THE EQUUS PARTNERSHIP

Member of the Association of Noise Consultants

CONSULTANTS IN ACOUSTICS

No. 27 FITZROY SQUARE, LONDON W1T 6ES

ENVIRONMENTAL NOISE ASSESSMENTS OF PROPOSED MECHANICAL PLANT

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EXECUTIVE SUMMARY

The EQUUS Partnership has been commissioned by Matthew Watts Associates Ltd. to undertake an environmental noise assessment in connection with proposed condensing units to be installed at No. 27 Fitzroy Square, London W1, as part of necessary refurbishment of the office accommodation.

This environmental noise assessment report has been prepared to accompany a Planning Application to be submitted by Matthew Watts Associates Ltd. The Planning Application seeks approval to the proposed installation of 2 no. new condensing units within a purpose designed acoustic louvred plant enclosure which will be located on the rear roof terrace at 1st floor level of the subject premises. The Application also seeks approval to the relocation of 2 no. nearby free standing condensing units to within the same enclosure.

The external plant items included within this noise assessment report therefore comprise 2 no. new Mitsubishi condensing units and 2 no. existing Daikin condensing units (all as described herein).

This Environmental Noise Assessment Report:

- Presents the results of an automated environmental noise survey undertaken at the rear of the subject premises to establish the existing daytime and evening ambient / background noise levels;
- Discusses environmental acoustic design targets for the proposed condenser plant in the context of national and local planning policy and other relevant industry standard guidance;
- Assesses noise emissions from the proposed condenser plant and any engineering controls (i.e. acoustic enclosure) deemed necessary to control noise emissions to mitigate any adverse noise impacts, in accordance with relevant national and local planning policy;
- Determines that there will be a Planning benefit in that the noise emissions from the 2 no. existing condensing units will be reduced as a result of being relocated and housed within the proposed acoustic enclosure.
- Concludes that cumulative environmental noise emissions due to operation of the proposed condenser plant should comply fully with relevant national and local planning policy (in particular the London Borough of Camden Planning Policy guidelines relating to environmental noise emissions from mechanical plant) provided that the condensing units and purpose designed acoustic enclosure are all as described herein.

1 THE SITE AND SURROUNDING AREA

The subject property is situated in Fitzroy Square, Fitzrovia, within a terrace of similar Georgian properties. Fitzroy Square is close to Euston Road and is located amongst other connecting streets between Cleveland Street and Tottenham Court Road.

It is proposed that 2 no. new condensing units will be installed within a purpose designed acoustic louvred plant enclosure to be located close to the rear boundary of the roof terrace at 1st floor level of the subject premises. In addition, it is proposed to relocate 2 no. existing condensing units currently positioned nearby on this roof terrace to within the same enclosure.

It was noted that there are existing mechanical plant items such as a 'flatbed' type dry air cooler and condensing unit enclosure etc. on other neighbouring roof terraces in the vicinity of the subject premises. Unusually, these were not distinctly audible during our site visit and it is assumed that they were inoperative (or operating at low duties) due to the impact of the Covid-19 pandemic on commercial building occupancy levels; and these plant may well ordinarily produce higher noise output levels. There was a slight audible plant 'hum', however, which appeared to be emanating from a number of small condensing units nearby.

The surrounding area is a mix of commercial and residential properties and the closest residential windows to the subject roof terrace are rooflights in No. 9 Fitzroy Mews to the south west and windows in No. 26 Fitzroy Square to the north west. Aside from the subject premises, the closest neighbouring office windows are in No. 28 Fitzroy Square to the south east. The approximate distance of the proposed plant enclosure to each of these windows is as follows:

a) No. 9 Fitzroy News - dwelling rooflights* approximately 2.5m from plant enclosure louvres.

b) No. 26 Fitzroy Square - dwelling windows approximately 8m from plant enclosure louvres.

c) No. 28 Fitzroy Square - office windows approximately 7m from plant enclosure louvres.

* It should be noted that the rooflights will benefit from significant 'natural' acoustic screening afforded by the building features and roofline.

There are various other buildings in the locality at distances further away than stated above which will be less affected by noise emissions from the proposed mechanical plant due to 'natural' acoustic screening afforded by the walls and other features of the subject premises.

2 PLANNING POLICY GUIDANCE

2.1 National Planning Policy

Current governmental guidance relating to the determination of planning applications is given in the recently updated National Planning Policy Framework (NPPF: February 2019 updated June 2019). The NPPF policy guidelines include, inter alia, references to conserving and enhancing the natural environment; for example by ensuring developments are not adversely affected by unacceptable levels of soil, air, water or noise pollution etc., by means of suitable mitigation measures.

