BUROHAPPOLD ENGINEERING

Phase 2 - UCL, Institute of Education

Stage 2 Acoustics Report

035833

3 December 2019

Revision 00

Revision	Description	Issued by	Date	Checked
00	For issue	GD	3/12/19	BFB

O:\035833 UCL Institute of Education\F41 Acoustics\Phase 2\03 Reports\01 Stage 2\191203 GD 035833 Stage 2 Acoustics Report - 00.docx

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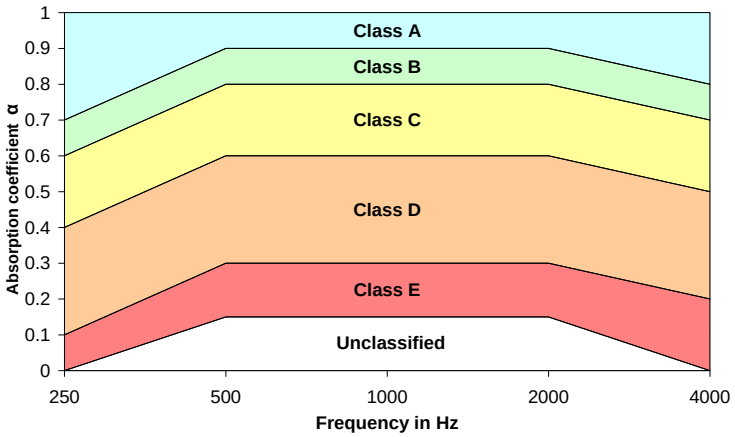
Glossary

Term	Definition
α (&- α_w)	Sound absorption coefficient (& weighted sound absorption coefficient) is a measure of the effectiveness of materials as sound absorbers; it is the ratio of the sound energy absorbed or transmitted (i.e. not reflected) by a surface to the total sound energy incident upon that surface. The value of the coefficient varies from 0 (perfect reflector) to 1 (perfect absorber).
A (& A_T)	Absorption area (& total absorption area) is equal to the product of multiplying the surface area of a construction (in m2) and its sound absorption coefficient (α).
Ambient Noise (as defined in BS 4142:2014)	Totally encompassing noise in a given situation at a given time; it is usually composed of noise from many sources, near and far.
Background Noise (as defined in BS 4142:2014)	A-weighted sound pressure level of the residual noise at the assessment position that is exceeded for 90% of a given time interval, T, measured using time weighting, F, and quoted to the nearest whole number of decibels.
Ctr	Spectrum adaptation term calculated using traffic noise as described in ISO 717-1:1996. This term is provided with weighted single values such as $D_{nT,w}$ or R_w to match with particular requirements (building acoustic or traffic noise spectrum).
Decibel, dB	Commonly used unit used for the comparison of the powers of levels sound. Abbreviation dB. Is the unit of level derived from the logarithm of the ratio between the value of a quantity and a reference value? For sound pressure level (L_p) the reference quantity is 2x10-5 N/m^2. The sound pressure level existing when microphone measured pressure is 2x10-5 N/m^2 is 0 dB, the threshold of hearing.
$D_{n,f,w}$	The weighted transmission of sound energy from a source room to a receiving room via structural (vibrational) paths in the construction mainly, e.g. walls, floors, ceilings.
$D_{nT,w}$ – standardised level difference	$D_{nT,w}$ is widely used to denote the weighted sound insulation criteria for residential dwellings, where T_0 is taken as 0.5 seconds. In the instance of testing in schools, T_0 is taken as the rooms T_{mf}.
$D_{n,Tw}$ (C, C_{tr})	Weighted standardized level difference: Single figure value of airborne sound insulation performance. This European index is described in ISO 140-4:1998 and ISO 717-1:1996. This performance describes the installed site performance of the composite separating constructions, including the partition element performance, the flanking path transmission and the reception room reverberation time factors. $D_{nT,w}$ target leads to a selection of adequate construction elements and methods to build the partition that are rated using weighted sound reduction index R_w (C;Ctr).
D_w	Weighted level difference: Single-number quantity that characterizes airborne sound insulation between rooms, but which is not adjusted to reference conditions
Flanking Noise	The transmission of sound around the perimeter or through holes within partitions (or barriers) that reduces the otherwise obtained sound transmission loss of a partition. Examples of flanking paths within buildings are ceiling plenum above partitions or raised floor cavities, ductwork, piping, and electrical conduit penetrations through partitions, back to back electrical boxes within partitions, window mullions, etc.
Frequency	Number of cycles per second, measured in hertz (Hz), related to sound pitch.
IANL – indoor ambient noise level	Table 1.1 in BB93 specifies the upper limit for indoor ambient noise levels within teaching areas. The design criteria is set for a 30-minute average level (i.e. $L_{Aeq,30mins}$). However, where there is negligible

