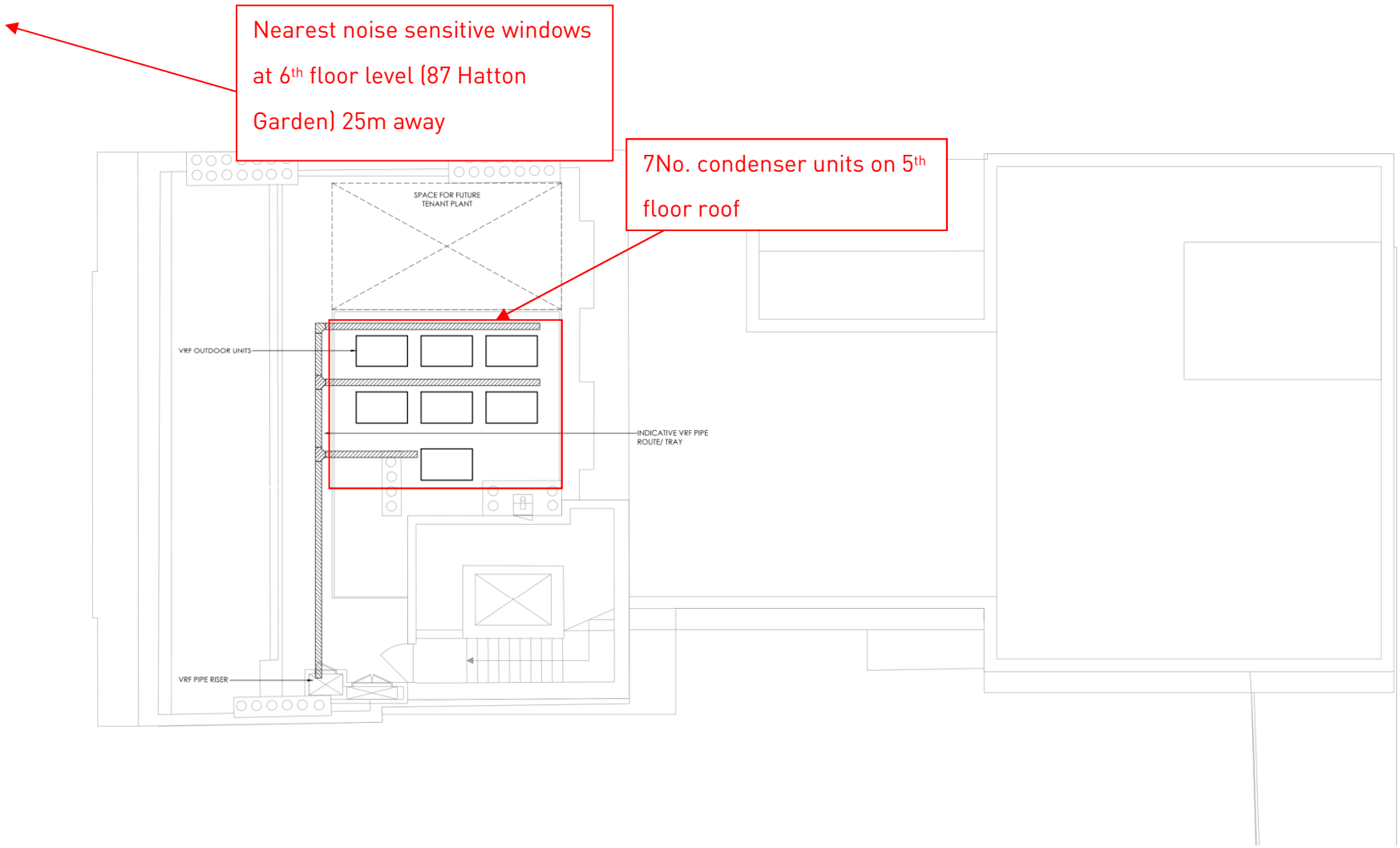
Fifth Floor Level / Roof Plan detailing proposed plant locations, measurement positions and nearest noise sensitive windows.

Site Plan 7346/SP1

26 August 2016

Not to Scale

RBA ACOUSTICS



Minerva House, Hatton Garden, London

Roof Level Plan detailing proposed plant locations, measurement positions and nearest noise sensitive windows.

