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HOLBORN TOWER
137 HIGH HOLBORN
LONDON

PLANT NOISE IMPACT ASSESSMENT

Technical Report: R5275-1 Rev 1

Date: 29th August 2014

For: APS
25 Worship Street
London
EC2A 2DX

24 Acoustics Document Control Sheet

Project Title: Holborn Tower, 137 High Holborn, London – Plant Noise Impact Assessment

Report Ref: R5275-1 Rev 1

Date: 29th August 2014

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For and on behalf of 24 Acoustics Ltd				

Document Status and Approval Schedule

Revision	Description	Prepared By	Approved By
0	Approved for Issue	Chris McConnell	Stephen Gosling
1	Updated to include assessment of proposed plant	Chris McConnell	Stephen Gosling

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1.0 INTRODUCTION

1.1 24 Acoustics Ltd has been instructed by APS to undertake a noise impact assessment in relation to proposed building services plant at Holborn Tower, 137 High Holborn, London.

1.2 Accordingly this noise impact assessment has included:

- Background noise monitoring;
- Determination of external noise limits for the proposed plant;
- Assessment of noise arising from the proposed plant.

1.3 This report presents the results of the assessment, following a site visit and background noise survey undertaken between the 9th and 17th July 2014.

1.4 All noise levels in this report are presented in dB relative to 20μPa.

2.0 SITE DESCRIPTION

2.1 The site is located at the junction of High Holborn and New Oxford Street. The surrounding buildings are mostly commercial premises, with the closest residential properties, Lytton Court, located to the rear of the site on Barter Street.

2.2 Holborn Tower is an eleven storey building and is currently used as office accommodation with retail use on the ground floor. The office floors are currently only partially occupied, with some vacant floors. Existing plant is located on the building, mostly on the upper floors and at roof level.

2.3 It is intended to submit a planning application for new building services plant. The proposed plant will comprise outdoor VRV units at first floor and eleventh floor level, and also an AHU and extract fan on each office floor (floors 1 to 10).

2.4 24 Acoustics has been advised that, for the purposes of this assessment, the operating hours of the plant will be from 08:00 to 20:00 hours on weekdays, in line with the expected hours of use of the office accommodation.

3.0 CRITERIA

National Planning Policy Framework and Noise Policy Statement for England

3.1 The National Planning Policy Framework (NPPF) [Reference 1] was published by the Department for Communities and Local Government in March 2012, and is now effective. This document is intended to replace specific guidance contained within previous planning policy guidance and statement documents which are currently in force. This document therefore supersedes PPG 24 [Reference 2] which previously provided guidance on noise relating to planning and new development. For noise the NPPF policy states that 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, while recognising that many developments will create some noise.

3.2 The NPPF also refers to the Noise Policy Statement for England (NPSE) [Reference 3] which is intended to apply to all forms of noise, including environmental noise, neighbour noise and neighbourhood noise. The NPSE sets out the Government's long-term vision to 'promote good health and a good quality of life through the effective management of noise within the context of Government policy on sustainable development' which is supported by the following aims.

- Avoid significant adverse impacts on health and quality of life;
- Mitigate and minimise adverse impacts on health and quality of life;

3.3 The NPSE defines the concept of a 'significant observed adverse effect level' (SOAEL) as 'the level above which significant adverse effects on health and quality of life occur'. The following guidance is provided within the NPSE:

"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."

BS 4142 (Method for Rating Industrial Noise Affecting Mixed Residential and Industrial Areas)

3.4 British Standard (BS) 4142 [Reference 4] provides a method for rating the effects of industrial noise on mixed residential and industrial areas. The standard advocates a comparison between the typical measured L_{A90} background noise level and L_{Aeq} noise level from the source being considered. For rating purposes if the noise source is tonal, intermittent or otherwise distinctive in character, a rating correction of +5 dB is applied. The standard states that a difference between the rating level and the background level of +10 dB indicates that 'complaints are likely', a difference of +5 dB is of 'marginal significance' and a difference of −10 dB is a 'positive indication that complaints are unlikely'.

London Borough of Camden - Development Policy DP28

3.5 London Borough of Camden's Development Policy DP28 'Noise and Vibration' [Reference 5] provides guidance on the control of noise and vibration through planning. The policy states "Development that exceeds Camden's Noise and Vibration Thresholds will not be permitted".

3.6 Specifically in relation to plant and machinery, Policy DP28 states "The Council will only grant permission for plant and machinery if it can be operated without cause harm to amenity and does not exceed our noise thresholds."

3.7 The London Borough of Camden's requirements for noise from fixed plant are stated in Table E of DP28 which states that, for noise from plant and machinery, at 1 metre external to a sensitive façade the noise level should be 5 dB below the minimum external background noise level (dB $L_{A90,\ 15\ min}$). Where noise from the plant has a distinctive tonal or impulsive nature, the limits should be reduced by a further 5 dB (i.e. 10 dB below the minimum external background noise level). The daytime period is assessed between 07:00-19:00 hours, evening period between 19:00-23:00 hours and night time period between 23:00-07:00 hours.

Local Authority Consultation

3.8 24 Acoustics has contacted Claire Parsons, Environmental Health Officer at London Borough of Camden, in relation to the noise assessment at this site. Ms Parsons has confirmed that Camden's standard requirements for noise from fixed plant (as outlined in Policy DP28) will apply to the new items of plant.

4.0 ENVIRONMENTAL NOISE MEASUREMENTS AND RESULTS

4.1 A background noise survey was undertaken on site from the 9th to the 17th July 2014. The microphone was installed adjacent to the building at fourth floor level. The measurement location used is considered representative of the nearest noise sensitive properties. The measurement location is shown in Figure 1.

