Report VA1649.161214.NIA

Museum House, London

Noise Impact Assessment

15 December 2016

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Contents

Attachments

1. Introduction

It is proposed to install a new air source heat pump at roof level at Museum House, London as part of the penthouse extension currently being undertaken.

Venta Acoustics has been commissioned by Hawes Price Ltd to undertake an assessment of the potential noise impact of these proposals in support of an application for planning permission.

An environmental noise survey has previously been undertaken previously by Clarke Saunders Associates to determine the background noise levels at the most affected noise sensitive receptors. These levels will be used to undertake an assessment of the likely impact with reference to the planning requirements of Camden Council.

2. Design Criterion and Assessment Methodology

2.1 Consultation with the Local Authority

Camden Council have confirmed that their planning policy requirements that noise emissions from plant is at least 5dB below the local background noise level as assessed at the most affected noise sensitive receivers.

Noise levels should also not exceed the background noise level by more than 1dB in any octave band between 63Hz and 8kHz. The requirements are summarised below.

> *Noise levels at a point 1 metre external to sensitive facades shall be at least 5dB(A) less than the existing background measurement (L_{A90}), expressed in dB(A) when all plant/equipment (or any part of it) is in operation unless the plant/equipment hereby permitted will have a noise that has a distinguishable, discrete continuous note (whine, hiss, screech, hum) and/or if there are distinct impulses (bangs, clicks, clatters, thumps), then the noise levels from that piece of plant/equipment at any sensitive façade shall be at least 10dB(A) below the L_{A90}, expressed in dB(A).*

However, recent discussions with Edward Davis, Environmental Health Officer at Camden Council have highlighted that a new set of criteria is at consultation stage currently, with the standard noise condition 1m from noise sensitive façades being a minimum of 10dB below than background (L_{A90}), or 15dB below the background should the plant have any tonal, intermittent or distinguishable characteristics. To ensure a robust assessment, the 10dB below background criterion has been adopted for this assessment.

It was confirmed with Nora-Andreea Constantinescu of Camden Council that the previous noise survey would be acceptable for use for this assessment.

2.2 BS8233:2014

BS8233 *Guidance on sound insulation and noise reduction for buildings* provides guidance as to suitable internal noise levels for different areas within residential buildings.

The relevant section of the standard is shown below in Table 2.1.

Activity	Location	07:00 to 23:00	23:00 to 07:00
Resting	Living Room	35 dB $L_{Aeq,\,16\,hour}$	-
Dining	Dining Room	40 dB $L_{Aeq,\,16\,hour}$	-
Sleeping (daytime resting)	Bedroom	35 dB $L_{Aeq,\,16\,hour}$	30 dB $L_{Aeq,\,8\,hour}$

Table 2.1 - Excerpt from BS8233: 2014 [dB ref. 20µPa]

3. Site Description

As illustrated on attached site plan VA1649/SP1, the site building is located on Museum Street. The most affected noise sensitive receptor is understood to be on the opposite side of Museum Street. To ensure a robust assessment, calculations have also been undertaken to the rear of the houses on Little Russell Street.

The previous survey noted that the dominant noise source was traffic in the surrounding street, with a contribution from plant on the surrounding buildings.

4. Environmental Noise Survey

The typical background noise levels measured during the Clarke Saunders Survey were:

Monitoring Period	Minmium $L_{A90,5min}$
07:00 – 23:00 hours	52 dB 7:00 - 7:05, 25/9/14
23:00 – 07:00 hours	48 dB 3:20 - 3:25, 25/9/14

Table 4.1 – Minimum background noise levels

The full Clarke Saunders report is attached in Appendix B.

4.2 Plant Noise Emission Limits

On the basis of the measured noise levels and the planning requirements of the Local Authority, and considering that it is not expected that tonal noise will be generated by the proposed plant units, the following plant specific sound levels should not be exceed at the most affected noise sensitive receivers:

Monitoring Period	Design Criterion (L_{Aeq})
07:00 – 23:00 hours	42
23:00 – 07:00 hours	38

Table 4.2 – Specific sound pressure levels not to be exceeded at most affected noise sensitive receivers

5. Predicted Noise Impact

5.1 Proposed plant

As a final decision as to the unit to be installed has not yet been made, both proposed units are assessed against the Council's plant noise requirements. The plant is proposed for installation at roof level at the location indicated on site plan VA1649/SP1.

This location benefits from line of sight screening, provided by the roof edge, from all noise sensitive receptors.

Plant Item	Quantity	Proposed Model
Air Source Heat Pump	1	Either Daikin REYQ10T or Daikin RXYSQ6P8V

Table 5.1 – Indicative plant selections assumed for this assessment.

Consulting the manufacturer's datasheets, the following noise emissions levels are attributed to the proposed plant items:

Plant Item	Octave Band Centre Frequency (Hz) Sound Pressure, L_p@1m, (dB)								dB(A)
	63	125	250	500	1k	2k	4k	8k	
Daikin REYQ10T	62	65	57	58	52	48	41	35	59
Daikin RXYSQ6P8V	65	57	56	53	50	45	38	33	55

Table 5.2 – Advised plant noise data used for the assessment.

5.2 Recommended Mitigation Measures

It is not envisaged that any additional mitigation measures beyond the site's inherent geometry will be required for external noise emissions.

