THE EQUUS PARTNERSHIP

Member of the Association of Noise Consultants

CONSULTANTS IN ACOUSTICS

20 FLAXMAN TERRACE, LONDON WC1H 9PN

ENVIRONMENTAL NOISE ASSESSMENTS OF PROPOSED MECHANICAL PLANT

Report Reference: EPL/9788/ENA/RP/02B

October 2020

Report prepared for:

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EXECUTIVE SUMMARY

The EQUUS Partnership has been commissioned by Salaft Properties Limited to undertake an environmental noise assessment in connection with proposed comfort cooling systems to be installed within 20 Flaxman Terrace, London WC1, as part of necessary refurbishment of the building. The proposed comfort cooling systems include roof mounted condenser units which are required to serve internal areas of the building at lower ground, ground, 1st and 2nd floor levels.

This Environmental Noise Assessment Report has been prepared to accompany a Planning Application submitted by Alsop Verrill Limited on behalf of Salaft Properties Limited and takes into consideration recent changes to the arrangement of the proposed rooftop plant enclosure.

The Planning Application seeks approval to the proposed installation of the required air cooled condenser units (in conjunction with the repositioning of an existing condenser unit) within a proposed new purpose built acoustic enclosure on an external flat roof area at 2nd floor level of the subject premises.

This Environmental Noise Assessment Report:

- Presents the results of an environmental noise survey undertaken in the vicinity of the site to establish existing ambient and 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, where necessary, the engineering controls (noise mitigation measures) that will be implemented to control noise emissions to mitigate any adverse noise impacts, in accordance with relevant national and local planning policy;
- Concludes that noise emissions due to operation of the proposed condenser plant should comply fully with relevant national and local planning policy, in particular the noise threshold policy of the Camden Local Plan, provided that noise mitigation measures are installed as detailed herein.

1 THE SITE AND SURROUNDING AREA

The subject property is located within Flaxman Terrace close to the junction with Burton Street and Dukes Road. This is an existing established commercial premises and comprises four floors of office accommodation with associated facilities.

It is proposed to install the new air cooled condenser units within a purpose built acoustic enclosure on a 2nd floor flat roof area at the northern end of the building. This roof area currently contains an existing air cooled condenser unit that serves the 2nd floor tenant which will be repositioned to within the new acoustic enclosure - i.e. as part of the proposed refurbishment.

The closest noise-sensitive property is a mansion block known as Flaxman Court directly opposite the subject premises (approximately 22m to the east of the proposed rooftop plant enclosure) which is terraced and comprises six storeys of residential apartments. At the southern end of the subject premises is a commercial property (22 Dukes Road) which is currently in use as office accommodation and is approximately 32m from the proposed rooftop plant enclosure. There are various other residential and commercial buildings in the locality at distances further away.

The proposed location of the new acoustic enclosure on the 2nd floor flat roof and the layout of the plant within are indicated on Cummings Commercial Ltd. drawing ref. '20 FT - Roof - V13 - Proposed' as attached in **Appendix A**.

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 3.2 of this report.

2.2 Local Planning Policy

The London Borough of Camden's adopted *"Camden Local Plan 2017"* includes 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 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).

** 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 environmental noise survey was undertaken to determine typical prevailing daytime background noise levels in the vicinity of the subject premises. This noise survey was conducted on Friday 10 January 2020.

It is understood the proposed condenser plant will operate during office hours only. The environmental noise survey therefore comprised fully attended noise monitoring during a daytime plant operating period when background noise levels were likely to be lowest in the surrounding area - i.e. 15.00 to 18.00 hours. The survey was conducted on the 2nd floor roof of the subject premises to minimise the impact of passing road traffic noise on the acoustic measurements.

3.1 Noise Measurement Locations

Noise measurements were made at the following measurement locations:

Position A: 2nd floor level flat roof area (northern end of roof) looking towards residential flats at No's. 43 to 66 Flaxman Court. The sound level meter was positioned close to the edge of the roof and 1.5m above roof level.

Position B: 2nd floor level flat roof area (central part of roof) looking towards residential flats at No's. 67 to 84 Flaxman Court. The sound level meter was positioned close to the edge of the roof and 1.5m above roof level.

Position C: 2nd floor level flat roof area (southern end of roof) looking towards 22 Dukes Road office premises. The sound level meter was positioned close to the edge of the roof and 1.5m above roof level.