With specific regard to noise, the NPPF has previously directed the reader to the advice contained in DEFRA's Noise Policy Statement for England (NPSE). This Policy Statement introduces the concept of a "Significant Observed Adverse Effect Level" (SOAEL), "Lowest Observed Adverse Effect Level" (LOAEL) and "No Observed Adverse Effect Level" (NOAEL). However, whilst the intent of the NPSE in relation to the NPPF is clear, the Noise Policy Statement for England does not, at this time, provide any quantitative threshold values for each identified level of "effect". Indeed, the NPSE carefully highlights that:

> *"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."*

The Government has previously issued *"National Planning Practice Guidance"* to assist in understanding the perception of noise effects, outcomes and actions that should be taken to align decision making with the NPPF. The table below sets out this guidance:

Perception	Examples of Outcomes	Increasing Effect Level	Action
Not noticeable	No Effect	No Observed Effect	**No specific measures required**
No Observed Adverse Effect Level (NOAEL)			
Noticeable and not intrusive	Noise can be heard, but does not cause any change in behaviour or attitude. Can slightly affect the acoustic character of the area but not such that there is a perceived change in the quality of life.	No Observed Adverse Effect	**No specific measures required**
Lowest Observed Adverse Effect Level (LOAEL)			
Noticeable and intrusive	Noise can be heard and causes small changes in behaviour and/or attitude, e.g. turning up volume of television; speaking more loudly; closing windows for some of the time because of the noise. Potential for non-awakening sleep disturbance. Affects the acoustic character of the area such that there is a perceived change in the quality of life.	Observed Adverse Effect	**Mitigate and reduce to a minimum**
Significant Observed Adverse Effect Level (SOAEL)			
Noticeable and disruptive	The noise causes a material change in behaviour and/or attitude, e.g. having to keep windows closed most of the time, avoiding certain activities during periods of intrusion. Potential for sleep disturbance resulting in difficulty in getting to sleep, premature awakening and difficulty in getting back to sleep. Quality of life diminished due to change in acoustic character of the area.	Significant Observed Adverse Effect	**Avoid**
Noticeable and very disruptive	Extensive and regular changes in behaviour and/or an inability to mitigate effect of noise leading to psychological stress or physiological effects, e.g. regular sleep deprivation/awakening; loss of appetite, significant, medically definable harm, e.g. auditory and non-auditory	Unacceptable Adverse Effect	**Prevent**

In light of the above, it can be seen that whilst the NPPF and associated planning practice guidance sets out stringent imperatives to ensure the satisfactory development of land in relation to possible noise impacts, the NPPF does not generally provide any detailed

technical guidance defining what may be considered to constitute a *"significant" or "other"* adverse impact. In the absence of such technical guidance, reference needs to be made to sustainable development standards contained within relevant *'industry standard'* guidance documents and/or local Planning policy guidance, as set out in Section 2.2 of this report.

2.2 Local Planning Policy

The London Borough of Camden's adopted *"Camden Local Plan"* includes, inter alia, recommended noise thresholds that are designed to reduce noise impact from industrial and commercial noise sources and thereby seek to protect the amenity of existing neighbours from proposed mechanical plant installations. The Council's most stringent plant noise emission criteria relevant to the *"Lowest Observed Adverse Effect Level" (LOAEL)* are contained within Table C in Appendix 3 (Noise Thresholds) of the Camden Local Plan and are summarised below:

Table C: Noise Levels Applicable to Proposed Industrial and Commercial Developments (Including Plant and Machinery)

Existing Noise Sensitive Receptor (Design Period)	Assessment Location	LOAEL (Green)
Dwellings ** (Day)	Garden used for main amenity (free field) and Outside living or dining or bedroom window (façade)	'Rating level' 10dB* below background
Dwellings ** (Night)	Outside bedroom window (façade)	'Rating level' 10dB* below background and no events exceeding 57 dB L_{Amax}

** 10dB should be increased to 15dB if the noise contains audible tonal elements (day and night). However, if it can be demonstrated that there is no significant difference in the character of the residual background noise and the specific noise from the proposed development then this reduction may not be required. In addition, a frequency analysis [to include the use of Noise Rating (NR) curves or other criteria curves] for the assessment of tonal or low frequency noise may be required.*

*** Levels given are for dwellings, however, levels are use specific and different levels will apply dependent on the use of the premises.*

3 ENVIRONMENTAL NOISE SURVEY

An automated environmental noise survey was undertaken to determine the prevailing daytime and early evening background noise levels in the vicinity of the subject premises. The noise monitoring equipment was left on site between Tuesday 17 and Wednesday 18 November, 2020.

3.1 Noise Monitoring Location

An initial inspection of the subject premises revealed the most suitable, secure, accessible, noise monitoring location to be in the centre of the rear terrace at 1st floor level (as indicated in Figure 1 below) - i.e. quite close to the location of the proposed acoustic enclosure.