5.3 Predicted noise levels

The cumulative noise level at the two identified most affected noise sensitive receivers, some 12 and 21 meters away, has been calculated on the basis of the above, with reference to the guidelines set out in ISO 9613-2:1996 *Attenuation of sound during propagation outdoors - Part 2: General method of calculation.*

A summary of the calculations are shown in Appendix C.

Proposed Unit	Museum Street	Little Russell Street	Design Criterion (L_{Aeq})
Daikin REYQ10T	27 dB	28 dB	38 dB
Daikin RXYSQ6P8V	24 dB	24 dB	38 dB

Table 5.3 – Predicted noise and levels and design criteria at noise sensitive locations

5.4 Comparison to BS8233:2014 Criteria

BS8233 assumes a loss of approximately 15dB for a partially open window. The external noise level shown in Table 5.3 would result in internal noise levels that comfortably achieve the guidelines shown in Table 2.1.

6. Conclusion

A noise assessment has been undertaken by Venta Acoustics in support of a planning application for the proposed introduction of new building services plant at Museum House, London.

A baseline noise survey has previously been undertaken by Clarke Saunders Associates to establish the background noise climate in the locality.

This has enabled noise emission limits to be set at the most affected noise sensitive receiver such that the proposed installation meets the requirements of Camden Council.

The noise emission levels from either of the proposed condensing unit options have been assessed to be compliant with the plant noise emission limits.

The proposed scheme is not expected to have a significant adverse noise impact and the relevant Planning Conditions have been shown to be met.

Jamie Duncan MIOA


Most Affected Receiver
Little Russel Street Receiver
Proposed New Plant Location
Google Earth

1.1 Acoustic Terminology

The human impact of sounds is dependent upon many complex interrelated factors such as 'loudness', its frequency (or pitch) and variation in level. In order to have some objective measure of the annoyance, scales have been derived to allow for these subjective factors.

Sound	Vibrations propagating through a medium (air, water, etc.) that are detectable by the auditory system.
Noise	Sound that is unwanted by or disturbing to the perceiver.
Frequency	The rate per second of vibration constituting a wave, measured in Hertz (Hz), where 1Hz = 1 vibration cycle per second. The human hearing can generally detect sound having frequencies in the range 20Hz to 20kHz. Frequency corresponds to the perception of 'pitch', with low frequencies producing low 'notes' and higher frequencies producing high 'notes'.
dB(A):	Human hearing is more susceptible to mid-frequency sounds than those at high and low frequencies. To take account of this in measurements and predictions, the 'A' weighting scale is used so that the level of sound corresponds roughly to the level as it is typically discerned by humans. The measured or calculated 'A' weighted sound level is designated as dB(A) or L_A.
L_{eq} :	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 (e.g. 8 hour, 1 hour, etc). The concept of L_{eq} (equivalent continuous sound level) has primarily been used in assessing noise from industry, although its use is becoming more widespread in defining many other types of sounds, such as from amplified music and environmental sources such as aircraft and construction. Because L_{eq} is effectively a summation of a number of events, it does not in itself limit the magnitude of any individual event, and this is frequently used in conjunction with an absolute sound limit.
L_{10} & L_{90} :	Statistical L_n indices are used to describe the level and the degree of fluctuation of non-steady sound. 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 a typical maximum level. Similarly, L_{90} is the typical minimum level and is often used to describe background noise. It is common practice to use the L_{10} index to describe noise from traffic as, being a high average, it takes into account the increased annoyance that results from the non-steady nature of traffic flow.

1.2 Octave Band Frequencies

In order to determine the way in which the energy of sound is distributed across the frequency range, the International Standards Organisation has agreed on "preferred" bands of frequency for sound measurement and analysis. The widest and most commonly used band for frequency measurement and analysis is the Octave Band. In these bands, the upper frequency limit is twice the lower frequency limit, with the band being described by its "centre frequency" which is the average (geometric mean) of the upper and lower limits, e.g. 250 Hz octave band extends from 176 Hz to 353 Hz. The most commonly used octave bands are:

Octave Band Centre Frequency Hz	63	125	250	500	1000	2000	4000	8000

1.3 Human Perception of Broadband Noise

Because of the logarithmic nature of the decibel scale, it should be borne in mind that sound levels in dB(A) do not have a simple linear relationship. For example, 100dB(A) sound level is not twice as loud as 50dB(A). It has been found experimentally that changes in the average level of fluctuating sound, such as from traffic, need to be of the order of 3dB before becoming definitely perceptible to the human ear. Data from other experiments have indicated that a change in sound level of 10dB is perceived by the average listener as a doubling or halving of loudness. Using this information, a guide to the subjective interpretation of changes in environmental sound level can be given.

Change in Sound Level dB	Subjective Impression	Human Response
0 to 2	Imperceptible change in loudness	Marginal
3 to 5	Perceptible change in loudness	Noticeable
6 to 10	Up to a doubling or halving of loudness	Significant
11 to 15	More than a doubling or halving of loudness	Substantial
16 to 20	Up to a quadrupling or quartering of loudness	Substantial
21 or more	More than a quadrupling or quartering of loudness	Very Substantial

1.4 Earth Bunds and Barriers - Effective Screen Height

When considering the reduction in sound level of a source provided by a barrier, it is necessary to establish the "effective screen height". For example if a tall barrier exists between a sound source and a listener, with the barrier close to the listener, the listener will perceive the sound as being louder if he climbs up a ladder (and is closer to the top of the barrier) than if he were standing at ground level. Equally if he sat on the ground the sound would seem quieter than if he were standing. This is explained by the fact that the "effective screen height" is changing with the three cases above. In general, the greater the effective screen height, the greater the perceived reduction in sound level.