	change in the noise level, BB93 states that a much shorter time period (e.g. $L_{Aeq,5min}$) can be used. BB93 also states that for rooms identified having limits of $L_{eq,30min}$ 35 dBA or less, the noise should not regularly exceed $L_{1,30min}$ 55 dBA.
$L_{90,T}$ (& $L_{A90,T}$)	Sound pressure level exceeded for 90% of the measurement period. Referred to as background noise level.
$L_{Ar,T}$	Rating Noise Level (as defined in BS 4142:2014), the specific noise level plus any adjustment for the characteristic features of the noise.
$L_{eq,T}$ (& $L_{Aeq,T}$) - equivalent continuous noise level of a time-varying noise	Steady noise level which, over the period of time under consideration, contains the same amount of sound energy as the time-varying noise over the same period of time.
$L_{Fmax,T}$ (& $L_{AFmax,T}$)	The maximum sound pressure level measured during the measurement period T using the fast time constant.
$L'_{nT,w}$	Weighted standardized impact sound pressure level: a single-figure value of impact sound insulation performance. This European index is described in ISO 140-7:1998 and ISO 717-2:1997, used for comparing and rating floors and based on the values of L'_{nT} at different frequencies. L'_{nTw} target leads to a selection of adequate construction elements and methods to build the floor that are rated using weighted normalized impact sound pressure level $L_{n,w}$.
$L_{n,w}$	Weighted normalized impact sound pressure level: European single figure rating for transmission loss of impact sound through building elements as described in ISO 140-6:1998 and ISO 717-2:1997. The lower the $L_{n,w}$ the better the performance.
L_p - sound pressure level	Sound pressure level, in decibels, of a sound is 20 times the logarithm to the base of 10 of the ratio of the sound pressure to the reference pressure. The reference pressure shall be explicitly stated and is defined by standard.
Noise Rating (NR)	Curves developed by the International Organization for Standardization (ISO) to determine the acceptable indoor environment for hearing preservation, speech communication and annoyance. These can be compared to NC curves and also can be referred to equivalent dBA levels.
Reverberation Time (RT)	Time required for the steady sound pressure level in an enclosed space to decay by 60 dB, measured from the moment the sound source is switched off. Reverberation time is described in ISO 354:2003.
R_w (C, C_{tr})	Weighted sound reduction index: Single-figure value of sound reduction according to ISO 140-3:1995, used for rating partition systems, door-sets or glazing, based on the values of sound reduction index R at different frequencies. The higher the R_w the better the performance.
Single Event Level (SEL [L_{AE}])	The sound level over one second which would have the same energy content as the whole event.
Sound absorber classes	Sound absorption performance characteristics are defined by a class. Below is a diagram of the different classes of absorption available, taken from BS EN IS0 11654:1997. The y-axis is the absorption coefficient of the material with one being total absorption and zero being no absorption. The x-axis is the frequency of the sound.

