KP Acoustics Ltd
Britannia House
11 Glenthorne Road
London
W6 0LH

Tel: +44(0)208 222 8778
Fax: +44(0)208 222 8575
Email: info@kpacoustics.com
www.kpacoustics.com

29 NEW END, HAMPSTEAD, LONDON

PLANNING COMPLIANCE REVIEW

Report 13706.PCR.01.Rev. D

For:

Linton

14 Basil Street

Knightsbridge

London

SW3 1AJ

Site Address	Report Date	Revision History
29 New End, Hampstead, London	13/06/2016	Rev A – 01/07/2016 Rev B – 22/08/2016 Rev C – 31/03/2017 Rev D – 24/08/2017

CONTENTS

List of Attachments

1.0 INTRODUCTION

KP Acoustics Ltd, Britannia House, 11 Glenthorne Road, London, W6 0LH, has been commissioned by Linton, 14 Basil Street, Knightsbridge, London, SW3 1AJ, to undertake an environmental noise survey at 29 New End, Hampstead, London.

The background noise levels measured will be used to determine daytime and night-time noise emission criteria for a proposed installation of plant units, in agreement with the planning requirements of the London Borough of Camden.

This report presents the overall methodology and results from the environmental survey followed by calculations to demonstrate the feasibility of the proposed options for the plant installations to satisfy the emissions criterion at the closest noise-sensitive receiver and outline mitigation measures as appropriate.

2.0 ENVIRONMENTAL NOISE SURVEY AND EQUIPMENT

2.1 Procedure

Automated noise monitoring was undertaken on the proposed site as shown in Site Plan 13706.SP3. The choice of these positions was based both on accessibility and on collecting representative noise data in relation to the nearest noise sensitive receiver relative to the proposed plant installation. The duration of the survey was between 10:30 on 25/01/2016 and 10:10 on 27/01/2016.

Initial inspection of the site revealed that the background noise profile at the monitoring location was dominated by road traffic noise from the surrounding roads.

The weather during the course of the survey was generally dry with wind speeds within acceptable tolerances and therefore suitable for the measurement of environmental noise. The measurement procedure generally complied with ISO 1996-2:2007 Acoustics "Description, measurement and assessment of environmental noise - Part 2: Determination of environmental noise levels".

2.2 Equipment

The equipment calibration was verified before and after use and no abnormalities were observed.

The equipment used was as follows.

- 2 no. Svantek Tupe 957 Class 1 Sound Level Meter
- B&K Type 4231 Class 1 Calibrator

3.0 RESULTS

The results from the continuous noise monitoring are shown as a time history of L_{Aeq}, L_{Amax}, L_{A10} and L_{A90} averaged over 5 minute sample periods in 13706.TH1 (New End Elevation) and 13706.TH2 (North Elevation).

Minimum background noise levels are shown in Table 3.1.

	Minimum background noise level $L_{A90: 5min}$ **dB(A)** **New End Elevation**	**Minimum background noise level** $L_{A90: 5min}$ **dB(A)** **North Elevation**
Daytime (07:00-23:00)	39	40
Night-time (23:00-07:00)	35	38

Table 3.1: Minimum measured background noise levels

Measured ambient noise levels are shown in Table 3.2.

	Levels dB(A)	
	New End Elevation	North Elevation
Daytime $L_{Aeq,16hour}$	61	57
Night-time $L_{Aeq,8hour}$	58	49

Table 3.2 Site average noise levels for daytime and night time

4.0 NOISE CRITERIA

The criterion of The London Borough of Camden for noise emissions of new plant in this instance is as follows:

"The proposed plant and machinery shall be operated so as to ensure that any noise generated is "not audible" outside the nearest residential premises. To demonstrate inaudibility, you will need to provide calculations that show that the plant noise level is 10dBA below the lowest background level (LA90 (15minutes)) 1m from the nearest residential window, over the proposed operating hours. Tonality must also be taken into consideration."

We therefore propose to set the noise criterion as shown in Table 4.1 in order to comply with the above requirement.

	Daytime (07:00 to 23:00) North Elevation	Night-time (23:00 to 07:00) North Elevation
Noise criterion at nearest receiver	30dB(A)	28dB(A)

Table 4.1: Proposed Noise Emissions Criterion

As the proposed condenser units could be used anytime, we would recommend the adoption of the night-time criterion, to ensure that the amenity of the closest receiver will be protected.

5.0 DISCUSSION

It is understood that the plant installation is comprised of the following units:

Lower Ground Floor Plant unit installations

- 2 No. Mitsubishi PUMY-P200YKM condenser units
- 1 No. Mitsubishi PUMY-P112YKM condenser units
- 1 No. Mitsubishi PUMY-P140YKM condenser units
- 1 No. Mitsubishi PUMY-P125YKM condenser unit
- 1 No. Mitsubishi PUHZ -ZRP71KHA condenser unit
- 1 No. FN-EC01 Energy Centre Supply Fan
- 1 No. FN-EC01 Energy Centre Extract Fan
- 2 No. EF-03 A&B Car Park Extract Fan

The closest noise sensitive receiver to proposed condenser units installations will be a Living Room window located at First Floor (APT 07) of the proposed development (as shown in SP3 and SP4) and approximately between 7.5meters (min.) away. Similarly, the closest noise sensitive receiver to the outlet and inlet Fans will be a Bedroom window located at First Floor (APT 10) of the proposed development (as shown in SP4) and approximately 8 meters (min.) away.

Second Floor Plant unit installations

- 4 No. Mitsubishi PUMY-P200YKM condenser units
- 2 No. Mitsubishi PUMY-P125YKM condenser units

The closest noise sensitive receiver to proposed condenser units will be a Bedroom window (Lawn House) located to the West of the proposed development and approximately between 2 - 4 meters (min.) away.

Top Roof Plant unit Installations

- 5 No. Mitsubishi PUMY-P112YKM condenser units
- 7 No. Mitsubishi PUMY-P200YKM condenser units
- 2 No. Mitsubishi PUMY-P140YKM condenser units
- 1 No. Mitsubishi PUMY-P125YKM condenser unit
- 1 No. Mitsubishi PUHZ -ZRP60KHA condenser unit
- 1 No. SF-01 - Roof Mounted Axial Fan

The closest noise sensitive receiver to the proposed plant unit locations will be a Bedroom window located at Fifth Floor (APT 17), of the proposed development (as shown in SP2) and approximately between 5 - 9 meters (min.) away.

The sound pressure levels at 1m as provided by the manufacturer for the units are shown in Table 5.1.

	Sound Pressure Level (dB) in each Frequency Band (at 1m)							
Unit	**63Hz**	**125Hz**	**250Hz**	**500Hz**	**1kHz**	**2kHz**	**4kHz**	**8kHz**
Mitsubishi PUMY-P112YKM	64	52	52	49	46	41	35	29
Mitsubishi PUMY-P125YKM	57	53	52	51	46	42	36	30
Mitsubishi PUMY-P140YKM	59	60	51	52	47	42	37	31
Mitsubishi PUMY-P200YKM	64	59	54	53	52	47	41	35
Mitsubishi PUHZ -ZRP60KHA	No spectral data available from the manufacturers. The overall level as provided by the manufacturers is 48dB(A) at 1m							
Mitsubishi PUHZ -ZRP71KHA	No spectral data available from the manufacturers. The overall level as provided by the manufacturers is 48dB(A) at 1m							

Table 5.1 Manufacturer's Sound Pressure Levels at 1m

The sound power levels as provided by the manufacturer for the Fan units are shown in Table 5.2.

	Sound Power Level (dB) by octave frequency band (Hz)							
Unit	**63Hz**	**125Hz**	**250Hz**	**500Hz**	**1kHz**	**2kHz**	**4kHz**	**8kHz**
Fan SF-01– Breakout (L_w at 3m)	48	58	67	71	71	68	64	57
Axia Fan SF-01 - Outlet/Inlet (L_w)	68	78	86	91	91	88	84	77

	Sound Power Level (dB) by octave frequency band (Hz)							
Unit	**63Hz**	**125Hz**	**250Hz**	**500Hz**	**1kHz**	**2kHz**	**4kHz**	**8kHz**
EF-03 (A&B) Car Park Extract Fans	87	80	73	72	66	73	77	76
FN-EC01 - Energy Centre Supply Fan (Inlet)	80	75	70	71	68	60	62	55
Fan FN-EC02 - Energy Centre Extract Fan (Outlet)	84	79	80	77	79	68	64	58

Table 5.2 Manufacturer's Sound Power Levels.

5.1 Objective overview

Taking all acoustic corrections into consideration, including distance corrections, the noise level expected at the closest residential window would be as shown in Table 5.5. Detailed calculations are shown in Appendices B1-4.