Similarly, the attenuation provided by a barrier will be greater where it is aligned close to either the source or the listener than where the barrier is midway between the two.

Appendix B

Clarke Saunders Environmental Noise Survey Report

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REPORT AS7954.141112.NIA3

5th FLOOR EXTENSION
MUSEUM HOUSE
23-26 MUSEUM STREET

NOISE IMPACT ASSESSMENT

Prepared: 12 November 2014

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CONTENTS

List of Attachments

1. INTRODUCTION

It is proposed to extend the top floor of Museum House, Museum Street, London for residential use. The building is currently in use as a mixed use retail, office and residential building.

Clarke Saunders Associates has been commissioned by Devonshire Development (UK) Ltd to undertake an assessment of the current environmental noise and vibration impact on the site. Noise will be assessed in accordance with the National Planning Policy Framework with reference made to the relevant guidance set out in BS8233: 2014 *Guidance on sound Insulation and noise reduction for buildings* and the World Health Organisation *Guidelines for Community Noise*.

The background noise levels measured will be used to determine daytime and night-time noise emission limits for new building services plant in accordance with the planning requirements of Camden Council.

This assessment would also consider the requirement for any outline mitigation measures as appropriate for the proposed residential development.

2. NATIONAL PLANNING POLICY FRAMEWORK

The National Planning Policy Framework (NPPF) was published in March 2012 and revoked all previous planning policy statements and guidance notes.

The document sets out the Government's planning policies and how these are expected to be applied. Paragraph 123 refers to noise impact:

123. 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;*

and

- *identify and protect areas of tranquility which have remained relatively undisturbed by noise and are prized for their recreational and amenity value for this reason.*

With regards to mitigation, reference is made to the Noise Policy Statement for England (DEFRA, 2010). The Policy aims are defined as,

Through the effective management and control of environmental, neighbour and neighbourhood noise within the context of government policy on sustainable development:

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

Clarification of the terms *adverse* and *significant adverse* are given as follows,

There are two established concepts from toxicology that are currently being applied to noise impacts, for example, by the World Health Organisation. They are:

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.

It is not possible to have a single objective noise-based measure that defines SOAEL that is applicable to all sources of noise in all situations. Consequently, the SOAEL is likely to be different for different noise sources, for different receptors and at different times. It is acknowledged that further research is required to increase our understanding of what may constitute a significant adverse impact on health and quality of life from noise. However, not having specific SOAEL values in the NPSE provides the necessary policy flexibility until further evidence and suitable guidance is available.

In order to enable assessment of impacts in line with these requirements, reference should be made to other currently available guidance.

London Borough of Camden's Environmental Health department current guidelines advise that an evaluation of the external noise should be undertaken to achieve the internal noise levels stated in the World Health Organisation *Guidelines for Community Noise* (1999) and BS8233:2014 *Guidance on sound insulation and noise reduction for buildings*.

2.1 WHO Guidelines for Community Noise (1999)

The guidance in this document details suitable noise levels for various activities within residential and commercial buildings.

The relevant sections of this document are shown in Table 2.1.

Criterion	Environment	Design range $L_{Aeq,T}$ dB
Maintain speech intelligibility and avoid moderate annoyance, daytime and evening	Living Rooms	35
Prevent sleep disturbance, night time	Bedrooms	30

Table 2.1 - Excerpt from BS8233: 1999 (referred to by WHO) [dB ref. 20µPa]

This guidance also states that individual noise events should not normally exceed 45 dB $L_{Amax,fast}$ within bedrooms at night.

For outdoor living areas, it is stated that:

To protect the majority of people from being seriously annoyed during the daytime, the outdoor sound level from steady, continuous noise should not exceed 55dB L_{Aeq} on balconies, terraces and in outdoor living areas. To protect the majority of people from being moderately annoyed during the daytime, the outdoor sound level should not exceed 50dB L_{Aeq}. Where it is practical and feasible, the lower outdoor sound level should be considered the maximum desirable sound level for new development.

2.2 BS8233:2014 *Guidance on sound insulation and noise reduction for buildings*

The guidance in this document indicates acceptable noise levels for various activities within residential dwellings.

The relevant section of this standard is shown in the following table:

Activity	Location	07:00 to 23:00	23:00 to 07:00
Resting	Living Room	35 dB $L_{Aeq,\ 16\ hour}$	-
Dining	Dining Room	40 dB $L_{Aeq,\ 16\ hour}$	-
Sleeping (daytime resting)	Bedroom	35 dB $L_{Aeq,\ 16\ hour}$	30 dB $L_{Aeq,\ 8\ hour}$

Table 2.2 - Excerpt from BS8233: 2014 [dB ref. 20µPa]

For external areas the standard states the following:

For traditional external areas that are used for amenity space, such as gardens and patios, it is desirable that the external noise level does not exceed 50 dB

$L_{Aeq,T}$, with an upper guideline value of 55 dB $L_{Aeq,T}$ which would be acceptable in noisier environments.