3.2 Instrumentation

The following instrumentation was used for the environmental noise survey:

Brüel and Kjær Precision Real Time Analyser	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 the survey and the calibration was checked again upon completion. No drift was found to have occurred.

3.3 Weather Conditions

Weather conditions during the daytime environmental noise survey were generally cold with a very light breeze, entirely dry (no precipitation), and with 7-8 oktas cloud cover for most of the time.

3.4 Noise Survey Procedure

Measurements of the L_{A90}, L_{Aeq} and $L_{Amax,fast}$ sound levels were recorded over a 10-15 minute sample period at each measurement location (excluding periods where the 'back erase' facility of the real time analyser was used to eliminate non-representative short term peaks).

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

3.5 Noise Survey Results

The noise survey results are presented in **Tables 1 to 3** attached at **Appendix C**.

3.6 Discussion of Results

The ambient noise levels at all measurement locations were generally controlled by local and distant road traffic, but were also influenced by plant noise emissions from neighbouring and surrounding buildings, and also occasional passing pedestrians.

The lowest daytime background noise level sample was recorded at Position B - i.e. 2nd floor central roof area of the subject premises - adjacent the sloping roof section behind the extended brick roof detail over the building entrance (area visible in the photo below).

4 ACOUSTIC DESIGN TARGETS

4.1 Local Authority Requirements

As noted in Section 2.2 above, the London Borough of Camden require that cumulative noise emissions from proposed plant to nearby dwellings will need to be controlled to a level 10 dB(A) below the minimum measured daytime 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.

4.2 Typical Minimum Background Noise Levels

The minimum L_{A90} background noise levels recorded during the environmental noise surveys at each location are summarised in **Table 1** below:

Table 1: Minimum Measured Background Noise Levels

Measurement Location	Minimum Measured Background Noise Level, L_{A90} dB	
	Daytime Operating Hours	Night-Time Operating Hours
Position A	49.2 dB	N/A
Position B	48.4 dB	N/A
Position C	48.6 dB	N/A

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.

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. Site observations indicate that the neighbouring commercial property at 22 Dukes Road appears to rely on openable windows for natural 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 above minimum measured background noise levels, the Local Authority's requirements will require that mechanical services installations are designed in accordance with the following acoustic design targets:

Table 2: Proposed Environmental Acoustic Design Targets

Location of Noise Sensitive Receptors	Plant Noise Emission Rating Level, $L_{Aeq,15mins}$ dB	
	Daytime Operating Hours	Night-Time Hours
Residential: Flaxman Court (Flaxman Terrace)	38 dB *	N/A
Commercial: Office Building (22 Dukes Road)	50 dB **	N/A

* The above residential acoustic design targets are to be achieved at a distance of 1m from the nearest living room, dining room or bedroom window of nearby dwellings with all plant operating normally. It is apparent that the 'worst case' potential impact with regard to environmental noise emissions from the subject proposals would be outside the façade of the closest noise sensitive windows of Flaxman Court. This has therefore been considered in order to provide a 'robust' assessment in Planning terms.

** 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 PROPOSED PLANT AND NOISE MITIGATION MEASURES

All the 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 Existing / Proposed Condenser Units

5.1.1 Existing Toshiba Condenser Unit

The following manufacturer's 'free-field' sound pressure levels have been obtained for the existing 1 no. Toshiba condensing unit (model type MAP0801HT8). This published information relates to the measured noise level at 1m from the unit:

Toshiba Unit Noise Levels: Octave Band Sound Pressure Levels (dB re: $2x10^{-5}$ Pa)									
Operating Mode	**63**	**125**	**250**	**500**	**1k**	**2k**	**4k**	**8k**	**(A)**
MAP0801HT8 (Cooling Mode)	70	56	55	55	52	49	40	31	(57)
MAP0801HT8 (Heating Mode)	70	58	57	55	52	50	42	36	(58)

5.1.2 Proposed Panasonic Condenser Units

The following manufacturer's 'free-field' sound pressure levels have been obtained for the proposed 3 no. Panasonic condensing units (model type U-14MF2E8). This published information relates to the measured noise level at 1m from each unit:

Panasonic Unit Noise Levels: Octave Band Sound Pressure Levels (dB re: $2x10^{-5}$ Pa)									
Operating Mode	**63**	**125**	**250**	**500**	**1k**	**2k**	**4k**	**8k**	**(A)**
U-14MF2E8 (Standard Mode)	69	68	61	60	57	50	45	39	(62)
U-14MF2E8 (Quiet Mode)	68	67	60	57	54	48	43	38	(59)

5.2 Noise Mitigation Measures

5.2.1 Acoustic Enclosure

It is proposed to install the new air cooled condenser units within a purpose built acoustic enclosure on the 2nd floor flat roof area at the northern end of the building. This roof area currently contains an existing air cooled condenser unit that serves the 2nd floor tenant. This unit will be repositioned to within the new acoustic enclosure such that it will also benefit from the sound absorption provided by the proposed acoustic screening.

In order to provide adequate control of environmental noise emissions, it will be necessary for the acoustic enclosure walls to be at least 0.7m higher than the installed height of the existing/proposed condensing units (i.e. including the height of all support structures and anti-vibration equipment etc.) and comply with all other design requirements as specified below. The acoustic enclosure position and plant arrangement is shown on the drawing attached in **Appendix A**.

The proposed acoustic enclosure shall be manufactured from proprietary double skinned acoustic panels comprising a solid steel outer skin and (minimum) 23% free area perforated steel inner face. The acoustic panels shall be filled with acoustic insulation, and shall be orientated such that the acoustically absorptive side of the panels faces towards the condenser plant in order to effectively

absorb reflected noise. The outer face of the panels shall be finished and/or externally clad in accordance with the client's / architect's requirements.

The double skinned acoustic panels shall be filled with an acoustically absorptive mineral wool 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 supplier shall include all necessary framing and support posts to allow for all potential wind loading and stresses etc. The acoustic enclosure walls shall be formed from (at least) 50mm thick acoustic panels as manufactured by Allaway Acoustics (www.allawayacoustics.co.uk), Ambient Acoustics (www.noisecontrol-uk.com), Environmental Equipment Corporation (EEC) (www.eec.co.uk) or equal and approved supplier. The access door shall be of the same construction and shall be located within the western facing enclosure wall. The acoustic enclosure shall comply with the minimum acoustic performances tabulated below and shall be continuous - i.e. without any gaps between panels, below the screen* and/or around any pipework penetrations etc.

Minimum Acoustic Performance of Condenser Unit Screens								
Acoustic Performance	**63**	**125**	**250**	**500**	**1k**	**2k**	**4k**	**8k**
Minimum Sound Reduction Indices	12	15	22	27	30	35	35	35
Minimum Sound Absorption Coefficients	0.10	0.25	0.60	0.95	0.95	0.95	0.90	0.90

* The gaps between the supporting steel grillage and the roof shall be infilled using sound barrier mat material of at least 10 kg/m2 superficial weight lapped in accordance with the manufacturer's installation instructions (suitable sound barrier mat Type BM-P10 available from Siderise Ltd).

Please Note:
The specification requirements given above shall also fully apply to the access door to the enclosure (including the sound absorptive facing towards the condenser plant).

5.2.2 Time-Switch Controller

As a further Planning safeguard, and to minimise any potential risk of noise disturbance to neighbouring dwellings it is recommended that the proposed condenser plant be time-switch controlled to prevent operation overnight.

6 ENVIRONMENTAL PLANT NOISE ASSESSMENTS

6.1 Cumulative Plant Noise Emissions to Flaxman Court (Residential)

Calculations indicate the following 'worst case' cumulative daytime plant noise level outside the closest windows of Flaxman Court - i.e. with all existing/proposed condenser units operating together - allowing for the noise mitigation measures specified above:

'Worst case' daytime plant noise level outside Flaxman Court windows - 36 dB L_{Aeq}.

It may be seen that the calculated cumulative plant noise emission level accords with the daytime *'Environmental Acoustic Design Target'* of 38 dB L_{Aeq} referred to in Section 4.4 of this report, and as such, should therefore be satisfactory provided the specified noise mitigation measures are installed.

6.2 Cumulative Plant Noise Emissions to 22 Dukes Road (Offices)

Calculations indicate the following 'worst case' cumulative daytime plant noise level outside the closest office windows of 22 Dukes Road - i.e. with all existing/proposed condenser units operating together - allowing for the noise mitigation measures specified above:

'Worst case' daytime plant noise level outside office windows - 34 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.

6.3 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 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 refurbishment project.