Figure 1: Site Location Plan Showing Position of Noise Monitoring Equipment

Image courtesy of Google Earth ©

It is understood the subject condensing units will be required to operate during daytime office hours only (i.e. 08:00 - 19:00 hours). The automated noise monitoring equipment was left to operate over a 24 hour period for convenience and to ensure safe access periods onto and off the premises.

3.2 Instrumentation

The following instrumentation was used for the automated environmental noise monitoring:

Brüel and Kjær Precision Real Time Analyser / Data Logger	Type 2260B
Brüel and Kjær ½" Condenser Microphone	Type 4189
Brüel and Kjær Sound Level Calibrator	Type 4230
Brüel and Kjær ½" Windshield	Type UA 0237

The real time analyser was calibrated prior to each survey and the calibration was checked again upon completion. No drift was found to have occurred.

3.3 Weather Conditions

The weather conditions upon arrival at the subject premises were dry and cool, with a very light breeze and almost fully overcast (7-8 oktas cloud cover). Weather forecasts indicated less cloud cover later in the afternoon and in the early hours of the following morning, remaining dry and fairly calm at all times.

3.4 Noise Survey Procedure

The Brüel and Kjær real time analyser / data logger was set up to continually record the L_{A90}, L_{Aeq} and $L_{Amax,fast}$ sound levels over 15 minute sample periods.

Please refer to **Appendix A** for an explanation of the acoustic terminology used above.

3.5 Noise Survey Results

The noise survey results are presented in **Table 0808/NMR/T1** at **Appendix B**.

3.6 Discussion of Results

From observations made during our site visits, the underlying ambient / background noise levels were generally attributed to a combination of mechanical plant 'hum' from nearby buildings, with some influence from local and distant road traffic sources, and also occasional noises produced by nearby building occupants. As stated in Section 1 above, some of the plant in neighbouring buildings appeared to be inoperative (or operating at low duties) due to the impact of the Covid-19 pandemic on commercial building occupancy levels; and these plant may well ordinarily produce higher noise output levels. As such, the findings of this noise assessment report are robust in Planning terms.

4 ACOUSTIC DESIGN TARGETS

4.1 Local Authority Requirements

As noted in Section 2.2 above, the London Borough of Camden essentially requires that noise emissions from proposed plant to nearby dwellings will need to be controlled to a level 10 dB(A) below the minimum measured background noise level during the proposed operational hours of the plant, as measured at 1m from the nearest living room, dining room or bedroom window of nearby properties. The guidance within the Camden Local Plan indicates that plant noise emissions during the night-time period need consider bedroom windows only although this is not relevant in this instance.

The subject mechanical plant items (4 no. condensing units as described herein) are required to operate between the hours of 08:00 to 19:00 hours only - i.e. they are not required to operate overnight. As such, the lowest background noise levels measured between 08:00 and 19:00 hours should be considered when setting acoustic design targets.

4.2 Minimum Measured Background Noise Levels

The minimum L_{A90} background noise level recorded during the environmental noise survey is given in **Table 1** below:

Table 1: Minimum Measured Background Noise Level

Measurement Location	Minimum Measured Background Noise Level, $L_{A90,15\ mins}$ dB	
	Daytime Period (07:00 - 19:00)	Night-Time Period (19:00 - 07:00)
Rear Terrace (1st Floor Level)	41 dB	N/A

Please Note:

The proposed plant operating period is 08:00 to 19:00 hours.

4.3 Condenser Plant Noise Emissions to Commercial Premises

It is usual for reference to be made to BS 8233:2014 *"Guidance on Sound Insulation and Noise Reduction for Buildings"* when assessing plant noise emissions to neighbouring commercial premises. Section 7.7.4 of this standard, which contains the most stringent guidance, suggests that the ambient noise level in (unoccupied) executive offices should not exceed 35-40 dB $L_{Aeq,T}$.

Clearly, the level of sound transfer to internal areas of nearby commercial properties will be dictated by the type and acoustic performance of the external building envelope and whether the building is air-conditioned or relies on natural ventilation. The closest office windows appear to be openable, and so as a Planning safeguard, it has been assumed that the office windows may be opened for ventilation.

Guidance given in the World Health Organisation document "Guidelines For Community Noise" suggests that an open window will provide around 15 dB(A) sound reduction from outside to inside. It is therefore concluded that, in order to preserve the amenity of neighbouring offices in accordance with design standards suggested in BS 8233, the façade incident mechanical plant noise emission level should ideally not exceed 50 dB L_{Aeq} outside the openable windows of neighbouring commercial buildings.