4.2 Ambient noise levels were measured using the following equipment:

Rion (Type 1) precision grade sound level meter	Type NL-31;
Bruel and Kjaer acoustic calibrator	Type 4231.

4.3 The instrumentation was configured to continuously measure and store overall A-weighted statistical parameters including L_{Aeq} and L_{A90} (all measured on fast response) in 5 minute intervals. Measurements were made in accordance with BS 7445: 1991 "Description and measurement of environmental noise Part 2 - Acquisition of data pertinent to land use" [Reference 6].

4.4 The instrumentation at the measurement location was equipped with an environmental microphone and an extension cable. The instrument was powered by external batteries and stored in a weatherproof case. The calibration of the instrumentation was checked before and after the tests and no signal variation occurred. Calibration of 24 Acoustics' equipment is traceable to National Standards. The weather at the start and end of the survey period was dry and the wind speed was less than 5 m/s. The weather during the survey period was mostly dry, with some brief spells of precipitation which have been removed from the analysis.

Results

4.5 The measured noise levels are shown graphically in Appendix B. The prevailing background noise levels on site were noted to be affected by noise from road traffic on the surrounding roads as well as noise from plant on the surrounding buildings.

4.6 The measured background noise levels have been processed to obtain 15-minute values in order to derive plant noise emission limits in accordance with the requirements of the London Borough of Camden. The lowest background noise level during the proposed hours of operation, 08:00 to 20:00 hours on weekdays, was 55 dB $L_{A90,\ 15\ minute}$.

5.0 PLANT NOISE ASSESSMENT

Limiting Criteria for New Plant

5.1 The London Borough of Camden requires that the noise level of the new plant should be at least 5 dB below the lowest existing background noise level (L_{A90}) at the nearest noise sensitive façade. As such the external plant noise limit, to be achieved at 1m from the nearest noise sensitive window, is shown below:

- 50 dB $L_{Aeq,\ 15\ minute}$ during the proposed operating hours (08:00 to 20:00 hours on weekdays)

5.2 The above limit should be reduced by 5 dB if noise from the plant has a distinctive tonal or impulsive nature.

5.3 The plant noise limits should be achieved at the nearest noise sensitive properties; these are noted to be the residential properties at Lytton Court, located to the rear of the site on Barter Street, at a closest distance of approximately 6m from the proposed plant. Residential properties are also located further away at 17-19 Barter Street, at a closest distance of approximately 23m from the proposed plant. The noise sensitive properties are indicated on the site location plan in Figure 1.

Plant Noise Assessment

5.4 The proposed new plant is understood to comprise the following, as described in Table 1.

Location	Description
1st Floor Roof	4 x Daikin REYQ14T VRV units (with space for 2 x future units)
11th Floor Roof	1 x Daikin REYQ14T VRV unit 1 x Daikin REYQ8T VRV unit
Floors 1 to 10	1 x Nuaire Supply and Extract AHU (one unit on each floor) 1 x Nuaire ES-OPUSDC110-M Extract Fan (one unit on each floor)

Table 1: Summary of Proposed New Plant

5.5 The Nuaire AHUs and Extract Fans will be located inside the building, and will be connected via internal ductwork to louvres on the rear façade, to be located as shown in Figure 2. The first floor roof plant and eleventh floor roof plant locations are shown on Figures 3 and 4, respectively.

5.6 Note that this assessment has assumed a total of six VRV units on the first floor roof, which would allow for the two future units as indicated in the proposals.

5.7 The manufacturer's plant noise level data for the VRV units is stated in Table 2 below.

Plant Unit	Sound Power Level (dB) per Octave Band Frequency, Hz							dBA
	125	250	500	1k	2k	4k	8k	
Daikin REYQ14T	84	83	80	76	70	67	61	**82**
Daikin REYQ8T	77	78	76	74	67	64	59	**78**

Table 2: Daikin VRV Units – Manufacturer's Octave-band Sound Power Levels

5.8 The manufacturer's plant noise level data for the AHUs and extract fans is stated in Table 3 below.

Plant	In-duct Sound Power Level per Octave Band Centre Frequency (Hz)							
	63	125	250	500	1k	2k	4k	8k
Nuaire XB5 AHU – Intake	80	79	75	74	73	64	61	57
Nuaire XB5 AHU – Discharge	78	77	74	77	74	72	67	60
Nuaire ES-OPUSDC110-M - Discharge	-	76	71	63	63	62	58	52

Table 3: AHUs and Extract Fans – Manufacturer's Octave-band Sound Power Levels

5.9 Based on the manufacturer's stated noise levels, calculations have been undertaken to determine the plant noise levels at the nearest noise sensitive window, at Lytton Court. The calculations have taken into account atmospheric losses for distance and, for the 11th floor VRV units, acoustic screening from the roof edge. The calculations of noise from the ventilation louvres have also taken into account end reflections and directivity.

5.10 From examination of the manufacturer's plant noise levels (in octave bands), it is not expected that the proposed plant will have any tonal characteristics. Therefore, no character correction, for tonality or other distinctive features, has been included in the calculations.

5.11 Calculations indicate that, in order to achieve the established plant noise limit at the nearest noise sensitive window, noise mitigation measures would be required to the first floor VRV units and also to the AHUs and extract fans on each floor. The recommended mitigation measures are outlined below.

5.12 It is recommended that an acoustically rated enclosure be provided around the first floor VRV units, to achieve the required sound reduction performance specified in Table 4.

Required Minimum Sound Reduction Performance (dB) at Octave Band Frequency, Hz							
63	**125**	**250**	**500**	**1k**	**2k**	**4k**	**8k**
8	13	20	22	22	19	18	14

Table 4: Required Sound Reduction Performance of Enclosure around 1st Floor VRV Units

5.13 The enclosure should ensure that the 1st floor VRV units are fully enclosed on all sides, including a roof, whilst maintaining adequate airflow.