However, it is also recognized that these guideline values are not achievable in all circumstances where development might be desirable. In higher noise areas, such as city centres or urban areas adjoining the strategic transport network, a compromise between elevated noise levels and other factors, such as the convenience of living in these locations or making efficient use of land resources to ensure development needs can be met, might be warranted. In such a situation, development should be designed to achieve the lowest practicable levels in these external amenity spaces, but should not be prohibited.

3. SURVEY PROCEDURE & EQUIPMENT

A survey of the existing background noise levels was undertaken at the location shown in site plan AS7954/SP1. Measurements of consecutive 5-minute L_{Aeq}, L_{Amax}, L_{A10} and L_{A90} sound pressure levels were taken between 11:40 hours on Tuesday 23rd and 12:00 hours on Thursday 25th September 2014.

These measurements will allow suitable noise criteria to be set for the new building services plant, dependent on hours of operation.

The following equipment was used during the course of the survey:

- Norsonic data logging sound level meter type 118;
- Norsonic sound level calibrator type 1253.

The calibration of the sound level meter was verified before and after use. No calibration drift was detected.

The weather during the survey was dry with light winds, which made the conditions suitable for the measurement of environmental noise.

Measurements were made generally in accordance with ISO 1996-2:2007 *Acoustics - Description, measurement and assessment of environmental noise – Part 2: Determination of environmental noise levels.*

Please refer to Appendix A for details of the acoustic terminology used throughout this report.

4. RESULTS

Figures AS7954/TH1-TH2 show the L_{Aeq}, L_{Amax}, L_{A10} and L_{A90} sound pressure levels as time histories at the measurement position.

5. SUITABILITY OF THE SITE FOR RESIDENTIAL DEVELOPMENT

The site is affected by road traffic in the surrounding streets, with some contribution from fixed plant on nearby buildings.

The average noise levels for the '*Daytime*' and '*Night-time*' periods are shown in Table 5.1.

Daytime $L_{Aeq, 16 hour}$	Night-time, $L_{Aeq, 8 hour}$
58 dB	53 dB

Table 5.1 - Daytime and night-time average noise level at position [dB ref. 20µPa]

Measured minimum background noise levels are shown in Table 5.2 below.

Monitoring period	Minimum $L_{A90,5mins}$
07:00 - 23:00 hours	52 dB 07:00 - 07:05, 25/9/14
23:00 - 07:00 hours	48 dB 03:20 - 03:25, 25/9/14
24 hours	48 dB

Table 5.2 - Minimum measured background noise levels [dB ref. 20µPa]

6. DESIGN REVIEW

The following design review is based on the Collado Collins architectural drawings for the proposed construction available at the time of writing.

6.1 Architectural Arrangements

It has been assumed that all non-glazed elements, i.e. masonry walls/facings and the roof systems, will provide the following minimum sound insulation performances, when tested in accordance with ISO 10140-2:2010.

Construction	Single Figure Weighted Sound Reduction Figure (dB)
Building Fabric	54

Table 6.1 - Assumed minimum sound reduction indices of solid constructions

7. REQUIRED GLAZING PERFORMANCE

The minimum sound insulation specifications for the glazed elements of the building façade facing are given in the table below. These have been calculated using the monitoring data.

Glazing Type	Single Figure Weighted Sound Reduction Figure (dB)
Type A	R_w 31

Table 7.1 - Minimum required sound reduction indices for glazing

It is expected that standard, thermally sealed double glazing should provide adequate sound reduction to achieve suitable internal levels.

8. DISCUSSION

8.1 Glazing Specification

Table 8.1, below, identifies where the performance requirements shown in Table 6.1 apply:

Elevation	Floor	Glazing type required
All	5th	Type A

Table 8.1 - Locations for glazing types

It is important that the quoted minimum sound reduction specification is met by the panels and windows, including frames, seals, etc. Glass performance alone is not an acceptable means of demonstrating compliance with the specification for window performance.

The sound reduction of the windows should be met with any proposed trickle vents installed and open. If this cannot be met then alternative means of ventilation may be required.

With the above recommendations implemented, the noise levels within the residential dwellings would be expected to be less than those recommended in the WHO 1999 and BS8233:2014 guidance. Internal noise levels can therefore be considered to be between the NOEL the LOAEL levels.

9. PLANT NOISE DESIGN CRITERIA

Camden Council currently requires new plant to be 5dB below the background level. In addition, the background level must not be exceeded by more than 1dB in any octave band between 63Hz and 8kHz.

Noise levels at a point 1 metre external to sensitive facades shall be at least 5dB(A) less than the existing background measurement (L_{A90}), expressed in dB(A) when all plant/equipment (or any part of it) is in operation unless the plant/equipment hereby permitted will have a noise that has a distinguishable, discrete continuous note (whine, hiss, screech, hum) and/or if there are distinct impulses (bangs, clicks, clatters, thumps), then the noise levels from that piece of plant/equipment at any sensitive façade shall be at least 10dB(A) below the L_{A90}, expressed in dB(A).

It is not expected that tonal noise will be generated by the proposed plant units and so the plant noise emissions criteria that should not be exceeded at the nearest noise sensitive receiver should be set to the proposed levels detailed in Table 9.1 and Table 9.2.