4.4 Environmental Acoustic Design Targets

Based on the minimum measured background noise levels at the rear of the subject premises the Local Authority's guidelines will require that the mechanical plant installation is designed in accordance with the following acoustic design targets:

Table 2: Proposed Environmental Acoustic Design Targets

Location of Receptors	Plant Noise Emission Rating Level, $L_{Aeq,15mins}$ dB	
	Daytime Operating Hours (08:00 – 19:00)	Night-Time Hours
Dwelling: Outside Rear Façade of 26 Fitzroy Square	31 dB *	N/A
Dwelling: Outside Rooflight of 9 Fitzroy Mews	31 dB *	N/A
Office: Outside Rear Façade of 28 Fitzroy Square	50 dB **	N/A

* The above acoustic design target for the dwellings is to be achieved at a distance of 1m from the nearest window (or rooflight) of a habitable room with all plant operating normally.

** The above commercial acoustic design target is to be achieved at a distance of 1m from the nearest office window with all plant operating normally.

5 SUBJECT PLANT AND NOISE MITIGATION

The subject mechanical plant comprises 2 no. new Mitsubishi condensing units and 2 no. existing Daikin condensing units. The manufacturer's noise data for these plant items are detailed below.

All the condenser manufacturer's plant noise data referred to below shall be considered as 'limiting' (i.e. not to be exceeded) design criteria. Any changes to the tabulated plant noise levels, proposed plant selections, operating conditions and/or unit locations etc., shall be referred back to The EQUUS Partnership for further advice.

5.1 Proposed New Condensing Units

The following manufacturer's 'free-field' sound pressure levels have been obtained for the proposed 2 no. new Mitsubishi PUMY-SP140VKM.TH condensing units. This published information relates to the measured noise level at 1m from each unit:

Condensing Unit Noise Levels: Octave Band Sound Pressure Levels (dB re: $2x10^{-5}$ Pa)									
Operating Mode	**63**	**125**	**250**	**500**	**1k**	**2k**	**4k**	**8k**	**(A)**
PUMY-SP140VKM.TH (Cooling Mode)	57	56	55	51	49	45	38	30	(54)

Please Note:
The condensing units are only required to provide cooling as heating is provided by radiators.

5.2 Existing Condensing Units

The following manufacturer's 'free-field' sound pressure levels have been obtained for the existing 2 no. Daikin RXS25L2V1B condensing units. This published information relates to the measured noise level at 1m from each unit:

Comms Room. Cond. Unit Noise Levels: Octave Band Sound Pressure Levels (dB re: $2x10^{-5}$ Pa)									
Operating Mode	**63**	**125**	**250**	**500**	**1k**	**2k**	**4k**	**8k**	**(A)**
RXS25L2V1B (Cooling Mode)	42	43	43	40	38	31	25	20	(46)

Please Note:
The condensing units are only required to provide cooling as heating is provided by radiators.

5.3 Proposed Noise Mitigation

In order to provide adequate control of environmental noise emissions, it will be necessary for a proprietary acoustic louvred plant enclosure to be installed around the 4 no. subject condensing units at the boundary of the rear roof terrace at 1st floor level of the subject premises. The acoustic enclosure shall be as specified below and incorporate discharge attenuators fitted directly onto each of the condensing unit fans and acoustic intake louvres at each end of the enclosure. The height of the acoustic enclosure shall be sufficient to allow free intake airflow to all four condensing units.

Please refer to **Appendix C** for an illustration of the proposed acoustic louvred plant enclosure.

5.3.1 Acoustic Louvred Plant Enclosure

The proposed acoustic louvred plant enclosure shall be manufactured from proprietary double skinned panels comprising a solid steel outer skin on one side and (minimum) 23% free area perforated steel panel to the other side, filled with acoustic insulation, and orientated such that the acoustically absorptive side of the screens are facing towards the condenser plant to absorb reflected noise. The outer face of the panels shall be finished in accordance with the architect's requirements.

The double skinned panels shall be filled with an acoustically absorptive infill with a minimum density of at least 45kg/m³. The acoustic medium shall be inert, rot and vermin proof, non-hygroscopic and non-combustible. The acoustic medium shall be suitably faced with an acoustically transparent finish to prevent fibre migration. The acoustic medium shall not contain fibres that have a diameter of 3 microns or less and a length of 200 microns or less. The acoustic enclosure shall include all necessary framing and support posts to allow for potential wind loading and stresses etc.

The acoustic enclosure walls and roof sections shall be formed from (minimum) 50mm thick acoustic panels as manufactured by Ambient Acoustics (www.ambientacoustics.co.uk) or equal and approved and the acoustic enclosure shall comply with the minimum acoustic performances tabulated below. All panels and junctions etc. shall be acoustically sealed to prevent sound leakage:

Minimum Acoustic Performance of Condensing Unit Acoustic Enclosure								
Acoustic Performance	**63**	**125**	**250**	**500**	**1k**	**2k**	**4k**	**8k**
Minimum Sound Reduction Indices	19	19	21	30	43	44	45	45
Minimum Sound Absorption Coefficients	0.10	0.25	0.60	0.95	0.95	0.95	0.90	0.90