5.14 It is recommended that attenuation be installed, on the atmospheric side, to each AHU intake, AHU discharge and extract fan discharge to achieve the required sound reduction performance specified in Table 5.

Required Minimum Sound Reduction Performance (dB) at Octave Band Frequency, Hz							
63	**125**	**250**	**500**	**1k**	**2k**	**4k**	**8k**
3	6	13	20	23	21	19	15

Table 5: Required Performance of Atmospheric Attenuation to AHUs and Extract Fans

5.15 The attenuation should be installed to each AHU (intake and discharge) and extract fan system on each floor (floors 1 to 10) and it is expected that attenuators, or similar, will be located inside the building as shown on the mechanical engineers' sketch drawings.

5.16 The plant noise calculations, with attenuation, are provided in Appendix C.

5.17 With the recommended attenuation installed, the total calculated cumulative noise level from the proposed plant would not exceed the established limit of 50 dB $L_{Aeq,\ 15\ minute}$ at the nearest noise sensitive window, and would therefore be acceptable.

5.18 The above assessment has been undertaken for planning purposes only. External plant noise must be assessed during the detailed design stage, and mitigation measures appropriately specified, to ensure that the proposed plant complies with the noise limits required by London Borough of Camden.

6.0 CONCLUSIONS

6.1 A plant noise impact assessment has been carried out in relation to proposed building services plant at Holborn Tower, 137 High Holborn, London.

6.2 An environmental noise survey has been undertaken to determine the existing background noise levels at the nearest noise sensitive premises. Based upon the survey results and Local Authority requirements, limiting criteria applicable to noise from the installation of new external plant have been established.

6.3 Calculations have been undertaken, based on manufacturers' noise data, to determine the plant noise levels at the nearest noise sensitive window. Noise mitigation measures have been specified in order to ensure that noise from the plant will not exceed the established noise limit at the nearest noise sensitive window, during the proposed operating hours.

6.4 The calculations demonstrate that, with the recommended attenuation installed, the proposed plant will comply with the noise limits required by London Borough of Camden.

REFERENCES

1. Department for Communities and Local Government. National Planning Policy Framework, March 2012.

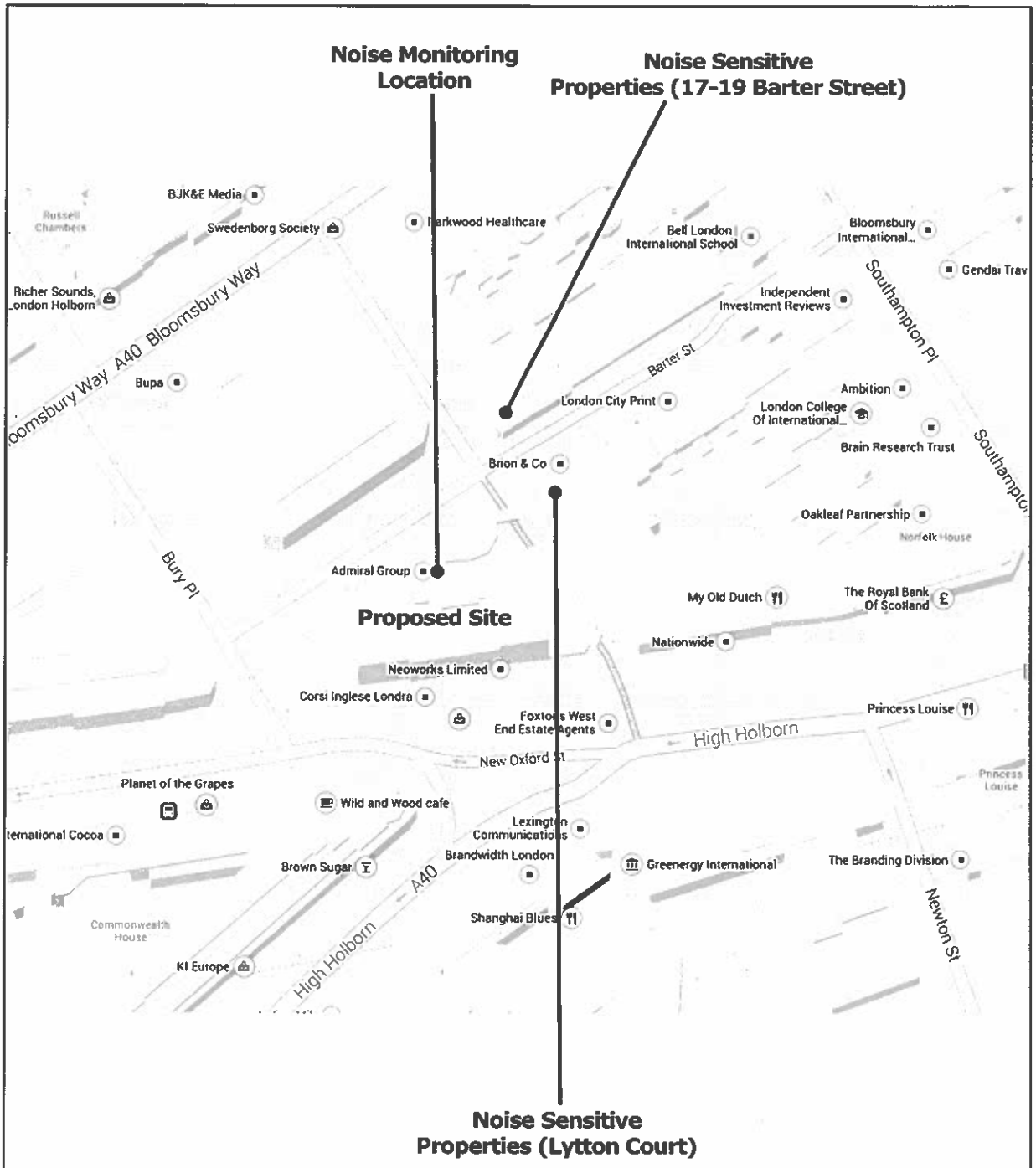
2. Department for the environment, Planning Policy Guidance 24, Planning and Noise, 1994.