Receiver	Criterion	Noise Level at Receiver (Residential Window)
Nearest Noise Sensitive Window at APT 17 - Bedroom 02, as shown in Appendix B1	28 dB(A)	28 dB(A)
Nearest Noise Sensitive Window at Lawn House, as shown in Appendix B2		24 dB(A)
Nearest Noise Sensitive Window at APT 02- Living Room, as shown in Appendix B3		27 dB(A)
Nearest Noise Sensitive Window at APT 07 Bedroom 02, as shown in Appendix B4		28 dB(A)

Table 5.3 Predicted noise level and criterion at nearest noise sensitive locations.

As shown in Appendices B1-4 and Table 5.3, transmission of noise to the nearest sensitive window due to the effects of the plant installations fully satisfies the emissions criteria set based on the requirements of The London Borough of Camden. However, this is providing that the mitigation measures indicated in Section 5.3 are implemented.

5.2 BS8233 Assessment

Furthermore, the levels shown in table 5.5 are to be considered outside of the nearest Noise Sensitive Window. Windows may be closed or partially closed leading to further attenuation, as follows.

Further calculations have been undertaken to assess whether the noise emissions from the plant units installation would be expected to meet the recognised British Standard recommendations, in order to further ensure the amenity of nearby noise sensitive receivers.

British Standard 8233:2014 '*Sound insulation and noise reduction for buildings – Code of Practice*' gives recommendations for acceptable internal noise levels in residential properties. Assuming worst case conditions, of the closest window being a bedroom, BS8233:2014 recommends 30 dB(A) as being the value for internal resting/sleeping conditions in night-time and 35 dB(A) in daytime.

With a calculated external levels shown in table 5.5, the residential window itself would need to provide no additional attenuation in order for the conditions to be achieved. According to BS8233:2014, even a partially open window offers 10-15dB attenuation, thus leading to a further reduced interior noise level.

<table>
<tr><th>Receiver</th><th>Design Range – For resting/sleeping conditions in a bedroom, in BS8233:2014</th><th>Noise Level at Receiver (due to plant installations)</th></tr>
<tr><td>Nearest Noise Sensitive Window at APT 17 - Bedroom 02, as shown in Appendix B1</td><td rowspan="2">30dB(A)</td><td>18 dB(A)</td></tr>
<tr><td>Nearest Noise Sensitive Window at Lawn House, as shown in Appendix B2</td><td>Non-significant</td></tr>
<tr><td>Nearest Noise Sensitive Window at APT 02- Living Room, as shown in Appendix B3</td><td>35dB(A)</td><td>17 dB(A)</td></tr>
<tr><td>Nearest Noise Sensitive Window at APT 07 Bedroom 02, as shown in Appendix B4</td><td rowspan="2">30dB(A)</td><td>18 dB(A)</td></tr>
<tr><td>Nearest Noise Sensitive Window at Apt 05 Bedroom 03, as shown in Appendix B5</td><td>23 dB(A)</td></tr>
</table>

Table 5.4 Noise levels and criteria inside nearest residential spaces

Predicted levels are shown in Table 5.4, with detailed calculations shown in Appendices B1-5. It can therefore be stated that, as well as complying with the requirements of The London Borough of Camden, the noise emissions from the proposed options for the plant unit installations would be expected to comfortably meet the most stringent recommendations of the relevant British Standard.

5.3 Proposed Mitigation Measures

In order to reduce noise emissions from the proposed Top Roof plant unit installations to within the criteria specified in Section 4.0, we would recommend the following:

A standard screen should be installed around the perimeter of the condenser unit's installations. The screen could be manufactured by pre-galvanised sheet steel and cover the full height of the units (min. height 1.3m) by blocking the direct line of sight to the closest receiver. In order to increase the screen's in-situ performance, the top of the screen could be recessed, pointing towards the units.

Furthermore, we would recommend that acoustic silencers are installed after and before of the proposed Fan.

The acoustic silencers should provide the minimum attenuation characteristics shown in Table 5.5.

	Attenuation Levels (dB) in each Frequency Band (at 1m)							
Unit	**63Hz**	**125Hz**	**250Hz**	**500Hz**	**1kHz**	**2kHz**	**4kHz**	**8kHz**
Acoustic Silencer after and before Axial Fan SF01 (45% area free, 900mm long)	-2	-5	-11	-17	-20	-19	-12	-10

Table 5.5: Required attenuation levels of proposed acoustic silencer.

Additionally, In order to reduce noise emissions from the proposed condenser units located to the West of the proposed development to within the criteria specified in Section 4.0, we would recommend that an acoustic enclosure with louvres (Environ) are installed for each condenser unit.

The acoustic enclosure with louvres should provide the minimum attenuation characteristics shown in Table 5.6.

	Attenuation Levels (dB) in each Frequency Band (at 1m)							
Unit	**63Hz**	**125Hz**	**250Hz**	**500Hz**	**1kHz**	**2kHz**	**4kHz**	**8kHz**
Acoustic enclosure with louvres for the proposed condenser units	-14	-16	-23	-30	-37	-39	-38	-39

Table 5.6: Required attenuation levels of the proposed enclosure.

Moreover, in order to reduce noise emissions from the proposed Fans located at the Lower Ground Floor Level to within the criteria specified in Section 4.0, we would recommend the following:

An acoustic silencer should be installed on the Energy Centre Extract Fan (Outlet) and should provide the minimum attenuation characteristics shown in Table 5.7.

	Attenuation Levels (dB) in each Frequency Band (at 1m)							
Unit	**63Hz**	**125Hz**	**250Hz**	**500Hz**	**1kHz**	**2kHz**	**4kHz**	**8kHz**
Acoustic Silencer - Energy Centre Extract Fan (Outlet) (45% area free, 1800 mm long)	-5	-10	-20	-32	-40	-37	-24	-16

Table 5.7: Required attenuation levels of proposed silencer for the Energy Centre Extract Fan (Outlet).

Furthermore, an acoustic silencer should be installed before the Energy Centre Supply Fan (Inlet) and should provide the minimum attenuation characteristics shown in Table 5.8.

	Attenuation Levels (dB) in each Frequency Band (at 1m)							
Unit	**63Hz**	**125Hz**	**250Hz**	**500Hz**	**1kHz**	**2kHz**	**4kHz**	**8kHz**
Acoustic Silencer - Energy Centre Supply Fan (Inlet) (45% area free, 1500 mm long)	-4	-9	-17	-28	-34	-35	-21	-14

Table 5.8: Required attenuation levels of proposed silencer for the Energy Centre Supply Fan (Inlet).

Finally, we would recommend that acoustic silencers are also installed after and before the Car Park Extract Fans - Exhaust air (Outlet) and should provide the minimum attenuation characteristics shown in Table 5.9.

	Attenuation Levels (dB) in each Frequency Band (at 1m)							
Unit	**63Hz**	**125Hz**	**250Hz**	**500Hz**	**1kHz**	**2kHz**	**4kHz**	**8kHz**
Acoustic Silencer after the Car Park Extract Fans - Exhaust air (Outlet) (45% area free, 2100 mm long)	-4	-9	-17	-28	-34	-35	-21	-14
Acoustic Silencer before the Car Park Extract Fans (Inlet) (45% area free, 900mm long)	-2	-5	-11	-17	-20	-19	-12	-10

Table 5.9: Required attenuation levels of proposed silencer for the Car Park Extract Fans (Inlet and outlet).

In order to ensure that no structure-borne noise is transferred within any noise-sensitive spaces, we would recommend adopting any suitable elements of the anti-vibration strategy shown in Appendix C.

The aforementioned silencers and acoustic louvres could be provided by companies such as EEC, Noico or any similar acoustic solutions supplier.