5.3.2 Condensing Unit Discharge Attenuators

The 4 no. condensing units shall each be fitted with a suitable discharge attenuator of approximately 600mm length selected to achieve the following acoustic performance:

Minimum Acoustic Performance of Condenser Unit Discharge Attenuator								
Acoustic Performance	**63**	**125**	**250**	**500**	**1k**	**2k**	**4k**	**8k**
Minimum Insertion Losses	3	4	9	17	24	21	18	13

5.3.3 Acoustic Intake Louvres

The acoustic enclosure shall have full width and height acoustic intake louvres fitted at each end of the enclosure selected to achieve the following acoustic performances:

Minimum Acoustic Performance of Acoustic Intake Louvres								
Acoustic Performance	**63**	**125**	**250**	**500**	**1k**	**2k**	**4k**	**8k**
Minimum Insertion Losses	7	8	11	12	15	16	13	11

5.3.4 Maximum Aerodynamic Resistance

The maximum allowable overall pressure drop of the proposed acoustic louvred plant enclosure (i.e. combined discharge + intake pressure drops) has been advised to be 30 Pa. under full airflow operating conditions.

5.3.5 Time-Switch Controller

As a further Planning safeguard, and to minimise plant noise emissions to the neighbouring properties, it is recommended that the subject condensing units be time-switch controlled to prevent their operation overnight.

6 ENVIRONMENTAL PLANT NOISE ASSESSMENTS

6.1 Cumulative Plant Noise Emissions to No. 9 Fitzroy Mews

Calculations indicate the following 'worst case' cumulative plant noise level outside the closest rooflight of No. 9 Fitzroy Mews - i.e. with all the subject condensing units operating together at maximum duty:

'Worst case' plant noise level outside dwelling rooflight - 28 dB L_{Aeq}.

It may be seen that the calculated cumulative plant noise emission level accords with the daytime *'Environmental Acoustic Design Target'* of 31 dB L_{Aeq} referred to in Section 4.4 of this report, and should therefore be satisfactory provided the specified noise mitigation measures are installed.

6.2 Cumulative Plant Noise Emissions to No. 26 Fitzroy Square

Calculations indicate the following 'worst case' cumulative plant noise level outside the closest window of No. 26 Fitzroy Square - i.e. with all the subject condensing units operating together at maximum duty:

'Worst case' plant noise level outside dwelling window - 29 dB L_{Aeq}.

It may be seen that the calculated cumulative plant noise emission level accords with the daytime *'Environmental Acoustic Design Target'* of 31 dB L_{Aeq} referred to in Section 4.4 of this report, and should therefore be satisfactory provided the specified noise mitigation measures are installed.

6.3 Cumulative Plant Noise Emissions to 28 Fitzroy Square (Offices)

Calculations indicate the following 'worst case' cumulative plant noise level outside the closest office windows - i.e. with all the subject condensing units operating together at maximum duty:

'Worst case' plant noise level outside office windows - 30 dB L_{Aeq}.

It may be seen that the calculated cumulative plant noise emission level accords with the daytime *'Environmental Acoustic Design Target'* of 50 dB L_{Aeq} referred to in Section 4.4 of this report, and should therefore be satisfactory provided the specified noise mitigation measures are installed.

6.4 Noise and Vibration Transmissions

Structure-borne noise and/or vibration transmission and airborne noise transmission into the subject premises (due to the proposed condenser plant operation) do not form part of this assessment report. However, it is recommended initially that the contractor ensures all condenser plant and associated pipework are installed on proprietary vibration isolation equipment (incorporating 'noise stop' pads where appropriate) designed and selected to achieve at least 95% isolation efficiency in accordance with good installation practice. Further noise and/or vibration assessments can be undertaken, if instructed, during the proposed office refurbishment.

7 CONCLUSIONS

An environmental noise survey has been undertaken in order to establish the prevailing ambient and background noise levels in the vicinity of the subject premises at No. 27 Fitzroy Square, London W1 during the daytime and early evening periods. Based on the noise measurement data, environmental noise emission design targets have been determined in accordance with the London Borough of Camden Planning Policy guidelines.

The cumulative environmental noise emissions due to operation of the proposed 2 no. new condensing units and 2 no. relocated (existing) condensing units have been assessed based on manufacturer's noise data and allowing for (i) the proposed purpose designed acoustic louvred plant enclosure and, where appropriate, (ii) the 'natural' acoustic screening afforded by the building features at the subject premises.

It is concluded that noise emissions due to operation of the proposed condenser plant should comply fully with relevant national and local planning policy, in particular the London Borough of Camden Planning Policy guidelines relating to environmental noise emissions from mechanical plant, provided that the plant is located within the acoustic enclosure described herein. Furthermore, there will be an associated Planning benefit in that the noise emissions from the 2 no. existing condensing units will be reduced as a result of being relocated and housed within the proposed acoustic enclosure.