3. DEFRA, Noise Policy Statement for England, March 2010.

4. British Standards Institution. British Standard 4142: 1997 Rating Industrial Noise Affecting Mixed Residential and Industrial Areas.

5. Camden Development Policies 2010-2025, Development Policy DP28 'Noise and Vibration'

6. British Standards Institution. British Standard 7445: 1991 'Description and measurement of environmental noise Part 2 - Acquisition of data pertinent to land use'



Project: Holborn Tower, London	**Description:** Existing Site Plan and Noise Measurement Location	
DWG No: Figure 1	**Scale:** N.T.S.	**Rev:** B
Date: August 2014	**Drawn By:** CM	**Job No:** 5275-1

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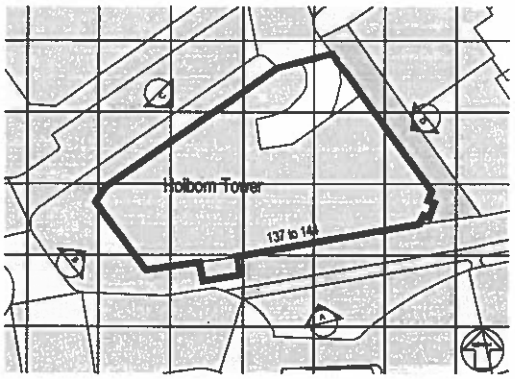
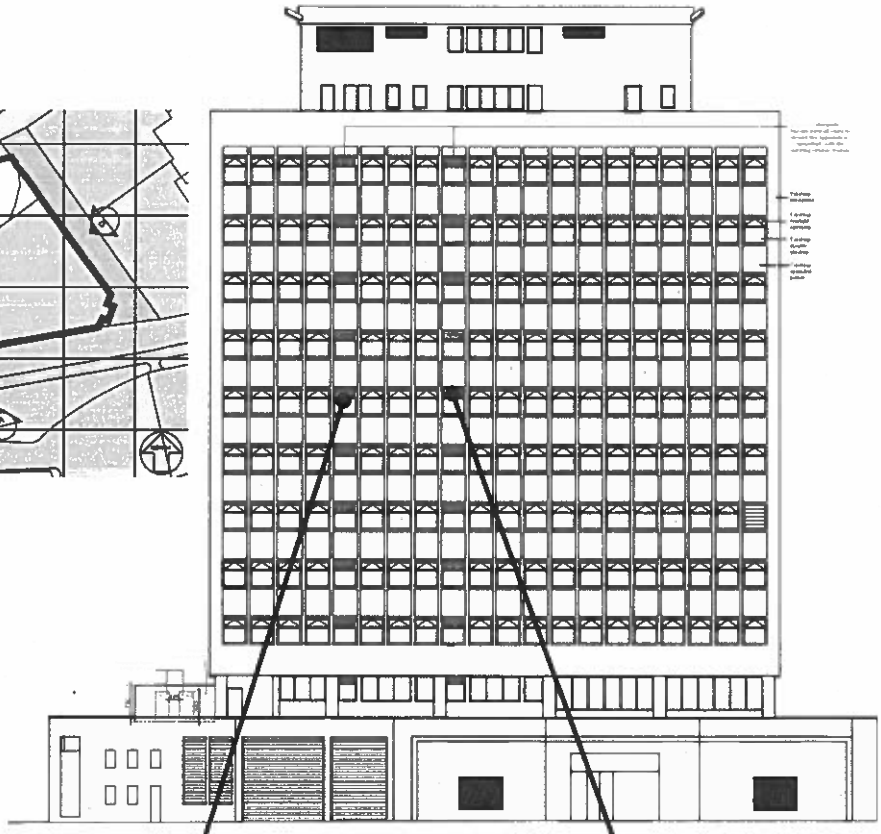