Daytime (07:00 – 23:00 hours)	Night-time (23:00 – 07:00 hours)	24 hours
L_{Aeq} 47 dB	L_{Aeq} 43 dB	L_{Aeq} 43 dB

Table 9.1 - Proposed design noise criteria **[dB ref. 20µPa]**

Freq (Hz)	63	125	250	500	1k	2k	4k	8k
Criterion	54	51	49	46	44	39	34	32

Table 9.2 - Spectral design criterion

10. PREDICTED NOISE IMPACT

10.1 Proposed plant

The selected plant has been confirmed as:

- 1 no. Daikin Condensing Unit Type REYQ10T

The approximate location of the plant to be installed is shown in site plan AS7954/SP1.

Noise levels generated by the type REYQ10T condenser to be installed have been confirmed by the manufacturer as follows:

Freq (Hz)	63	125	250	500	1000	2000	4000	8000	dB(A)
Lp @ 1m (dB)	61	62	61	57	52	46	43	36	58

Table 10.1 - Source noise data for the type REYQ10T condenser [dB ref. 20µPa]

10.2 Predicted noise levels

Following an inspection of the site, the nearest noise sensitive receiver is situated on Museum Street at 3rd floor level, as shown on the indicative site plan AS7954/SP1. This window is at least 18 metres away from the proposed plant location. Noise levels at all other residential receivers would be lower than at this window.

The cumulative noise level at the nearest noise sensitive receiver has been assessed with reference to the guidelines set out in BS4142:1997 *Method for rating industrial noise affecting mixed residential and industrial areas* as guidance, using the noise data above.

Freq (Hz)	63	125	250	500	1k	2k	4k	8k	dB(A)
Criterion	54	51	49	46	44	39	34	32	43
Predicted level at 1m from receiver	36	37	36	32	27	21	18	11	33

Table 10.2 - Predicted noise level and criteria at nearest noise sensitive location [dB ref. 20 µPa]

A summary of the calculations are shown in Appendix B.

All other air handling and extract plant will be fitted with acoustically specified splitter silencers in order that the cumulative noise level does not exceed the 24-hour design noise criterion.

10.3 Comparison to BS8233:2014 Criteria

BS8233 assumes a loss of approximately 15dB for a partially open window. The external noise level shown in Table 10.2 would result in an internal noise levels that would be considerably lower than the levels shown in Table 2.2.

11. CONCLUSIONS

Measurements have been made of the prevailing noise climate at the proposed site for residential development at Museum House, Museum Street, London.

The measured levels have been assessed against the National Planning Policy Framework and currently available standards and guidance documents including World Health Organisation *Guidelines for Community Noise* (1999) and BS8233:2014 *Guidance on sound Insulation and noise reduction for buildings*, to consider whether the site is suitable for its proposed residential use.

The survey has allowed the minimum sound reduction requirements of the external building fabric to be established as a performance specification.

However, it is important that the successful contractor demonstrates in a UKAS accredited or an equal and approved laboratory that the minimum sound reduction requirements can be achieved by their proposed window systems.

Measurements have been made to establish the current background noise climate. This has enabled a 24-hour design criterion to be set for the control of plant noise emissions to noise sensitive properties, in accordance with Camden Council's requirements.

Data for the new condensing unit has been used to predict the noise impact of the new plant on neighbouring residential properties.

Compliance with the noise emission design criterion has been demonstrated. No further mitigation measures are, therefore, required for external noise emissions.

Jamie Duncan
Jamie Duncan (Nov 12, 2014)