7 CONCLUSIONS

A daytime 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 20 Flaxman Terrace, London WC1. Based on the measured levels, environmental noise emission design targets have been determined in accordance with the London Borough of Camden's policy requirements.

Cumulative environmental noise emissions due to operation of the existing/proposed condenser plant have been assessed based on manufacturer's noise data and allowing for the proposed noise mitigation measures - i.e. proprietary acoustic enclosure surrounding the plant.

It is concluded that noise emissions due to operation of the proposed plant should comply fully with relevant national and local planning policy, in particular the noise threshold policy of the Camden Local Plan, provided the noise mitigation measures are installed as detailed within this report.

As a further Planning safeguard, and to minimise any potential risk of noise disturbance to neighbouring dwellings it has been recommended that the proposed condenser plant should be time-switch controlled to prevent any 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.

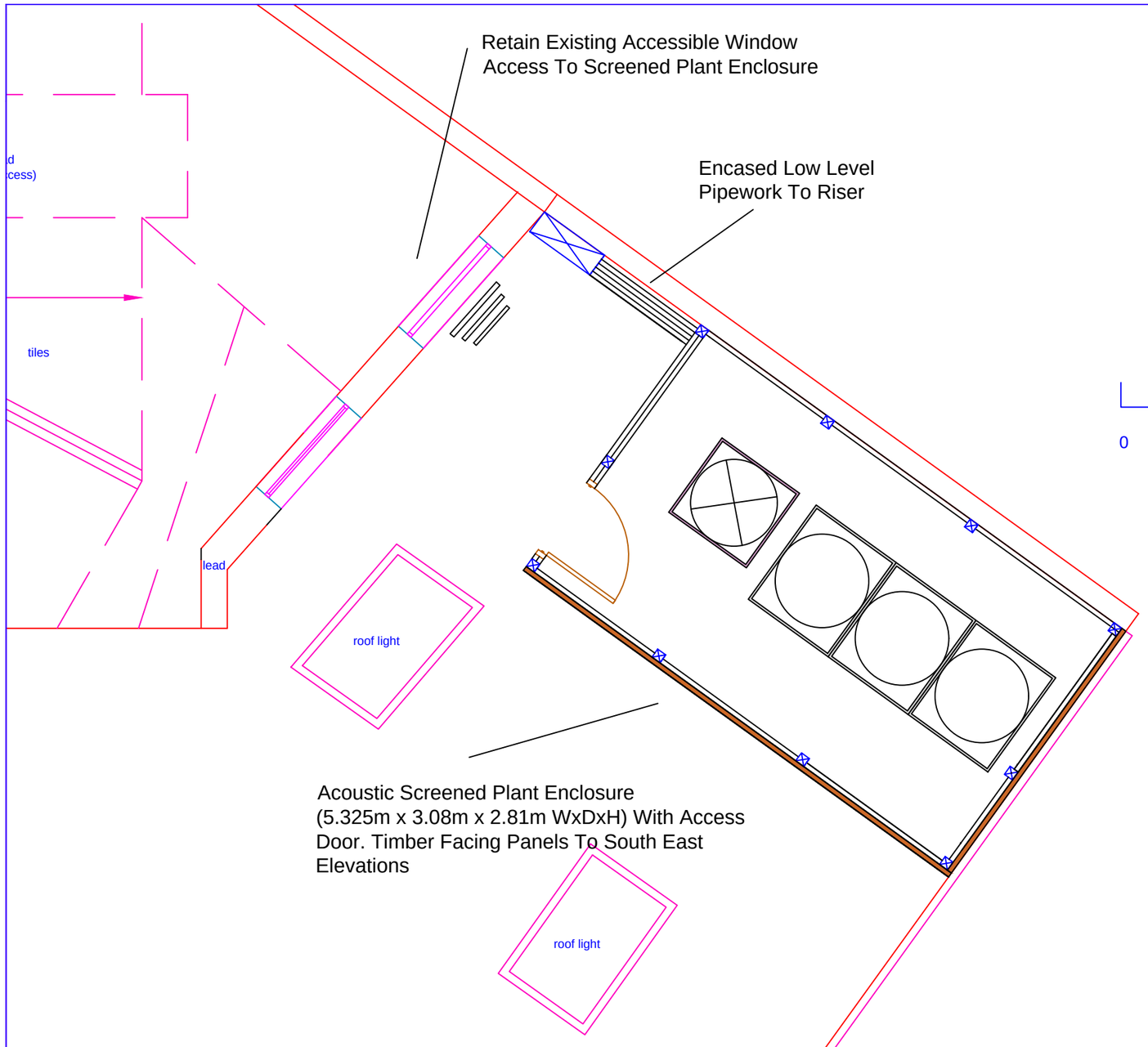
Report Prepared by:

Steven G. Gardner MIOA..……

Report Checked by:

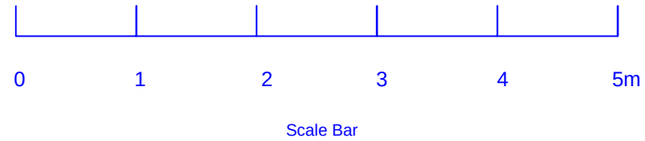
Christopher Hookway AMIOA………

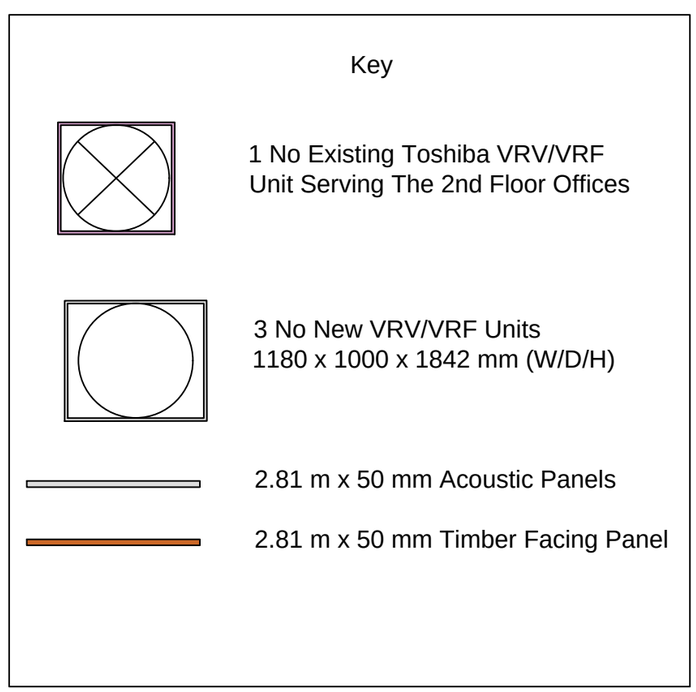
APPENDIX A



20 Flaxman Terrace
Amended Roof Level Plan
Proposed

Scale 1:50 @ A3





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NB: Do not scale off this drawing. All dimensions to be checked on site.

Notes: N/A

Client: Salaft Properties Ltd

Project: Flaxman Terrace

Details: Amended Proposed Roof Level Layout

Date: 27th October 2020
Dwg: 20 FT - Roof - V13 - Proposed - 1:50 Scale
Rev: N/A
Scale: 1:50 @ A3
Status: N/A

Drawn By: Mark Addicott

APPENDIX B

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 C

TABLE 1:
Daytime Noise Measurements Results: Position A (2nd Floor Flat Roof Area - Northern)

Time	Measured Sound Level, dB		
	$L_{A90,10mins}$	$L_{Aeq,10mins}$	$L_{Amax,fast}$
15.00 - 16.00	49.8	55.7	72.5
16.00 - 17.00	49.2	55.2	70.0
17.00 - 18.00	49.8	56.4	74.7

TABLE 2:
Daytime Noise Measurements Results: Position B (2nd Floor Flat Roof Area - Central)

Time	Measured Sound Level, dB		
	$L_{A90,10mins}$	$L_{Aeq,10mins}$	$L_{Amax,fast}$
15.00 - 16.00	49.4	55.0	72.6
16.00 - 17.00	48.4	55.5	70.9
17.00 - 18.00	49.6	55.2	71.5

TABLE 3:
Daytime Noise Measurements Results: Position C (2nd Floor Flat Roof Area - Southern)

Time	Measured Sound Level, dB		
	$L_{A90,10mins}$	$L_{Aeq,10mins}$	$L_{Amax,fast}$
15.00 - 16.00	49.2	53.5	69.6
16.00 - 17.00	48.6	54.6	71.9
17.00 - 18.00	49.8	55.5	72.2

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.