2 Site Plan , Elevation Reference
Scale 1:250

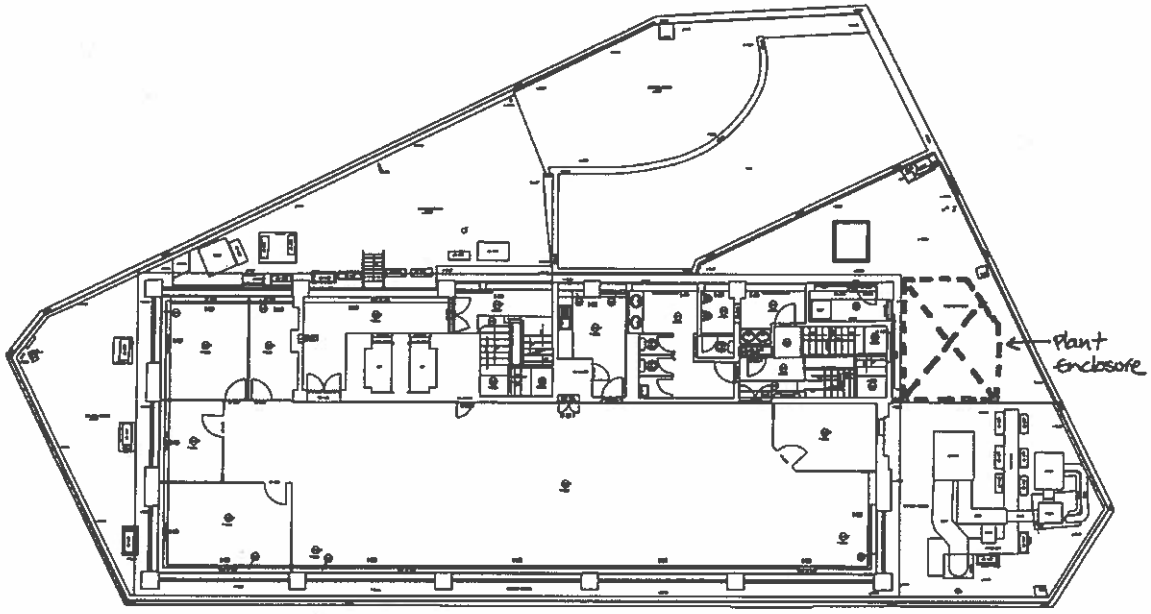


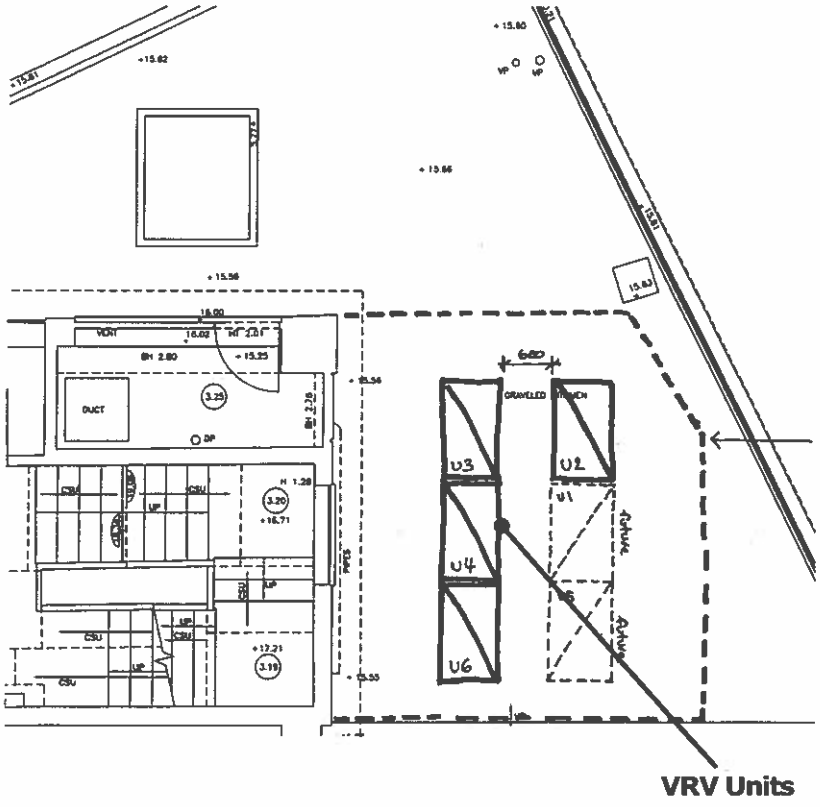
1 Proposed Rear External Elevation
Scale 1:100

Air Intake Louvres (One Per Floor)

Air Discharge Louvres (One Per Floor)

Project: Holborn Tower, London	**Description:** Rear Elevation Showing Louvre Locations		24Acoustics
DWG No: Figure 2	**Scale:** N.T.S.	**Rev:** A	
Date: August 2014	**Drawn By:** CM	**Job No:** 5275-1	





Project: Holborn Tower, London	**Description:** 1st Floor Roof – Plant Locations	
DWG No: Figure 3	**Scale:** N.T.S.	**Rev:** A
Date: August 2014	**Drawn By:** CM	**Job No:** 5275-1