	
Specific Noise Level (as defined in BS 4142:2014)	The equivalent continuous A-weighted sound pressure level at the assessment position produced by the specific noise source over a given reference time interval.
T_{mf} – mid frequency reverberation time	Within BB93, the reverberation time criteria are set in terms of the averaged value of the 500 Hz, 1000 Hz and 2000 Hz frequency bands. The various levels for T_{mf} are specified within Table 1.5 of BB93 and are generally upper limits. The Sub-Note to Table 1.5 notes that the specified mid-frequency reverberation times are for 'finished but unoccupied and unfurnished rooms'.
Vibration	Force which oscillates about some specified reference point. Vibration is commonly expressed in terms of frequency such as cycles per second (cps), Hertz (Hz), cycles per minute (cpm) or (rpm) and strokes per minute (spm). This is the number of oscillations which occurs in that time period. The amplitude is the magnitude or distance of travel of the force.
Weightings (as defined in IEC 61672:2003):	A-Weighting: Frequency weighting devised to attempt to take into account the fact that human response to sound is not equally sensitive to all frequencies; it consists of an electronic filter in a sound level meter, which attempts to build in this variability into the indicated noise level reading so that it will correlate, approximately, with human response.). C-Weighting: One of the frequency weightings corresponding to the 100-phon contour and the closest to the linear or un-weighted value.

1 Introduction

BuroHappold Acoustics have been appointed by UCL Estates to provide acoustics consultancy on the proposed Phase 2 refurbishment works of the Institute of Education building, 20 Bedford Way, London.

The scheme is understood to consist of open-plan offices, cellular offices, meeting rooms, social spaces, teaching spaces, meeting rooms, WCs and other associated spaces, located across Cores A, B and C of the existing building. It is understood that the scheme is to follow a design and build procurement route. Whilst much of the design is currently under development, the aim of the issue of this report is to clarify the external plant noise limits.

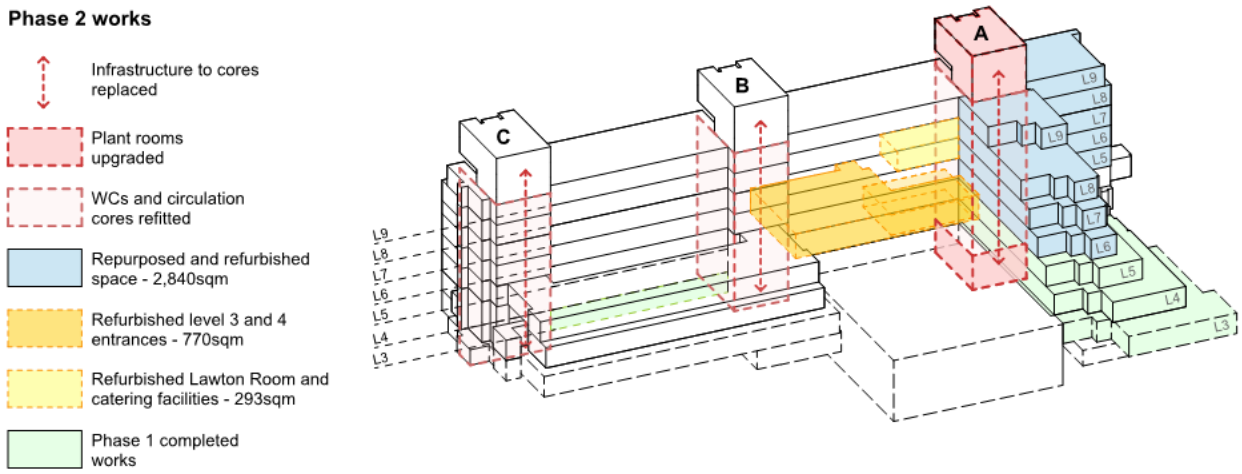


Figure 1-1: Drawing showing Phase 2 refurbishment areas and Cores locations

1.1 Reference Codes & Standards

This acoustic design report is informed by the following list of codes and standards:

- BREEAM UK Refurbishment and Fit-out 2014 – Non-domestic buildings:
  - Pol 05 Reduction of noise pollution – up to 1 credit available:

    The noise levels from the new development, when measured at nearest noise sensitive receptor, are to be no more than 5 dB or 3 dB more than the background noise levels, for daytime (0700 - 2300) and night-time (2300 – 0700) respectively.