6.0 CONCLUSION

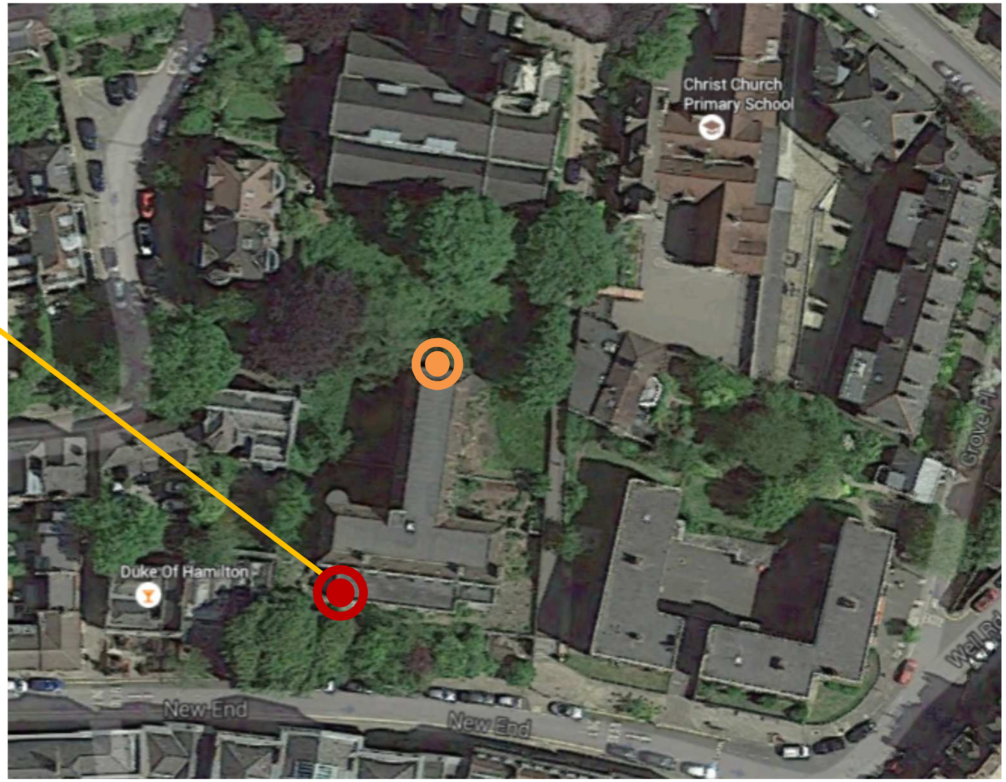
An environmental noise survey has been undertaken at 29 New End, Hampstead, London by KP Acoustics Ltd between 10:30 on 25/01/2016 and 10:10 on 27/01/2016. The results of the survey have enabled criteria to be set for noise emissions from proposed plant units.

Using manufacturer noise data, noise levels are predicted at the nearby noise sensitive receivers for compliance with current requirements.

Calculations show that noise emissions from the proposed plant unit installations would meet the requirements of The London Borough of Camden, providing that the mitigation measures stipulated in Section 5.3 are implemented.

Report by:
Goncalo Lemos MIOA, MSEE
KP Acoustics Ltd.

Checked by:
Kyriakos Papanagiotou MIOA
KP Acoustics Ltd.



Noise Survey Monitoring position – New End Elevation

Noise Survey Monitoring position – North Elevation

Title:

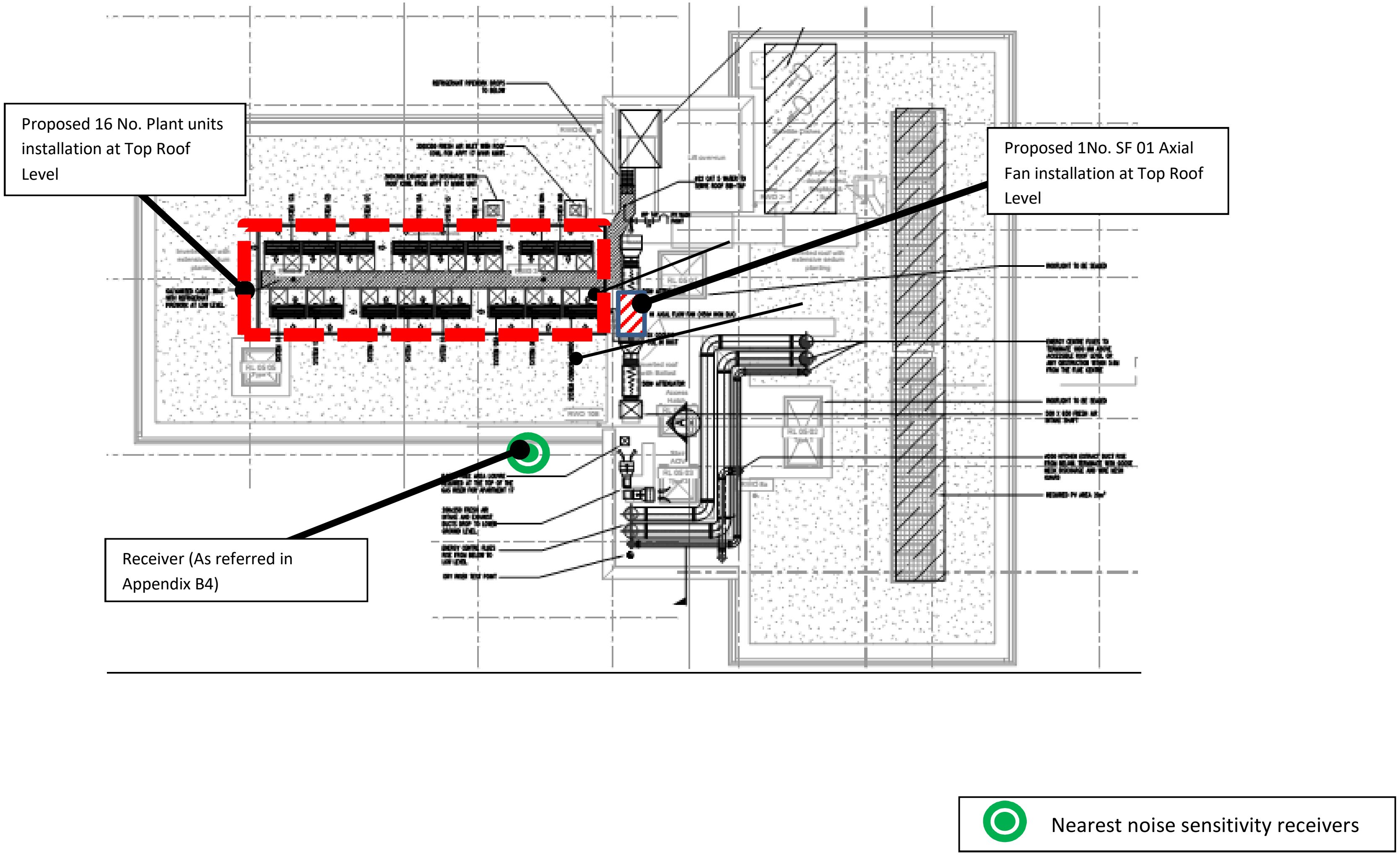
Indicative site plan showing noise monitoring positions

(source Google Maps)

Date: 24 August 2017

FIGURE 13706.SP1

KP acoustics



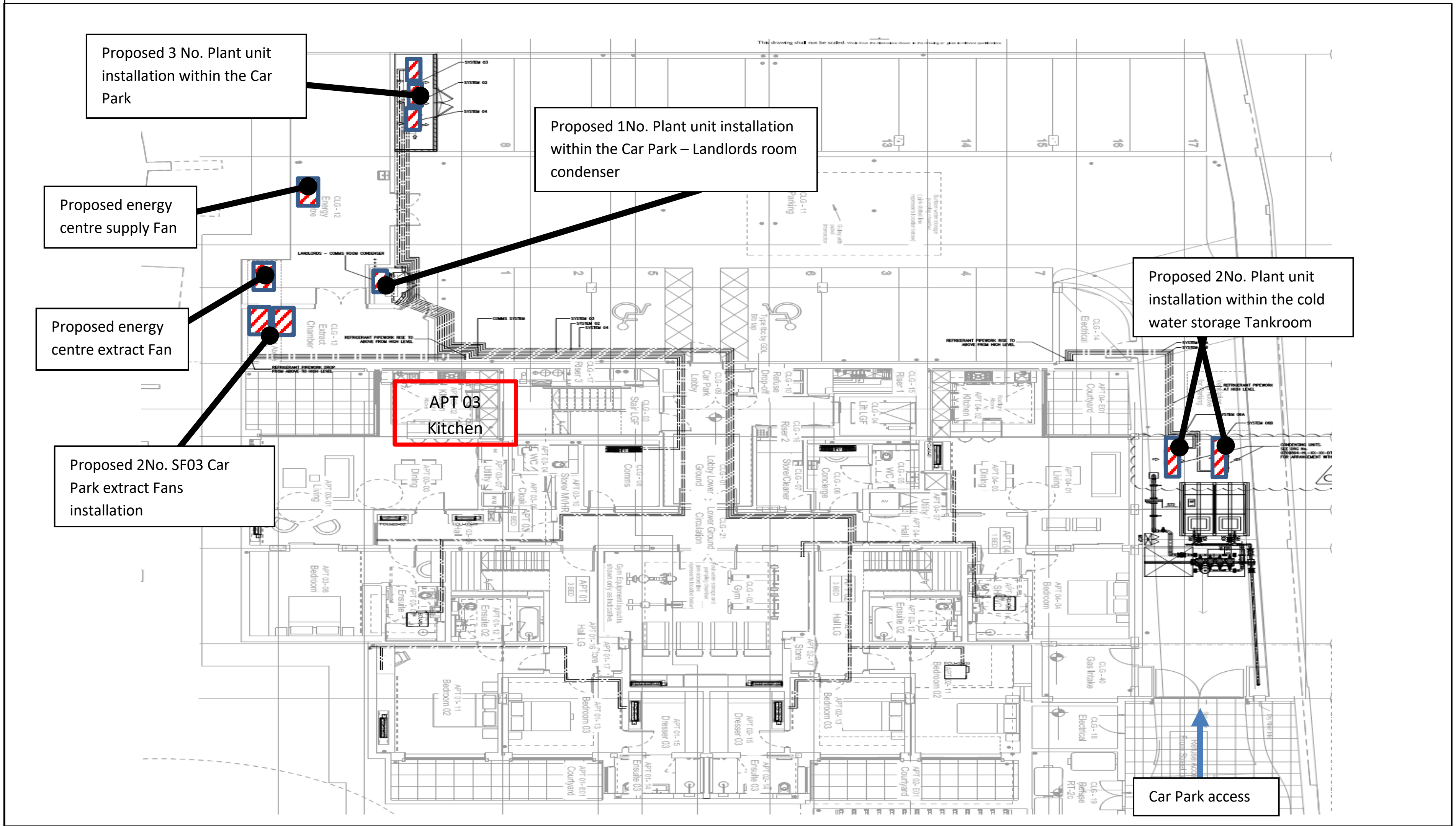
Title:

Indicative site plan showing plant installation at Top Roof Level and nearest noise sensitivity receiver

Date: 24 August 2017

FIGURE 13706.SP2

KP acoustics



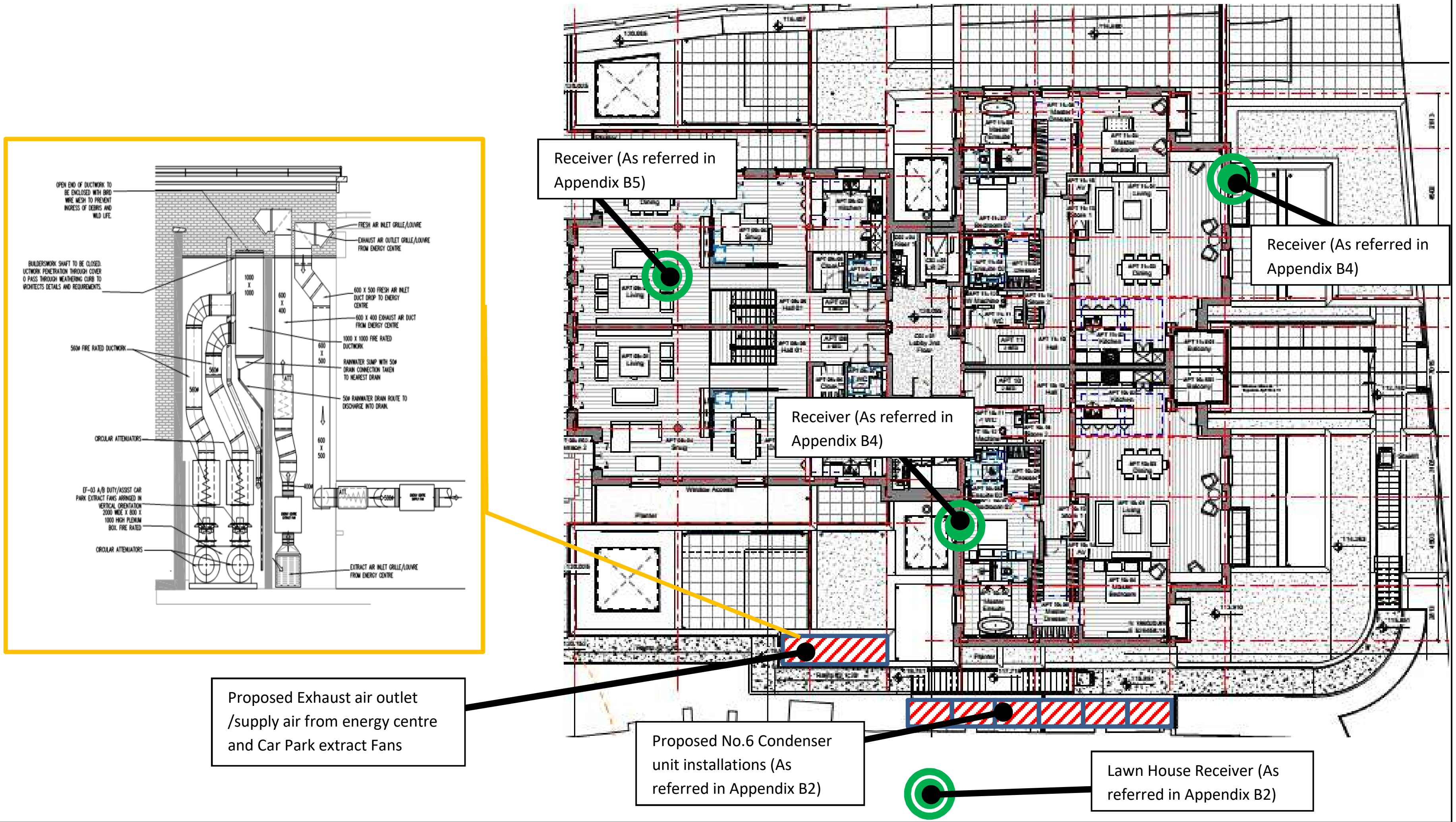
Title:

Indicative site plan showing plant installation at Lower Ground Floor

Date: 24 August 2017

FIGURE 13706.SP3

KP acoustics



Title:

Indicative site plan showing plant installation at Lower Ground Floor, Second Floor and receiver locations