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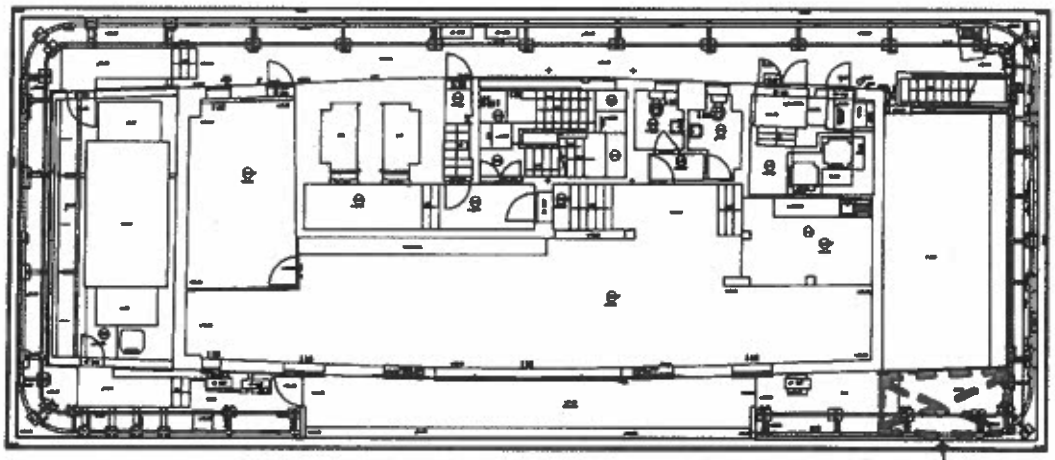
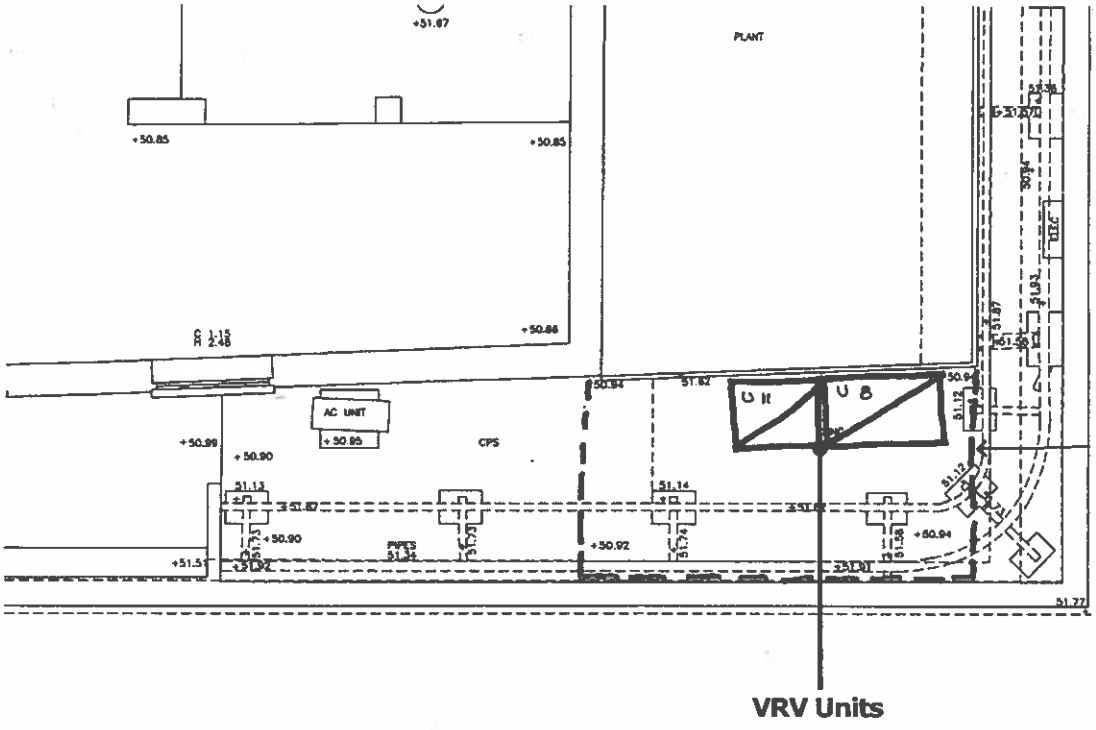


Plant enclosure.



Project: Holborn Tower, London	**Description:** 11th Floor Roof – Plant Locations		24Acoustics
DWG No: Figure 4	**Scale:** N.T.S.	**Rev:** A	
Date: August 2014	**Drawn By:** CM	**Job No:** 5275-1	

APPENDIX A: ACOUSTIC TERMINOLOGY

Noise Levels

Noise is defined as unwanted sound. The range of audible sound is from 0 to 140 dB. The frequency response of the ear is usually taken to be around 18 Hz (number of oscillations per second) to 18000 Hz. The ear does not respond equally to different frequencies at the same level. It is more sensitive in the mid-frequency range than the lower and higher frequencies and because of this, the low and high frequency components of a sound are reduced in important by applying a weighting (filtering) circuit to the noise measuring instrument. The weighting which is most widely used and which correlates best with subjective response to noise is the dBA weighting. This is an internationally accepted standard for noise measurements.

For variable sources, such as traffic, a difference of 3 dBA is just distinguishable. In addition, a doubling of traffic flow will increase the overall noise by 3 dBA. The 'loudness' of a noise is a purely subjective parameter, but it is generally accepted that an increase/ decrease of 10 dBA corresponds to a doubling/ halving in perceived loudness.

External noise levels are rarely steady, but rise and fall according to activities within an area. In attempt to produce a figure that relates this variable noise level to subjective response, a number of noise indices have been developed. These include:

i) The L_{Amax} noise level

This is the maximum noise level recorded over the measurement period.

ii) The L_{Aeq} noise level

This is "equivalent continuous A-weighted sound pressure level, in decibels" and is defined in British Standard BS 7445 [2] as the "value of the A-weighted sound pressure level of a continuous, steady sound that, within a specified time internal, T, has the same mean square sound pressure as a sound under consideration whose level varies with time".

It is a unit commonly used to describe construction noise and noise from industrial premises and is the most suitable unit for the description of other forms of environmental noise. In more straightforward terms, it is a measure of energy within the varying noise.