    Since the requirements of the local authority (the planning requirements of Camden Council state that noise emissions from new plant should be a minimum of 5dB below the lowest measured background noise level), are more stringent, the BREEAM criteria can automatically be met when the local planning requirements are satisfied.

2 Site and External Noise Survey Results

2.1 Introduction

BuroHappold Engineering conducted external noise surveys on 4th October, 10th October and 8th December 2016 within the vicinity of the development site, relating to the design of the building and its associated services plant.

Surveys were undertaken in order to:

- Capture the existing background noise levels at nearby noise-sensitive (i.e. residential/hospital ward) receptors. This allows the specification of limiting noise levels for any externally located (or external terminations of) services plant, to see that the installation will not unduly increase existing noise levels in the vicinity of the site in line with pertinent criteria.

Noise measurements were made using a 01dB Solo sound level meter (serial number 203726) and a Brüel & Kjær 2250 sound level meter (serial number 203726) generally in accordance with BS EN 60651:1994 and BS 7445:1993. The meters were calibrated before and after use with a calibrator. No significant drift was witnessed. It was overcast but dry with wind speeds no greater than 5 ms^{-1}.

2.2 Measurement Locations

The noise survey methodology undertaken provides a comprehensive and complete picture of how noise levels vary around the site throughout various times of the day and night. Measurement locations are detailed below and marked on an annotated aerial image in Figure 2-1**.**

- **Location 1** – Short term (manned) noise measurement, located on the eastern side of the institute on Bedford Way at approximately 1.5 metres above ground level;
- **Location 2** – Short term (manned) noise measurement, located on the southern side of the institute on Russell Square at approximately 1.5 metres above ground level;
- **Location 3** – Short term (manned) noise measurement, located on the western side of the institute on Thornaugh Street at approximately 1.5 metres above ground level;
- **Location 4** – Short term (manned) noise measurement, located on the northern side of the institute on Gordon Square at approximately 1.5 metres above ground level; and
- **Location 5** – Short term (manned) noise measurement, located near the centre of the western side of the institute 1.5 metres above ground level.