Date: 24 August 2017

FIGURE 13706.SP3

KP acoustics

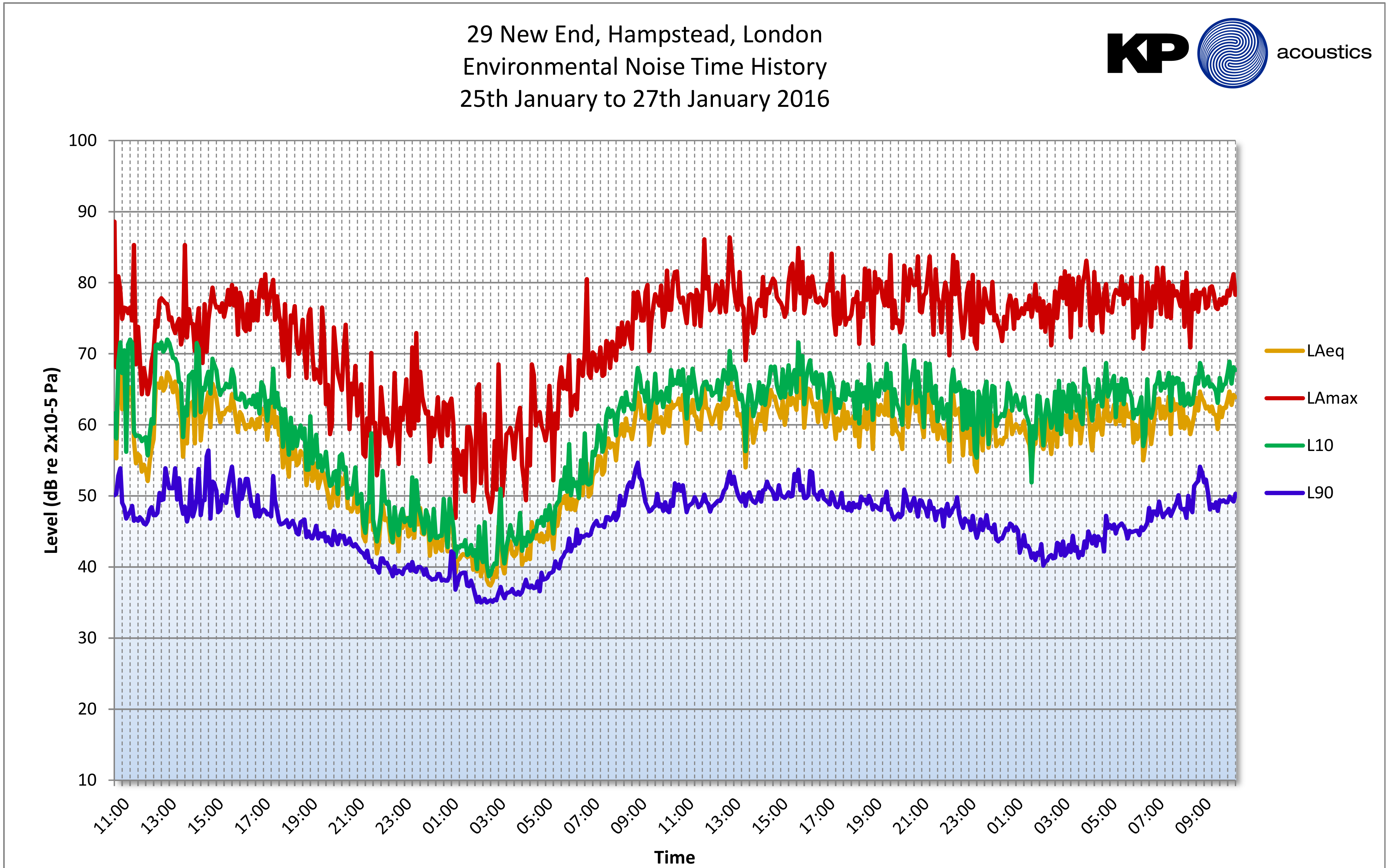


Figure 13706.TH1

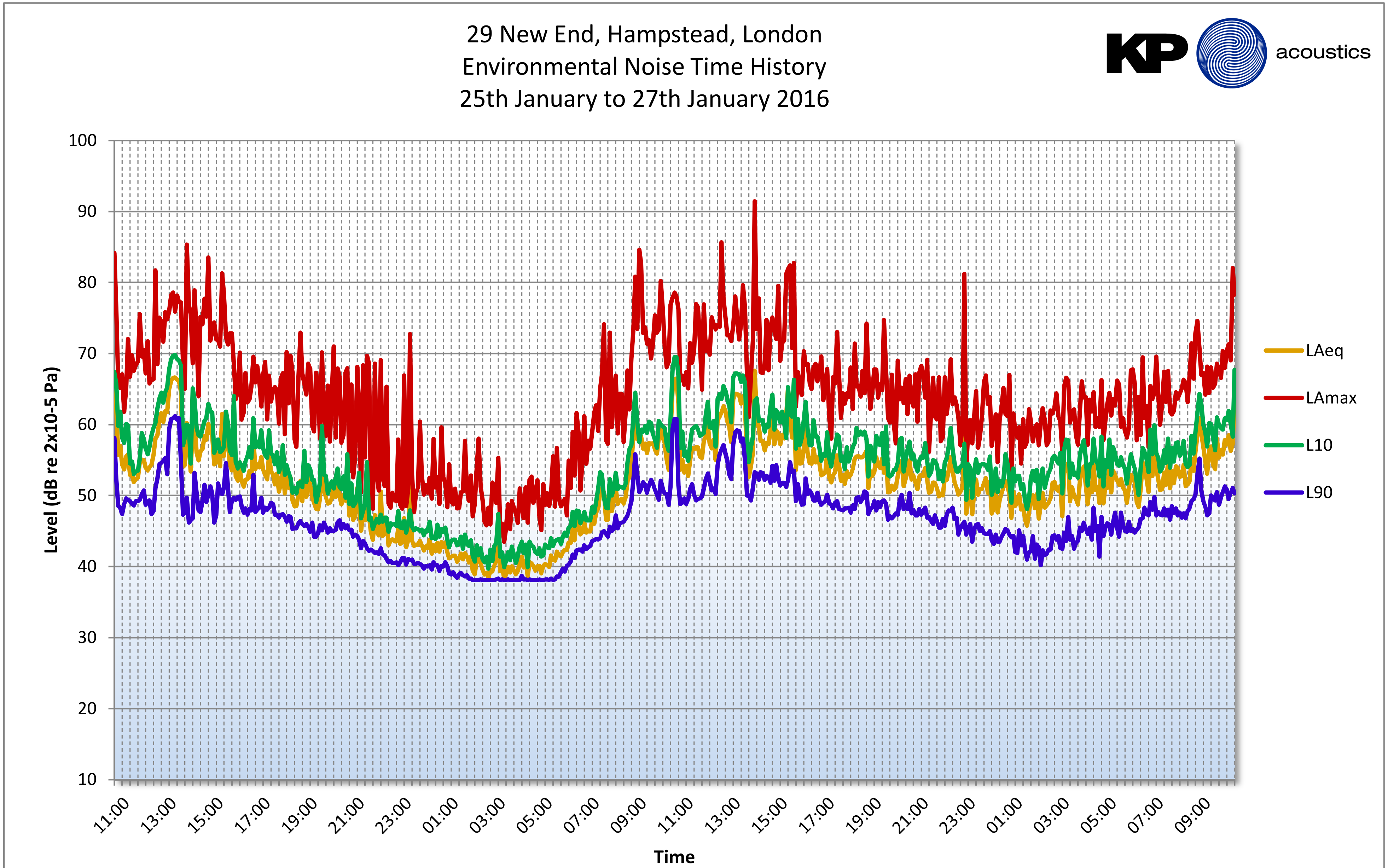


Figure 13706.TH2

APPENDIX A

GENERAL ACOUSTIC TERMINOLOGY

Decibel scale - dB

In practice, when sound intensity or sound pressure is measured, a logarithmic scale is used in which the unit is the 'decibel', dB. This is derived from the human auditory system, where the dynamic range of human hearing is so large, in the order of 10^{13} units, that only a logarithmic scale is the sensible solution for displaying such a range.

Decibel scale, 'A' weighted - dB(A)

The human ear is less sensitive at frequency extremes, below 125Hz and above 16Khz. A sound level meter models the ears variable sensitivity to sound at different frequencies. This is achieved by building a filter into the Sound Level Meter with a similar frequency response to that of the ear, an A-weighted filter where the unit is dB(A).

L_{eq}

The sound from noise sources often fluctuates widely during a given period of time. An average value can be measured, the equivalent sound pressure level L_{eq}. The L_{eq} is the equivalent sound level which would deliver the same sound energy as the actual fluctuating sound measured in the same time period.

L_{10}

This is the level exceeded for no more than 10% of the time. This parameter is often used as a "not to exceed" criterion for noise.

L_{90}

This is the level exceeded for no more than 90% of the time. This parameter is often used as a descriptor of "background noise" for environmental impact studies.

L_{max}

This is the maximum sound pressure level that has been measured over a period.

Octave Bands

In order to completely determine the composition of a sound it is necessary to determine the sound level at each frequency individually. Usually, values are stated in octave bands. The audible frequency region is divided into 11 such octave bands whose centre frequencies are defined in accordance with international standards. These centre frequencies are: 16, 31.5, 63, 125, 250, 500, 1000, 2000, 4000, 8000 and 16000 Hertz.

Environmental noise terms are defined in BS7445, *Description and Measurement of Environmental Noise*.

Appendix A

Applied Acoustic Terminology

Addition of noise from several sources

Noise from different sound sources combines to produce a sound level higher than that from any individual source. Two equally intense sound sources operating together produce a sound level which is 3dB higher than a single source and 4 sources produce a 6dB higher sound level.

Attenuation by distance

Sound which propagates from a point source in free air attenuates by 6dB for each doubling of distance from the noise source. Sound energy from line sources (e.g. stream of cars) drops off by 3dB for each doubling of distance.

Subjective impression of noise

Hearing perception is highly individualised. Sensitivity to noise also depends on frequency content, time of occurrence, duration of sound and psychological factors such as emotion and expectations. The following table is a guide to explain increases or decreases in sound levels for many scenarios.

Change in sound level (dB)	Change in perceived loudness
1	Imperceptible
3	Just barely perceptible
6	Clearly noticeable
10	About twice as loud

Transmission path(s)

The transmission path is the path the sound takes from the source to the receiver. Where multiple paths exist in parallel, the reduction in each path should be calculated and summed at the receiving point. Outdoor barriers can block transmission paths, for example traffic noise. The effectiveness of barriers is dependent on factors such as its distance from the noise source and the receiver, its height and construction.

Ground-borne vibration

In addition to airborne noise levels caused by transportation, construction, and industrial sources there is also the generation of ground-borne vibration to consider. This can lead to structure-borne noise, perceptible vibration, or in rare cases, building damage.

Sound insulation - Absorption within porous materials

Upon encountering a porous material, sound energy is absorbed. Porous materials which are intended to absorb sound are known as absorbents, and usually absorb 50 to 90% of the energy and are frequency dependent. Some are designed to absorb low frequencies, some for high frequencies and more exotic designs being able to absorb very wide ranges of frequencies. The energy is converted into both mechanical movement and heat within the material; both the stiffness and mass of panels affect the sound insulation performance.