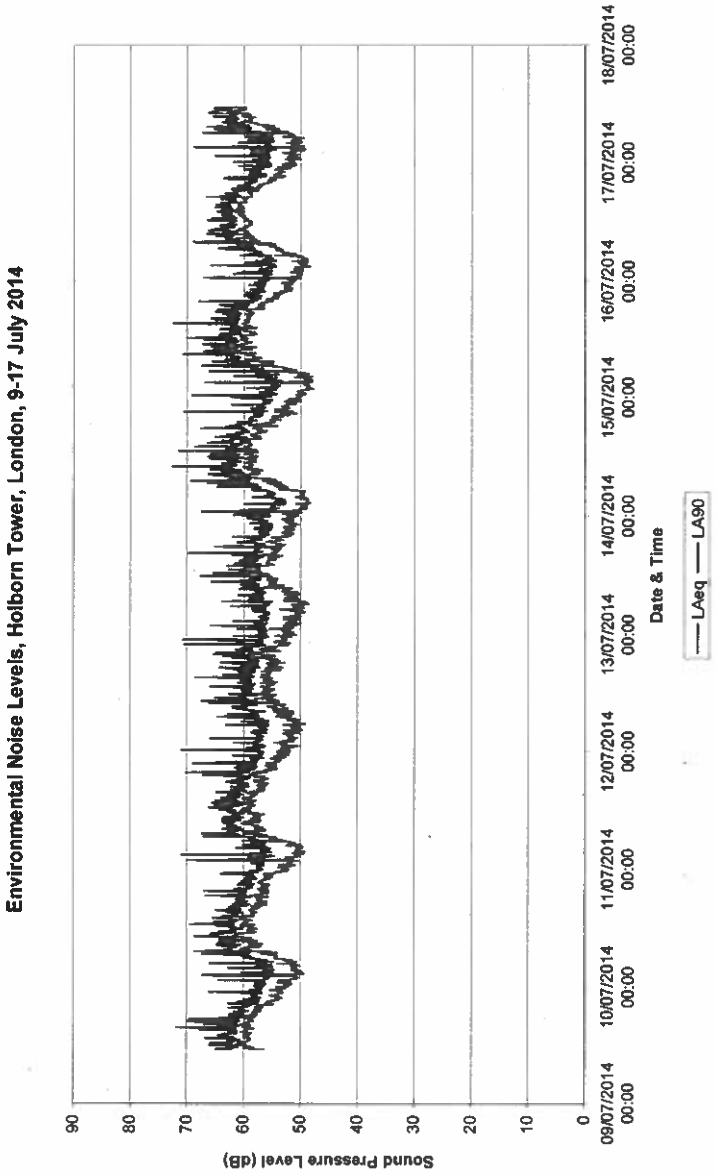
iii) The L_{A10} noise level

This is the noise level that is exceeded for 10% of the measurement period and gives an indication of the noisier levels. It is a unit that has been used over many years for the measurement and assessment of road traffic noise.

iv) The L_{A90} noise level

This is the noise level that is exceeded for 90% of the measurement period and gives an indication of the noise level during the quieter periods. It is often referred to as the background noise level and is used in the assessment of disturbance from industrial noise.

APPENDIX B: MEASURED NOISE LEVELS



APPENDIX C: PLANT NOISE CALCULATIONS

Calculations of external plant noise to nearest residential window at Lytton Court:

	1st Floor A/C plant								
	Daikin REYQ14T x 4 with space for x 2 additional units								
REYQ14T	**63Hz**	**125Hz**	**250Hz**	**500Hz**	**1kHz**	**2kHz**	**4kHz**	**8kHz**	**dBA**
1 unit Lw	82	84	83	80	76	70	67	61	82
6 x units	8	8	8	8	8	8	8	8	
Enclosure sound reduction	-8	-13	-20	-22	-22	-19	-18	-14	
distance 6m	-16	-16	-16	-16	-16	-16	-16	-16	
hemispherical	-8	-8	-8	-8	-8	-8	-8	-8	
Lp at resi	58	55	47	42	38	35	33	31	46
	11th Floor A/C plant								
	Daikin REYQ14T x 1 and REYQ8T x 1								
REYQ14T	**63Hz**	**125Hz**	**250Hz**	**500Hz**	**1kHz**	**2kHz**	**4kHz**	**8kHz**	**dBA**
1 unit Lw	82	84	83	80	76	70	67	61	82
screening loss - Roof Edge	-7	-8	-9	-10	-11	-14	-16	-16	
distance 33m	-30	-30	-30	-30	-30	-30	-30	-30	
hemispherical	-8	-8	-8	-8	-8	-8	-8	-8	
Lp at resi	37	38	36	32	27	18	13	7	33
REYQ8T	**63Hz**	**125Hz**	**250Hz**	**500Hz**	**1kHz**	**2kHz**	**4kHz**	**8kHz**	**dBA**
1 unit Lw	79	77	78	76	74	67	64	59	78
screening loss - Roof Edge	-7	-8	-9	-10	-11	-14	-16	-16	
distance 33m	-30	-30	-30	-30	-30	-30	-30	-30	
hemispherical	-8	-8	-8	-8	-8	-8	-8	-8	
Lp at resi	34	31	31	28	25	15	10	5	29

	Ventilation Plant Floors 1-3								
	Office heat recovery AHU (supply and extract) per floor and toilet extract per floor, fans inside building								
Office Supply									
Nuaire XB5	**63Hz**	**125Hz**	**250Hz**	**500Hz**	**1kHz**	**2kHz**	**4kHz**	**8kHz**	**dBA**
Intake in-duct Lw	80	79	75	74	73	64	61	57	76
Attenuation Performance	-3	-6	-13	-20	-23	-21	-19	-15	
End Reflection	-6	-3	-1	0	0	0	0	0	
Intake Louvre Lw	70	70	61	54	50	43	42	42	59
3 Louvres	5	5	5	5	5	5	5	5	
distance 14m	-23	-23	-23	-23	-23	-23	-23	-23	
hemispherical	-8	-8	-8	-8	-8	-8	-8	-8	
directivity	1	2	3	3	4	4	4	4	
Lp at resi	45	46	38	31	28	20	20	20	35
Office Extract									
Nuaire XB5	**63Hz**	**125Hz**	**250Hz**	**500Hz**	**1kHz**	**2kHz**	**4kHz**	**8kHz**	**dBA**
Discharge in-duct Lw	78	77	74	77	74	72	67	60	79
Attenuation Performance	-3	-6	-13	-20	-23	-21	-19	-15	
In duct Lw	75	71	61	57	51	51	48	45	61
Toilet Extract									
Nuaire ES-OPUSDC110-M	**63Hz**	**125Hz**	**250Hz**	**500Hz**	**1kHz**	**2kHz**	**4kHz**	**8kHz**	**dBA**
Discharge in-duct Lw	77	76	71	63	63	62	58	52	69
Attenuation Performance	-3	-6	-13	-20	-23	-21	-19	-15	
In duct Lw	74	70	58	43	40	41	39	37	56
Cumulative Extract									
Discharge In duct total Lw	77	73	63	57	52	51	48	46	
End Reflection	-6	-3	-1	0	0	0	0	0	
Discharge Louvre Lw	71	70	62	57	52	51	48	46	61
3 Louvres	5	5	5	5	5	5	5	5	
distance 19m	-26	-26	-26	-26	-26	-26	-26	-26	
hemispherical	-8	-8	-8	-8	-8	-8	-8	-8	
directivity	1	2	3	3	4	4	4	4	
Lp at resi	43	43	36	31	27	26	23	21	35