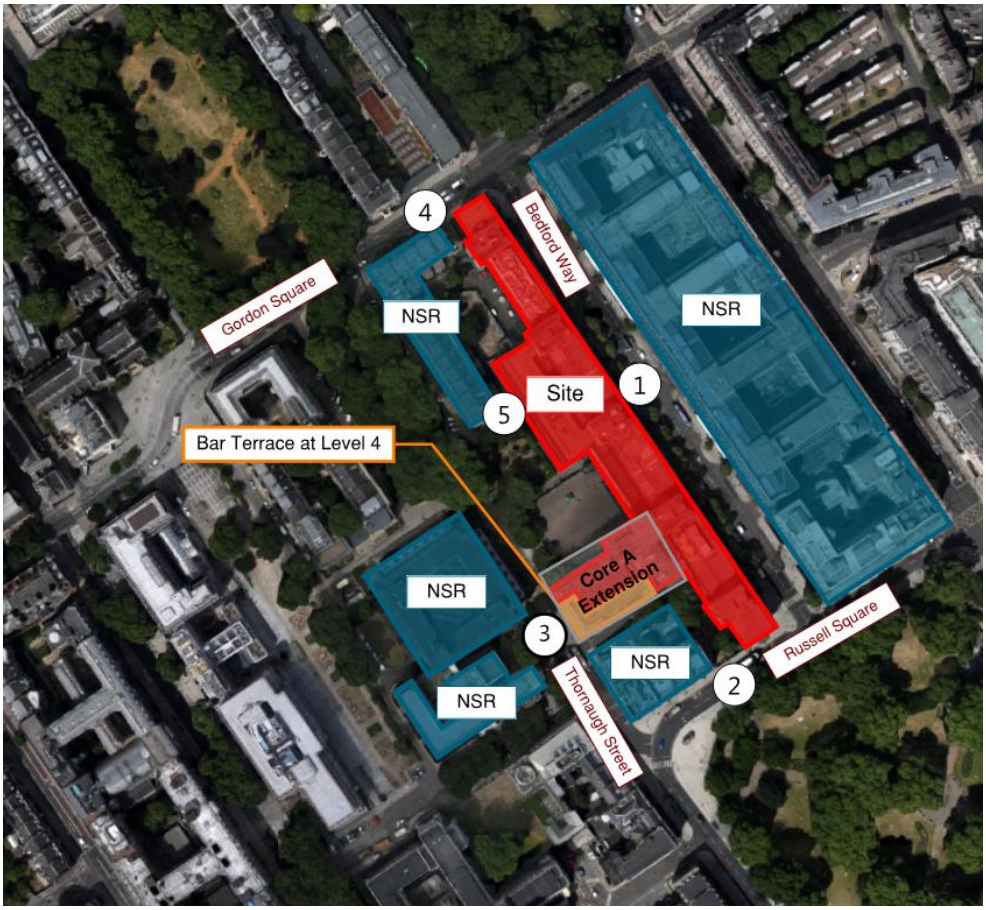


Figure 2-1: Site plan showing noise monitoring locations and noise sensitive receptors (NSRs)

The 'typical' values reported in the following table are averages of each descriptor during the relevant measurement period. For the L_{Aeq}, the averaging is logarithmic. For the statistical values, the averaging was chosen to show the typical value for the range identified. Although not a mathematical average, the typical value has been represented by the mean of the measured levels. The time period, T, was typically set to 15 minutes. All values are in dBA.

Terminology used to describe the measured noise levels are as follows:

- **$L_{Aeq,15mins}$** – the average A-weighted sound pressure level within a 15-minute period. Typically thought of as the average ambient noise level at a particular time, and likely to be due to a combination of various noise sources, near and far;
- **$L_{AF,max}$** – the maximum instantaneous A-weighted sound pressure level measured during a 15-minute period. Typically corresponding to a short-duration event with a very high SPL, for example motorbike passing by, car horn etc; and
- **$L_{A90,15mins}$** – the A-weighted sound pressure level exceeded for 90% of the measurement period i.e. a level which would be perceived as a constant, background noise level. Typically, largely unaffected by local traffic pass-by or by transient events. More usually attributable to constantly-running building services plant or distant road traffic. What you would hear when there is no local traffic present (or other readily-identifiable noise source).

2.3 Results

Table 2-1: Noise survey results

Noise measurements (4th and 10th Oct 2016) (dB)						
Period	**Start time**	**End time**	**$L_{Aeq,T}$**	**$L_{AF,max}$**	**$L_{A90,T}$**	**Comments**
Location 1						
Day	04/10/2016 15:24	04/10/2016 15:40	66	78	57	Medium traffic on the front road, students walking / talking
	04/10/2016 16:40	04/10/2016 16:55	67	90	59	
	10/10/2016 17:40	10/10/2016 17:55	66	89	60	Peak time, large number of pedestrians and cars, however traffic jam meant cars were at a standstill most of the time.
Typical			**66**	**88**	**59**	
Location 2						
Day	04/10/2016 15:57	04/10/2016 16:12	67	84	59	Traffic from Russell Square, buses and cars. Students talking / walking
	10/10/2016 17:58	10/10/2016 18:13	65	83	59	High traffic, however at standstill most of the time.
Typical			**66**	**83**	**59**	
Location 3						
Day	04/10/2016 16:13	04/10/2016 16:28	58	77	53	No circulation, calm, few students walking / talking
	10/10/2016 18:34	10/10/2016 18:49	50	66	47	Very calm, pedestrians and occasional cyclists.
Typical			**56**	**74**	**50**	
Location 4						
Day	04/10/2016 16:29	04/10/2016 16:44	66	85	60	Medium traffic, students talking / walking
	10/10/2016 18:16	10/10/2016 18:31	66	84	61	High traffic, however mostly stopped at traffic lights.
Typical			**66**	**84**	**61**	