As a further Planning safeguard, and to minimise plant noise emissions to the neighbouring properties, it is recommended that the subject condensing units be time-switch controlled to prevent their operation overnight.

All the plant noise data referred to within this report are to be considered as 'limiting' (i.e. not to be exceeded) design criteria. Any changes to the stated plant noise levels, proposed plant selections, operating conditions, unit locations and/or arrangements etc., shall be referred back to The EQUUS Partnership for further review and advice.

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APPENDIX A

GLOSSARY OF ACOUSTIC TERMINOLOGY

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General

A vibrating surface or turbulent fluid flow will cause pressure fluctuations in the surrounding air. These pressure fluctuations are perceived by the human ear as "sound".

Measurement Units

The human ear can detect sound pressures as low as about 20 µPa, and can tolerate (for short periods) sound pressures as high as 200 Pa, an amplitude range of 10 million times. To take account of this huge amplitude range, sound pressure levels (often written in "acoustic shorthand" as SPL or Lp) are quantified using a logarithmic scale, the decibel (dB) scale. This is based on a reference pressure of 20µPa, thus a sound pressure of 20µPa would equate to 0dB and a pressure of 200Pa would equate to 140dB.

Frequency (Pitch) Characteristics

The sound received at any particular location is not solely influenced by the sound pressure level, the frequency characteristics (pitch) of the noise is also an important factor. Noise audible to a human (with "normal" hearing), typically covers the frequency range 20 Hertz to 20,000 Hertz. Hertz (Hz) are defined as the number of times the sound pressure fluctuates in one second. "Low" pitched sounds fluctuate less times per second than "high" pitched sounds. Whilst humans are capable of detecting a wide range of frequencies, the ear is not equally sensitive to all frequencies – the ear is most sensitive at frequencies towards the middle of the audible range and less sensitive to the lower and higher frequencies.

To take account of this frequency response, sound pressure fluctuations are normally quantified by applying a frequency-weighting network or filter which simulates the frequency response of the ear. In essence, this means that more significance is given to the frequencies at which the ear is most sensitive and less significance to those at which the ear is less sensitive. Noise measurements relating to human reaction are generally made using an "A-weighting" network. These measurements are reported as A-weighted decibels or dB(A). The A-weighted sound pressure level is written in "acoustic shorthand" as L_A.

Variation of Sound with Time

It will be appreciated that the sound pressure level of most noise sources will fluctuate with time. In order to take account of the way in which the human ear perceives noise, it is normal for the sound pressure level to be quantified using a time weighting network, to mimic the speed of response of the human ear. The standardised setting for most types of noise is a "Fast" time weighting.

The manner in which sound fluctuates with time can also influence the subjective manner in which noise is perceived. Noise can be continuous (showing no significant variation with time as in the case of a fan), intermittent (i.e. the noise is transient in it's nature, such as a train pass-by) or impulsive (i.e. there is a sudden build up of noise - this can range from "clanking" types sounds as might be experienced next to railway goods yard or a high energy discharge such as an explosion)

Measurement of Sound

Sound pressure levels are measured using equipment comprising a pressure-sensitive microphone, associated amplifier, frequency weighting network, time weighted network and output indicator. In its simplest form this is a small hand-held instrument called a sound level meter. More sophisticated instrumentation (a sound level analyser) is also available which allows the real-time output of the frequency characteristics of the sound to be quantified.

Comparison of Sound Levels

To put the significance of noise measurement into context, the following Table presents the A-weighted sound pressure level of some typical sources:

Sound Pressure Level, dB(A)	Typical Noise Source . Activity
160	Saturn Rocket Taking Off
140	Military Jet Taking Off at 30m
100	Nightclub
90	Heavy goods vehicle driving past at 7m
80	Busy urban road
70	Domestic vacuum cleaner at 3m
60	Busy office environment
55	Normal speech at 1m
40	Whispered conversation at 2m
30	Bedroom at night (BS 8233: 1999)
20	Remote country location
0	Threshold of hearing – a very eery silence

Addition of Sound Levels

It is important to note that the use of a logarithmic scale to describe noise does not allow normal arithmetic addition. This means that two noise sources each generating a level of, say, 60dB(A) will not generate a combined sourd level of 120dB(A). The values must be added logarithmically, which would actually yield a combined sound level of 63dB(A) in this example.

Subjective Perception of Sound Levels Changes

With regard to the human perception of sound level changes, the human ear:

- Cannot generally perceive a sound level difference of less than 3dB(A)
- Will perceive a sound level difference of 4-5dB(A) as "noticeable"
- Will perceive a sound level difference of 10dB(A) as a doubling (or halving) of loudness.