APPENDIX B1

29 New End, Hampstead, London

PROPOSED PLANT UNIT EMISSIONS CALCULATIONS

Source: Proposed Plant Units Installation at Top roof	*Frequency, Hz*								
Receiver: Nearest Noise Sensitive Window at APT 17 - Bedroom 02	***63***	***125***	***250***	***500***	***1k***	***2k***	***4k***	***8k***	***dB(A)***
Manufacturers Sound Pressure/Power Levels									
7No. Mitsubishi PUMY-P200YKM									
Mitsubishi PUMY-P200YKM - Cooling Mode (Sound Pressure Levels at 1m)	64	59	54	53	52	47	41	35	
Correction for number of units 7 No.	8	8	8	8	8	8	8	8	
Attenuation provided by distance (min.8 m)	-18	-18	-18	-18	-18	-18	-18	-18	
Attenuation Provided by building's envelope	-11	-13	-17	-20	-22	-25	-28	-28	
Attenuation provided by acoustic screen (1300mm height) or louvres (150mm)	-3	-5	-7	-9	-13	-13	-13	-12	
Total Sound Pressure level from Mitsubishi PUMY-P200YKM at closest noise sensitive receiver	40	31	20	14	7	0	0	0	20
5 No. Mitsubishi PUMY-P112YKM									
Mitsubishi PUMY-P112YKM (Sound Pressure Levels at 1m)	64	52	52	49	46	41	35	29	
Correction for number of units 5 No.	7	7	7	7	7	7	7	7	
Attenuation provided by distance (min.7 m)	-17	-17	-17	-17	-17	-17	-17	-17	
Attenuation Provided by building's envelope	-11	-13	-17	-20	-22	-25	-28	-28	
Attenuation provided by acoustic screen (1300mm height) or louvres (150mm)	-3	-5	-7	-9	-13	-13	-13	-12	
Total Sound Pressure level from Mitsubishi PUMY-P112YKM at closest noise sensitive receiver	40	24	18	10	1	0	0	0	17
2 No. Mitsubishi PUMY-P140YKM									
Mitsubishi PUMY-P140YKM (Sound Pressure Levels at 1m)	59	60	51	52	47	42	37	31	
Correction for number of units 2 No.	3	3	3	3	3	3	3	3	
Attenuation provided by distance (min.5m)	-16	-16	-16	-16	-16	-16	-16	-16	
Attenuation Provided by building's envelope	-7	-9	-12	-16	-19	-23	-23	-23	
Attenuation provided by acoustic screen (1300mm height) or louvres (150mm)	-3	-5	-7	-9	-13	-13	-13	-12	
Total Sound Pressure level from Mitsubishi PUMY-P140YKM at closest noise sensitive receiver	36	33	19	14	2	0	0	0	20
1No. Mitsubishi PUMY-P125YKM									
Mitsubishi PUMY-P125YKM (Sound Pressure Levels at 1m)	57	53	52	51	46	42	36	30	
Attenuation provided by distance (min.5 m)	-14	-14	-14	-14	-14	-14	-14	-14	
Attenuation Provided by building's envelope	-7	-9	-12	-16	-19	-23	-23	-23	
Attenuation provided by acoustic screen (1300mm height) or louvres (150mm)	-3	-5	-7	-9	-13	-13	-13	-12	
Total Sound Pressure level from Mitsubishi PUMY-P125YKM at closest noise sensitive receiver	33	25	19	12	0	0	0	0	16
1 No. Mitsubishi PUHZ -ZRP60KHA									
Mitsubishi PUHZ -ZRP60KHA (Sound Pressure Levels at 1m)									48
Attenuation provided by distance (min.6 m)									-14
Attenuation Provided by building's envelope									-15
Attenuation provided by acoustic screen (1300mm height) or louvres (150mm)									-9
Total Sound Pressure level from Mitsubishi PUHZ -ZRP60KHA at closest noise sensitive receiver									10
Axial Fan SF-01 - Case Breakout									
1 No.Fan SF-01 (Sound pressure Level at 3m, dB)	48	58	67	71	71	68	64	57	
Correction to Sound Pressure Level at 1m	-11	-11	-11	-11	-11	-11	-11	-11	
Attenuation provided by distance (min. 8.5m)	-15	-15	-15	-15	-15	-15	-15	-15	
Attenuation Provided by building's envelope	-11	-13	-18	-23	-26	-28	-33	-33	
Total Sound Pressure Levels from Fan - Case Breakout at closest noise sensitive receiver	11	19	23	22	19	14	5	0	24
Axial Fan SF-01 - Termination point (inlet)									
1 No. Axial Fan SF-01 - (Sound power level, dB)	68	78	86	91	91	88	84	77	
Correction to Sound Pressure Level at 1m	-11	-11	-11	-11	-11	-11	-11	-11	
Attenuation provided by distance (min. 9m)	-19	-19	-19	-19	-19	-19	-19	-19	
Attenuation Provided by building's envelope	-11	-13	-18	-23	-26	-28	-33	-33	
Correction for directivity	-5	-9	-11	-11	-12	-12	-15	-15	

APPENDIX B1 (Cont.)

29 New End, Hampstead, London

PROPOSED PLANT UNIT EMISSIONS CALCULATIONS

Source: Proposed Plant Units Installation at Top roof	*Frequency, Hz*								
Receiver: Nearest Noise Sensitive Window at APT 17 - Bedroom 02	***63***	***125***	***250***	***500***	***1k***	***2k***	***4k***	***8k***	***dB(A)***
Attenuation provided by proposed silencer after fan (50% area free, 900 mm long)	-2	-4	-9	-15	-17	-14	-10	-8	
Total Sound Pressure Levels from Fan SF-01 - Termination point (inlet) at closest noise sensitive receiver	20	22	18	12	6	4	0	0	15
Axial Fan SF-01 - Outlet duct breakout									
1 No.Axial Fan SF-01 - (Sound power level, dB)	68	78	86	91	91	88	84	77	
Correction to Sound Pressure Level at 1m	-11	-11	-11	-11	-11	-11	-11	-11	
Correction for 20g galvanised steel duct	-3	-8	-15	-20	-26	-32	-38	-40	
Attenuation provided by distance (min. 6m)	-14	-14	-14	-14	-14	-14	-14	-14	
Attenuation Provided by building's envelope	-7	-9	-12	-16	-19	-23	-23	-23	
Attenuation provided by proposed silencer before fan (50% area free, 900 mm long)	-2	-4	-9	-15	-17	-14	-10	-8	
Total Sound Pressure level from Axial Fan SF-01 - Outlet duct breakout at closest noise sensitive receiver	31	32	25	15	4	0	0	0	20
Sound pressure level 1m from closest noise sensitive receiver									**28**

Design Criterion	**28**

APPENDIX B1

29 New End, Hampstead, London

PROPOSED PLANT UNIT EMISSIONS CALCULATIONS

Source: Proposed Plant Units Installation to the West of the property	*Frequency, Hz*								
Receiver: Nearest Noise Sensitive Window at Lawn House	***63***	***125***	***250***	***500***	***1k***	***2k***	***4k***	***8k***	***dB(A)***
Manufacturers Sound Pressure									
1No. Mitsubishi PUMY-P200YKM (Top level installation)									
Mitsubishi PUMY-P200YKM - Cooling Mode (Sound Pressure Levels at 1m)	64	59	54	53	52	47	41	35	
Correction due to reflections	6	6	6	6	6	6	6	6	
Attenuation Provided by Directivity	-1	-2	-5	-9	-11	-11	-11	-11	
Attenuation Provided by building's envelope	-5	-7	-9	-11	-13	-14	-14	-14	
Attenuation provided by distance (min.2.2 m)	-7	-7	-7	-7	-7	-7	-7	-7	
Attenuation provided by acoustic enclosure with louvres (Environ)	-14	-16	-23	-30	-37	-39	-38	-39	
Total Sound Pressure level from Mitsubishi PUMY-P200YKM at closest noise sensitive receiver	43	33	16	2	-10	-18	-23	-30	20
1 No. Mitsubishi PUMY-P125YKM (Top level installation)									
Mitsubishi PUMY-P125YKM (Sound Pressure Levels at 1m)	57	53	52	51	46	42	36	30	
Correction due to reflections	6	6	6	6	6	6	6	6	
Attenuation Provided by Directivity	-1	-2	-5	-9	-11	-11	-11	-11	
Attenuation Provided by building's envelope	-5	-7	-9	-11	-13	-14	-14	-14	
Attenuation provided by distance (min.2.2 m)	-7	-7	-7	-7	-7	-7	-7	-7	
Attenuation provided by acoustic enclosure with louvres (Environ)	-14	-16	-23	-30	-37	-39	-38	-39	
Total Sound Pressure level from Mitsubishi PUMY-P125YKM at closest noise sensitive receiver	36	27	14	0	0	0	0	0	15
1No. Mitsubishi PUMY-P200YKM (Meadle level installation)									
Mitsubishi PUMY-P200YKM - Cooling Mode (Sound Pressure Levels at 1m)	64	59	54	53	52	47	41	35	
Correction due to reflections	6	6	6	6	6	6	6	6	
Attenuation Provided by Directivity	-1	-2	-5	-9	-11	-11	-11	-11	
Attenuation Provided by building's envelope	-5	-7	-9	-11	-13	-14	-14	-14	
Attenuation provided by distance (min.3 m)	-10	-10	-10	-10	-10	-10	-10	-10	
Attenuation provided by acoustic enclosure with louvres (Environ)	-14	-16	-23	-30	-37	-39	-38	-39	
Total Sound Pressure level from Mitsubishi PUMY-P200YKM at closest noise sensitive receiver	40	30	13	-1	-13	-21	-26	-33	18
1 No. Mitsubishi PUMY-P125YKM ((Low level installation)									
Mitsubishi PUMY-P125YKM (Sound Pressure Levels at 1m)	57	53	52	51	46	42	36	30	
Correction due to reflections	6	6	6	6	6	6	6	6	
Attenuation Provided by Directivity	-1	-2	-5	-9	-11	-11	-11	-11	
Attenuation Provided by building's envelope	-5	-7	-9	-11	-13	-14	-14	-14	
Attenuation provided by distance (min.3 m)	-10	-10	-10	-10	-10	-10	-10	-10	
Attenuation provided by acoustic enclosure with louvres (Environ)	-14	-16	-23	-30	-37	-39	-38	-39	
Total Sound Pressure level from Mitsubishi PUMY-P125YKM at closest noise sensitive receiver	33	24	11	-3	0	0	0	0	13
2No. Mitsubishi PUMY-P200YKM (Low level installation)									
Mitsubishi PUMY-P200YKM - Cooling Mode (Sound Pressure Levels at 1m)	64	59	54	53	52	47	41	35	
Correction for number of units 2 No.	3	3	3	3	3	3	3	3	
Correction due to reflections	6	6	6	6	6	6	6	6	
Attenuation Provided by Directivity	-1	-2	-5	-9	-11	-11	-11	-11	
Attenuation Provided by building's envelope	-5	-7	-9	-11	-13	-14	-14	-14	
Attenuation provided by distance (min.4 m)	-12	-12	-12	-12	-12	-12	-12	-12	
Attenuation provided by acoustic enclosure with louvres (Environ)	-14	-16	-23	-30	-37	-39	-38	-39	
Total Sound Pressure level from Mitsubishi PUMY-P200YKM at closest noise sensitive receiver	41	31	14	0	-12	-20	-25	-32	18
Sound pressure level 1m from closest noise sensitive receiver	**47**	**37**	**21**	**7**	**4**	**3**	**3**	**3**	**24**