Noise measurements (8th December 2016) (dB)						
Period	**Start time**	**End time**	**$L_{Aeq,T}$**	**$L_{AF,max}$**	**$L_{A90,T}$**	**Comments**
Location 5						
Day	16:38	16:53	48	59	46	No individual distinguishable noise sources were noted during the survey and the noise climate was subjectively noted to be quiet. Any noise from the adjacent construction site was excluded.
	16:53	17:08	48	65	46	
	17:08	17:23	48	60	46	
	17:23	17:38	48	58	46	
Typical			**48**	**61**	**46**	

2.4 Discussion

As can be seen from the results above, elevations that are immediately adjacent to Bedford Way, Russell Square and Gordon Square experience noise levels of $L_{Aeq,T}$ 66 dBA. However, there is a considerable disparity to the 'rear' elevations, shielded from Bedford Way, Russell Square and Gordon Square by the building itself and all other façades, with these quieter elevations experiencing a noise impact of $L_{Aeq,T}$ 48 and 56 dBA at Locations 5 and 3 respectively.

3 Plant Noise Break-Out

3.1 Introduction

Any external plant needs to be controlled in order to ensure that the future associated noise from fixed noise sources associated with the development do not increase the existing noise levels at nearby noise-sensitive receptors to an unreasonable degree.

3.2 Design Criteria

As mentioned in Section 1.1, in order to comply with the planning requirements of Camden Council, noise emissions from new plant should be a minimum of 5 dB below the lowest measured background noise level, $L_{A90,T}$, as measured in the locality of the nearest or most exposed noise-sensitive development. Since the requirements of the Local Authority with regards to limiting plant noise are more stringent, BREEAM criteria Pol 05 can automatically be met when the local planning requirements are satisfied.

3.3 External Plant Noise Limits

The closest noise sensitive receptors are shown in Figure 2-1. The cumulative noise output of all plant items operating simultaneously needs to be assessed in accordance with BS 7445 and controlled such the noise impact associated with the development does not exceed the design criteria of 5 dB below the lowest $L_{A90,T}$ during the day at the nearest NSR.

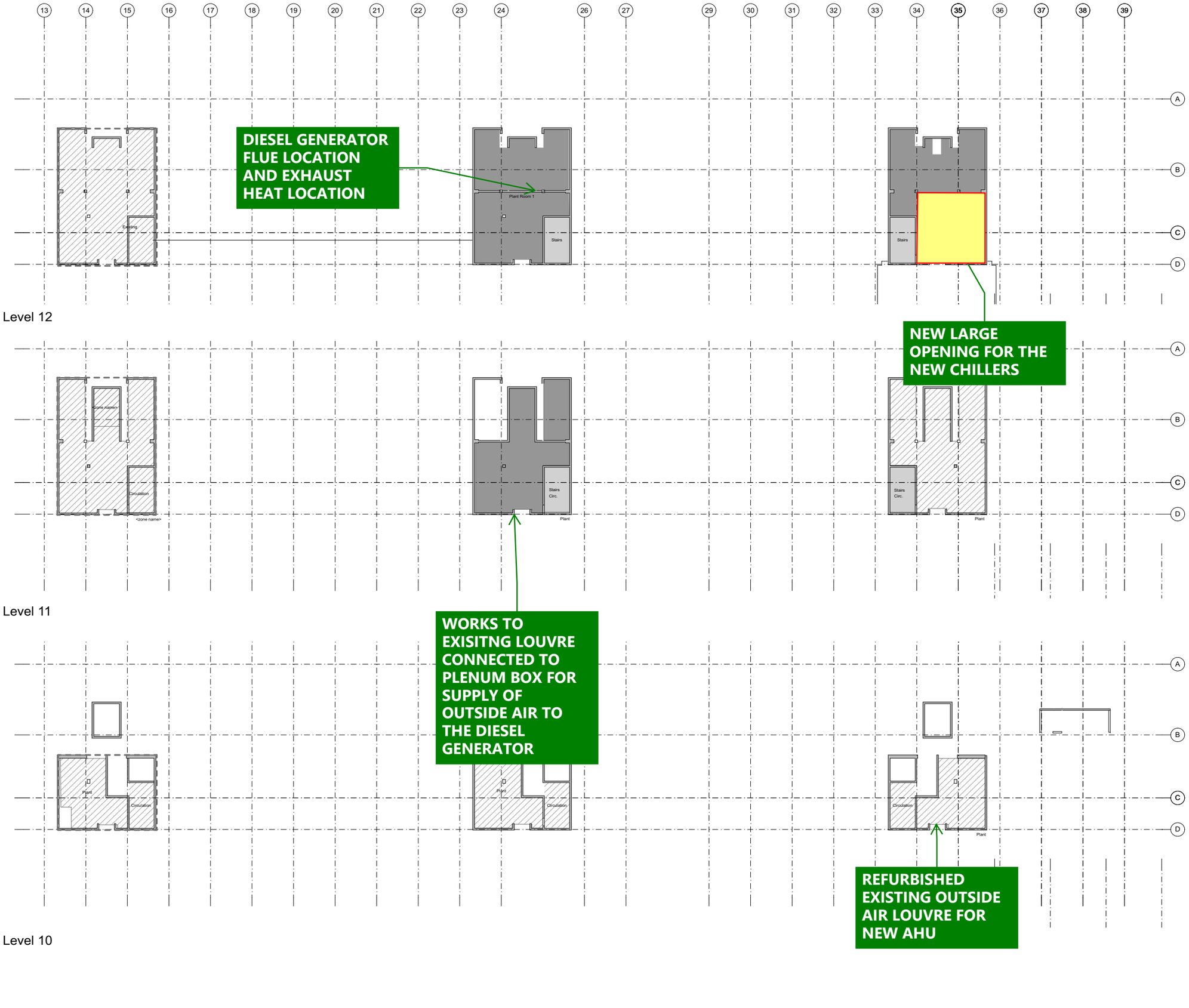
For example, the lowest measured background noise level recorded on site was $L_{A90,1h}$ 46 dBA at Location 5, as presented in Section 2.3. Therefore, in order to meet the design criteria at the nearest NSRs to this location, any noise associated with the plant of the new development shall be controlled such that its level at the nearest NSR is not greater than $L_{Aeq,T}$ 41 dBA.