GLOSSARY OF ACOUSTIC TERMINOLOGY

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Acoustic Terminology

As stated previously, most sources of noise will fluctuate with time. In order to characterize such noise, it is therefore normal to represent the noise climate using a variety of noise parameters and statistical indices. The most commonly adopted noise parameters are described below:

$L_{Aeq,T}$ This is the equivalent continuous A-weighted sound level measured over a specified time period "T". This is the notional continuous sound level which, over the time T, contains the same amount of energy as the actual fluctuating sound being measured. This parameter is widely accepted as being the most appropriate noise descriptor for most environmental noise and the effects of noise on humans.

$L_{Amax,fast}$ This is maximum A-weighted sound pressure measured with a fast frequency response recorded during the stated measurement period. It is typically used to characterise the highest sound level caused during a noise event.

$L_{A90,T}$ This is the A-weighted sound pressure level exceeded for 90% of the specified time period "T". It is normally used to describe the underlying background noise level of an environment since it inherently excludes the effects of transient noise sources.

Noise Rating (NR) Level

When describing noise from building services installations, it is common to express noise levels in terms of a Noise Rating (NR) Level. The NR level is determined by plotting the measured frequency spectrum of a noise against a series of reference curves, which roughly approximate to equal loudness values. This method permits higher sound levels at low frequencies corresponding to the sensitivity of the human ear. The NR level is defined as the value of the highest curve "touched" by the plotted frequency spectrum. For typical sources of building services noise, the overall A-weighted sound level is numerically around 5-6dB higher than the NR level of the noise.

α_w The "**Weighted Absorption Coefficient**" (α_w) is a single figure measure of the overall sound absorption capabilities of a building element determined in accordance with BS EN ISO 11654: 1997.

APPENDIX B

TABLE 0808/NMR/T1:
Automated Noise Monitoring Results (Rear Terrace at 1st Floor Level)

Measurement Start Time	Measured Sound Pressure Level, dB		
	$L_{A90,15mins}$	$L_{Aeq,15mins}$	$L_{Amax,fast}$
13.00	45.0*	54.9*	81.0*
13.15	44.4	46.8	62.7
13.30	43.8	46.2	63.4
13.45	43.6	46.3	63.6
14.00	43.2	45.1	59.5
14.15	43.2	46.3	62.8
14.30	43.0	45.2	62.4
14.45	42.8	45.4	59.8
15.00	42.6	44.8	63.0
15.15	43.0	44.6	58.0
15.30	42.6	44.7	61.7
15.45	43.2	44.9	58.5
16.00	42.8	44.8	59.1
16.15	42.8	46.5	62.3
16.30	42.4	44.2	65.4
16.45	42.0	43.2	54.5

Measurement Start Time	Measured Sound Pressure Level, dB		
	$L_{A90,15mins}$	$L_{Aeq,15mins}$	$L_{Amax,fast}$
17.00	41.6	44.0	60.7
17.15	41.8	43.3	55.6
17.30	41.2	43.1	57.9
17.45	41.6	44.1	61.3
18.00	41.2	43.1	58.1
18.15	41.0	42.9	53.6
18.30	41.8	43.3	51.2
18.45	41.0	42.7	55.9
19.00	41.2	43.1	60.0
19.15	41.0	42.8	54.7
19.30	40.8	42.3	54.3
19.45	41.2	43.1	58.6
20.00	42.0	43.1	53.3
20.15	40.8	42.2	53.4
20.30	41.2	42.6	60.2
20.45	40.4	43.1	52.9
21.00	40.0	43.3	59.9
21.15	40.2	41.7	54.9

Measurement Start Time	Measured Sound Pressure Level, dB		
	$L_{A90,15mins}$	$L_{Aeq,15mins}$	$L_{Amax,fast}$
21.30	40.4	41.8	52.1
21.45	40.8	42.8	52.5
22.00	40.4	55.4	78.4
22.15	40.4	54.1	76.7
22.30	41.4	42.7	50.6
22.45	41.0	42.1	48.5
23.00	38.8	40.5	52.4
23.15	38.4	40.2	46.2
23.30	38.0	39.9	56.6
23.45	38.4	40.1	54.6
00.00	38.4	39.9	47.3
00.15	39.2	40.3	49.3
00.30	38.2	39.5	51.2
00.45	38.2	39.5	46.6
01.00	38.4	39.9	46.6
01.15	38.0	39.4	48.8
01.30	38.8	40.9	57.9
01.45	39.8	41.2	47.5

Measurement Start Time	Measured Sound Pressure Level, dB		
	$L_{A90,15mins}$	$L_{Aeq,15mins}$	$L_{Amax,fast}$
02.00	37.8	40.0	61.4
02.15	37.8	40.4	52.2
02.30	38.4	40.0	44.3
02.45	37.6	38.9	53.4
03.00	38.8	40.1	43.5
03.15	37.8	39.1	54.6
03.30	39.4	41.4	60.7
03.45	38.8	41.2	58.3
04.00	39.6	41.0	46.4
04.15	40.4	42.3	63.8
04.30	38.2	40.2	47.0
04.45	38.2	39.2	44.7
05.00	38.4	39.6	46.4
05.15	38.2	39.1	45.9
05.30	38.6	39.8	44.8
05.45	39.0	40.6	47.8
06.00	41.4	42.5	51.3
06.15	40.4	41.9	54.0