Site Plan 7346/SP2

26 August 2016

Not to Scale

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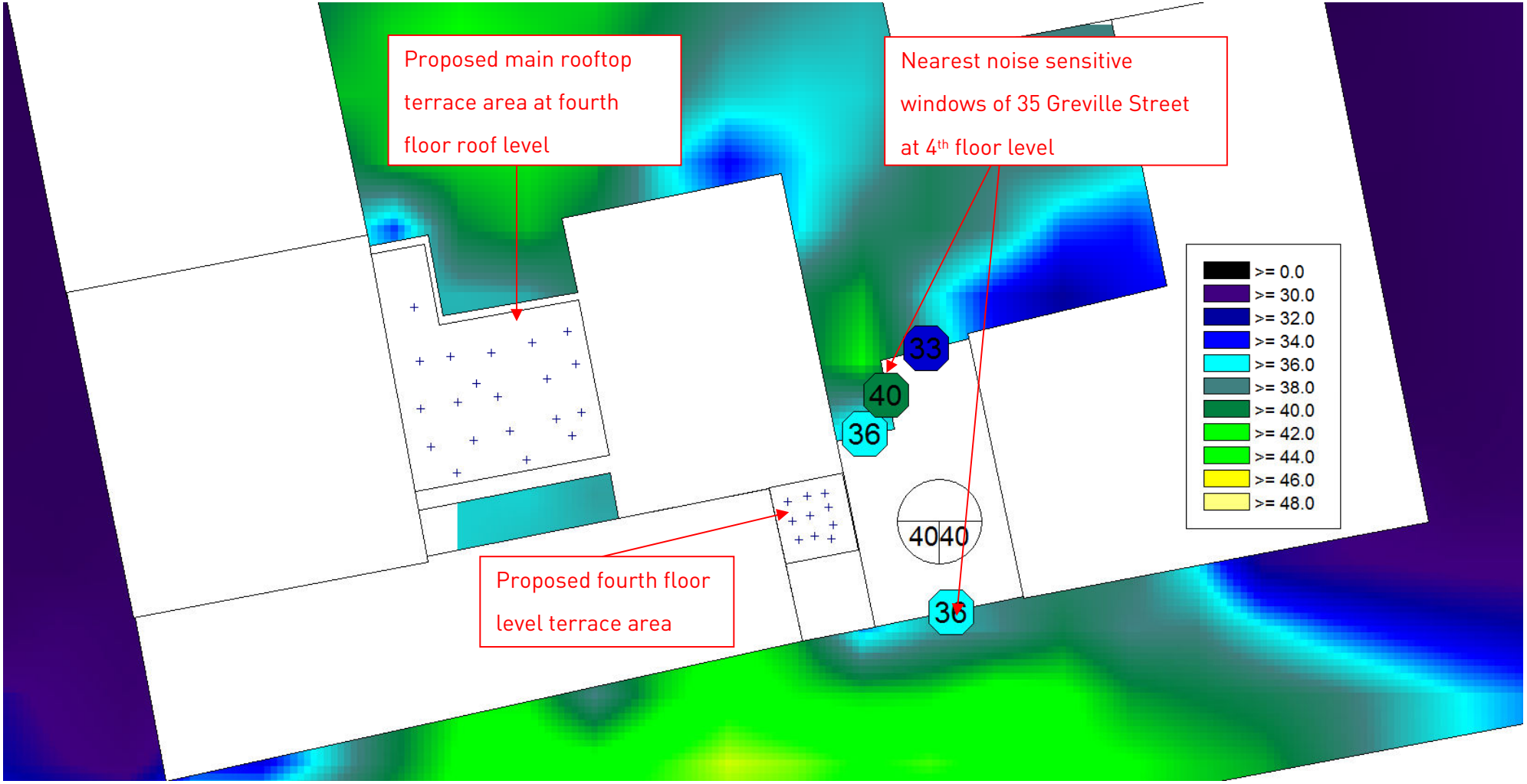

Minerva House, Hatton Garden, London

CadnaA noise map detailing terrace area occupant noise levels.

CadnaA 7346/Cad

26 August 2016

Not to Scale

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