Jamie Duncan MIOA

CLARKE SAUNDERS ASSOCIATES

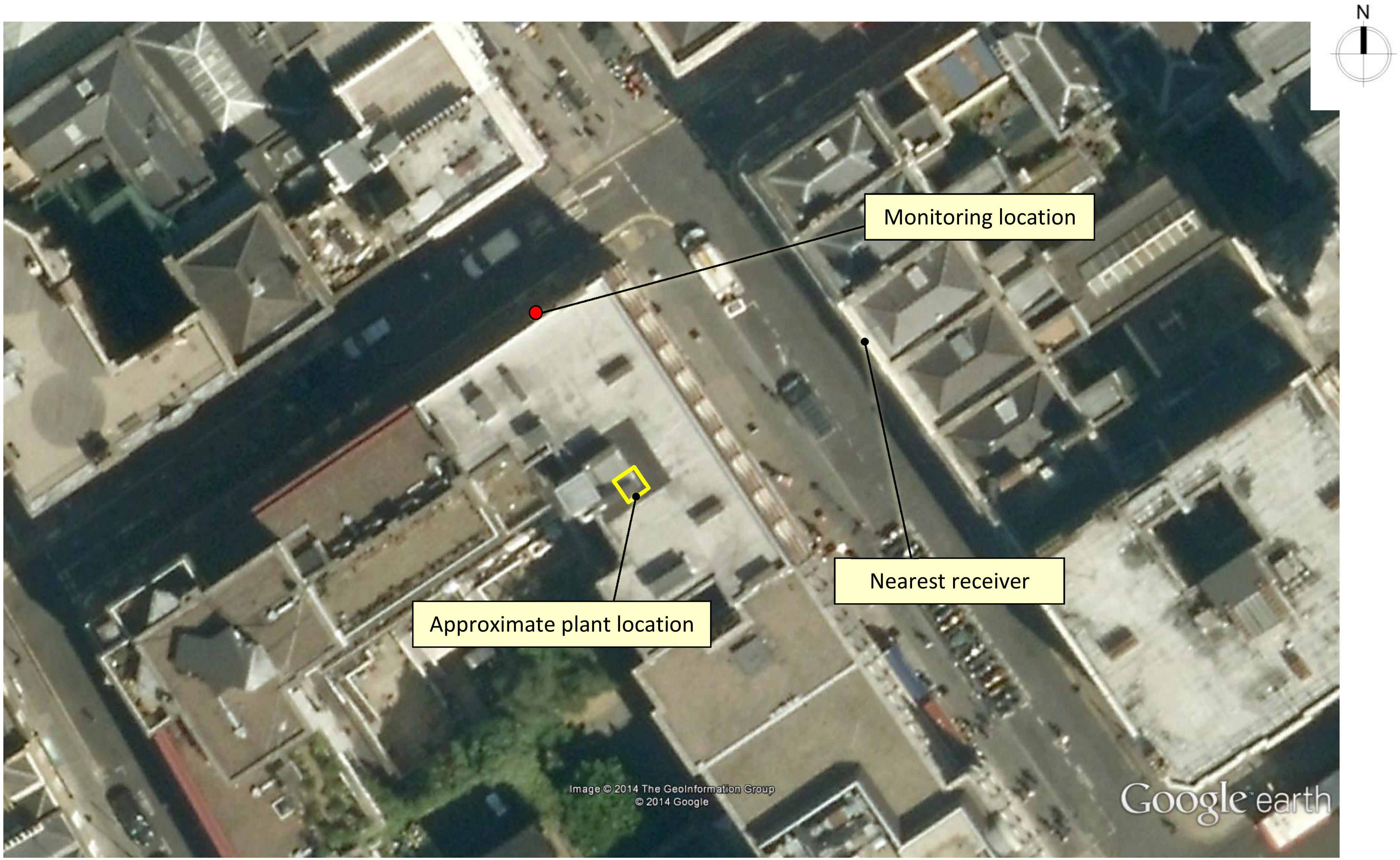
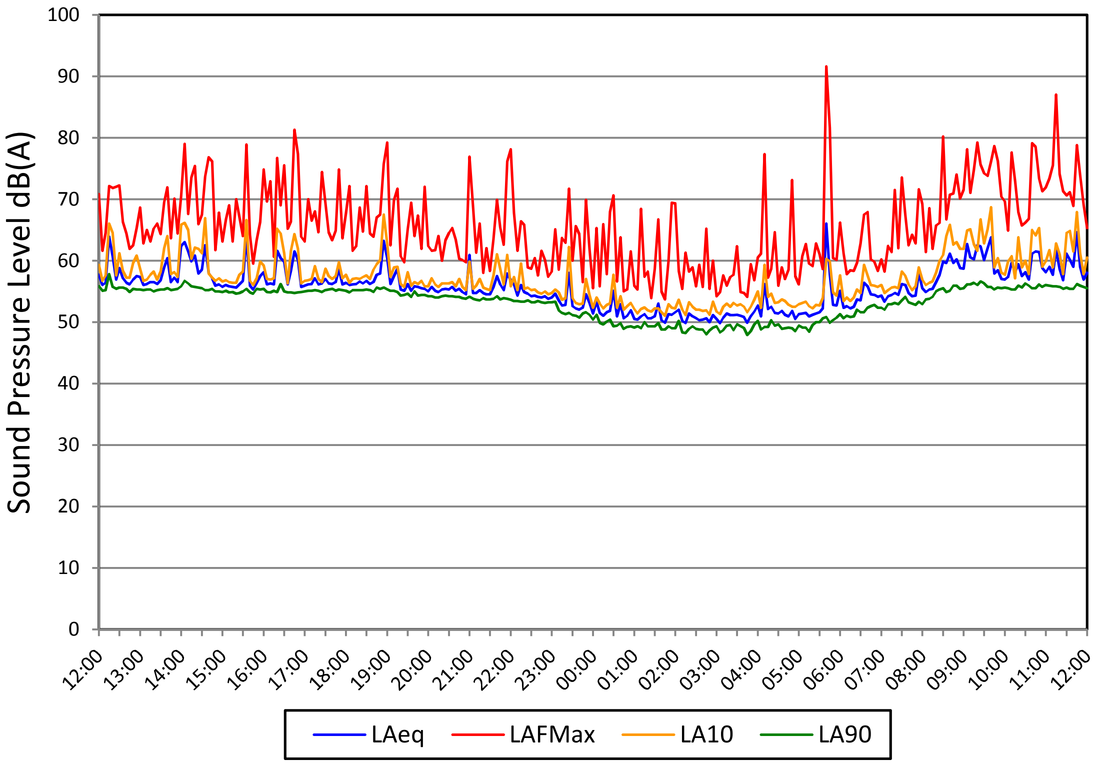