Should any plant operating at night be considered at later stages, the assessment is to be completed for that period in a similar manner. For clarity, this means establishing the night-time background noise level $L_{A90,T}$ and setting the cumulative noise limit for all new plant at 5 dB below it, as measured at the nearest NSR in terms of $L_{Aeq,T}$.

3.4 Outline Plant Proposals

As part of the proposed refurbishment programme, plant is to be proposed to serve the building. Appendix A shows the extent and location of proposed external Mechanical, Electrical and Plumbing (MEP) works during Phase 2 of the refurbishment programme. Detailed plant specifications are yet to be outlined for acoustic assessment, this is to be progressed during Stage 3 of the design process in-line with the requirements above.

Appendix A External Plant Locations



Key Plan

Notes:

- To be read in conjunction with all other drawings, specifications and reports
- Workspace layouts indicative - to be developed further through Stakeholder Consultation

Key

- Refer to MEP information for extent of works to plant and risers
- No works to existing areas
- Extent of phase 2 Architectural works
- Extent of Phase 2 core works
- Refer to MEP information for extent of works to Core C - life safety enabling works only. Existing doors replaced to meet fire separation requirements
- New internal doors and screens
- New internal fire doors to existing openings
- Existing internal doors - no works
- Internal doors to be demolished
- Stage 2 Plus amendments

Rev	Date	Prep	Check	Description
P03	10.07.19	AT	JA	Issued for Tender
P02	10.06.19	AT	JA	Issued for costing
P01	31.05.19	AT	JA	Issued for coordination

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Client
University College London UCL

Project
UCL IOE Masterplan
Phase 2

Drawing Title
Proposed Phase 2 GA Plan
Plant Rooms

Purpose of Issue
For Information

Status Code
S2

Scale
1:200, 1:100 @ A1

Drawing Number

project	originator	zone	level	type	role	number
IOE	PPA	ZZ	RF	DR	A	3220

Revision
P03

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