Design Criterion	**28**

APPENDIX B3

29 New End, Hampstead, London

PROPOSED PLANT UNIT EMISSIONS CALCULATIONS

Source: Proposed Plant Installation within Car Park and Water storage Tankroom	*Frequency, Hz*								
Receiver: Nearest Noise Sensitive Window at APT 02- Living Room	***63***	***125***	***250***	***500***	***1k***	***2k***	***4k***	***8k***	***dB(A)***
Manufacturers Sound Pressure									
Reverberation field in Car Park (dB increment)									
Concrete absorption coefficient (α)	0.01	0.01	0.02	0.02	0.02	0.02	0.03	0.03	
Total surface area (350m^2)	350	350	350	350	350	350	350	350	
Room Constant	4	4	7	7	7	7	11	11	
Correction due to reverberation field	1	1	-3	-3	-3	-3	-4	-4	
1 No. Mitsubishi PUMY-P200YKM at rear Car Park									
Mitsubishi PUMY-P200YKM - Cooling Mode (Sound Pressure Levels at 1m)	64	59	54	53	52	47	41	35	56
Correction due to reverberation field	1	1	-3	-3	-3	-3	-4	-4	
Correction for surface area (9m^2)	4	4	4	4	4	4	4	4	
Correction due to reflections, dB	3	3	3	3	3	3	3	3	
Attenuation provided by building envelope	-9	-11	-13	-20	-21	-25	-30	-30	
Attenuation provided by distance (min. 7.5m)	-18	-18	-18	-18	-18	-18	-18	-18	
Attenuation due to directivity	-3	-5	-6	-9	-11	-11	-11	-11	
Total Sound Pressure level from Mitsubishi PUMY-P200YKM at closest noise sensitive receiver	41	32	21	10	6	0	0	0	20
1 No. Mitsubishi PUMY-P200YKM at Water storage Tankroom									
Mitsubishi PUMY-P200YKM - Cooling Mode (Sound Pressure Levels at 1m)	64	59	54	53	52	47	41	35	56
Correction due to reverberation field	1	1	-3	-3	-3	-3	-4	-4	
Correction for surface area (9m^2)	4	4	4	4	4	4	4	4	
Correction due to reflections, dB	3	3	3	3	3	3	3	3	
Attenuation provided by building envelope	-9	-11	-13	-20	-21	-25	-30	-30	
Attenuation provided by distance (min. 7.5m)	-18	-18	-18	-18	-18	-18	-18	-18	
Attenuation due to directivity	-3	-5	-6	-9	-11	-11	-11	-11	
Total Sound Pressure level from Mitsubishi PUMY-P200YKM at closest noise sensitive receiver	41	32	21	10	6	0	0	0	20
1No. Mitsubishi PUMY-P125YKM at rear Car Park									
Mitsubishi PUMY-P125YKM (Sound Pressure Levels at 1m)	57	53	52	51	46	42	36	30	52
Correction due to reverberation field	1	1	-3	-3	-3	-3	-4	-4	
Correction for surface area (9m^2)	4	4	4	4	4	4	4	4	
Correction due to reflections, dB	3	3	3	3	3	3	3	3	
Attenuation provided by building envelope	-9	-11	-13	-20	-21	-25	-30	-30	
Attenuation provided by distance (min. 7.5m)	-18	-18	-18	-18	-18	-18	-18	-18	
Attenuation due to directivity	-3	-5	-6	-9	-11	-11	-11	-11	
Total Sound Pressure level from Mitsubishi PUMY-P125YKM at closest noise sensitive receiver	34	26	19	8	0	0	0	0	15
1 No. Mitsubishi PUMY-P140YKM at rear Car Park									
Mitsubishi PUMY-P140YKM (Sound Pressure Levels at 1m)	59	60	51	52	47	42	37	31	53
Correction due to reverberation field	1	1	-3	-3	0	-3	-4	-4	
Correction for surface area (9m^2)	4	4	4	4	4	4	4	4	
Correction due to reflections, dB	3	3	3	3	3	3	3	3	
Attenuation provided by building envelope	-9	-11	-13	-20	-21	-25	-30	-30	
Attenuation provided by distance (min. 7.5m)	-18	-18	-18	-18	-18	-18	-18	-18	
Attenuation due to directivity	-3	-5	-6	-9	-11	-11	-11	-11	
Total Sound Pressure level from Mitsubishi PUMY-P140YKM at closest noise sensitive receiver	36	33	18	9	3	0	0	0	19
1 No. Mitsubishi PUMY-P112YKM at Water storage Tankroom									
Mitsubishi PUMY-P112YKM (Sound Pressure Levels at 1m)	64	52	52	49	46	41	35	29	51
Correction due to reverberation field	1	1	-3	-3	-3	-3	-4	-4	
Correction for surface area (9m^2)	4	4	4	4	4	4	4	4	
Correction due to reflections, dB	3	3	3	3	3	3	3	3	
Attenuation provided by building envelope	-9	-11	-13	-20	-21	-25	-30	-30	
Attenuation provided by distance (min. 7.5m)	-18	-18	-18	-18	-18	-18	-18	-18	
Attenuation due to directivity	-3	-5	-6	-9	-11	-11	-11	-11	
Total Sound Pressure level from Mitsubishi PUMY-P140YKM at closest noise sensitive receiver	41	25	19	6	0	0	0	0	17
1 No. Mitsubishi PUHZ -ZRP71KHA at Car Park (Landlords condenser)									
Mitsubishi PUHZ -ZRP71KHA (Sound Pressure Levels at 1m)									48

APPENDIX B3(Cont.)