Figure AS7954/SP1

Museum House, 2326 Museum Street, London

Environmental Noise Time History

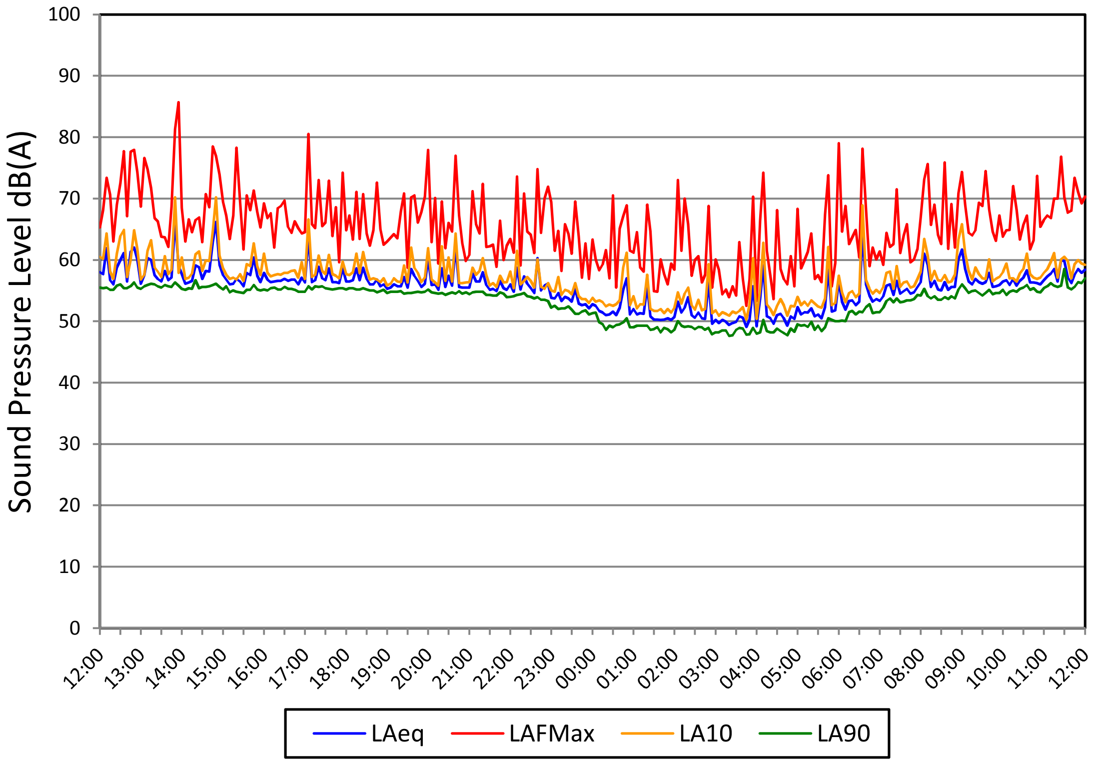


Tuesday 23 September to Wednesday 24 September 2014

Figure AS7954/TH1

Museum House, 2326 Museum Street, London

Environmental Noise Time History



Wednesday 24 September to Thursday 25 September 2014

Figure AS7954/TH2

APPENDIX A

ACOUSTIC TERMINOLOGY & HUMAN RESPONSE TO BROADBAND NOISE

1.0 ACOUSTIC TERMINOLOGY

The annoyance produced by noise is dependent upon many complex interrelated factors such as 'loudness', its frequency (or pitch) and any variations in its level. In order to have some objective measure of the annoyance, scales have been derived to allow for these subjective factors.

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.

L_{10} & L_{90} : 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.

It is common practice to use the L_{10} index to describe traffic noise, as being a high average, it takes into account the increased annoyance that results from the non-steady nature of traffic noise.

L_{eq} : The concept of L_{eq} (equivalent continuous sound level) has up to recently been primarily used in assessing noise in industry but seems now to be finding use in defining many other types of noise, such as aircraft noise, environmental noise and construction noise.

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 (e.g. 8 hour, 1 hour, etc).

The use of digital technology in sound level meters now makes the measurement of L_{eq} very straightforward.

Because L_{eq} is effectively a summation of a number of noise events, it does not in itself limit the magnitude of any individual event, and this is frequently used in conjunction with an absolute noise limit.

L_{max} : L_{max} is the maximum sound pressure level recorded over the period stated. L_{max} is sometimes used in assessing environmental noise where occasional loud noises occur, which may have little effect on the L_{eq} noise level.

D The sound insulation performance of a construction is a function of the difference in noise level either side of the construction in the presence of a loud noise source in one of the pair of rooms under test. *D*, is therefore simply the *level difference* in decibels between the two rooms in different frequency bands.

D_w D_w is the *Weighted Level Difference* The level difference is determined as above, but weighted in accordance with the procedures laid down in BS EN ISO 717-1.

$D_{nT,w}$ $D_{nT,w}$ is the *Weighted Standardised Level Difference* as defined in BS EN ISO 717-1 and represents the *weighted level difference*, as described above, corrected for room reverberant characteristics.

C_{tr} C_{tr} is a spectrum adaptation term to be added to a single number quantity such as $D_{nT,w}$, to take account of characteristics of a particular sound.

$L'_{nT,w}$ $L'_{nT,w}$ is the *Weighted Standardised Impact Sound Pressure Level* as defined in BS EN ISO 717-2 and represents the level of sound pressure when measured within room where the floor above is under excitation from a calibrated tapping machine, corrected for the receive room reverberant characteristics.