APPENDIX C: PLANT NOISE CALCULATIONS – (Continued)

	Ventilation Plant Floors 4-6								
	Office heat recovery AHU (supply and extract) per floor and toilet extract per floor, fans inside building								
Office Supply									
Nuaire XB5	**63Hz**	**125Hz**	**250Hz**	**500Hz**	**1kHz**	**2kHz**	**4kHz**	**8kHz**	**dBA**
Intake in-duct Lw	80	79	75	74	73	64	61	57	76
Attenuation Performance	-3	-6	-13	-20	-23	-21	-19	-15	
End Reflection	-6	-3	-1	0	0	0	0	0	
Intake Louvre Lw	70	70	61	54	50	43	42	42	59
3 Louvres	5	5	5	5	5	5	5	5	
distance 16m	-24	-24	-24	-24	-24	-24	-24	-24	
hemispherical	-8	-8	-8	-8	-8	-8	-8	-8	
directivity	1	1	1	2	2	2	2	2	
Lp at resi	44	43	35	28	25	17	17	17	33
Office Extract									
Nuaire XB5	**63Hz**	**125Hz**	**250Hz**	**500Hz**	**1kHz**	**2kHz**	**4kHz**	**8kHz**	**dBA**
Discharge in-duct Lw	78	77	74	77	74	72	67	60	79
Attenuation Performance	-3	-6	-13	-20	-23	-21	-19	-15	
In duct Lw	75	71	61	57	51	51	48	45	61
Toilet Extract									
Nuaire ES-OPUSDC110-M	**63Hz**	**125Hz**	**250Hz**	**500Hz**	**1kHz**	**2kHz**	**4kHz**	**8kHz**	**dBA**
Discharge in-duct Lw	77	76	71	63	63	62	58	52	69
Attenuation Performance	-3	-6	-13	-20	-23	-21	-19	-15	
In duct Lw	74	70	58	43	40	41	39	37	56
Cumulative Extract									
Discharge in duct total Lw	77	73	63	57	52	51	48	46	
End Reflection	-6	-3	-1	0	0	0	0	0	
Discharge Louvre Lw	71	70	62	57	52	51	48	46	61
3 Louvres	5	5	5	5	5	5	5	5	
distance 21m	-26	-26	-26	-26	-26	-26	-26	-26	
hemispherical	-8	-8	-8	-8	-8	-8	-8	-8	
directivity	1	1	1	2	2	2	2	2	
Lp at resi	42	42	34	29	24	23	21	18	33
	Ventilation Plant Floors 7-10								
	Office heat recovery AHU (supply and extract) per floor and toilet extract per floor, fans inside building								
Office Supply									
Nuaire XB5	**63Hz**	**125Hz**	**250Hz**	**500Hz**	**1kHz**	**2kHz**	**4kHz**	**8kHz**	**dBA**
Intake in-duct Lw	80	79	75	74	73	64	61	57	76
Attenuation Performance	-3	-6	-13	-20	-23	-21	-19	-15	
End Reflection	-6	-3	-1	0	0	0	0	0	
Intake Louvre Lw	70	70	61	54	50	43	42	42	59
4 Louvres	6	6	6	6	6	6	6	6	
distance 24m	-28	-28	-28	-28	-28	-28	-28	-28	
hemispherical	-8	-8	-8	-8	-8	-8	-8	-8	
directivity	1	1	1	2	2	2	2	2	
Lp at resi	41	41	33	26	23	15	14	14	30
Office Extract									
Nuaire XB5	**63Hz**	**125Hz**	**250Hz**	**500Hz**	**1kHz**	**2kHz**	**4kHz**	**8kHz**	**dBA**
Discharge in-duct Lw	78	77	74	77	74	72	67	60	79
Attenuation Performance	-3	-6	-13	-20	-23	-21	-19	-15	
In duct Lw	75	71	61	57	51	51	48	45	61
Toilet Extract									
Nuaire ES-OPUSDC110-M	**63Hz**	**125Hz**	**250Hz**	**500Hz**	**1kHz**	**2kHz**	**4kHz**	**8kHz**	**dBA**
Discharge in-duct Lw	77	76	71	63	63	62	58	52	69
Attenuation Performance	-3	-6	-13	-20	-23	-21	-19	-15	
In duct Lw	74	70	58	43	40	41	39	37	56
Cumulative Extract									
Discharge in duct total Lw	77	73	63	57	52	51	48	46	
End Reflection	-6	-3	-1	0	0	0	0	0	
Discharge Louvre Lw	71	70	62	57	52	51	48	46	61
4 Louvres	6	6	6	6	6	6	6	6	
distance 27m	-29	-29	-29	-29	-29	-29	-29	-29	
hemispherical	-8	-8	-8	-8	-8	-8	-8	-8	
directivity	1	1	1	2	2	2	2	2	
Lp at resi	41	41	33	28	23	22	20	17	32
	63Hz	**125Hz**	**250Hz**	**500Hz**	**1kHz**	**2kHz**	**4kHz**	**8kHz**	**dBA**
TOTAL Plant Noise at Resi	59	57	49	43	40	36	34	32	47