29 New End, Hampstead, London

PROPOSED PLANT UNIT EMISSIONS CALCULATIONS

Source: Proposed Plant Installation within Car Park and Water storage Tankroom	*Frequency, Hz*								
Receiver: Nearest Noise Sensitive Window at APT 02- Living Room	***63***	***125***	***250***	***500***	***1k***	***2k***	***4k***	***8k***	***dB(A)***
Correction due to reverberation field									1
Correction for surface area ($9m^2$)									4
Attenuation provided by building envelope									-18
Attenuation provided by distance (min. 7.5m)									-18
Total Sound Pressure level from Mitsubishi PUHZ -ZRP71KHA at closest noise sensitive receiver									17
Axial Fan EF-03 - outlet									
No.Fan EF-03 (Sound pressure Level at 3m, dB)	86	79	73	71	68	74	78	76	
Correction to Sound Pressure Level at 1m	-11	-11	-11	-11	-11	-11	-11	-11	
Correction for surface area ($9m^2$)	4	4	4	4	4	4	4	4	
Attenuation provided by distance (min. 7.5m)	-18	-18	-18	-18	-18	-18	-18	-18	
Attenuation Provided by building's envelope	-11	-13	-18	-23	-26	-28	-33	-33	
Attenuation due to directivity	-3	-5	-6	-9	-11	-11	-11	-11	
Attenuation provided by proposed silencer before fan (50% area free, 900 mm long)	-2	-4	-9	-15	-17	-14	-10	-8	
Total Sound Pressure Levels from Fan - Case Breakout at closest noise sensitive receiver	45	32	15	0	0	0	0	0	21
Sound pressure level 1m from closest noise sensitive receiver									**27**

Design Criterion	**28**

APPENDIX B4

29 New End, Hampstead, London

PROPOSED PLANT UNIT EMISSIONS CALCULATIONS

Source: Proposed Plant Installation at Lower Ground Energy Centre and Car Park Extract Fan	*Frequency, Hz*								
Receiver: Nearest Noise Sensitive Window at APT 07 Bedroom 02	***63***	***125***	***250***	***500***	***1k***	***2k***	***4k***	***8k***	***dB(A)***
Manufacturers Sound Power Levels									
2 No. EF-03 (A&B) Car Park Extract Fans - Exhaust air (Outlet)									
Fan EF-03 (A&B) - (Sound Power Level, dB)	87	80	73	72	66	73	77	76	
Correction to Sound Pressure Level at 1m	-11	-11	-11	-11	-11	-11	-11	-11	
Correction due to number (2)	3	3	3	3	3	3	3	3	
Attenuation provided by distance (min. 8 m)	-18	-18	-18	-18	-18	-18	-18	-18	
Attenuation Provided by Directivity	-4	-7	-9	-12	-12	-12	-15	-15	
Attenuation provided by proposed silencer (45% area free, 2100mm long)	-6	-11	-23	-36	-40	-39	-29	-18	
Total Sound Pressure Levels from Fan EF-03 - Outlet at closest noise sensitive receiver	51	36	15	0	0	0	7	17	27
1 No. FN-EC01 - Energy Centre Supply Fan (Inlet)									
1 No. Fan -FN-EC01 - (Sound Power Level, dB)	80	75	70	71	68	60	62	55	
Correction to Sound Pressure Level at 1m	-11	-11	-11	-11	-11	-11	-11	-11	
Attenuation provided by distance (min. 8 m)	-18	-18	-18	-18	-18	-18	-18	-18	
Attenuation Provided by Directivity	-4	-7	-9	-12	-12	-12	-15	-15	
Attenuation provided by proposed silencer (45% area free, 1500mm long)	-4	-9	-17	-28	-34	-35	-21	-14	
Total Sound Pressure Levels from Fan -AXC 450-6 at closest noise sensitive receiver	43	30	15	2	0	0	0	0	19
1 No. Fan FN-EC02 - Energy Centre Extract Fan (Outlet)									
1 No. Fan FN-EC02 - (Sound power level, dB)	84	79	80	77	79	68	64	58	
Correction to Sound Pressure Level at 1m	-11	-11	-11	-11	-11	-11	-11	-11	
Attenuation provided by distance (min. 8 m)	-18	-18	-18	-18	-18	-18	-18	-18	
Correction for directivity	-4	-7	-9	-12	-12	-12	-15	-15	
Attenuation provided by proposed silencer (45% area free, 1800mm long)	-5	-10	-20	-32	-40	-37	-24	-16	
Total Sound Pressure Levels from Fan FN-EC02 Outlet - at closest noise sensitive receiver	46	33	22	4	0	0	0	0	22
Sound pressure level 1m from closest noise sensitive receiver	**53**	**38**	**23**	**4**	**0**	**0**	**7**	**17**	**28**

Design Criterion	**28**

APPENDIX B5

29 New End, Hampstead, London

NOISE BREAKOUT EMISSIONS CALCULATIONS

Acoustic Calculation used for indoor Transmission:

$$SPL_{outdoor} = SPL_{indoor} - SRI_{composite} + 10\log_{10} S + 10\log\left(\frac{Q}{4\pi r^2}\right) - 6dB$$

Source: Plant units within the Lower Ground Floor Car Park	*Frequency, Hz*								
Receiver:Closest nearest residential - Apt 05 Bedroom 03	***63***	***125***	***250***	***500***	***1k***	***2k***	***4k***	***8k***	***dB(A)***
Measured Sound Pressure Levels									
Overall noise level calculated within the Car Park									72
Sound reduction index of the proposed concrete party floor									-50
Correction for total area (S = 20m^2)									13
Correction for directivity (Q) and distance (r) (Q=2, r = 2m)									-6
Non reverberant correction									-6
Predicted sound pressure level 1within the nearest residential receiver									**23**

Design Criterion	**30**

ANTI-VIBRATION MOUNTING SPECIFICATION REFERENCE DOCUMENT

1.0 General

1.1 All mountings shall provide the static deflection, under the equipment weight, shown in the schedules. Mounting selection should allow for any eccentric load distribution or torque reaction, so that the design deflection is achieved on all mountings under the equipment, under operating conditions.

1.2 It is the supplier's responsibility to ensure that all mountings offered are suitable for the loads, operating and environmental conditions which will prevail. Particular attention should be paid to mountings which will be exposed to atmospheric conditions to prevent corrosion.

1.3 All mountings shall be colour coded, or otherwise marked, to indicate their load capacity, to facilitate identification during installation.

Where use of resilient supports allows omission of pipe flexible connections for vibration/noise isolation, it shall be the Mechanical Service Consultant's or Contractor's responsibility to decide whether such devices are required to compensate for misalignment or thermal strain.

2.1 Type A Mounting (Caged Spring Type)

2.1.1 Each mounting shall consist of cast or fabricated telescopic top and bottom housings enclosing one or more helical steel springs as the principle isolation elements, and shall incorporate a built-in levelling device. The housing should be designed to permit visual inspection of the springs after installation, i.e. the spring must not be totally enclosed.

2.1.2 The springs shall have an outside diameter of not less than 75% of the operating height, and be selected to have at least 50% overload capacity before becoming coil-bound.

2.1.3 The bottom plate of each mounting shall have bonded to it a rubber/neoprene pad designed to attenuate any high frequency energy transmitted by the springs.

2.1.4 Mountings incorporating snubbers or restraining devices shall be designed so that the snubbing, damping or restraining mechanism is capable of being adjusted to have no significant effect during the normal running of the isolated machine.

2.1.5 All nuts, bolts or other elements used for adjustment of a mounting shall incorporate locking mechanisms to prevent the isolator going out of adjustment as a result of vibration or accidental or unauthorised tampering.

2.2 Type B Mounting (Open Spring Type)

2.2.1 Each mounting shall consist of one or more helical steel springs as the principal isolation elements, and shall incorporate a built-in levelling device.

2.2.2 The springs shall be fixed or otherwise securely located to cast or fabricated top and bottom plates, shall have an outside diameter of not less than 75% of the operating height, and shall be selected to have at least 50% overload capacity before becoming coil-bound.

2.2.3 The bottom plate shall have bonded to it a rubber/ neoprene pad designed to attenuate any high frequency energy transmitted by the springs.

2.3 Type C Mounting (Rubber/Neoprene Type)

Each mounting shall consist of a steel top plate and base plate completely embedded in oil resistant rubber/neoprene. Each mounting shall be capable of being fitted with a levelling device, and should have bolt holes in the base plate and a threaded metal insert in the top plate so that they can be bolted to the floor and equipment where required.

3.0 Plant Bases

3.1 Type A Bases (A.V. Rails)

An A.V. Rail shall comprise a steel beam with two or more height-saving brackets. The steel sections must be sufficiently rigid to prevent undue strain in the equipment and if necessary should be checked by the Structural Engineer.

3.2 Type B Bases (Steel Plant Bases)

Steel plant bases shall comprise an all-welded steel framework of sufficient rigidity to provide adequate support for the equipment, and fitted with isolator height saving brackets. The frame depth shall be approximately 1/10 of the longest dimension of the equipment with a minimum of 150 mm. This form of base may be used as a composite A.V. rail system.

3.3 Type C Bases (Concrete Inertia Base: for use with steel springs)

These shall consist of an all-welded steel pouring frame-work with height saving brackets, and a frame depth of approximately 1/12 of the longest dimension of the equipment, with a minimum of 100 mm. The bottom of the pouring frame should be blanked off, and concrete (2300 kg/m^3) poured in over steel reinforcing rods positioned 35 mm above the bottom. The inertia base should be sufficiently large to provide support for all parts of the equipment, including any components which over-hang the equipment base, such as suction and discharge elbows on centrifugal pumps.