APPENDIX A

ACOUSTIC TERMINOLOGY & HUMAN RESPONSE TO BROADBAND NOISE

2.0 OCTAVE BAND FREQUENCIES

In order to determine the way in which the energy of sound is distributed across the frequency range, the International Standards Organisation have agreed on "preferred" bands of frequency for sound measurement and analysis. The widest and most commonly used band for frequency measurement and analysis is the Octave Band. In these bands, the upper frequency limit is twice the lower frequency limit, with the band being described by its "centre frequency" which is the average (geometric mean) of the upper and lower limits, eg. 250 Hz octave band runs from 176 Hz to 353 Hz. The most commonly used bands are:

Octave Band Centre Frequency Hz	63	125	250	500	1000	2000	4000	8000

3.0 HUMAN PERCEPTION OF BROADBAND NOISE

Because of the logarithmic nature of the decibel scale, it should be borne in mind that noise levels in dB(A) do not have a simple linear relationship. For example, 100dB(A) is not twice as loud as 50 dB(A) sound level. It has been found experimentally that changes in the average level of fluctuating sound, such as traffic noise, need to be of the order of 3 dB(A) before becoming definitely perceptible to the human ear. Data from other experiments have indicated that a change in sound level of 10 dB(A) is perceived by the average listener as a doubling or halving of loudness. Using this information, a guide to the subjective interpretation of changes in traffic noise level can be given.

INTERPRETATION

Change in Sound Level dB(A)	Subjective Impression	Human Response
0 to 2	Imperceptible change in loudness	Marginal
3 to 5	Perceptible change in loudness	Noticeable
6 to 10	Up to a doubling or halving of loudness	Significant
11 to 15	More than a doubling or halving of loudness	Substantial
16 to 20	Up to a quadrupling or quartering of loudness	Substantial
21 or more	More than a quadrupling or quartering of loudness	Very Substantial

4.0 EARTH BUNDS AND BARRIERS - EFFECTIVE SCREEN HEIGHT

When considering the reduction in noise level of a source provided by a barrier, it is necessary to establish the "effective screen height". For example if a 3 metre high barrier exists between a noise source and a listener, with the barrier close to the listener, the listener will perceive the noise source is louder, if he climbs up a ladder (and is closer to the top of the barrier) than if he were standing at ground level. Equally if he sat on the ground the noise source would seem quieter than it was if he were standing. This may be explained by the fact that the "effective screen height" is changing with the three cases above, the greater the effective screen height, in general, the greater the reduction in noise level.

Where the noise sources are various roads, the attenuation provided by a fixed barrier at a specific property will be greater for roads close to the barrier than for roads further away.

APPENDIX B

EXTERNAL PLANT NOISE EMISSIONS CALCULATIONS

Calculation 1:

			63	125	250	500	1000	2000	4000	8000	dB(A)
Daikin REYQ10T	Lp	1 m	61	62	61	57	52	46	43	36	58
Distance Loss		18 m	-25	-25	-25	-25	-25	-25	-25	-25	
Level At Receiver			*36*	*37*	*36*	*32*	*27*	*21*	*18*	*11*	33

24-hour plant noise design criterion 43 dB(A)

APPENDIX C

VA1649 - Museum House, London

Noise Impact Assessment

Option 1 - Daikin REYQ10T

Museum Street Receiver

		63 Hz	125 Hz	250 Hz	500 Hz	1 kHz	2 kHz	4 kHz	8 kHz	dB(A)
Daikin REYQ10T	Lp @ 1m	62	65	57	58	52	48	41	35	**59**
Number of Plant	1	0	0	0	0	0	0	0	0	
Distance Loss	To 21m	-26	-26	-26	-26	-26	-26	-26	-26	
Screening loss (line of sight)		-5	-5	-5	-5	-5	-5	-5	-5	
Level at receiver		**31**	**34**	**26**	**27**	**21**	**17**	**10**	**4**	**27**

Little Russell Street Receiver

		63 Hz	125 Hz	250 Hz	500 Hz	1 kHz	2 kHz	4 kHz	8 kHz	dB(A)
Daikin REYQ10T	Lp @ 1m	62	65	57	58	52	48	41	35	**59**
Number of Plant	1	0	0	0	0	0	0	0	0	
Distance Loss	To 12m	-22	-22	-22	-22	-22	-22	-22	-22	
Screening loss (finite Barrier)*		-6	-6	-7	-9	-11	-14	-16	-18	
Level at receiver		**34**	**37**	**28**	**27**	**19**	**12**	**3**	**-5**	**28**

* screening loss limited to 18dB

Option 2 - Daikin RXYSQ6P8V

Museum Street Receiver

		63 Hz	125 Hz	250 Hz	500 Hz	1 kHz	2 kHz	4 kHz	8 kHz	dB(A)
Daikin RXYSQ6P8V	Lp @ 1m	65	57	56	53	50	45	38	33	**55**
Number of Plant	1	0	0	0	0	0	0	0	0	
Distance Loss	To 21m	-26	-26	-26	-26	-26	-26	-26	-26	
Screening loss (line of sight)		-5	-5	-5	-5	-5	-5	-5	-5	
Level at receiver		**34**	**26**	**25**	**22**	**19**	**14**	**7**	**2**	**24**

Little Russell Street Receiver

		63 Hz	125 Hz	250 Hz	500 Hz	1 kHz	2 kHz	4 kHz	8 kHz	dB(A)
Daikin RXYSQ6P8V	Lp @ 1m	65	57	56	53	50	45	38	33	**55**
Number of Plant	1	0	0	0	0	0	0	0	0	
Distance Loss	To 12m	-22	-22	-22	-22	-22	-22	-22	-22	
Screening loss (finite Barrier)*		-6	-6	-7	-9	-11	-14	-16	-18	
Level at receiver		**37**	**29**	**27**	**22**	**17**	**9**	**0**	**-7**	**24**

* screening loss limited to 18dB