Measurement Start Time	Measured Sound Pressure Level, dB		
	$L_{A90,15mins}$	$L_{Aeq,15mins}$	$L_{Amax,fast}$
06.30	40.2	41.5	48.1
06.45	41.6	43.8	59.7
07.00	41.2	43.8	60.7
07.15	42.0	44.2	62.8
07.30	41.8	43.5	57.7
07.45	42.4	44.1	60.8
08.00	42.6	44.3	62.3
08.15	42.8	44.9	59.9
08.30	43.1	45.2	61.7
08.45	43.3	45.4	63.2
09.00	43.6	45.6	62.5
09.15	43.6	46.0	65.1
09.30	43.4	45.1	62.8
09.45	43.2	45.3	63.0
10.00	43.4	44.8	61.6
10.15	43.2	44.5	59.8
10.30	43.3	44.7	60.3
10.45	43.0	44.5	61.8

Measurement Start Time	Measured Sound Pressure Level, dB		
	$L_{A90,15mins}$	$L_{Aeq,15mins}$	$L_{Amax,fast}$
11.00	42.8	44.4	61.2
11.15	42.5	44.2	60.4
11.30	42.7	44.3	61.3
11.45	42.9	44.6	61.0
12.00	43.2	45.0	62.4
12.15	43.4	45.4	61.4
12.30	43.8	45.8	62.3
12.45	44.2	46.3	63.6

* Includes setting up noise etc.

Please Note:

The measurement results tabulated above are shown to one decimal place as recorded by the real time analyser but this is not intended to imply that degree of accuracy.

APPENDIX C

27 FITZROY SQUARE
ACOUSTIC ENCLOSURE

AA68XX 181220

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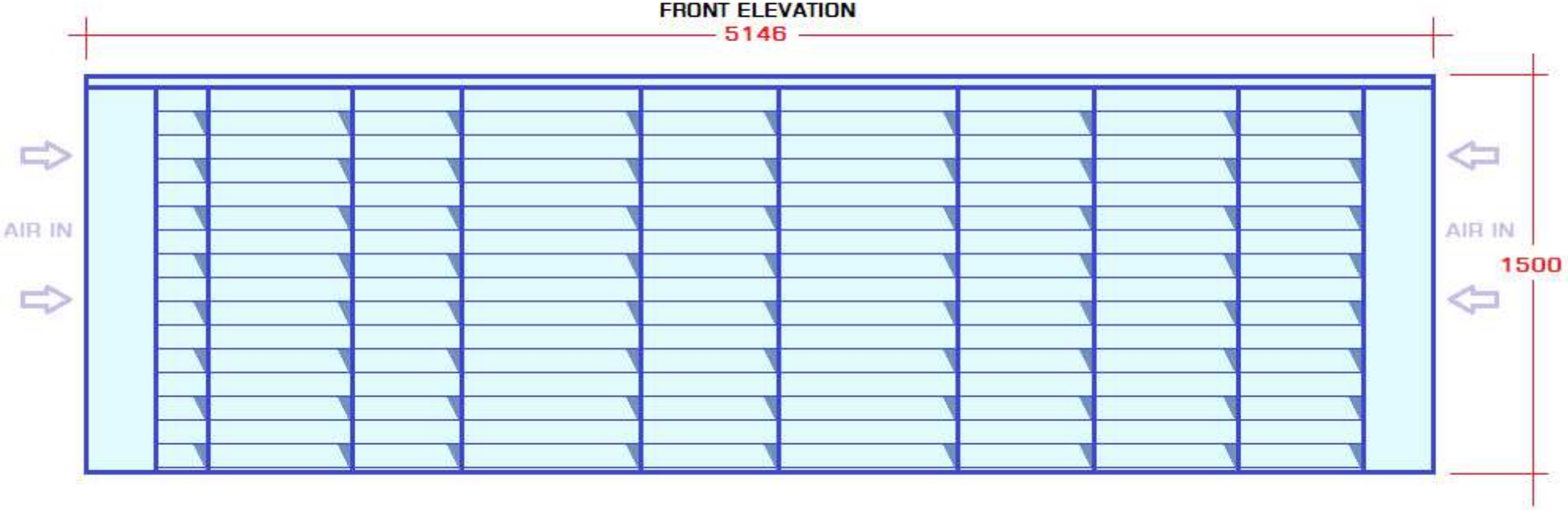
FRONT ELEVATION



PLAN VIEW